ASSESSMENT OF SUSTAINABLE HOUSING AFFORDABILITY IN MALAYSIA BASED ON PEOPLE'S PERCEPTION USING COPRAS METHOD

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Abstract

Rapid urbanisation and economic development in Malaysia since the late 1980s has resulted in a significant expansion of housing development in urban areas. The Malaysian housing sector has thrived owing to growing market and active supply-demand dynamics. However, the increase in housing price has aroused greater public concern about the future direction of the housing sector in this country. Cheap and low-quality houses have often been associated with affordable housing. Nevertheless, this may not be true if sustainability is taken into account. In dealing with sustainable housing affordability, the criteria relating to social, economic and environment are necessary to be considered in determining the best alternative for the sustainable area. This research was conducted in Klang Valley, Malaysia using COPRAS method. The results indicate that area with high utility degree is the best area that conforms to the sustainable housing affordability criteria and vice versa. The research has contributed to a new knowledge because it is the first paper in Malaysia to address such issues using COPRAS framework.

Keywords: *Sustainability, COPRAS, MCDM, Housing, Affordability*

1. INTRODUCTION

The government of Malaysia aspires to accommodate the population in quality and affordable housing as stipulated in the National Housing Policy. Malaysia has extensive laws covering property development in which its focus revolves around fulfilling the need and requirements for sustainable development through physical, economic, social as well as environmental (Othman, K. N., and Alias, A., 2011). The sustainable housing can be represented as being analogous to ecologically sustainable development which in many cases reduces to smaller concept around environmental performance, water treatment or energy efficiency (Pullen et. al., 2010).

The idea of sustainability is relatively acceptable in Malaysia but opened to the critical solution. Abidin (2010) believes that Malaysian property developers are now beginning to embrace the concept of sustainability as part of their marketing campaign and strategic product differentiation as compared to their competitors. Realising the need to balance up the relationship between economic development, social integration and environmental protection, the government has taken a multitude of initiatives to minimise the impact of economic growth on the environment Abidin, Z.N. (2010).

Although sustainable housing affordability generates much interest among researchers in other countries, none of the local studies has focused on sustainable housing affordability. Thus, the main objective of this paper is to establish a set of criteria for sustainable housing affordability which will be used to identify the best area that can sustain its housing affordability. The study employs one of the Multi-Criteria Decision Making (MCDM) techniques namely the multi-attribute Complex Proportional Assessment (COPRAS) method. In order to gain more insight into the sustainable housing affordability, this paper is organised as follows. First, relevant literature encompasses the concept of sustainability, sustainable housing affordability and factors influencing them are discussed. Then, follows the discussion on the criteria of sustainable housing affordability and the tools used in assessing sustainability. Thereafter, analysis and conclusion of the paper are presented and discussed.

1.1 The Concept of Sustainability

The term sustainability is vague and open to different interpretations. There is no single definition can describe the very word of sustainability. Beck and Cummings (1996) argue that debate on what constitutes sustainability will only retard progress in making the concept of sustainability operational, Beck and et. al (1996). Perhaps this uniqueness that makes this term so much interesting. The lack of authoritative definition allows it to embody broad concepts which in turn, bestow upon it the ability of being flexible. In other words, it can be adopted locally to suit the local context and any situation.

Sustainability in the most direct definition is the observation of balancing between the three fundamentals; economic development, social equity and environmental protection (Drexhage & et.al, 2010). Figure 1 illustrates the integrated nature of the concept of sustainability which brings together the impact of economic, social and environment. In a wider aspect, sustainability can also include social attributes (health and equity), human values (freedom tolerance and respect for nature) and ecological (climate, air quality and land-use efficiency) (Kates et. al. (2005);Islam, N. (1996); Van Vliet, W. (1996). White (2013) on the other hand used a tag cloud system to identify the most recurrent word used to define sustainability. A tag cloud or word cloud is visually representing a particular part of the text for the purpose of making analytical comparisons. White (2013) found that the most common words which define sustainability are the environment, social and economic, life, system and nature.

