New Statistical Approach and Innovation to Measure Social Well-Being and Sustainable Growth

Min-Max Scaling: New Statistical Approach to Measure Malaysian Well-Being Index

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Abstract

This study is to examine the use of a new methodology, namely Min-Max Scaling in the calculation of Malaysian Well-being Index. The Malaysian Well-being Index (MyWI) Report is developed to measure the well-being of Malaysians from an economic and social perspective. MyWI comprises five economic components namely transportation, communications, education, income and distribution and working life. Meanwhile, there are nine social components which are housing, entertainment and recreation, public safety, social participation, governance, culture, health, environment and family. Data for all the indicators used in MyWI are based on secondary data that are sourced from various ministries and agencies as well as the private sector. The reference years are from 2000 to 2021. Since 1999, MyWI has used this technique, the Z-score to standardize each indicator. The base year is 2000, where the value of the indices equals 100. Concurrently, the Min-Max Scaling technique was most widely used for index compilation internationally. The result from using the Z-score technique shows MyWI performance in 2021 improved by 1.3 per cent to 119.2 points, as compared to 117.2 points in 2020. Meanwhile, the result of MyWI using the Min-Max Scaling technique reveals the 2021 value is 0.62 higher than 0.60 in 2020 driven by the growth of economic well-being score, 0.69 in 2021 and 0.56 value of social well-being index.

Keywords: Malaysia Well-being Index, Z-score, Min-Max Scaling

Introduction

Well-being is an important value in people's lives and it can be used to measure societal progress. The topic of wellbeing has always captured the attention of human society and wise thinkers have debated it since the beginning of time. There are various countries that use the Min-Max method in measuring well-being as shown in Table 1.

Table 1

Organizational using Min-Max Scaling methodology

Indices	Organizational
Human Development Index (HDI)	United Nations Development Programme (UNDP)
Better Life Index (BLI)	Organisation for Economic Co-operation and Development (OECD)
Sustainable Society Index (SSI)	United Nations Global Compact (UNGC)
Indeks Kesejahteraan Keluarga (IKK)	Lembaga Penduduk dan Pembangunan Keluarga Negara (LPPKN)
Indeks Kesejahteraan Psikologi Malaysia (IKPM)	Jabatan Perkhidmatan Awam (JPA)

In response, many countries began to discover alternative mechanisms for measuring the well-being of the nation's population. There are common approaches to measure well-being in terms of framework, reporting and progress of nation's population. Measuring well-being involves assigning numerical values to these dimensions and combining them into an overall index value. There are different methods available to standardize and scale the numerical values assigned to the dimensions of well-being. One commonly used method is Z-score standardization, which calculates the deviation of each data point from the mean and expresses it in terms of standard deviations. This method ensures that each data point is standardized and comparable across different dimensions. Another commonly used method is Min-Max Scaling, which rescales each data point to a specific range, typically between 0 and 1. Both Z-score standardization and Min-Max Scaling have their advantages and limitations when used for compiling the Malaysian Well-Being Index.

Moreover, there are multitude of data normalization techniques available namely Min-Max normalization, Z-score normalization, coefficient based on normalization etc. Data normalization may also vary based on the level of measurement of the variables namely nominal scale variables, ordinal scale variable interval scale variable, additive scale variable etc. Based on this study, it's found that Min-Max Normalization is on the most popular and overly used data normalization techniques. To prove the effectiveness of the proposed data normalization technique we will also create a simple linear regression models and assess each set's value R^2 to better understand its usability and effectiveness which is Z-score. Most of the popular techniques for example mean and standard deviation based on Z-score, Min-Max etc. are sensitive to outliers (Kappal, 2019).

Data transformation with normalization can be done in several ways, namely Min-Max normalization, Z-score normalization, Decimal Scaling normalization, Sigmoidal normalization, and Soft-max normalization (Henderi, Rahwanto, & Wahyuningsih, 2021). Min-Max normalization is a normalization method by performing linear

transformations of the original data so as to produce a balance of value comparisons between data before and after the process. The Min-Max method in this study is considered better than the normalization method using the Z-score.

Min-Max Scaling is a simple and easy-to-understand normalization technique. It involves scaling the data to a fixed range, typically between 0 and 1. This makes it easy to implement and interpret, even for those who are new to machine learning and data science. This can help machine learning algorithms converge faster and more accurately (Bhandari, 2020).

In line with the current needs and situation, the calculation of MyWI has been improved using a new methodology which is Min-Max Scaling as compared to the previous method which is Z-score. The use of index scores to measure people's well-being is based on the Human Development Index, Better Life Index and international reference manuals. Malaysian Well-Being Index uses score values to measure the level of well-being of Malaysian, which is from 0.000 to 1.000. This measurement shows that the higher the score obtained, the better the level of well-being of Malaysian. In order to facilitate the interpretation of people's level of well-being, various countries have used the distribution score category that is divided into several levels of well-being in each country.

Methodology

This study aims to measure the level of Malaysian well-being using the latest methodology by focusing on objective indicators since its existence since 2000. This part of the research reviews the major methodological developments that have affected the Index. Data collection for MyWI indicators was using secondary data or administrative data from various agencies of Malaysian Government.

The Linear Scaling Technique (LST) is used to meet the objective study named Min-Max Scaling. LST is procedure used to standardize the range of a variable so that they all take values between zero and one (0,1) (Osberg, 2009). This serves for two purposes which are it standardizes variables in such a way that an increase is always good for well-being and a decrease is always bad. Then, it prevents well-being from being dominated by a few underlying variables that take on very large range of values.

