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Application of topic modelling and neural network analysis to analyze life satisfaction

Aplicação de modelagem de tópicos e análise de redes neurais para analisar a satisfação com a vida

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Abstract

This study aims analyze the important influencing factors that affect the life satisfaction of Koreans, and to identify the relative importance of these factors. For this purpose, we utilize academic papers on what influences life satisfaction, and questionnaire data from the survey on social integration conducted annually by the Korean Government. A topic modelling analysis method was used to derive important influencing factors, and a neural network analysis method, one of the machine learning methods, was used to analyze the relative importance of influencing factors. The analysis showed that the factor that had the greatest impact on Koreans' life satisfaction was satisfaction with work. Other factors included self-esteem, level of worry and anxiety, and level of satisfaction with health status. The study used methods such as topic modeling and neural network analysis to derive the main factors affecting life satisfaction and analyze the relative importance of the factor involved. The study results suggest that in recognition of the importance of job satisfaction, future research should be expanded, and that the Korean Government should introduce various policies to increase job satisfaction.

Keywords: Life satisfaction. Machine learning. Multi-layer perceptron. Neural network analysis. Quality of life. Topic modeling.

Resumo

O objetivo deste estudo é analisar os importantes fatores que influenciam a satisfação com a vida dos coreanos e identificar a sua importância. Para tanto, utilizamos artigos acadêmicos relacionados aos fatores que influenciam a satisfação com a vida e dados de questionários da pesquisa sobre integração social realizada anualmente pelo governo coreano. Um método de análise de modelagem de tópicos foi usado para derivar fatores de influência importantes, e um método de análise de rede neural, um dos métodos de aprendizado de máquina, foi usado para analisar a importância relativa dos fatores de influência. A análise mostrou que o fator que teve maior impacto na satisfação com a vida dos coreanos foi a satisfação com o trabalho. Outros fatores incluíram autoestima, nível de preocupação, ansiedade e nível de satisfação com o estado de saúde. O estudo utilizou métodos como modelagem de tópicos e análise de redes neurais para derivar os principais fatores que afetam a satisfação com a vida e analisar a importância relativa dos fatores envolvidos nela. Os resultados do estudo sugerem que, em reconhecimento

da importância da satisfação no trabalho, futuras pesquisas nesta área devem ser expandidas e que o governo coreano deve introduzir várias políticas para promover esse aspecto.

Palavras-chave: Satisfação com a vida. Aprendizado de máquina. Perceptron multicamadas. Análise de redes neurais. Qualidade de vida. Modelagem de tópicos.

Introduction

Three main concepts relating to the quality of human life have been considered particularly important: life satisfaction, happiness and well-being (Choi; Lee, 2014; Choi, 2014a; Choi; Choi; Lee, 2023). *Life satisfaction* focuses on how an individual evaluates his or her life overall. Life satisfaction is a subjective judgement, which involves an individual's evaluation of how he or she feels about his or her life conditions, accomplishments and goals. This implies satisfaction from a long-term perspective. *Happiness*, meanwhile, often refers to a momentary emotional state. This can include positive emotions such as pleasure, joy, and satisfaction, and it is closely related to the emotional responses felt in everyday experiences. Also, happiness can be of a more short-term and volatile nature. *Well-being* is a more comprehensive concept. It embraces life satisfaction and happiness along with other factors, and includes physical, mental and emotional health as well as self-actualization, meaningful relationships and economic stability. Well-being is concerned with individuals living to their full potential.

Although these three concepts overlap, each emphasizes a different aspect of a person's life. Of the three concepts, life satisfaction is the most important. There are several reasons for this. First, life satisfaction represents how an individual evaluates his or her life in the long term. It reflects not simply a momentary emotion or temporary state, but a sense of satisfaction and accomplishment throughout life. Therefore, it has a significant impact on an individual's long-term well-being and health and is a key factor in understanding the quality of human life. In addition, life satisfaction is important not only for individuals but also in social and economic terms. When determining social and economic policies, life satisfaction can be used as an important indicator to evaluate residents' well-being. This can help policymakers develop education, employment, health and social care policies more effectively.

