Research article

A proposed integrated happiness framework to achieve sustainable development

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ABSTRACT

Given the global call for more non-GDP-based indicators of national well-being, this study proposes a model incorporating economic and psychological (happiness) indicators. Considering the subjective nature of happiness, happiness measurements should incorporate individuals' inner strengths and satisfaction with their external environment. Furthermore, although numerous studies have found that positive psychology approaches can improve happiness, they have yet to be incorporated into any happiness models. Hence, this study proposes an integrated happiness framework that covers objective economic and subjective happiness factors to measure well-being beyond GDP. The study tests the model using survey data from Malaysia as a case study. A total of 1,368 participants were recruited with probability proportional to size. The study discovered that Malaysians' inner strengths are rated higher than their external conditions. It seems Malaysians do not live in a way that cultivates their virtues. Overall, the study suggests that inner strength is crucial in shaping happiness (150 words).

1. Introduction

Maximizing GDP has been the primary policy goal of almost all countries worldwide since the end of World War II (Cavalletti and Corsi, 2018). GDP is a long-used well-being measure, that represents the market value of all goods and services produced by an economy. However, the exclusive focus on GDP has overlooked the negative effects of economic growth on society, such as climate change and national welfare (Fleurbaey, 2009). Referring to Schepelmann et al. Ed (2009), GDP does not suitably account for social and environmental costs and benefits. It is problematic if welfare is being considered from a purely financial point of view to achieve sustainable decision-making. Based on Ivkovic (2016), the usage of GDP as a universal measure of progress and well-being is inadequate since this economic measure solely reflects productivity. Moreover, it was exclusively a monetary measure. In addition, GDP has been criticized by a number of famous economists such as Kenneth Arrow, Simon Kuznets, Daniel Kahneman, Robert Solow, and Muhammad Yunus for its exclusive focus on production (Wesselink et al., 2007). Referring to Oulton (2012), GDP may not a *measure* of human welfare, but it can be considered an element of welfare. The volume of goods and services available to the average person clearly contributes to welfare in the wider sense, though of course, it is far from being the only component. In cross-country data, GDP per capita is highly correlated with other

factors which are important for human welfare. Hence, the Commission on the Measurement of Economic Performance and Social Progress (CMEPSP) has recommended broadening the scope of traditional indicators and developing more inclusive indicators that cover social well-being, including happiness and sustainability, to parallel indicators based on raw economic growth.

To overcome the weakness of GDP, many national and international institutions are searching for appropriate complements. Based on Ng (2008), public policy should put more emphasis on the factors that contribute to happiness compared to simply stressing economic production and consumption. Referring to Ouyang et al. (2020), the key goal of sustainable development is to increase happiness. Pursuing happiness is the ultimate dream of human beings (Larsen and Eid 2008). However, happiness is fleeting and easily influenced by how we think. Jeremy Bentham, the founder of utilitarianism in the 18th century, claimed that happiness consisted of a net balance of pleasures over pain. He believed that the only standard of valuation of pleasure was quantitative. However, his theory has failed to capture its qualities (Narens and Skyrms, 2020). Later, John Stuart Mill refined the theory by aiming at moral utility. For example, a feeling of the need to help mankind can bring the greatest happiness (Das, 2020). Hence, the adoption of happiness as a calculable and measurable "sociotechnical" development will be a

significant factor in expanding the political shift from an economic prosperity model to an emotional flourishing model (Fanti, 2020).

Currently, there is no agreement among researchers on the description of happiness and its related constructs (Diener et al., 2010; Kern et al., 2014). In the literature, happiness is often referred to as subjective well-being (Diener, 2006), emotional well-being (Fordyce, 1988), or quality of life (Ratzlaff et al., 2000), indicating a close relationship among these constructs. Subjective well-being was proposed as a more suitable "Big One" that includes the relevant aspects of global well-being; it can be assumed to be synonymous with happiness (Diener, 2006). Anywhere, happiness is not purely well-being, although both have the same basic elements. However, an individual's sense of happiness can serve as a "proxy" for well-being. In general, happiness is a kind of subjective appreciation of one's current moment or entire life. It can be understood either as a goal or as a choice. If happiness is a goal, it can be explained from an economic perspective, that happiness is good, and unhappiness is bad. If happiness is a choice, it mainly depends on how each individual reacts or responds to the networks of relationships they have with other individuals. If these relationships run smoothly, happiness will increase, and vice versa. The state of mind is the key to sustaining happiness. Nevertheless, our state of mind is always influenced by our values, how we prioritize them, and how we interpret our various relationships.

Given this need, the development of a happiness measurement technique is an important and challenging task. To do this, we must fix the time and space that we would like to measure. For example, current happiness (happiness within the present time and space), whole life happiness (happiness from birth to death), or lived life happiness (happiness from birth to now). Since the natural characteristics of happiness are subjective and fleeting, happiness measurement should focus on individuals' subjective satisfaction with their outer and inner environments within a specific time and space. Happiness should be measured on a routine basis, similar to how blood pressure is monitored. According to Kubiszewski et al. (2018), understanding the associations between objective and subjective variables is vital to improving policy. They found that individuals' perceptions of the objective conditions that support their well-being are quite limited. As such, incorporating both what individuals perceive and value and the factors that they do not perceive well are crucial in supporting their well-being. This highlights the importance of incorporating subjective indicators into any happiness measurements, in addition to objective economic indicators such as GDP.

Traditional psychology has dominated for a decade as psychology was aimed at curing mental illness instead of promoting the health and happiness of someone in the early decade (Seligman and Csikszentmihalyi, 2014). In 1998, during the annual meeting of the American Psychology Association, Martin Seligman was the first person who used the term "Positive Psychology" and set it as its foundation with the major purpose of enhancing an individual's psychological strengths to improve their condition. Positive psychology can be defined as "a loose confederation of those interested in studying happiness, human strengths, virtues and in helping people achieve a better quality of life" (Seligman and Csikszentmihalyi, 2014). Positive psychology accommodates both hedonic and eudemonic theories and reinterprets well-being. From the perspective of positive psychology, happiness can be cultivated.

Science has discovered that the flow of thoughts shapes the brain and that it is possible to strengthen positive brain states (Hanson, 2009). When the neurons fire together, they are together. This mental activity creates new neural structures (LeDoux, 2003). Thus, even fleeting thoughts and feelings can leave lasting marks on the brain. Therefore, from the perspective of positive psychology, happiness is a choice and a way of thinking. How we think determines our present happiness. In the PERMA model (latest model of positive psychology), which comprises positive emotion, engagement, relationships, meaning, and accomplishments, each individual ought to maximize the five PERMA elements to achieve a life of full gratification and happiness. The model demonstrates how these elements can be maximized. However, all five components of the PERMA model have one common element, which is "strength." In other words, the model suggests empowering oneself to enhance happiness. Compare the economic theory, stresses the importance of objective life circumstances to well-being. For example, one can improve happiness by getting more money and living in better external conditions. In an attempt to bridge these definitions, and in direct response to the UN's Sustainable Development Goal 3 (good health and well-being for people), this study proposes an integrated happiness framework that covers both psychology-based and economics-based measurements to accurately monitor well-being beyond GDP.