The key reason why it may be necessary to scale variables is that raw data have significantly different proportional ranges. In a standard index number approach, a raw variable is normalized to 100 in a base year and changes over time represent per cent changes in the underlying variable. The problem with this is that trends in the overall composite index will be dominated by variables with large proportional ranges because their per cent changes are larger (Osberg & Sharpe, 2010).

The data was scaled from zero to one (0,1) according to two situations. First, if a variable increase corresponds to an increase in overall well-being, the value is scaled according to the formula:

$$I_j = \frac{x - x_{min}}{x_{max} - x_{min}}$$

Second, if a variable increase corresponds to a decrease in overall well-being, the value is scaled according to the formula:

$$I_j = \frac{x_{max} - x}{x_{max} - x_{min}}$$

In both cases, the range of values is 0-1, and 0 corresponds to the lowest level of well-being, and 1 corresponds to the highest. This technique is used to scale all variables in many indices, including the Human Development Index, Better Life Index, Sustainable Society Index, Indeks Kesejahteraan Keluarga Malaysia, Indeks Kesejahteraan Psikologi Malaysia and Indeks Belia Malaysia. Composite index assigns equal weight to indicators and components. Each dimension is normalized through linear scaling and aggregation relies on equal weighting (Osberg & Sharpe, 2010). This study using five levels of well-being as shown in Table 2.

Table 2

Cut point of Well-Being Scoring

Score Cut points	Category of Well-Being
0.00 – 0.20	Very Unhappy
0.21 – 0.40	Unhappy
0.41 – 0.60	Moderately Happy
0.61 – 0.80	Happy
0.81 – 1.00	Very Happy

Result

The study shows that the MyWI using the Z-score and Min-Max method gives different growth rates in 2021 as shown in Table 3.

Table 3

MyWI using the Z-score and Min-Max method

Method	Z-score (2000=100)			Min-Max Score		
	2020	**2021**	**Percentage Change**	**2020**	**2021**	**Percentage Change**
Economic Sub-composite	**126.0**	**127.2**	**1.0**	**0.69**	**0.71**	**2.9**
Transportation	127.2	125.8	-1.1	0.68	0.66	-2.9
Communications	129.4	131.1	1.3	0.83	0.88	6.0
Education	132.2	133.8	1.2	0.69	0.70	1.4
Income and Distribution	117.8	120.6	2.4	0.51	0.56	9.8
Working Life	123.4	124.7	1.1	0.73	0.76	4.1
Sosial Sub-composite	**113.1**	**114.7**	**1.4**	**0.56**	**0.58**	**3.6**
Housing	119.6	120.8	1.0	0.56	0.58	3.6
Entertainment and Recreation	109.8	104.5	-4.8	0.36	0.23	-36.1
Public Safety	134.1	138.7	3.4	0.87	0.95	9.2
Social Participation	132.8	130.9	-1.4	0.89	0.84	-5.6
Governance	117.7	125.7	6.8	0.56	0.71	26.8
Culture	90.2	96.0	6.4	0.16	0.22	37.5
Health	110.4	108.4	-1.8	0.66	0.66	0.0
Environment	105.6	108.5	2.7	0.45	0.46	2.2
Family	97.7	98.9	1.2	0.51	0.53	3.9
Malaysian Well-Being Index	**117.7**	**119.2**	**1.3**	**0.60**	**0.62**	**3.3**

Z-score Findings

Table 3 shows the results of the MyWI using Z-score methodology shows that MyWI performance in 2021 improved by 1.3 per cent to 119.2 points as compared to 117.7 points in 2020. Both well-being sub-composites showed an increase in 2021. The economic well-being sub-composite recorded an increase of 1.0 per cent in 2021 to 127.2 points and the social well-being sub-composite increased by 1.4 per cent to 114.7 points in the same period.

Min-Max Findings

Based on the Min-Max methodology shows that MyWI performance in 2021 was at a happy level with a score of 0.62 as compared to 0.60 points in 2020. Both well-being sub-composites showed an increase in 2021. The economic well-being sub-composite

recorded at a happy level with a score of 0.71. Meanwhile, the social well-being sub-composite was at a moderately happy level with a score of 0.58 in the same period.

Discussion and Conclusion

An alternative approach to Z-score normalization is Min-Max Scaling. It is a method to normalize data by eliminating the measurement unit of data and make it easier to compare data from different places. It allows variables to have differing means and standard deviations but equal ranges. Meanwhile, Z-score resulting all variables in data set have equal means (0) and standard deviations (1) but different ranges. The calculation of Malaysian Well-Being Index can be compared to Human Development Index, which was also calculated by Min-Max Scaling. However, though the calculating methods are similar, the components are significantly different. According to Human Development Report 2021, Malaysia's HDI score is 0.804 which indicates Malaysia is the high human development category. Meanwhile, based on this study, the MyWI score shows 0.62. It is slightly lower than HDI because there are four components contained in HDI compared to MyWI which has 14 components. Thus, in this study, further analysis needs to be conducted by look into components that truly gave impact to Malaysian well-being. It is needed to reviewing back the components to avoid multicollinearity and noise to the data.

Overall, these alternative measures can provide a more comprehensive picture of country's progress and help policymakers make more informed decisions about how to improve rakyat's well- being and quality of life.

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