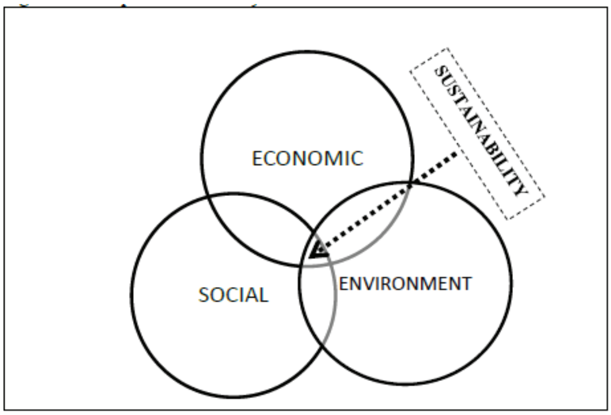

Figure 1: Concept of Sustainability

In addition, Kibert (2004) defines the sustainable building as facilities which are the outcome of sustainable construction for the sole objective of enhancing health, improve resources efficiency and limiting the detrimental effect of the built environment on the ecological system. On the other side of the coin, Hardi and Zidan (1997) define sustainability in a more philosophical nature where it revolves around the idea of being a persistence of particular necessary and desired attributes of people, communities and organization surrounding the eco-system over an indefinite period. This idea expresses the interrelationship between people and its surrounding.

1.2 Sustainable Housing Affordability

Medineckiene et al. (2010) highlight the need for a sustainability method that would incorporate the concept of sustainability into decision-making as more and more people in this world are still living in an inadequate shelter. The subject matter should consider the current situation of economic, social and built environment. Maliene and Malys (2009) put forward the notion of sustainable housing as those that are well available, high quality, economical, ecological, aesthetical, design, comfortable, and cosy. Sustainable housing should also consider the short and long-term costs of running a home or in another word; it is not only affordable but also cost-efficient with good energy, waste, and water management.

Mulliner and Maliene (2011) introduce the premise of ‘sustainable housing affordability’ in which they establish an initial system of criteria that somehow represents the core concept of sustainable housing affordability. Mulliner and Maliene (2011) argue that housing affordability shall not be considered in isolation with other criteria namely location, social, environment and economic sustainability of the housing. Mulliner and Maliene (2011) further suggested that affordable housing is not merely about cheap homes, but it must take into consideration a lot of other factors.

Mulliner et al. (2013) further enforced that housing which is not well connected to jobs, high-quality services and infrastructure has contributed to low demand and resulted in abandonment. Therefore, sustainability should deal with the major backbone of housing design and a fundamental dimension of housing quality. The pre-requisite for sustainable housing affordability is not limited to physical attributes, but also stresses the importance of community involvement and the challenge of getting the ‘right mix’.

Choguill (2007) proposes a set of policies for the housing sector to be sustainable in each of the chosen areas. It includes involvement of the community, affordable and quality of construction material, development of building standards, housing finance and the regulation of land matter; all of which are supposed to support sustainable housing. Iman (2006) suggests the same view where a sustainable housing must be environmentally appropriate, financially viable, socially acceptable and technically feasible. Payne and Raiborn (2001) interestingly pointed out that the term 'environmentally appropriate' refers to a human or its inherent value.

1.3 Criteria for Sustainable Housing Affordability

Many researchers have ventured into the discussion on what makes housing sustainable and affordable. Karuppannan and Sivam (2009) particularly listed down a myriad of indicators to achieve sustainable development and affordable housing. They found that there were many instances where elements of affordability are aligned with sustainability domain which is common to both affordability and sustainability domains. Therefore, it is theoretically possible to sustain affordable housing.

The measures to implement environment sustainability in affordable housing go against the primary objective of providing cheap houses (Yates, J. 2008). Since the cost to implement sustainability can be very high, it will eventually be absorbed as housing cost. Moreover, sustainability has received limited attention in valuation profession (Warren-Myers, G., 2013) and as a result, the investors hesitate to invest in sustainable housing. Therefore, less investment reduces innovators' incentive to implement the concept of sustainability. On the contrary, MacKillop (2012) was of the opinion that sustainable housing can significantly impact affordability by minimizing or reducing the overall use of energy and water consumption.

Pullen et al. (2010) develop a framework to determine the criteria for sustainable housing affordability. Pullen et al. (2010) establish a set of criteria consist of nine distinct elements and sub-elements that clearly describe the core elements. The core elements include efficiency (energy, water), construction (materials, methods), procurement (government, private, public-private partnership), affordability (purchase or rent), desirability, dwelling sizes, appropriate density (low, medium, high), adaptability and social acceptability. On the same token, Mcalpine & Birnie (2007) introduce a 2-tier system of sustainability consist of a headline and strategic indicators to monitor the quantifiable sustainability themes. The indicators include, among others, the quality of housing, environment quality, land use, household and commercial waste and local transportation.