Sustainable development, an absolute indicator of well-being, cannot succeed in unhappy societies. Happy nations appear to take responsibility for society and the environment (Sameer et al., 2021). This finding has challenged the traditional notion that happiness and sustainability are separate pathways. Appreciating the role of pleasure and joy could guide responsible environmental behaviors by making people want to take care of the many settings in which joy and pleasure take place, including the environment. Hales (2010) described an emotionally healthy person as someone who exhibits flexibility and adaptability to different circumstances, a sense of meaning and affirmation in life, an understanding that the self is not the center of the universe, compassion, selflessness, and a sense of control over the mind and body. Thus, the pursuit of happiness should be realized as a fundamental human goal for all nations and integrated into public policy objectives (Leite et al., 2020).

2. Literature review

2.1. Existing non-GDP-based measures

Since GDP has been recognized as an inadequate measure of human happiness, looking beyond GDP has received much attention from researchers, institutions, and authorities. The prospect of measurements going beyond GDP has lifted the hope of significant social change (Porritt, 2007). Based on a literature review of the existing global and national happiness indices and related psychological theories, we identified several happiness measurements that have been developed worldwide. We now summarize some of the main approaches.

The Human Development Index (HDI) was first developed by Mahbub ul Haq in 1990 and was further used and modified by the United Nations Development Programme (UNDP) to measure national development. HDI is a composite index of life expectancy, education, and per capita income. In 2010, the Inequality-Adjusted Human Development Index (IHDI) was introduced, which incorporated an inequality component. However, the simple HDI remains useful as an index for human development. To transform a real variable, X, into a unit-free index between 0 and 1, the following formula is used:

X index = (actual value – minimum value)/(maximum value – minimum value).

Equal weight is given to the three components integrated into the HDI (life expectancy, education, and per capita income). The HDI is categorized as low, medium, high, and very high, according to the following four thresholds, respectively: <0.550, 0.550–0.699, 0.770–0.799, and >0.8.

However, the HDI has received criticism from some researchers and institutions. Although it is considered to be one of the most comprehensive well-being indices to date in terms of the number of countries it covers, it overlooks areas beyond education, health, and income that need to be investigated to truly capture all aspects of human life (Bhanojirao, 1991). For example, the contribution of technological development to human civilization is not included, and there is limited attention concerning a global perspective on development. Based on McGillivray and White (1993), HDI's treatment of income is inappropriate, and its contribution to the assessment of development levels differs markedly among country groups.

The Happy Planet Index (HPI) is an index of human well-being and environmental impact that was introduced by the New Economics

Foundation in July 2006. The HPI measures how efficiently countries achieve long, happy, and sustainable lives for their populations. There are four components in the HPI: experienced well-being, life expectancy, inequality, and ecological footprint. HPI scores show the relationships among the components from which the index is constructed. Experienced well-being measures the overall satisfaction of residents in each country using a scale from zero to ten (collected from the Gallup World Poll). Life expectancy refers to the average number of years a person is expected to live in each country based on data collected from the UN. Inequality measures the inequality between people within the same country. It is a measurement of how unequal the distribution of life expectancy and experienced well-being scores are within a country. This is expressed as a percentage. The ecological footprint measures the average impact on the environment of each resident in a country based on data collected from the Global Footprint Network. It is expressed using a standardized unit, which is the global hectare (gha) per person. Referring to Campus and Porcu (2010), HPI does not reflect the same reality illustrated by GDP. However, the index has received much criticism because the developer of the index equated the definition of personal happiness with planetary, and environmental happiness. In addition, the component indices are often mutually correlated (Bondarchik et al., 2016). Personal happiness is a deep, individual feeling. This is different from an overall view of happiness in which ecological efficiency supports well-being.

The OECD Better Life Index (BLI) was launched in May 2011. It is an interactive tool that allows people to compare countries' performances according to their preferences in terms of what makes for a better life. BLI was designed by the Berlin-based agency Raureif in collaboration with Moritz Stefaner. As mentioned earlier, the CMEPSP has recommended that the world address the concerns about GDP's failure to give a true account of people's current and future well-being. Hence, BLI includes eleven dimensions of well-being: civic engagement, community, education, environment, health, housing, income, jobs, life satisfaction, safety, and work-life balance. The research design was based on self-reported data on the wiki progress (https://www.oecdbetterlifeindex.org/), which is a web application that allows users to refer to and compare their preferences with others in life. One major criticism of the BLI is that it uses a limited subset of indicators that are used by other happiness measurements in the world. In addition, some researchers argue that important items are missing in the index, such as social networks, freedom of speech, poverty, economic inequality, health insurance, and pollution. Referring to Monteiro et al. (2019), although the BLI is the most comprehensive well-being indicator in that it considers 11 of the 14 well-being dimensions, it only includes 38 countries (among which Malaysia is not included). Thus, it does not allow for useful inferences about countries outside this set.

Gross National Happiness (GNH) started as the goal of the government of Bhutan, as defined in the Constitution of Bhutan in July 2008. It includes an index used to measure the collective happiness and well-being of Bhutanese people and was developed by the Centre for Bhutan Studies with the help of researchers from Oxford University. GNH is distinguishable from GDP in that it values collective happiness. GNH is divided into four pillars: sustainable and equitable socio-economic development, environmental conservation, preservation and promotion of culture, and good governance. The four pillars are further divided into nine domains: psychological well-being, health, time use, education, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience, and living standards. Each domain is composed of subjective and objective indicators. Although the domains have equal weights, the indicators within each domain differ in weight. The research used mixed methods through the combination of a qualitative and quantitative questionnaire to survey a total sample of 8700 people, which was a representative sample in terms of social groups and regions in Bhutan (Ura et al., 2012). Referring to Metz (2014), GNH included some areas that were overlooked by influential Western indices and called for an absorbing cross-cultural exchange to understand the nature of well-being for public policy. However, GNH has been criticized

as a propaganda tool used by the Bhutanese government to divert attention from its purported involvement in ethnic cleansing and human rights abuses. Furthermore, most domains focused on the outer dimensions of well-being.

The Gross National Well-Being Index (GNW) is a global development measurement framework published in 2005 by the International Institute of Management in the US. There are seven development areas in the index: mental and emotional, physical and health, work and income, social relations, economic and retirement, political and government, and living environment. GNW scores are based on a 10-point Likert scale survey ranging from 0 (*very dissatisfied*) to 10 (*very satisfied*). Most wellness areas include both subjective results (via a survey) and objective data. Referring to Volkovitckaia et al. (2020), the practice of using complementary indices, which were compiled based on national indicators, was implemented about twenty years ago by the governments of Australia, Ireland, and the UK. For instance, the UK uses GNW to complement GDP. GNW opened the door for several international initiatives such as the new science of happiness economics that advances well-being policy-making all over the world. However, most areas of the GNW focus on the outer dimension of well-being and the model lacks specific psychological models to support it.

The Malaysia Happiness Index (MHI) was developed by the Federal Department of Town and Country Planning Malaysia to enhance the understanding of a sustainable city through the concept of subjective well-being. The MHI consists of 13 questions related to stress, health, family, job, income, religion, neighborhood, community, safety, facilities, services provided by the local authorities, political representatives, and the living environment (Rosly and Rashid, 2013). To test the index, a total of 44,500 questionnaires were distributed to 71 local authorities throughout Malaysia. The analysis was made using the statistical package to get the mean value of all the criteria and divided by 100 to obtain the percentage. Although the statistical analysis was performed to identify mean values, the study lacked detailed empirical work and is not very comprehensive. Most of the questions measure outer factors rather than inner factors. Furthermore, the index uses only one question to measure each criterion, which is insufficient and lacks statistical validation.