In addition, a high degree of life satisfaction is associated with psychological stability and positive social relationships. It plays a significant role in managing stress, promoting mental health and strengthening social bonds. For this reason, life satisfaction is viewed as especially important relative to other, similar concepts, and ongoing research on it can bring about many improvements in various fields such as personal welfare, social stability, policymaking and health promotion. Today, massive amounts of data related to life satisfaction are produced, and advanced big data analysis techniques such as neural networks can be applied here, enabling personalized predictions and inferences based on individual data. Thereby, it has been possible to more accurately identify the factors that affect individual life satisfaction. At the same time, research in this field needs to be strengthened, so that policymakers can use methods such as big data analytics to develop and evaluate more effective social and economic policies.

Against this background, the aim of this study is, first, to analyze what the important factors affect life satisfaction, using topic modelling method, and second, to identify the relative importance of these factors, using neural network analysis method. This knowledge should make it possible to predict and classify the level of life satisfaction of individuals.

Theoretical Discussion and Research Questions

Research on life satisfaction (Easterlin, 1974; Putnam, 2000; Diener; Biswas-Diener, 2002; Blanchflower; Oswald, 2004; Podoshen; Li; Zhang, 2011; Chyi; Mao, 2012; Choi, 2014b; Beja, 2015; Cui, 2018; Kim, 2018; Wang; Cheng; Smyth, 2019; Jasielska, 2020; Choi, 2023) mainly considers factors such as an individual's emotional state, mental health, social relationships and economic situation. These factors often interact in complex ways and manifest themselves differently in diverse cultural and social contexts. For example, Our World in Data's study of how people perceive their own and other people's happiness showed that people generally tend to underestimate other people's levels of happiness. This phenomenon may be based on social prejudices and personal experiences, which adds complexity to the study of life satisfaction.

Additionally, research organizations such as the Pew Research Center (<https://www.pewresearch.org/>) are conducting studies relating to life satisfaction across a variety of topics and regions, but these studies mainly use traditional methods such as surveys. These methods provide relatively limited amounts of data compared to those offered by large-scale data analysis.

According to a study in Health and Quality of Life Outcomes (BioMed Central; <https://hqlo.biomedcentral.com/>), multi-dimensional analyses of well-being, including life satisfaction, often use statistical methods such as structural equation modelling. These methods are useful for analyzing complex interactions and multi-dimensional characteristics but may be less intuitive and require more specialized knowledge than big data analysis methodologies.

Harvard T. H. Chan (<https://www.hsph.harvard.edu/>) research on life satisfaction often relies on existing long-term data, according to the Chan School of Public Health. These studies tend to rely more on empirical data than big data analysis. In addition, research in this field often seeks to comprehensively examine a variety of factors relating to well-being, and this approach may require an in-depth understanding of specific factors rather than the analysis of large data sets.

The application of big data analysis methods to life satisfaction research is at present limited (Cho, 2018; Choi, 2023; Choi; Kee, 2024). Major reasons for this include the complexity of the research, the diversity of data, and the heavy reliance on traditional research methods. However, with the development of cutting-edge analysis techniques, the need to apply big data analysis methods such as topic modelling and neural network analysis to life satisfaction research is increasing.

In sum, life satisfaction is influenced by various factors such as an individual's mental health, social relationships, economic situation and cultural background. Methods such as topic modelling and neural network analysis can integrate and analyze these multi-dimensional factors, which helps us to better understand the complex factors that affect life satisfaction. In addition, large-scale, real-time data collected from social media, online platforms, health tracking apps, etc. can provide realistic and timely insights into life satisfaction. Technologies such as neural network analysis are useful for effectively processing such large-scale data and predicting trends. In particular, factors influencing individualized life satisfaction can be identified via topic modelling and neural network analysis. This can help provide personalized interventions and services, which can contribute to more effective mental health management and improved well-being.

In this study, in light of the theoretical discussions reviewed above, the following research questions are set:

1. What are the factors that affect life satisfaction?
2. What is the relative importance of the factors affecting Koreans' life satisfaction?

Methodology

Data

The analysis data to be used in this study is divided into two types. The first type consists of academic papers dealing with the topic of life satisfaction. In this study, the abstracts of papers from academic journals managed by the publisher Springer that contain the term 'life satisfaction' in their titles are extracted and analyzed. The reason for choosing journals managed by Springer as the subject of analysis is twofold: first, these journals include a significant number of publications related to the topic of 'life satisfaction,' which is the main focus of this study; and second, there is an established license agreement between the big data analysis tool Netminer 4.5, which is being used in this research, and Springer's journals, making data utilization more convenient.