This paper applies a combination of literature review and semi-structured interviews that were verified by questionnaire surveys to determine their relative importance. However, it is not ideal to implement the same concept as implemented in other countries due to different culture, preferences and attitude of the Malaysians. Using Mulliner and Maliene (2011) work as a base, this paper adds, removes and adjusts the criteria to suit the local context. The final list of positive factors tailors to Malaysian context was developed (Table 1). Nevertheless, the impact of such indicators on housing sustainability can be difficult to assess as suggested by Dahl, A. L. (2012). Therefore, the indicators set in Table 1 are used to justify the best area that suits sustainable housing affordability as a result of the impact of such indicators.

Table 1: Selected Criteria for Sustainable Housing Affordability in Malaysia

Sustainable Housing Affordability Indicators		**Sources**
F1	House Price	(Burke et al., 2007; Mulliner & Maliene, 2011)
F2	House Quality	(Department of the Environment Heritage and Local Government, 2007; Mulliner & Maliene, 2011; The Ministry of Urban Wellbeing Housing and Local Government, 2013)
F3	House Type	(Hurtubia et al., 2010)
F4	House Finishes	(Fierro et al., 2009)
F5	House Design	(Fierro et al., 2009)
F6	Interior Features	(Hurtubia et al., 2010)
F7	Position of the House in Layout Plan	(Hurtubia et al., 2010)
F8	Size of Built-up Area	(Fierro et al., 2009)
F9	Size of Land Area	(Fierro et al., 2009)
F10	Built-up Area	(Fierro et al., 2009)
F11	Age of the House	(Fierro et al., 2009)
F12	Topography	(Fierro et al., 2009)
F13	Property Interest	(Lu, 2002; Saunders, 1990)
F14	Near to Commercial Area	(Mulliner & Maliene, 2011; Samuels, 2004)
F15	Near to Hospitals	(Mulliner & Maliene, 2011; Zhu et al.,2006)
F16	Near to Post Office	Own research
F17	Near to Entertainment	(Isalou et al., 2014; Mulliner & Maliene, 2011; Yusuf & Resosurdarmo, 2009
F18	Near to Transportation	(Australian Conservation Foundation, 2008; Mulliner & Maliene, 2011)
F19	Near to Place of Worship	Own research
F20	Near to Education	(Clark et al., 2006; Mulliner & Maliene, 2011; Samuels, 2004)
F21	Near to Workplace	(King, 2008; Mulliner & Maliene, 2011)
F22	Environment Quality	(Cowan & Hill, 2005; Zhu et al., 2006)
F23	Security	(Hipp, 2010; Samuels, 2004)
F24	Traffic Congestion	(Brownstone & Golob, 2009; Shen et al., 2011)
F25	Density	(Brownstone & Golob, 2009; Samuels, 2004)
F26	View	(Zhu et al., 2006)
F27	Exterior Condition	Own research

F28	Availability of Waste Management	(Hardi & Zidan, 1997; Joseph, 2006; Mulliner & Maliene, 2011)
F29	Safety Level	(Hipp, 2010; Samuels, 2004)
F30	Theme or Concept	Own research
F31	Availability of Child Care	(Mulliner & Maliene, 2011)
F32	Electrical Supply	(Elliot & Stratford, 2009; Maliene & Malys, 2009; Mulliner & Maliene, 2011)

1.4 Measuring Sustainable Housing Affordability

Assessing sustainability can be a daunting task. Very few researchers have embarked on the quest to assess the progress and effectiveness of sustainability application. Authors such as Pullen et al. (2010), describe the development and assess affordability and sustainability in residential developments where it stressed the need for a more integrated system-based approach that reflects a clearer need for social sustainability. Furthermore, Medineckiene et al. (2010_a) turn the spotlight on the importance of a process of addressing sustainability to integrate the concept of sustainability into decision-making procedure. Mulliner and Maliene (2011) push the boundary by proposing a set of criteria that represents sustainable housing affordability. A multi-criteria decision making (MCDM) technique is then used to assess and rank the said criteria. Several researchers focus on the strengths and weaknesses of diverse criteria or factors in assessing sustainable housing affordability (Hak, et al, 2012; , Hardi, P., & Zidan, T. 1997; Mori and Christodoulou, 2012).