Table 1 provides a summary of the existing global and national happiness indices. Based on the review, we found that most indices focus on outer indicators, and less attention has been given to the inner indicators. Out of the six happiness measurements that we discussed, all six included health in their indices, followed by economics in five out of six. Governance and community are included in four happiness measurements, followed by the environment, safety, and education, which are included in three happiness measurements. Two of the six measurements included culture in their indices. The existing happiness measurements do not divide the inner indicators into sub-dimensions, which diminishes their weighting in the overall measurement. This contradicts the reality that happiness is more related to emotional than intellectual development. Outer indicators alone cannot be used to measure happiness.

2.2. Positive psychology: the PERMA model

Individual happiness relates more to emotional than intellectual development (Ho, 2011). Therefore, a new approach to measurement is required. Given the overall lack of attention to internal psychological aspects of happiness in the above models, it is important to identify some relevant measures in this regard. Positive psychology can be used to produce national indicators of happiness (Diener, 2000). The PERMA model of positive psychology is one of the most promising approaches. Seligman (2011) hypothesized that PERMA comprises the key elements of well-being and can build positive qualities of life. Goodman et al. (2018) found that their data were entirely consistent with Seligman's hypothesis. Schueller and Seligman (2010) discovered all components in positive psychology are distinguishable and correlate positively with subjective well-being. Furthermore, the PERMA model proves an acceptable model fit, with internal and cross-time consistency and

Table 1. Summary of review on some existing global and national happiness indices.

Dimensions	Components/Indices	HDI	HPI	BLI	GNH	GNW	MHI
OUTER							
Health	life expectancy	√	√				
	health			√	√		√
	physical & health					√	
Economic	per capita income	√					
	income			√			√
	jobs			√			√
	work & income					√	
	economic & retirement					√	
	living standards				√		
Governance	civic engagement			√			
	political & government					√	
	good governance				√		
	facilities						√
	services provided by the local authorities						√
	political representative						√
Community	community			√			
	work life balance			√			
	social relations					√	
	community vitality				√		
	family						√
	neighbourhood						√
Environment	ecological footprint		√				
	environment			√			
	ecological diversity and resilience				√		
Safety	safety			√			√
	living environment					√	√
Education	education	√		√	√		
Cultural	cultural diversity and resilience				√		
	religion						√
Time Use	time use				√		
Housing	housing			√			
INNER	experienced well-being		√				
	inequality		√				
	life satisfaction			√			
	mental & emotional					√	
	psychological well-being				√		
	stress						√

convergent and divergent validity (Butler and Kern, 2016). It is a tool for measuring well-being and allows individuals to monitor their well-being across various psychosocial areas. In addition, the PERMA model is culturally consistent and can be used to align priorities and choices towards a greater state of happiness while preserving cultural strengths (D'raven and Zaidi, 2016).

The PERMA model demonstrates how each of its components can be maximized, leading to happiness. We now briefly discuss each of these components. Firstly, positive emotion is a core element of a state of well-being. It comprises the capability to be optimistic and view life from a positive perspective (Fulmer, 2015). Many previous studies have found that happiness is linked to positive emotions as these emotions have the potential to influence happiness (Quoidbach et al., 2010; Cohn et al., 2009). Ahmed (2010) revealed that taking part in affective and moral work, which is deemed good can make us feel happy ourselves and eventually make others happy. The next element, engagement, refers to a specific way to be involved in any life activity. People find enjoyment in doing something, whether working on an interesting project, dancing, cooking, or playing the piano. Participation in pleasurable activities can help expand skills, intelligence, and emotional capabilities. Engagement in meaningful activities has a strong influence on well-being (Schueller

and Seligman, 2010; Kim et al., 2013). The third element, relationships, is considered one of the most significant elements in the PERMA model. Many empirical studies have found that good relationships with others strongly and positively influence happiness. Having a good relationship with other individuals in society can contribute greatly to well-being (Schueller and Seligman, 2010; Fulmer, 2015). The fourth element, meaning, is important for anyone involved in a particular activity. Answering the questions "Who am I?" and "Why are we in this world?" can drive us towards fulfillment. Creating meaning in life leads to true happiness (Wong, 2013). For example, going out of one's way to help people, doing charitable acts, and contributing to the welfare of society are activities in which an individual goes beyond living for themselves. Living a life that connects oneself to larger forces will make life more meaningful. Lastly, accomplishment refers to an individual's pursuit of a goal that is worthy of devoting their life to (Fulmer, 2015). Antaramian (2017) revealed that most students who were satisfied with their lives scored higher Grade Point Averages (GPAs) than those who were less satisfied. Making effort to achieve certain goals will give us a sense of satisfaction, pride, and fulfillment.

However, in the context of national indicators, the PERMA model focuses solely on the psychological perspective without considering any
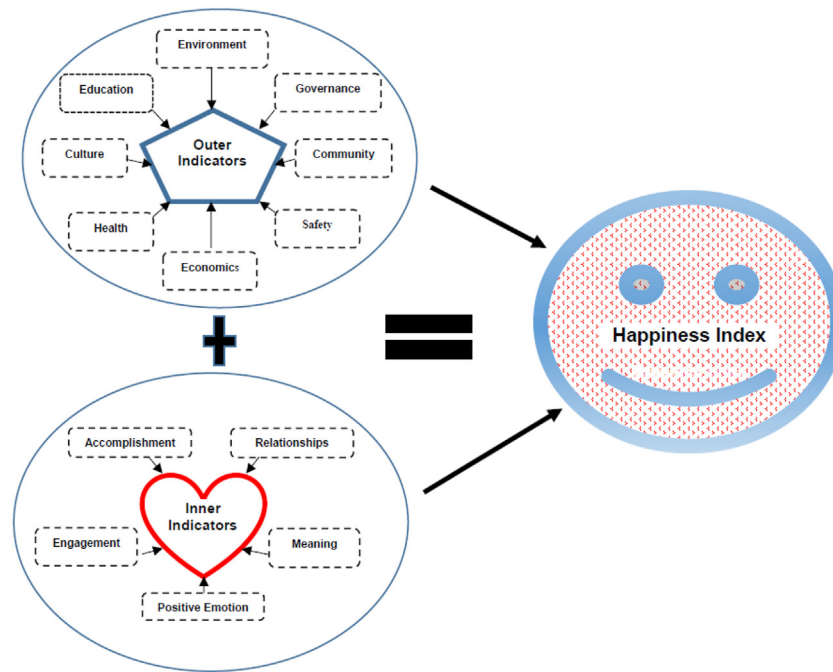
Figure 1. Proposed integrated happiness indicators framework.

outer indicators. Furthermore, this model is more about interpersonal rather than collective happiness. Following this line of thought, happiness measurement should also consider the outer environment instead of focusing solely on interpersonal strengths. If we do not look after the outer environment, personal and collective happiness will also diminish. Hence, in this study, we aimed to develop a measure of happiness that balanced the strengths and weaknesses of all the measures and indicators described in this section.

