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The measurement of sustainable housing affordability using a multiple criteria decision-making (MCDM) framework: Case Study of Malaysia

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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 factors or criteria are necessary to be weighed-in in determining the best alternative or options available in any particular area. This research has been conducted in five urban areas in Klang Valley, Malaysia using COPRAS method (one of the MCDM methods). The method could be realized by giving weigh to individual factors. The findings indicate that area with high utility degree is the best area that conforms to the sustainable housing affordability factors. Likewise, an area with lower ranking in utility degree can be described as a worst-performing area in terms of conforming to sustainable housing affordability factors. The originality of this research has contributed to a new picture in sustainable housing affordability in the country because it is the first paper in Malaysia to address such issues using COPRAS framework.

Keywords: Sustainability, affordability, housing, COPRAS, MCDM

1. Introduction

Housing is a basic need for any citizen that enhances the quality of individual life. Although several housing policies have been introduced since the early 1970s, Malaysian Government has improved its National Housing Policy (NHP) in 2011 concentrating on quality and affordable housing. Since then, there has always been a mismatch between the demand and supply for housing in Malaysia. Apparently, the majority of the population, especially the middle-income group, needs affordable housing but the supply and demand have never met. Many factors have contributed to this phenomenon, and one of them is that the supply of housing units does not meet the demand criteria. In recent years, the house prices have soared to exorbitant levels in major cities of Malaysia which directly affect affordability level of the middle-income group to own a house. Other factors have also contributed to housing issues such as the development cost and selling price that persistently influence the supply and demand in the housing sector.

Housing affordability is a complex issue that must be carefully interpreted and assessed not solely based on economic viability but should also include the quality of life of the population. The Malaysian government has been encouraging its citizen to own a house by developing affordable and adequate housing through private sector participation. Its main aim is to enable the house buyers to occupy a housing unit that meets the norm of well-established social requirements such as household types and sizes. With this respect, the buyers are expected to have a certain surplus out of their income taking into consideration the monthly repayment that they have to serve the financial institutions. In such a case, the ability of house purchaser is to pay a monthly mortgage repayment must be reflected in their income surplus for the purpose of purchasing the necessity goods and fulfilling other commitments. Therefore, the definition of housing affordability should deal with these issues.

However, housing affordability issue has always been discussed on its own, without including other factors that would influence it. Mulliner *et.al.* (2013) Stressed that housing affordability should be mutually discussed with sustainability issue because they are affecting one another. Indeed, Maliene and Malys (2009) have emphasized that affordable housing is one of the criteria that could deliver a sustainable community. Similarly, to create a sustainable community, the existence of affordable housing products is important in any housing development. Thus, the above argument shows that affordability and sustainability are of growing concerns about creating a sustainable community.

This paper intends to focus on the measurement of housing affordability among the middle-income group in Malaysia by revealing their ability to own a house and is organized as follows. First, the literature review is conducted to cover the concept of housing affordability. In the next section, sustainable housing affordability is discussed. Then, follows the discussion on theoretical framework and research methodology that includes the technique used in the analysis. Thereafter, summary and conclusions based on statistical modelling are discussed.

2. Housing Affordability

Measuring housing affordability can be difficult especially in determining and conceptualizing the accurate and actual housing affordability among the purchasers. Mulliner *et al.* (2013) suggested the traditional way of conceiving and measuring affordability is the ratio of house price to income. A research by Ryan and Enderle (2012) used the house price to income ratio as a tool to assess the household affordability based on their level of income. Hulchanski (1995) argued that if a household needs to pay more than a certain percentage of income to obtain adequate and appropriate housing, then a housing affordability problem exists. Therefore, household income should be considered as a major determinant of affordability because the income itself determines the ability and willingness of a household to pay for housing.

The current measure of affordability focuses only on the economic viability without taking into consideration any other attributes that also lead to the affordability problems. As discussed by Viteikiene and Zavadskas (2007), the evaluation of sustainable city consist of social, economic and environmental components. Fundamentally, sustainable housing affordability can be summarized as a house that both fulfil the requirement of sustainability and at the same time is affordable and appropriate in terms of size and location. Affordable housing might be considered as a *need* and not *want* (Arman *et al.*, 2009).