A total of 1,000 papers were selected, based on relevance. Here, relevance is first determined by the frequency with which a keyword or phrase appears within a document. That is, papers in which the keyword 'life satisfaction' appears more frequently may be considered more relevant. Secondly, suppose the keyword appears in both the title and abstract. In that case, greater importance is assigned, under the assumption that these sections succinctly represent the core content and focus of the document.

The second type consists of national survey data collected in 2022 by the Korea Institute of Public Administration (KIPA) (KOSIS; <https://kosis.kr/index/index.do>; KIPA; <https://www.kipa.re.kr/site/kipa/main.do>). These data stem from the results of a survey of social integration status that aims to comprehensively investigate the living conditions of Korean citizens. The total number of respondents included in the survey was 8,077.

Analysis procedure

First, we derive the multiple factors that affect life satisfaction through analysis of the academic papers. After organizing and condensing the factors derived in this way, we draw on the data from the survey questionnaire produced by KIPA in 2022 to conduct statistical analysis.

Analysis method

The first research aim, analysis to extract the factors affecting life satisfaction, utilizes a topic modelling method. Topic modelling is one of the machine learning analysis methods used for discovering and classifying hidden topic patterns in big data, and it is also a method used to identify and classify topics within text data (Rego Rodríguez; Germán Flores; Vitón-Castillo, 2022; Choi; Mohamed, 2023a, 2023b; Larrosa; Galgano; Gutiérrez, 2023; Panduro, 2023). Here, it is performed on the abstracts of academic papers with 'life satisfaction' in the title. The analysis of the second research objective, the relative importance of the factors affecting Koreans' life satisfaction, will be conducted using the neural network analysis method. Through this analysis, the importance weights of the variables affecting life satisfaction will be calculated, and which variables are particularly important will be identified. There are various methods for such analysis, but in this study, the multi-layer perceptron (MLP) method, one of the neural network analysis methods, will be applied. Originally, neural network analysis, especially with large sample sizes, demonstrates excellent predictive power through the application of parallel processing methods, and does not require statistical assumptions necessary for model derivation, making it suitable for studies like this one. Additionally, the MLP method is chosen among neural network analyses because it is the

most fundamental algorithm that secures high predictive power in classification and estimation without the need for assumptions such as the independence of independent variables (Lee, 2003; Cho, 2018; Villa-Soto, 2022). Therefore, we analyze KIPA's survey data using variables related to the derived influencing factors.

Results

Basic analysis of data

Table 1 below presents information on the frequency of words derived through basic data analysis. As Table 1 indicates, 'life satisfaction' had the highest frequency, at 4,038 occurrences. However, because life satisfaction is connected to almost all the other words, it will be excluded from the subsequent analysis process.

Table 1 – Frequency of occurrence of words.

	Part of Speech(POS)	Frequency	Word length	Name Type	Author Keyword
life satisfaction	Proper Noun	4038	17	-	False
relationship	Common Noun	1010	12	-	False
effect	Common Noun	927	6	-	False
life	Common Noun	828	4	-	False
health	Common Noun	755	6	-	False
satisfaction	Common Noun	741	12	-	False
well being	Common Noun	650	10	-	False
level	Common Noun	591	5	-	False
adult	Common Noun	482	5	-	False
model	Common Noun	481	5	-	False
association	Common Noun	477	11	-	False
factor	Common Noun	468	6	-	False
student	Common Noun	461	7	-	False
research	Common Noun	450	8	-	False
LS	Common Noun	446	2	Organization Name	False
datum	Common Noun	437	5	-	False
adolescent	Common Noun	431	10	-	False
role	Common Noun	424	4	-	False
age	Common Noun	424	3	-	False
group	Common Noun	418	5	-	False
finding	Common Noun	414	7	-	False
country	Common Noun	387	7	-	False
support	Common Noun	375	7	-	False
individual	Common Noun	369	10	-	False

Note: The table above exemplarily presents words included up to the 25th rank by word frequency.