3. Data and methods

Finally, this study combined economics-based and psychology-based measurements of happiness to form an integrated happiness framework (Figure 1), using Malaysia as a case study. Overall, the study adopted, modified, and integrated the GNH, MHI, and BLI into eight dimensions of outer indicators: environment, education, governance, culture, community, health, safety, and economics. For the inner indicators, the study adopted and modified the PERMA profiler developed by Julie Butler and Margaret Kern from the Positive Psychology Center at the University of Pennsylvania, based on the five dimensions of the PERMA model described above: positive emotion, engagement, relationships, meaning, and accomplishments.

The questionnaire was divided into four sections: happiness and value of life, external environment, positive psychology, and demographics. With the exception of the demographic section, responses were scored on 7-point Likert scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). For the happiness section, a total of five questions were adopted and modified from the questionnaire designed by Diener et al. (1985). The external environment section consisted of eight dimensions: environment, education, governance, culture, community, health, safety, and economics. Each dimension consisted of three questions that we are mostly adopted and modified from the GNH (Centre for Bhutan Studies and the GNH Research Royal Government of Bhutan, 2014) and the MHI (Rosly and Rashid, 2013). For positive psychology, questions were adopted and modified from the PERMA model (Butler and Kern, 2016). Each dimension consisted of three questions.

Since the survey was conducted in a cross-cultural research setting, the questionnaire was translated into Malay, the national language of Malaysia, and another local language, Mandarin. Back-translation was used: the questionnaire was translated into Malay by one translator and then translated back into English by another independent translator who had not seen the original questionnaire. The two versions were then compared. Similar procedures were followed for the Mandarin version. The questionnaire is written in clear and comprehensible wording that is easily understandable for people of all education levels. The questionnaire was randomly distributed face-to-face from February to June 2016 with a clear explanation provided to the respondents. They were informed to consent verbally and written in the questionnaire. All responses are collected for this academic research purpose and will be kept strictly confidential. Their participation in this survey is entirely voluntary and free to withdraw at any time. In addition, this project has been granted ethics approval from the university.

A pre-test of five people (for each language version) from the target groups was conducted to identify the problematic questions that might lead to biased answers. In addition, the study randomly drew 100 respondents from the target group to carry out a pilot test. The feedback was reviewed and corrections were made accordingly. Later, the sample was selected using multistage random sampling and a probability proportional to size was used in the sample selection. In a **stratified sample**, we divide Malaysia's population into homogeneous subpopulations called *strata* (the plural of *stratum*) based on location, race, and gender identity. Every member of the population studied should be in exactly one stratum. Hence, the study participants are a representative sample of the composition of a Malaysian population. The study includes all the states of Malaysia and three federal territories. For each state, a quota selection based on the ratio of ethnicities (Malay, Chinese, Indian, and Indigenous; 67.4%, 24.6%, 7.3%, and 0.7%; Department of Statistics Malaysia, 2010) was used. Referring to the 2010 Malaysian population and housing census, the total population in Malaysia was 24, 661, 135. In terms of calculating sample size, there are no precise answers, as each study differs in terms of the population and the theories employed in the research. According to Hair et al. (2014), 500 samples are required for seven or more latent constructs, and a construct should have at least three items. Based on a 95% confidence interval, 80% power, and 0.03 error margins, the estimated sample size for our study was 1,068. All selected respondents were Malaysian and categorized as youths or adults according to UN definitions (i.e., above 15 years old).

Since the study customized various measurement items from the literature, exploratory factor analysis (EFA) was used on the data

collected from the pilot test to determine the dimensionality of the measuring items. This confirmed that the final questionnaire was appropriate and clearly defined. Measurement items with low factor loading (less than 0.6) and higher cross-loading items (factor loading greater than 0.6 for more than one dimension) were deleted.

To test for model fit, convergent validity, and construct validity, the study conducted confirmatory factor analysis (CFA) on the data collected from the field study. CFA is a special form of factor analysis that assesses the unidimensionality, validity, and reliability of the latent construct. It is employed to test whether the measures of a construct are consistent with the researcher's understanding of the nature of that construct. Based on CFA, any item that did not fit the measurement model due to low factor loading was removed. The study adopted pooled CFA in which all latent constructs are combined. Subsequently, the fitness indexes were examined to ensure that they met the required level. This study removed those measurement items that did not meet the minimum requirement (0.5). We continued to rerun the measurement model until the fitness indexes achieved the minimum requirement, and the model was deemed to fit.

After validating the measurement model, the critical factors for happiness were verified. The study adopted the max-min procedure to convert indicators into indices. This is a standard method that is commonly used by many researchers (including Mahbub ul Haq during the development of the HDI). The formula is:

Formula: (Actual value – min value)/(Max value – min value).

The actual value is the value chosen by the respondent. The maximum (minimum) value refers to the highest (lowest) number that can be chosen by respondents. In terms of weight, the study adopted equal weights for all dimensions, based on the recognition of their equal status. In policy assessments, balanced development should be a priority, and each dimension in our framework contributes equally to human happiness. This study also adopted equal weights for both the outer and inner indices.

4. Findings

4.1. Respondents' profile

Although the estimated minimum sample size was identified as 1,068, 1,400 questionnaires were distributed to prevent an insufficient sample size due to incomplete questionnaires. Of these, 1,368 completed questionnaires were collected. With 1368 respondents in this research, the sample size far exceeds recommended levels and has adequate power for testing. The study collected approximately 90–100 respondents from each state and 49–50 respondents from the federal territories. Among respondents, 39.6% were male and 60.3% were female. Most respondents earned less than RM3,000 (approximately US$717) per month (76.5%) and lived in urban areas (66.7%). Regarding education level, 51.4% of respondents had secondary school education or below. Most were in the 15–24 years age range (42.8%), followed by 25–34 years old (25.8%). Approximately 46.1% of the respondents had a household size between five and seven members. A large number (47.6%) of respondents were working in the corporate sector and were single (54.6%). The details are presented in Table 2.

4.2. CFA results

The study found that the factor loadings for the initial measurement model, Sa1, H5, and H6, did not achieve the minimum requirement >0.5 (Hair et al., 2010). Therefore, they were deleted from the measurement model. Because all the other factor loadings met the required value of 0.5, the model was considered unidimensional. The final measurement model displayed the model after deleting Sa1, H5, and H6. Both initial and final measurement models are shown in Appendix A and Appendix B.

Several fit indices can be used to test model fit. To measure how well the model specified by the researchers reproduces the observed data, absolute fit measurements are required. Examples of these measurements are chi-square statistics, the goodness of fit index (GFI), adjusted goodness of fit index (AGFI), and root mean square error of approximation

Table 2. Respondents' profile.