Many researchers found that house price to income ratio is imperfect (Hulchanski, 1995; Kutty, 2005; Gabriel *et.al.,* 2005). House price to income ratio would create a complex interaction in interpreting the affordability level of a household due to the significant difference between the living styles of each household. Hulchanski (1995) questioned the validity and reliability of the housing expenditure-to-income ratio in determining affordability. Fundamentally, the house price in the urban centre can be much higher than those located in the rural area while the price of the luxury house tends to be higher than the price of low-cost housing. Furthermore, Kutty (2005) discovered that a household may face additional expenditures such as for food, education, health care, training and child care. These additional expenditures are vital to a household and therefore, focusing on whether it can afford such basic goods after paying for housing is important. In addition, Gabriel *et.al.* (2005) suggested the need for a broader understanding of housing affordability, beyond the straightforward calculation of housing costs and income ratios. Consequently, Bogdon and Can (1997) also added that the concerns of the condition, location and neighbourhood characteristics of the housing is important when assessing affordability. Additionally, house buyer's preferences and behaviour vary which affect the affordability level in purchasing a house. The house buyer behaviour could contribute to housing affordability indirectly since different behaviour could lead to different decision making. However, the information on the behaviour can be limited due to inaccessibility.

3. Sustainable Housing Affordability

The first concern in sustaining affordability is to deliver sustainable community by delivering healthy and attractive environment to the society. Maliene and Malys (2009) suggested that the present government should not just provide only enough supply of affordable houses, but must also create sustainable communities. Their research identified three key determinants in sustainable communities that consist of a healthy environment, a prosperous economy and also social well-being. In this research, the focus is on the housing affordability and at the same time attempts to enhance the sustainability factor in housing for the benefits of house buyer.

According to a guideline by the Department of the Environment (2007), a quality housing is a housing development that fulfil all requirement standards by the government, includes promoting high design and standards in construction, accessible, practice a high performance of environment and provide with amenities and infrastructure that could enable the house buyer living in a sustainable housing development and produce a sustainable communities. In addition, Fisher *et.al.* (2009) stated that affordability should consider the opportunity costs that are facing the households due to housing location. Specifically, quality housing could be said to embrace a pleasantly affordable home environment that are comfortable.

Besides, the research done by Fisher *et al.* (2009) stressed the issues on the goal of affordable housing policy which should provide adequate structures for the household. In addition, they suggested that the supply units should be accessible to jobs, in safe areas and close to decent schools. In this respect, the situation of working household tends to create another concern that is to find a place for the child care. The location to access the child care centre would cost the household expenditure to increase and it is in a way could influence the level of affordability and could determine the level of sustainable in their housing area.

Sustainable housing is also said to be located within a safe residential environment. House buyers usually raise a high concern about security and safety inside and outside of their house. Samuels (2004) emphasized that the physical security of the house can be achieved by installing security devices. On the other hand, the low level of safety in the environment could also be considered as the accessibility of public to private space that sometimes lead to unauthorized entry. This situation could cause the loss of money and can be life-threatening to the household and communities. Therefore, the household may have to spend more money in order to prevent crime incident such as an emergency alarm. Also, Mulliner and Maliene (2011) stressed out the matter regarding safety and security and agreed that these criteria should be taken into account in determining sustainable housing affordability.

Easy access to parks and open spaces are also important factors that the house buyer considers in making a purchase decision (Zhu *et al.*, 2006). According to a report by CABE, the author Cowan and Hill (2005) stated that individuals health could be improved dramatically if they live closer to the green space. In addition, the authors also stressed that green space has the potential for enhancing social structure which means it can unite people together and at the same time develop a sustainable community by increasing social interactions between the household. Furthermore, accessibility to open green spaces within a housing development will attract the community from different social groups to engage with each other. In this respect, these factors must be considered to determine the accurate affordability level among house buyers. Therefore, a wider measurement of housing affordability would be useful in measuring the affordability level in today's current situation. Six (6) areas can be considered encompassing a range of economic, environmental and social criteria that influence both the affordability and sustainability of housing (Mulliner *et. al.*, 2013).

4. Measurement of Sustainable Housing affordability

In order to have a wider measurement of housing affordability (not focusing on the house price to household income ratio alone), multi-criteria analysis is a suitable tool to measure accurate affordability level (Zapatero *et al,* 1997). Zapatero *et al* (1997) explained that the multi-criteria analysis is often known as multi-criteria decision making (MCDM) by the School of American and multi-criteria decision aid (MCDA) by the European School. A study by *Mulliner et al.*

(2013) found that MCDM can address various quantitative and qualitative criteria that affect both housing affordability and sustainability. This analysis allows the researcher to assess the sustainable housing affordability with the consideration of the various factors that can contribute directly to the problems and analyse the aggregation of several evaluation criteria in order to choose, rank or determine the right decision making (Zapatero et al, 1997). The objective is to enable the decision maker to solve problems by providing them a proper tool towards uncovering the decision in purchasing a house that have a multi-facet number of criteria affecting affordability levels of the households.

Haarstrick and Lazarevska (2009) highlighted that the resources are the main components in MCDM techniques. The term resources include the accuracy of possible attributes, criteria and alternatives used in the decision making as they are going to affect the results of decision making at the end of the process. According to Triantaphyllou as cited in Mulliner *et al.* (2013), while conducting MCDM techniques in research, there are three steps that need to be followed. The steps can be applied to all types of research field since they are the general steps in utilizing MCDM techniques.