Topic modelling analysis: analysis of the factors affecting life satisfaction

Before conducting topic modelling on the factors influencing life satisfaction, we sought first to create an *ego network* of 'influencing factors'. Ego networks are a form of social network analysis that represents the relationships between a specific individual (ego) and other individuals (alters) directly connected to that individual (Lee, 2003; Cho, 2018; Amaral; Araújo; Moraes, 2022; Tiwari *et al.*, 2023). Ego networks are used to understand the structure and characteristics of an

individual's social relationships. Since the network for the data to be analyzed here was too large, we first constructed an ego network for 'influencing factors' and performed topic modelling around this. As a result, this network included a total of 762 words.

The next step was to perform topic modelling. The Figure 1 below shows nine topics derived through topic modeling analysis.

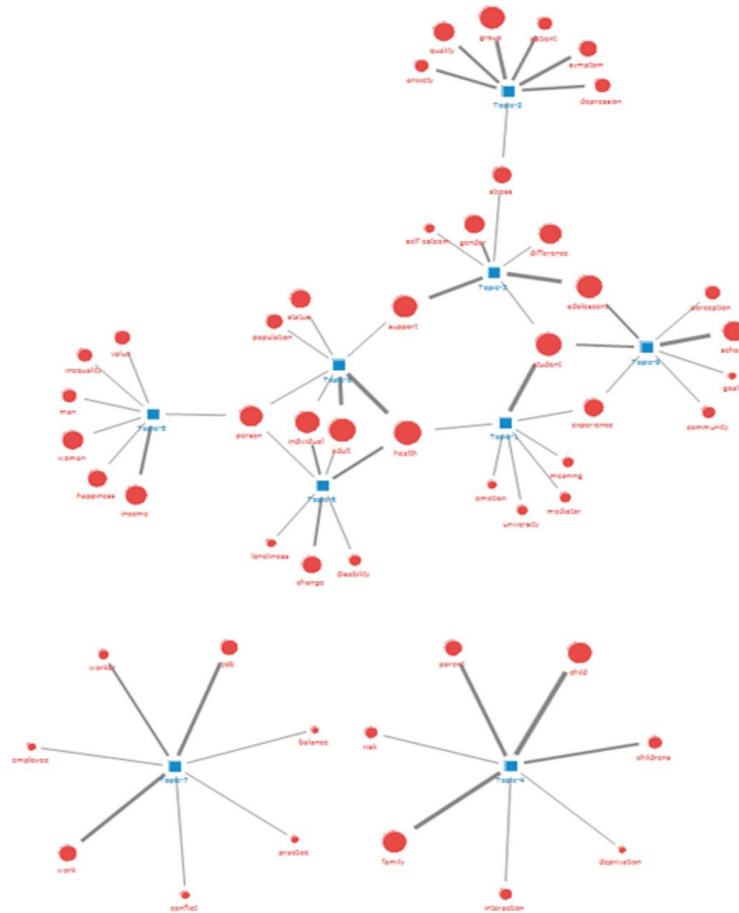


Figure 1 - Derivation of the nine topics.

The nine topics derived from Figure 1 include words that overlap with each other. To prevent this redundancy and condense further, Pathfinder net (PFnet) analysis and clustering analysis was performed.

As a result of clustering the factors affecting life satisfaction, they are divided into groups, as follows:

- G1: loneliness, interaction, health, community, disability, quality, patient.
- G2: self-esteem, women, adolescent, student, mediator, perception, emotion.
- G3: income, change, group, difference, happiness, inequality, value.
- G4: worker, balance, job, employee, conflict.
- G5: goal, experience, support, practice.
- G6: parent, family, child, children, deprivation.
- G7: stress, anxiety, depression.

As the above list shows, in comprehensively analyzing the characteristics of words composed by group, G1 is the degree of loneliness, G2 that of self-esteem, G3 that of awareness of income and inequality, G4 that of satisfaction with work, G5 that of self-esteem, G6 for degree of family relationships, and G7 for the degree of anxiety and stress.

Neural Network Analysis: analysis of the relative importance of the factors affecting life satisfaction

Basic analysis of data

In the topic modelling, we derived the influencing factors that theoretically affect life satisfaction. The next step is to analyze whether these actually function as important influencing factors in people's lives. The Government of the Republic of Korea conducts an annual survey of the lives of Korean citizens. Surveys of people's social capital, levels of trust and satisfaction with life are being conducted by the Korea Institute of Public Administration (KIPA), under the overall name Social Integration Survey (respondents 8,077).