2. METHODOLOGY

The geographical area of study is the Klang Valley because this region constitutes almost half of the total amount of residential construction stocks in the country [42]. Questionnaires were distributed to residents within six of the most demanded areas namely Petaling Jaya ($\mathbf{q_1}$), Kuala Lumpur ($\mathbf{q_2}$), Klang ($\mathbf{q_3}$), Shah Alam ($\mathbf{q_4}$), Putrajaya ($\mathbf{q_5}$) and other area within the same region ($\mathbf{q_6}$). The purpose of the questionnaires is to verify and elicit respondents' opinion on what factors constitute sustainable housing affordability. All the 1000 distributed questionnaires were returned from valid respondents of which 179 from Petaling Jaya, Kuala Lumpur (189), Klang (213), Shah Alam (190), Putrajaya (201) and others (28).

The total of 32 criteria or factors is considered to be relevant in assessing sustainable housing affordability as listed in Table 1. Respondents distinguish each factor based on its relative importance towards sustainable housing affordability. Responses are ranked on a five-point Likert Scale. Likert scale was used because of its simplicity in expressing the respondent level of agreement. The established ranks are then evaluated using the COPRAS method which is one of the MCDM techniques.

2.1 Complex Proportional Assessment (COPRAS) and Multi-Criteria Decision Making (MCDM)

Most existing literature focuses on house price rather than holistic measures of the condition, locational attributes and neighbourhood characteristic Bogdon & Can, A. (1997). A Complex Proportional Assessment (COPRAS) method applies to the varieties of research in built environment. COPRAS is used as a tool to assess sustainable housing affordability based on factors or criteria systems as discussed before. The method is suitable for cases where data are expressed in interval forms (Popovic et. al 2012) and used to determine the priority and the utility degree of alternatives (Zavadskas & Kaklauskas, 1996); [Zavadskas et. al, 2008). Ustinovichius et al. (2007) characterize COPRAS and its variations (COPRAS-G, COPRAS-F) as a method to account for direct and proportional significance and the weightage of another alternative on a system of factors

COPRAS is one of the many MCDM techniques. More examples of MCDM techniques include, among others, SAW, ELECTRE, AHP and TOPSIS, which serve a distinct purpose. For example, AHP is suitable when preferences for several criteria and alternative cannot be quantified (Eldrandaly and AbdelAziz, N. 2009). MCDM is particularly useful in making a highly complex decision by applying weigh or priorities (Aruldoss et.al, 2013) involving a careful selection of resources to ensure the accuracy of criteria, alternatives or factors (Haarstrick and Lazarevska, 2009). Due to its effectiveness and simple process, MCDM has gained wide acceptance throughout different sectors such as information technology, construction industry and sports (Dey et. al., 2011; Zhu et. al., 2006; Zolfani, et. al., (2008). There is also a plenty of MCDM application relating to built environment (Table 2). COPRAS seems to be well recognised and widely used in assessing sustainability issues in built environment.

Table 2: The use of MCDM technique in built-environment

Author	Related Research	Method Used
Medineckiene (2016)	-Focuses on multi-criteria selection of a dwelling house - taking into account the ecological aspects and impact on the environment, economic and social conditions.	COPRAS, SAW, MEW, AHP
Zolfani et al (2008)	-Focuses on quality control managers with a set of criteria namely knowledge of product and raw material, experience and educational background, administrative orientation, behavioral flexibility, risk evaluation ability, payment and teamwork	AHP, COPRAS-G
Bender et.al . (2000)	- Focuses on the perception of environmental quality in residential areas - Using different environmental quality factors	AHP
Kaklaukas et.al (2007a) Kaklaukas et.al (2008b)	- Focuses on construction factors, among others, economic, quality, technical, technological and comfort.	COPRAS
Mulliner & Maliene (2011)	- Focuses on housing affordability in different locations using a set of criteria according to their relative importance to sustainable housing affordability.	COPRAS

The advantages of COPRAS as compared to other types of MCDM techniques can be summarised as follow (Mulliner & Maliene, 2011):

- The simplicity of design and calculation.
- High adaptability.
- The complete aggregate of ranking.
- Measuring both quantitative and qualitative in a single test.
- Flexibility to account for both positive and negative (maximising and minimising) evaluation criteria.
- Estimation of alternative degrees of utility in considering the better or worse alternative.

2.2 Evaluation of Sustainable Housing Affordability by Utilizing COPRAS Method

The data were analysed using COPRAS method involving five main steps (Kaklauskas et. al, 2005), [Kaklauskas et.al. (2007_a); Kaklauskas et.al. (2007_b); Dey et. al., 2011); Mulliner et. al 2013).