State	n	Percent
Sarawak	98	7.2
Sabah	100	7.3
Kelantan	89	6.5
Terengganu	97	7.1
Pahang	94	6.9
Perlis	93	6.8
Kedah	92	6.7
Pulau Pinang	89	6.5
Perak	94	6.9
N. Sembilan	89	6.5
Selangor	91	6.7
Melaka	94	6.9
Johor	100	7.3
Kuala Lumpur	49	3.6
Labuan	49	3.6
Putrajaya	50	3.7
Gender	**n**	**Percent**
Male	542	39.6
Female	825	60.3
Not applicable	1	0.01
Religion	**n**	**Percent**
Muslim	940	68.7
Buddhism	234	17.1
Hinduism	43	3.1
Christian	117	8.6
Taoism	16	1.2
No religion	18	1.3
Ethnic	**n**	**Percent**
Malay	873	63.8
Chinese	284	20.8
Indian	50	3.7
Kadazan	44	3.2
Iban	18	1.3
Others	99	7.2
Monthly Income	**n**	**Percent**
<1,000	511	37.4
1,000–2,999	535	39.1
3,000–4,999	214	15.6
5,000–6,999	56	4.1
7,000–9,999	29	2.1
>10,000	19	1.4
No applicable	4	0.3
Area	**n**	**Percent**
Urban	912	66.7
Rural	456	33.3
Education	**n**	**Percent**
No formal education	35	2.6
Primary school	41	3.0
Secondary school	627	45.8
Certified	179	13.1
Diploma	241	17.6
Bachelor degree	189	13.8
Master degree	45	3.3
Ph.D.	9	0.7
Not applicable	2	0.1
Age	**n**	**Percent**
15–24	585	42.8
25–34	353	25.8
35–44	163	11.9

(continued on next page)

Table 2 (*continued*)

State	n	Percent
45–54	118	8.6
55–64	85	6.2
65 and above	64	4.7
Household Size	**n**	**Percent**
1–2	146	10.7
3–4	414	30.3
5–7	631	46.1
8 and above	176	12.9
No applicable	1	0.1
Occupation	**n**	**Percent**
Businessman	273	20.0
Civil servant	122	8.9
Corporate servant	651	47.6
NGO staff	32	2.3
Housewife/man	13	1.0
Retired	50	3.7
Student	153	11.2
Unemployed	11	0.8
Other	63	4.6
Marital Status	**n**	**Percent**
Single	747	54.6
Married	562	41.1
Separate	11	0.8
Divorced	26	1.9
Widowed	12	0.9
Others	9	0.7
Not applicable	1	0.1

Table 3. Convergent validity report for each construct in the model.

Constructs	Items	Factor loadings	AVE (>0.4)	CR (>0.6)
Outer Indicators				
Environment	Env1	0.698	0.471	0.728
	Env2	0.698		
	Env3	0.663		
Education	Edu1	0.676	0.596	0.814
	Edu2	0.874		
	Edu3	0.754		
Governance	Go1	0.850	0.665	0.855
	Go2	0.891		
	Go3	0.692		
Culture	Cul1	0.681	0.434	0.697
	Cul2	0.632		
	Cul3	0.663		
Community	Co1	0.637	0.462	0.720
	Co2	0.752		
	Co3	0.645		
Health	He1	0.652	0.493	0.744
	He2	0.681		
	He3	0.768		
Safety	Sa1	Deleted	0.860	0.925
	Sa2	0.942		
	Sa3	0.913		
Economic	Eco1	0.846	0.548	0.780
	Eco2	0.789		
	Eco3	0.554		
Inner Indicators				
Meaning	M1	0.859	0.741	0.896
	M2	0.895		
	M3	0.827		
Engagement	En1	0.760	0.544	0.782
	En2	0.730		
	En3	0.723		
Relationships	R1	0.623	0.559	0.789
	R2	0.868		
	R3	0.732		
Positive Emotion	P1	0.888	0.794	0.920
	P2	0.894		
	P3	0.891		
Accomplishments	A1	0.873	0.698	0.874
	A2	0.868		
	A3	0.761		
Dependent Variable				
Happiness	H1	0.774	0.711	0.907
	H2	0.799		
	H3	0.907		
	H4	0.885		
	H5	Deleted		
	H6	Deleted		

(RMSEA). To assess model fit relative to the null model, incremental fit measurements are required. Examples of these measurements are the normed fit index (NFI), comparative fit index (CFI), and Tucker Lewis index (TLI). Based on Hair et al. (2010), at least three to four fit indices (among GFI, AGFI, RMSEA, NFI, CFI, TLI, and relative chi-square) are required to establish model fit. These indices indicate how well the proposed model captures the covariance among the items in the measurement model. For a good fit, GFI, CFI, and TLI should be greater than or equal to 0.9 (Hair et al., 1998). Moreover, AGFI should be greater than 0.8 and RMSEA should be less than 0.08 (Hair et al., 1995). In addition, the relative chi-square must also be less than 5.0 (Bentler, 1990). As a rule, the final measurement model achieved all the required fitness indices. In addition, the study presented a high acceptance level of reliability statistic, with Cronbach's alpha ($\alpha \geq 0.943$).

To measure construct validity (i.e., whether the construct measures what it claims to), convergent and discriminant validity must be tested. Based on Gholami et al. (2013), loadings, average variance extracted (AVE), and composite reliability (CR) are the three measurements that need to be verified to test convergent validity. According to Hair et al. (2010), higher factor loadings (≥ 0.5) indicate high convergent validity. Referring to Fornell and Larcker (1981), AVE above 0.4 can be accepted with a CR higher than 0.6. A higher AVE indicates high convergent validity, and a higher CR is considered to be reliable. Table 3 shows the details of the full convergent validity results for the model. Based on the results, all the constructs achieved high convergent validity and construct reliability. Discriminant validity refers to the extent to which a construct is truly distinct from other constructs. Discriminant validity was examined by comparing the correlations between the constructs and the square root of the AVE for each construct (Fornell and Larcker, 1981). The AVE of a latent variable should be higher than the squared correlations between the latent variable and all other variables. Table 4 shows the details of the discriminant validity results for the model. The results

showed that all the values on the diagonals (in bold) were larger than the corresponding row and column values. Therefore, all the constructs achieved discriminant validity.

4.3. An integrated happiness index for Malaysia

Since this is the first attempt to integrate the PERMA model with the existing global happiness measurements, it is vital to test it in a real setting. After validating the measurement model, the critical factors for happiness were verified. As mentioned earlier, the study adopted the max-min procedure to convert indicators into indices and equal weights

Table 4. Discriminant validity report for each construct in the model.

	Environment	Education	Governance	Culture	Community	Health	Safety	Economic	Meaning	Engagement	Relationships	Positive Emotion	Accomplishments	Happiness
Environment	0.686													
Education	0.320	0.772												
Governance	0.370	0.301	0.815											
Culture	0.494	0.241	0.257	0.659										
Community	0.456	0.321	0.421	0.440	0.680									
Health	0.516	0.243	0.258	0.176	0.311	0.702								
Safety	0.171	0.171	0.194	0.109	0.155	0.196	0.927							
Economic	0.275	0.274	0.252	0.165	0.362	0.227	0.096	0.740						
Meaning	0.263	0.155	0.120	0.291	0.252	0.212	0.049	0.157	0.861					
Engagement	0.202	0.102	0.152	0.135	0.208	0.128	0.023	0.136	0.247	0.738				
Relationships	0.223	0.146	0.084	0.343	0.205	0.132	0.064	0.092	0.468	0.179	0.748			
Positive Emotion	0.296	0.181	0.141	0.260	0.294	0.227	0.069	0.189	0.359	0.195	0.448	0.891		
Accomplishments	0.246	0.136	0.108	0.225	0.228	0.176	0.069	0.115	0.527	0.187	0.341	0.346	0.835	
Happiness	0.181	0.133	0.100	0.213	0.202	0.189	0.057	0.228	0.249	0.068	0.242	0.346	0.201	0.843

for all dimensions. Based on the findings, Malaysians scored 0.676 for happiness, with a relatively higher score for the inner index (0.722) than the outer index (0.630). This result shows that Malaysians' inner strength was stronger than their satisfaction with their outer environment. Figure 2 shows the outer and inner indices based on each dimension. Among the outer factors, Malaysians scored highest in terms of culture (0.759), followed by community (0.694), environment (0.656), education (0.644), and health (0.610). However, they scored lowest in safety (0.519), followed by governance (0.565), and economic factors (0.593). In summary, public safety, governance' performance, and economic achievements require more attention from policymakers. Effective strategies are required to improve these dimensions. Among the inner factors, Malaysians scored highest in relationships (0.772), followed by positive emotions (0.753). The score for meaning (0.722) was in the middle range. Malaysians scored the lowest in engagement (0.658) and accomplishments (0.703). The low score for engagement suggests that Malaysians do not live in a way that cultivates their virtues and strengths.