In this study, we use survey data of the 2022 Social Integration Survey. Meanwhile, in this study, in addition to the seven influencing factors derived through topic modelling, we will include influencing variables related to personal background (gender, age, education level) and compare and analyze their importance.

Looking at the basic statistics of the variables used in this study, as regards gender, there are 4,004 men (49.6%) and 4,073 women (50.4%), roughly similar numbers. When residents are divided into urban and rural (urban_rural_2), the former comprises 6,711 people (83.1%) and the latter 1,366 people (16.9%). The life satisfaction variable is a continuous variable made up of 0–10 points, but to divide it into a dichotomous form 0–5 points are categorized as 1 (low) and 6–10 points as 2 (high). *Life satisfaction* was used as a dependent variable. According to this classification, Type 1, with 'low' life satisfaction, comprises 2,230 people (27.6%) and Type 2, with 'high' life satisfaction, 5,847 people (72.4%).

Analysis of the relative importance of the factors

At the neural network analysis stage, the input layer comprised of gender (sex_2), family relationship (family_2) and urban and rural (urban_rural_2) variables, and the covariates were anxiety, work, esteem, inequality, loneliness, support, age, and health. Income and education variables were also included. The number of nodes in the input layer was 20, and the standardization method was used as a covariate adjustment method. The number of hidden layers was set to 1, the number of nodes in hidden layer 1 was 7, and the activation function was set to the hyperbolic tangent method. Meanwhile, in the case of the output layer, the dependent variable used a binary value dividing 'life satisfaction' into 'low' and 'high' (life_2_1); the number of nodes is 2 and the activation function is the soft max method.

Figure 2 depicts the neural network derived from the neural network analysis. In the diagram, thick lines indicate strong connections. This means that the weight of the connection is large, indicating that it has a significant influence on the neural network's decisions. A larger weight means that the signal transmitted through that connection has a stronger effect on the next neuron. Additionally, a thick line indicates that the corresponding path is frequently activated. This means that the connection was used frequently during the neural network learning process, suggesting that the feature plays a key role in the output.