1. A selection of various factors and the normalisation of the decision-making matrix. As mentioned, the purpose of this paper is to assess sustainable housing affordability in a number of alternative areas to create a ranking of alternatives. Thus, COPRAS with the ability to handle both positive and negative factors come in handy. The following formula is used by taking the overall mean score to allow direct comparison between all factors:

$$m_{pq} = \frac{\bar{\bar{w}}_{pq}}{\sum_{q=1}^{n} x_{pq}} x_{pq}$$

Where x_{pq} is the value of the ***p***-th criterion of the ***q***-th options, and $\bar{\bar{w}}_p$ is the weight of the ***p***-th criterion.

Table 3 shows the overall mean score for each factor and derive the overall score and relative weight, $\bar{\bar{w}}$.

Table 3: Overall mean score and the weight of each factor

Factors	**Mean Score (overall)**	**Weight, m**
House Price	4.2747	3.3755
House Quality	4.1847	3.3044
House Type	3.8889	3.0709
House Finishes	3.8443	3.0356
House Design	3.8345	3.0279
Interior Features	3.7409	2.9540
Position of the House in Layout Plan	3.8271	3.0221
Size of Built-up Area	3.9264	3.1005
Size of Land Area	3.8937	3.0746
Built-up Area	3.9372	3.1090
Age of the House	3.9027	3.0818

Topography	3.8343	3.0277
Property Interest	4.0255	3.1787
Near to Commercial Area	3.9000	3.0796
Near to Hospitals	3.9869	3.1482
Near to Post Office	3.7755	2.9813
Near to Entertainment	3.6168	2.8560
Near to Transportation	4.0728	3.2161
Near to Place of Worship	4.0132	3.1690
Near to Education	4.0353	3.1865
Near to Workplace	4.0335	3.1850
Environmental Quality	4.1628	3.2871
Security	4.0728	3.2161
Traffic Congestion	4.0325	3.1843
Density	3.8576	3.0461
View	3.8564	3.0452
Exterior Condition	3.9798	3.1426
Availability of Waste Management	4.0152	3.1706
Safety Level	4.2571	3.3616
Theme or Concept	3.6620	2.8917
Availability of Child Care	3.8632	3.0506
Electrical Supply	4.3306	3.4196
Total	**126.6389**	**100.0000**

Table 4 indicates the mean score for each option and derives the individual mean score of each factor, which is essential for the next step.

Table 4: The weight and mean score for each factor

Factors, p	**Weight, w**	**Mean score for each option, *q***					
		q_1	q_2	q_3	q_4	q_5	q_6
House Price	3.3755	4.3128	4.4392	4.4645	4.2312	3.9391	4.1429
House Quality	3.3044	4.1404	4.3545	4.3128	4.1183	4.0000	4.1071
House Type	3.0709	3.9326	3.9312	3.8768	3.8011	3.8990	3.9286
House Finishes	3.0356	3.8427	3.8511	3.9194	3.7849	3.8030	3.9286
House Design	3.0279	4.1006	3.7447	3.8768	3.7204	3.7337	3.8929
Interior Features	2.9540	3.8764	3.6684	3.8483	3.6432	3.6583	3.7857
Position of the House in Layout Plan	3.0221	3.8202	3.8889	3.8571	3.7634	3.7828	3.9643

Size of Built-up Area	3.1005	3.8436	3.9894	4.0095	3.8656	3.8442	4.3929
Size of Land Area	3.0746	3.7640	3.8936	4.0190	3.9247	3.8030	4.2222
Built-up Area	3.1090	3.8268	3.9677	4.0758	3.9135	3.8384	4.2500
Age of the House	3.0818	3.8827	3.8763	4.0332	3.8750	3.8291	3.9286
Topography	3.0277	3.7472	3.7419	3.9858	3.8352	3.7990	4.1071
Property Interest	3.1787	3.8409	4.0688	4.2180	4.0440	3.9082	4.1481
Near to Commercial Area	3.0796	3.8827	4.1111	3.9336	3.7935	3.7839	3.8571
Near to Hospitals	3.1482	3.8324	4.2646	3.9479	3.9838	3.9347	3.7857
Near to Post Office	2.9813	3.6089	3.8984	3.8294	3.7135	3.8442	3.5357
Near to Entertainment	2.8560	3.4407	3.6402	3.6967	3.5568	3.7035	3.7500
Near to Transportation	3.2161	3.9777	4.3968	3.9479	4.1027	3.9391	4.1786
Near to Place of Worship	3.1690	4.1404	4.0423	3.8294	4.0811	4.0153	3.9286
Near to Education	3.1865	3.9218	4.0317	3.9479	4.1189	4.1357	4.1786
Near to Workplace	3.1850	4.0447	4.1217	3.9905	4.1250	3.8872	4.1071
Environmental Quality	3.2871	4.1742	4.2751	4.1564	4.2120	4.0000	4.2143
Security	3.2161	4.1173	4.3651	4.0190	4.0055	3.8794	4.0357
Traffic Congestion	3.1843	3.9492	4.2116	4.0865	3.9946	3.9095	4.0714
Density	3.0461	3.8436	3.9418	3.8152	3.8207	3.8492	4.0000
View	3.0452	3.8045	3.9101	3.8810	3.7880	3.8744	3.9643
Exterior Condition	3.1426	3.9330	4.0529	3.9716	3.9891	3.9548	3.9643
Availability of Waste Management	3.1706	3.8764	4.1852	4.0237	4.0870	3.8939	4.0714