The study further explored the performance of each state and federal territory in Malaysia due to their different economic conditions and socio-demographic characteristics. Table 5 indicates the GDP and some socio-demographic characteristics of Malaysia's states and territories.

Figure 3 indicates that Melaka, the historic state located in the southern region of Peninsular Malaysia, next to the Straits of Malacca, scored highest in happiness (0.753), followed by Terengganu, a sultanate state located on the east coast of Peninsular Malaysia (0.713). Referring to the GDP of Malaysian states in 2015 released by the Department of Statistics Malaysia, Melaka and Terengganu are among the five poorest Malaysian states besides federal territories. Nevertheless, they scored highest for happiness. Hence, lower-income does not necessarily reduce subjective happiness. In addition, all the other states and federal territories in Malaysia scored below 0.70, ranging from 0.612 to 0.696. Johor, the southernmost state of Peninsular Malaysia, scored lowest (0.612), followed by Penang, located on the northwest coast of Peninsular Malaysia (0.637). Johor and Penang are the third and fifth richest states besides federal territories. However, their happiness levels were the lowest. Whereas, Kuala Lumpur, the national capital and largest city in Malaysia scored 0.679. Figure 4 displays the outer and inner indices for each state and federal territory. Based on the results, outer index scores ranged from 0.562 to 0.687. Once again, Johor scored lowest on the outer index, followed by Penang. Terengganu scored highest (0.687), followed by Melaka (0.685). For the inner index, Melaka scored highest (0.820), followed by Labuan (0.757), a federal territory in East Malaysia. The performance gap between Melaka and other states or federal territories seems to be higher in terms of the inner dimensions. Besides income, different socio-demographic characteristics such as the ethnic ratio may affect the happiness gap among different states and federal territories. Hence, this study would like to further explore the happiness level of each ethnic group in Malaysia.

Today we are living in an increasingly culturally diverse world. Malaysia, a multi-ethnic and multicultural society, is one of the most suitable places to observe differences in happiness levels among cultures, ethnicities, and religious groups. Beatty and Tuch (1997) report that even when confining their analysis to middle-class respondents, black express lower happiness than whites. Hence, they conclude that race continues to exert a significant impact on subjective well-being. A racial gap will remain even after controlling for many socioeconomic statuses due to other unobserved factors such as discrimination (Iceland and Ludwig-Dehm, 2019). Referring to Figure 5, the Malay (Malaysia's largest ethnic group), scored highest in happiness (0.692). Conversely, the Han Chinese, the second largest ethnic group in Malaysia, scored lowest (0.624). Based on the results, it seems that there is a relatively large disparity in happiness between these two ethnicities. In addition, Iban, the largest indigenous group of Sarawak, scored the second-lowest in happiness (0.651), followed by Indians (0.679), who form approximately 7% of the total population in Malaysia, and Kadazan (0.679), an ethnic group indigenous to the state of Sabah in Malaysia. Based on Knies et al.
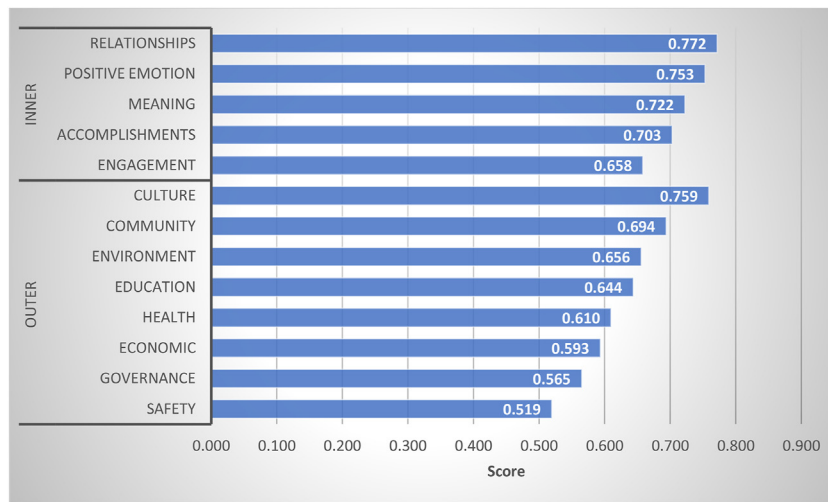
Figure 2. Outer and inner indices based on each component.

Table 5. GDP & socio-demographic characteristics of Malaysia's states & territories.

State/Territories	2015 GDP	2010 Socio-demographic Distribution				
	(RM Million)	Population	Area (km^2)	Urban Population (%)	Malay and Indigeneous (%)	Chinese and Indian Minority (%)
Selangor	239,968	5,411,324	8,104	91.4	57.1	42.1
Kuala Lumpur (FT)	160,388	1,627,172	243	100	45.9	53.5
Sarawak	106,063	2,420,009	124,450	53.8	74.8	24.8
Johor	98,880	3,348,283	19,210	71.9	58.9	40.7
Sabah	70,421	3,117,405	73,631	54	84.8	13.1
Pulau Pinang	69,844	1,520,143	1,048	90.8	43.6	56
Perak	58,033	2,258,428	21,035	69.7	57	42.6
Pahang	45,882	1,443,365	36,137	50.5	79	20.6
N. Sembilan	37,539	997,071	6,686	66.5	61.3	38.4
Kedah	35,999	1,890,098	9,500	64.6	77.9	20,9
Melaka	31,715	788,706	1,664	86.5	66.9	32.6
Terengganu	27,760	1,015,776	13,035	59.1	97	2.8
Kelantan	19,722	1,459,994	15,099	42.4	95.7	3.7
Labuan (FT)	5,119	86,908	91	82.3	83.7	14.3
Perlis	4,917	227,025	821	51.4	88.4	9.2
Putrajaya (FT)	NA	67,964	49	100	98	1.9

Note: FT are refer to the federal territories.
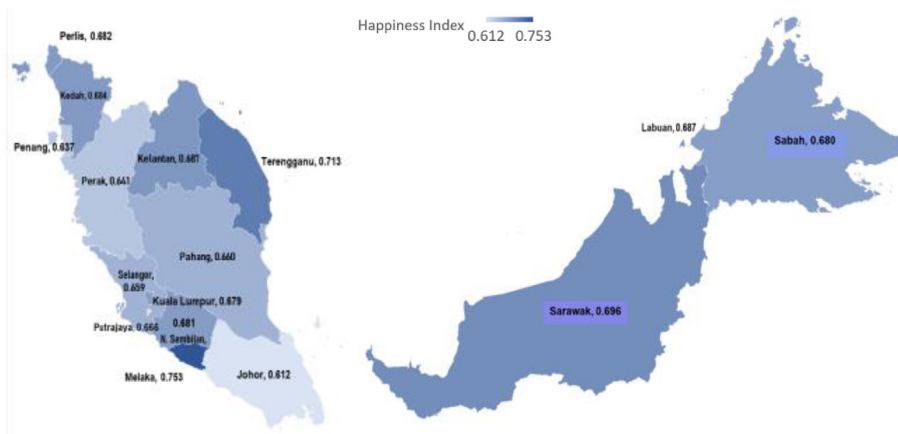Source: National Census 2010 and Official Portal, Department of Statistics Malaysia.