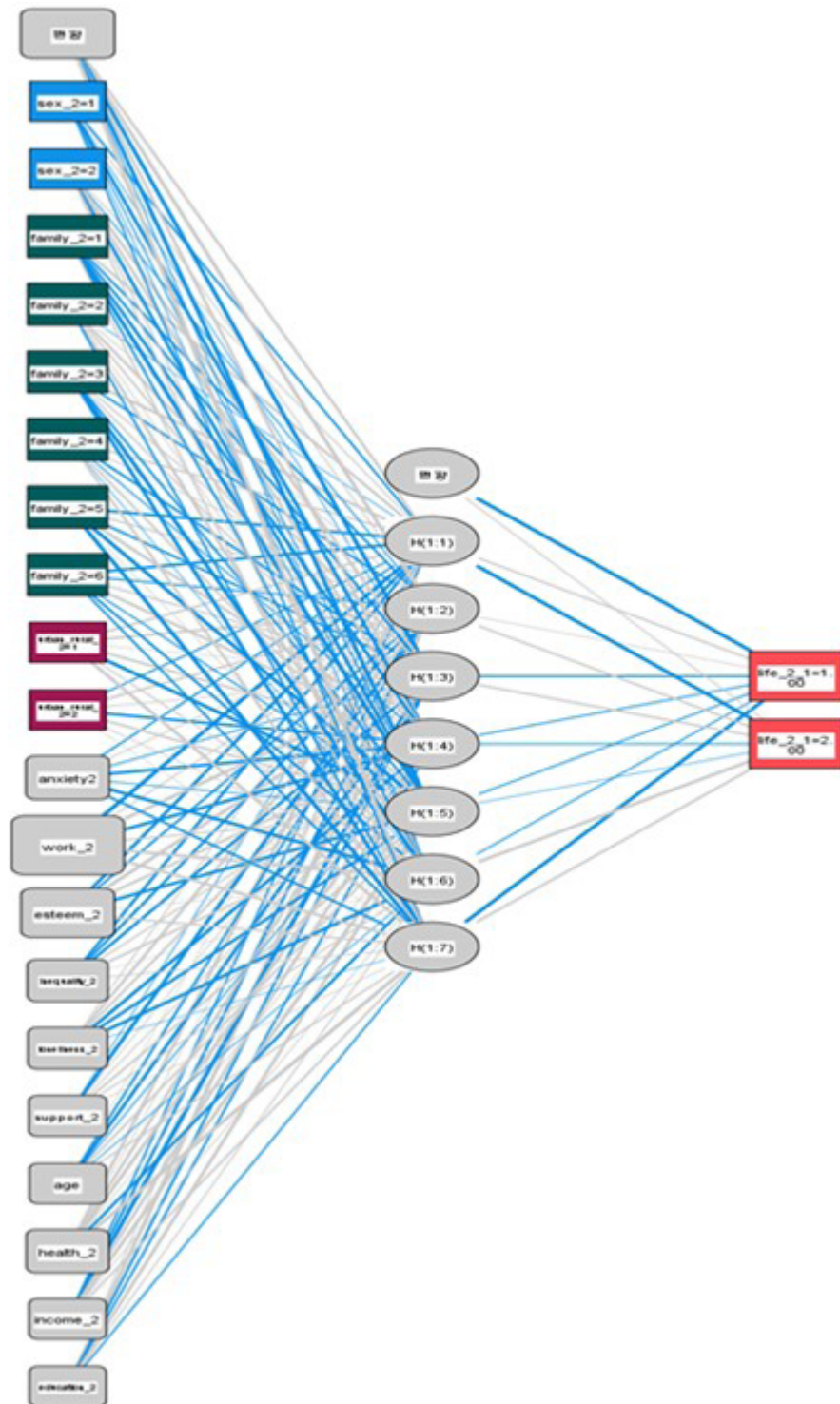


Figure 2 - Neural network diagram.

In light of the parameter estimates presented in Table 1, the neural network analysis results from this study can be judged good. However, when interpreting the parameter estimates of a neural network, it is important to understand how these values interact in the overall network. Also, evaluating the performance of the entire model with only a single weight or bias value can be misleading, so it is important to interpret it in the context of the entire network.

Table 2 shows the relative importance of the independent variables used to analyze influencing factors on life satisfaction. In neural network analysis, the importance of each independent variable (feature) indicates how much it affects the model's prediction. Understanding the importance of each feature in complex machine learning models such as neural networks helps to interpret the model's decisions and create more effective feature selection and engineering. As Table 2 shows, satisfaction with one's work (work_2) appeared to have the greatest impact on life satisfaction. The next most influential variables were self-esteem (esteem_2), the absence of worry or anxiety (anxiety_2) and satisfaction with health (health_2). What is unusual here is that there is a very large gap in influence between satisfaction with one's work, which is the variable with the greatest influence (work_2), and other variables. In other words, it can be seen that satisfaction with one's work has a decisive influence on life satisfaction.

Table 2 - Importance of independent variables.

	sex_2	.012	3.1%
family_2	.052		13.6%
urban rural_2	.015		4.1%
anxiety_2	.085		22.4%
work_2	.380		100.0%
esteem_2	.188		49.5%
inequality_2	.055		14.6%
loneliness_2	.044		11.6%
support_2	.029		7.7%
age_2	.018		4.9%
health_2	.078		20.4%
income_2	.024		6.4%
education_2	.018		4.9%

Figure 3 represents graphically the importance of the independent variables that affect life satisfaction. It can be seen that satisfaction with work (work_2), the variable with the greatest influence, has an overwhelmingly large impact.