Safety Level	3.3616	4.2416	4.5397	4.2180	4.2717	4.0251	4.2963
Theme or Concept	2.8917	3.6927	3.7143	3.6682	3.5297	3.6884	3.7500
Availability of Child Care	3.0506	3.7978	3.9048	3.8048	3.8152	4.0101	3.7143
Electrical Supply	3.4196	4.2753	4.5319	4.3839	4.3135	4.1357	4.4286
Total	**100.0000**						

2. Summation of weighted normalizes decision-making matrix by calculating the sums of both positive and negative alternatives (Table 5). The sums of S_{+q} of attributes values which provide larger values are preferable (optimization direction is maximising) as compared to other options. The sums of S_{-q} of attributes values which constitute smaller values are preferable (optimization direction is minimising) as compared to other options. For example, the lower the negative (minimising) values for the house price, the better the sustainable housing affordability is. Likewise, the higher the positive (maximising), the better it indicates. The formula to calculate the sums are as follows:

$$S_q^+ = \sum_{e_p=+} m_{pq}$$

$$S_q^- = \sum_{e_p=-} m_{pq}$$

Table 5 represents the normalised decision matrix for the six chosen areas in the Klang Valley region namely Petaling Jaya (**q_1**), Kuala Lumpur (**q_2**), Klang (**q_3**), Shah Alam (**q_4**), Putrajaya (**q_5**) and other (**q_6**). Other (**q_6**) refers to the area within the Klang Valley region which does not fall under the five main areas (q_1- q_5).

Table 5: Normalized decision matrix

Factors, p	**e**	**Options, q**					
		q_1	**q_2**	**q_3**	**q_4**	**q_5**	**q_6**
House Price	-	0.570	0.587	0.590	0.559	0.521	0.548
House Quality	+	0.547	0.575	0.569	0.544	0.528	0.542
House Type	+	0.517	0.517	0.509	0.499	0.512	0.516
House Finishes	+	0.504	0.505	0.514	0.497	0.499	0.516
House Design	+	0.538	0.492	0.509	0.488	0.490	0.511
Interior Features	+	0.509	0.482	0.506	0.479	0.481	0.497
Position House in Layout Plan	+	0.500	0.509	0.505	0.493	0.495	0.519

Size of Built-up Area	+	0.498	0.517	0.519	0.501	0.498	0.569
Size of Land Area	+	0.490	0.507	0.523	0.511	0.495	0.549
Built-up Area	+	0.498	0.517	0.531	0.510	0.500	0.553
Age of the House	-	0.511	0.510	0.531	0.510	0.504	0.517
Topography	-	0.489	0.488	0.520	0.500	0.495	0.536
Property Interest	-	0.504	0.534	0.553	0.531	0.513	0.544
Near to Commercial Area	+	0.512	0.542	0.519	0.500	0.499	0.508
Near to Hospitals	+	0.508	0.565	0.523	0.528	0.522	0.502
Near to Post Office	+	0.480	0.518	0.509	0.494	0.511	0.470
Near to Entertainment	+	0.451	0.477	0.485	0.466	0.485	0.492
Near to Transportation	+	0.521	0.576	0.517	0.538	0.516	0.548
Near to Place of Worship	+	0.546	0.533	0.505	0.538	0.529	0.518
Near to Education	+	0.514	0.528	0.517	0.539	0.542	0.547
Near to Workplace	+	0.531	0.541	0.524	0.541	0.510	0.539
Environmental Quality	+	0.548	0.561	0.546	0.553	0.525	0.553
Security	+	0.542	0.575	0.529	0.527	0.511	0.531
Traffic Congestion	-	0.519	0.554	0.537	0.525	0.514	0.535
Density	-	0.503	0.516	0.499	0.500	0.504	0.524
View	+	0.499	0.513	0.509	0.497	0.508	0.520
Exterior Condition	+	0.518	0.534	0.523	0.525	0.521	0.522
Availability Waste Management	+	0.509	0.550	0.529	0.537	0.511	0.535
Safety Level	-	0.557	0.596	0.554	0.561	0.529	0.564
Theme or Concept	+	0.484	0.487	0.481	0.463	0.484	0.492
Available of Child Care	+	0.503	0.517	0.504	0.505	0.531	0.492
Electric Supply	+	0.561	0.594	0.575	0.566	0.543	0.581