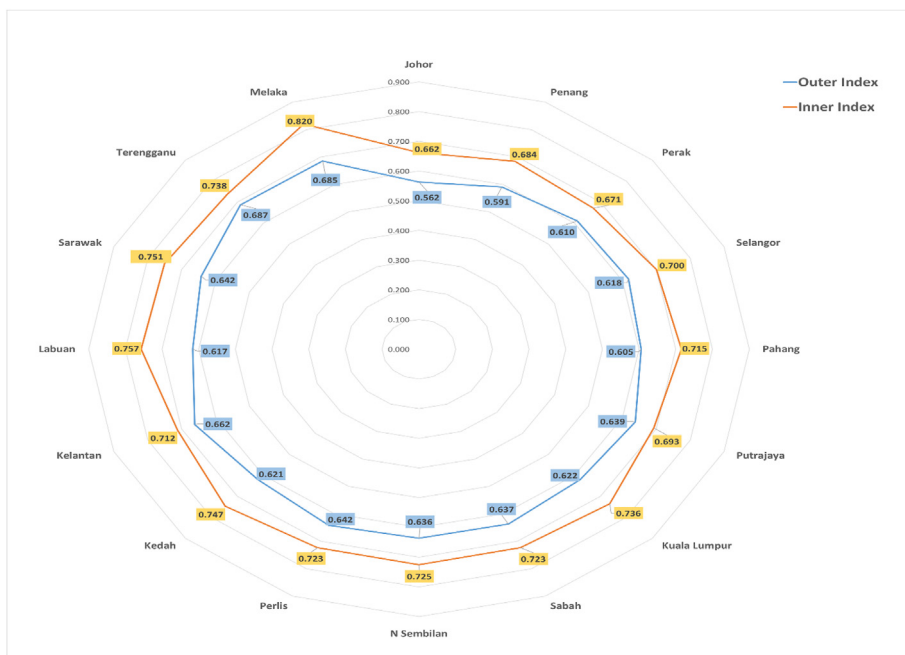**Figure 3.** Happiness indices for each state and federal territory in Malaysia.

Figure 4. Outer and inner indices for each state and federal territory in Malaysia.
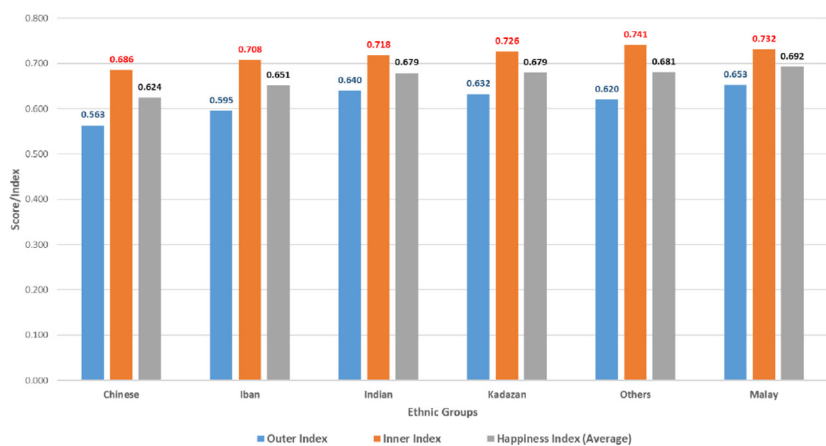

Figure 5. Outer, Inner, and Happiness Indices based on Ethnic Groups in Malaysia.

(2016) and Bobowik et al. (2015), ethnic minorities tend to be less happy than majority populations.

Going into more detail, the Malay scored highest in the outer index (0.653) and second highest in the inner index (0.732). However, the Han Chinese scored lowest in both the outer and inner indices (0.563 and 0.686), respectively. Therefore, it is crucial that policymakers provide special attention, mutual understanding, and support to ethnic minorities and the indigenous groups in Malaysia. In terms of the outer index, the Iban scored second lowest (0.595) after the Han Chinese, followed by other ethnicities (0.620), Kadazan (0.632), and Indians (0.640). For the inner index, the Iban also scored the second lowest (0.708) after the Han Chinese, followed by Indians (0.718), Kadazan (0.726), and other ethnicities (0.741). Hence, it seems like the states and federal territories with a higher ratio of ethnic minorities are less happy.

5. Discussion

5.1. Novelty of the research

This study is the first attempt to integrate subjective inner indicators into a proposed happiness index; most existing global happiness indices are focused on the outer dimensions. In addition, this research is also the first attempt to incorporate a psychological model into an integrated happiness framework and test it with a case study. To date, numerous happiness measurement studies have been conducted worldwide. However, none of the non-GDP-based measurement models we identified have incorporated a positive psychology model into their happiness measurement. They usually included one or two psychological components instead of a whole model. Furthermore, some previous studies have focused solely on the psychological perspective, without incorporating any outer indicators (Lorente et al., 2019). Thus, this study provides a foundation for an interdisciplinary integration of economics-based and psychology-based measurements of happiness. In this way, this study significantly contributes to the knowledge of happiness indices, psychology, and economics.

By integrating almost all the outer dimensions of happiness identified in the extensive literature reviews, the proposed framework presents a broad picture of the public's outer and inner dimensions of happiness. Since human well-being is the best absolute indicator of sustainable development, a holistic happiness measurement model is crucially needed to achieve sustainable development. Based on such an approach, policymakers can better understand and measure the needs of their

people without simply stressing yearly economic production and consumption. The uniqueness of this framework can serve as a guideline for developing new holistic national happiness indices. The findings also reveal more evidence that policymakers need to have a deeper look at a spectrum of various factors when considering national happiness. Furthermore, they provide insights into how and when policymakers can adequately and effectively cultivate happiness. This is a practical contribution to policymaking and society at large.

5.2. Happiness and ethnicity in Malaysia

Referring to the result of the data analysis, the study found an interesting link between ethnicity and happiness. Based on the Malaysia National Census 2010, the states and federal territories that consist of a higher ratio of native people, including Malay and indigenous groups, tend to be happier. For example, Melaka and Terengganu have a higher ratio of native people (66.9% and 97%, respectively). These two states are happier than Johor and Penang, which comprise a slightly lower ratio of native people (58.9% and 43.6%, respectively). This result may be driven by the interconnected relationships between ethnicities' happiness and states' happiness. Different ethnic groups may face different difficulties because of the nature of their characteristics, occupations, family structures, social status, values, life expectations, education and skill levels, special privileges, opportunities, and discrimination experiences. According to Harris and Han (2020), unfair multiracialism continues both structurally and informally in Malaysian society. Minorities in Malaysia experience cultural and political discrimination. Chng and Tan (2017) found that people become annoyed and antagonistic when they are being racially excluded. Hence, racial discrimination may be one of the reasons for unhappiness, especially among non-native citizens. Along these lines, Kushnirovich and Sherman (2018) found a significant happiness gap between the majority group and the migrant minority group (Israeli-born Arab citizens) in Israel. Jun et al. (2017) also revealed that whites will withhold their support for white political candidates who are highly identified with their race to avoid provoking minorities in the US. In summary, policies should focus on increasing the economic possibilities of minority groups. Research focusing on various perspectives such as ethnicity, culture, religion, and region is crucial to improving human happiness and looking beyond GDP for long-term sustainability. This study's findings from Malaysia reveal the perspective of a multiracial developing country.