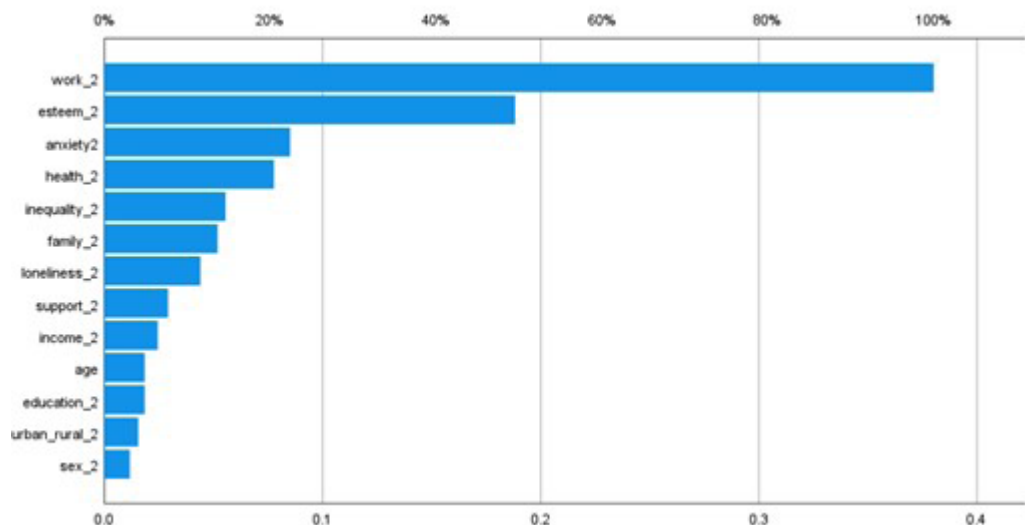


Figure 3 - Normalization importance of independent variables.

Discussion

Analysis, using topic modelling and neural network analysis, of the factors exerting the most influence on Koreans' life satisfaction shows that these are: satisfaction with one's work, self-esteem, and degree of worry. Health status and other factors also appear as important variables. These results have a number of theoretical and policy implications. The *theoretical* implications are as follows:

1. There is a need for research on the correlation between job satisfaction and life satisfaction. These results support the theory that job satisfaction has a significant impact on an individual's overall life satisfaction. This shows that a job is not just a source of income, but an important part of self-realization, social status, and daily life. Additionally, these results provide important data for psychological and sociological research exploring the relationship between occupational success and individual well-being.
2. The impact of self-esteem on life satisfaction provides important information for research on self-concept and psychological well-being. This helps us understand how a person's identity, self-perception and social perception affect their overall quality of life.
3. The impact of worry levels on life satisfaction calls for psychological research exploring the relationship between stress and psychological well-being. The suggestion is that stress management and positive thinking may be important in improving an individual's quality of life.
4. The fact that health status has a significant impact on life satisfaction shows that physical and mental health are closely connected. This represents essential information for the fields of health psychology and public health in seeking to understand how health affects an individual's overall well-being.

Attending to these theoretical implications implies deepening research relating to Koreans' life satisfaction in various academic fields, which will, in turn, enable a deeper understanding of human behaviour and social structure. In addition, these theoretical insights can provide policymakers with the basic data needed to develop human-centred policies.

The *policy* implications are as follows:

1. There is a need for government to take a greater interest in job policies and workplace satisfaction. The central government should focus on creating quality jobs. It is important to increase workers' job satisfaction through employment stability, improvement in working environments, and appropriate wage policy. In addition, vocational training and retraining programmes should be strengthened so as to increase labour market flexibility and support individual career development.
2. Allocation of resources to mental health and welfare policies should be increased. Policies are needed to improve self-esteem and mental health. For example, a campaign should be launched to increase access to mental health services and improve social awareness of mental health. In addition, it will be desirable to promote the psychological stability of workers by supporting stress management and mental health promotion programmes and encouraging mental health programmes in the workplace.
3. Since health status affects life satisfaction, prevention-oriented health policies should be strengthened. This could include, for example, promoting healthy lifestyles and improving

the quality of public health services. In particular, there is a need to strengthen chronic disease prevention and management programmes and develop policies to support healthy ageing.

4. Social support networks should be strengthened. It is vital to develop programmes that promote mutual support within the community so as to increase connectivity and a sense of belonging among residents. Reinforcing community-centred events and activities is also necessary. There is a need to promote resident participation and revitalize the local community by organizing a range of local events and activities.

Conclusions

The investigation revealed that the primary determinant influencing the life satisfaction of Koreans is their level of job satisfaction. Additional determinants encompass self-esteem, the degree of worry and anxiety, and satisfaction with health status. This study distinguished itself by leveraging big data and machine learning methods, marking a significant academic contribution. Such methodologies not only enhanced the precision of forecasting the elements impacting life satisfaction but also validated their findings against survey data on actual life satisfaction levels. The findings underscore the critical role of job satisfaction and advocate for the expansion of future research in this domain, emphasizing the need for the Korean Government to implement diverse strategies to boost job satisfaction. Conclusively, the study highlights the importance and potential for the increased application of big data and machine learning techniques in academic research, suggesting that such approaches should be more widely adopted and further developed.

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