3. The relative significance $\boldsymbol{H_q}$ of each option, based on positive (+) and negative (-), are calculated using the formula below:

$$H_q = S_q^+ + \frac{S_{min}^- \sum_{q=1}^{n} S_q^-}{S_q^- \sum_{q=1}^{n} \frac{S_{min}^-}{S_q^-}} = S_q^+ + \frac{\sum_{q=1}^{n} S_q^-}{S_q^- \sum_{q=1}^{n} \frac{1}{S_q^-}}$$

Where the minimum values S_q^- are cancelled, the higher value corresponds to a more sustainable housing affordability.

4. In this stage, prioritisation is determined by the largest $\boldsymbol{H_q}$. $\boldsymbol{H_{max}}$ is the optimal value and the best among alternatives. Options are ranked from highest to lowest of relative significance $\boldsymbol{H_q}$. (Table 7)

5. The degree of utility is determined by comparing each option by the one option with $\boldsymbol{H_{max}}$. The area with the highest degree of utility ($\check{u}_q$ = 100%) represents an area that most satisfies sustainable housing affordability. Other options will show utility values ranging from 0%-100% indicators of the worst to best-case scenario. The degree of utility $\check{u}_q$ of the options $\boldsymbol{O_q}$ is calculated by the following formula:

3. RESULTS AND DISCUSSION

3.1 Demographic

Distribution of respondents was divided almost equally between the six regions. Each area represents circa 20% share of total respondents (+-2%) and only 3% respondents are from 'others' (Figure 2).

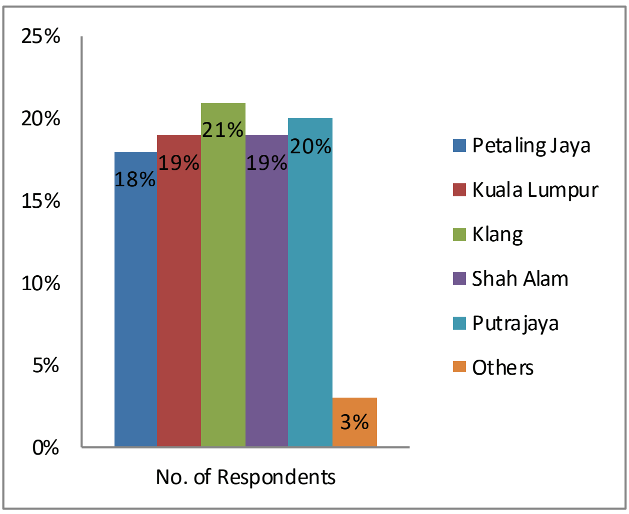

Figure 2: Distribution of respondents according to area

Table 6 accounts for a demographic analysis of the respondents according to employment sector, marital status and sex. There are 425 (42.5%) government and 575 (57.5%) private sector employees. The total of 436 respondents (43.6%) are single, and 549 (54.9%) are married while only 15 (1.5%) respondents are divorced. The distribution of male-female is almost equal to 49.6% (496 respondents) and 50.4% (504 respondents) respectively.

Table 6: Demographic Analysis

Categories		Percentage (%)
Employment Sector	Government	42.5
	Private	57.5
Marital Status	Single	43.6
	Married	54.9
	Divorced	1.5
Sex	Male	49.6
	Female	50.4

3.2 COPRAS

The step-by-step procedure in COPRAS assessment (Section 2.2) produces the following results (Table 7).