5.3. General well-being among malaysian

In general, among the outer indicators, Malaysians are less satisfied with their safety conditions, governance performance, and economic achievements. Firstly, happiness depends heavily on safety concerns. Yamada et al. (2009) revealed that personal safety is considered one of the key facets of life among university students. According to Cheng and Smyth's (2015) study in China, living in a safe neighborhood has a positive effect on happiness. Perceived neighborhood qualities are also significantly associated with the happiness of Japanese people across life stages (Kim and Lee, 2018). Secondly, governance performance is vital; many empirical studies have verified the robust connection between happiness and governance. Urban governance is one of the key factors that influence happiness (Musa et al., 2017). Orviska et al. (2014) revealed that democratic satisfaction also has an impact on happiness. Thirdly, with regards to economic needs, many studies have linked economic development to happiness. Inflation, income, and unemployment are the three main economic factors that have a wide influence on happiness (Frey and Stutzer, 2010). However, high incomes do not necessarily improve emotional well-being (Kahneman and Deaton, 2010). More money can enhance subjective well-being (by preventing poverty or as the result of living in a developed nation); nonetheless, the effect reduces in the long term (Diener and Biswas, 2002). According to Mahadea (2013), high income leads to higher happiness in developing

countries. However, high income indirectly leads to happiness after an income threshold is reached in developed countries. Hence, the findings of the present study contradict Mahadea (2013). We found that high (low) income states and federal territories are less (more) happy in Malaysia, a developing country. This could be explained by the fact that Malaysians have lower expectations or greater inner strengths.

Looking at the inner indicators, Malaysians showed lower scores in engagement and accomplishment, suggesting they are not living in a way that cultivates their virtues and strengths. When employees are engaged in their work, they are highly energetic, enthusiastic, and fully immersed in their jobs (Schaufeli and Bakker, 2004). Choi (2016) discovered that university students in South Korea who were more deeply engaged in their studies showed better performance and higher satisfaction. Therefore, enhancing engagement in life is an important aim. According to Joo and Lee (2017), higher perceived organizational support and psychological capital will increase employees' engagement in their work and satisfaction with their careers, and eventually make them happier. Engagement also requires control over one's actions; it increases when a person has autonomy in his or her work (Bakker et al., 2003; Iwasaki et al., 2018). Once students generate a positive attitude toward their studies, they are more engaged in studying (Cotton et al., 2002). Additionally, satisfaction obtained from internal communication will increase employee engagement and happiness (Lalić et al., 2020). Moreover, mindfulness has been positively related to work engagement by enhancing the experience of being engaged and focused (Coo and Salanova, 2018). Thus, maintaining positive states of mind, such as being focused in the present moment, is an important indicator of well-being (Bakker and Demerouti, 2008) and promotes organizational functioning (Rich et al., 2010). Instead of solely depending on future-oriented working styles, present-moment-focused working styles may be more effective (Shonin et al., 2014). In summary, self-control, positive attitudes, mindfulness, perceived organizational support, autonomy, and efficient internal communication are vital to cultivate engagement. These skills need to be incorporated into Malaysian education and internalized into the culture. Discovering Malaysians' strengths and engaging these strengths in daily life activities will eventually increase their happiness and appreciation of themselves, others, and the world.

5.4. Limitations and future studies

The major limitation of this study is that respondents may not have answered honestly. Respondents may have assumed that the government had implemented this research. For instance, two questions within the questionnaire asked, "How satisfied are you with the performance of police in preventing crime?" and "How satisfied are you with the performance of police in responding promptly to a crime?" For each query, respondents were not satisfied with the services or overall performance of the police; however, they favored playing it safe and circling the average range instead of describing themselves as unsatisfied. It is likely that some of them were worried that their answers might be discovered by third parties, even though the researchers ensured participants that the survey was anonymous.

In addition, this study was unable to determine the effect of the proposed integrated happiness model and variable patterns over time. Compared to cross-sectional studies, longitudinal studies are more powerful and provide high accuracy when observing changes. It would be useful if future research tested our model in a longitudinal study. A continuous national survey of happiness based on a holistic and empirical framework is crucial for obtaining precise longitudinal data. Moreover, the occupation of the sample in this study appeared to be skewed towards office workers. Additional empirical work is required to adequately cover manual workers.

Furthermore, more empirical work on the inter-relationships between inner and outer indicators is needed. Understanding the causal paths between these variables is vital to contribute to the knowledge of happiness indices and improve their accuracy and inclusiveness. In addition, the effect of the outer and inner dimensions on happiness can be studied

further to determine a suitable weightage of both dimensions based on different countries' conditions. Referring to the literature review, positive psychology strongly and positively affects happiness, which could nurture positive resources to counteract the negative symptoms (Forgeard et al., 2011; Kern et al., 2014; Mercer and MacIntyre, 2014; Sepulveda and Ibáñez, 2013; Smit, 2015). Expanding research on this dimension is essential. In addition, most of the outer indicators in this study focused on the respondents' satisfaction with their human-made surroundings. Hence, the framework can be further expanded to incorporate the effect of the natural environment on human happiness.

Besides that, the proposed happiness framework should be tested in different national contexts, including in developed countries. Geographical, ethnic, gender, and age differences in happiness may also be further explored. Differences in the inner dimensions of different cities require further investigation to study the reasons behind them.

6. Conclusion

In summary, this study is the first attempt to incorporate a psychological model into an integrated happiness framework with equal weighting. This framework can serve as a guideline to assist policymakers in designing happiness measurements and developing better policies. National happiness needs to be measured more frequently and should not simply stress economic production and consumption. Such an approach will eventually facilitate the progress of sustainable development. The increase in adolescents' depression and anxiety disorder in Malaysia from 12% in 2011 to 29% in 2017 (Othman and Essau, 2019) is alarming. Referring to Büchs and Koch (2019), degrowth scholars and activists have argued that degrowth in developed nations will need to be part of a global effort to tackle climate change and to preserve the conditions for future generations' basic needs satisfaction. Against this background, a new "measuring rod" for well-being is needed as well as a dialogue between current and future generations to support cultural shifts in well-being. Happiness policies should take into account the complicated influence of psychological factors (Senik, 2014). They should incorporate the insights of the PERMA model, which can be used to educate individuals who are struggling to enhance their well-being (Peterson et al., 2005). Hence, an inclusive happiness model that covers inner psychological and outer objective factors is essential.

Declarations

Author contribution statement

Shay-Wei Choon: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools, or data; Wrote the paper.

Chia-Chi Yong: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Siow-Kian Tan: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools, or data.

Siow-Hooi Tan: Performed the experiments; Contributed reagents, materials, analysis tools, or data.

Funding statement

Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

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