Table 7: Selected Sustainable Housing Affordability Areas

Criteria p	$\mathbf{q_1}$		$\mathbf{q_2}$		$\mathbf{q_3}$		$\mathbf{q_4}$		$\mathbf{q_5}$		$\mathbf{q_6}$	
S_q^+	12.83		13.23		12.98		12.84		12.75		13.12	
S_q^-	3.65		3.78		3.78		3.69		3.58		3.77	
$\boldsymbol{H_q}$	16.59		16.86		16.61		16.57		16.59		16.77	
Priority	4		1		3		6		5		2	
$\check{U}_q$(%)	98.38%		100.00%		98.51%		98.25%		98.36%		99.46%	

Table 7 shows that the location that best describes the most sustainable housing affordability is Kuala Lumpur ($\mathbf{q_2}$) as reflected in utility degree of 100%. The second best factor is 'others' ($\mathbf{q_6}$) with utility degree of 99.46%. However, for the purpose of this paper, 'others' ($\mathbf{q_6}$) has to be omitted because the area does not represent any specific location as discussed in Section 3.2. The next best in ranking is Klang ($\mathbf{q_3}$) with utility degree of 98.51% followed by Petaling Jaya ($\mathbf{q_1}$) at 98.38%. Shah Alam ($\mathbf{q_4}$) is the lowest in ranking as reflected in utility degree of 98.25% that is slightly lower than Putrajaya ($\mathbf{q_5}$) with utility degree of 98.36%.

Amongst the six areas, Kuala Lumpur ($\mathbf{q_2}$) may not have cheaper house price as compared to other areas. Most population concerns on house price as well as other factors such as density, traffic level and safety level. Surprisingly, the respondents are willing to discount all these factors in favour of housing quality and very high accessibility.

Putrajaya (q_5) may have been the country's first intelligent city with sustainable planning, but the results suggest that the area is not popular among the house-buyers. This could be due to Putrajaya (q_5), being as the federal administrative centre of the federal government of Malaysia, caters specific group of respondents, especially the government servants.

With encouragement through various government-backed subsidy and loan programmes, government servants are more dominant in the housing sector. Looking at the respondents' demographic, there are an equal number of private and public sector employees which prevents the result from being skewed towards one particular direction. However, Putrajaya did score very high in some factors such as high accessibility, low density, and the availability of childcare.

According to Table 7, Shah Alam ($\mathbf{q}_4$) has the lowest utility degree, thus, the worst performing area in relation to the predetermined factors of sustainable housing affordability. Shah Alam ($\mathbf{q}_4$) scored particularly worst in building-related factors such as housing type, finishes, design, interior features and position of the house in layout plan. However, Shah Alam ($\mathbf{q}_4$) scored better than other areas such as Kuala Lumpur ($\mathbf{q}_2$) and Klang ($\mathbf{q}_3$) in terms of traffic congestion.

Each of the six areas above has almost equal utility degrees. Evidence shows that the difference between the best option ($\mathbf{q}_2$) to the worst option ($\mathbf{q}_4$) is minuscule of 1.75%. This could be translated in layman terms as being the advantages and disadvantages of both areas are almost equal and often interchangeable to one another, other factors offset thus the cycle continues. Great improvement can be made by focusing on a smaller area, i.e. by zoning, precinct or section within the larger area. For example, Shah Alam ($\mathbf{q}_4$) consists of many sections and narrowing down the focus may produce a different outcome. Nevertheless, COPRAS method has substantially demonstrated its effectiveness in providing the utility degree of options and due to its flexibility could be applied to any region and place and the weight can be adjusted to suit any context.

4. CONCLUSION

With the overall rising of house price and cost of living, purchasers are compelled to find alternatives or options among the many few choices left. Over times, the decision-making process is long and perilous with nothing else to base upon other than price and household income. It is a time alternative to being put out there to understand better and discriminate the market according to what being most important to individual and society. This paper adequately explicates the necessity to shift our emphasis from the traditional price-income-cost genre towards sustainability-quality-affordability value. Sustainable housing affordability can be used as the main driver of green growth of Malaysian housing development.

Housing is one aspect of life but unfortunately, cannot be controlled by an individual. The government, the private sector, as well as potential owners must make a distinction between cheap housing and sustainable housing affordability as this issue will get even more complicated as we delve deeper into the topic. The bottom line is, with cooperation between these parties, we could arrive at what makes a house sustainable outside the limitation of simply housing cost. The government in local authority can use the same methodology in the proper planning of urban dwellings. Private developers, on the other hand, may use the result to find an alternative area to be developed as well as what can be improved in future housing developments to increase its appeal to a larger masses. This would prove beneficial to gain the upper hand against competing rivals. The results and method presented could also be used by the public in determining and deciding the best area to buy future houses according to their preferences.

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