The first step is to determine relevant attributes, criteria and indicator that contribute to the problems. In particular, a distinctive MCDM problem involves some attributes to be assessed and use some criteria or indicators to assess that particular attributes (Department for Communities and Local Government, 2009). Each of the attributes will create value for each criterion and indicator that would then have these values to be assessed and ranked.

The second step is to attach numerical measures to weight the importance of the criteria and to measure the impacts of the alternative on these criteria. The ratio of any criteria weights or alternatives ratings should not be extremely high or extremely low as this will avoid irrational cases or imbalances scale-induced between methods and performance.

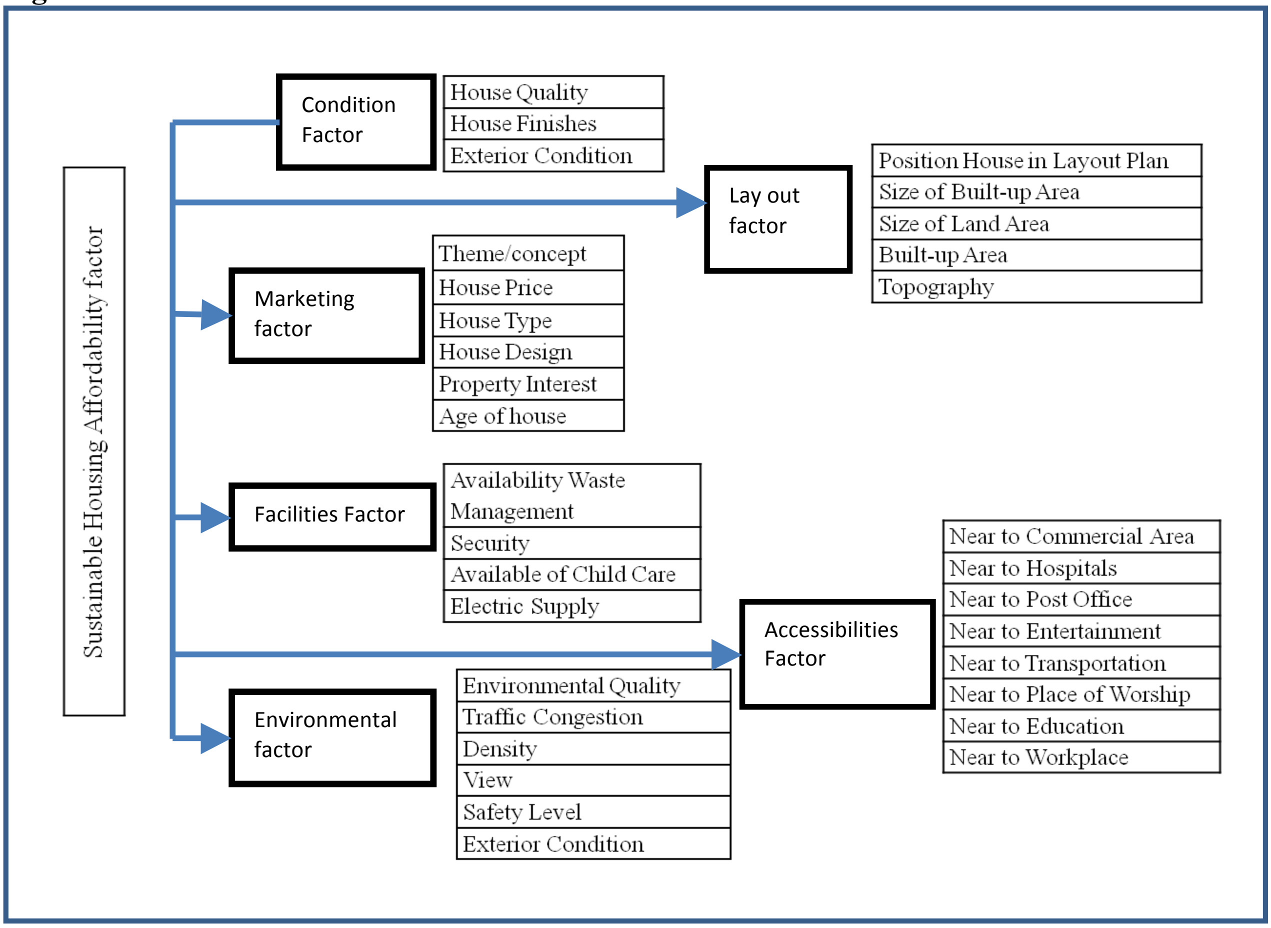
The last step in conducting MCDM is to process the numerical values to determine a ranking of each alternative. The MCDM methods are used to process the numerical values for each alternative with their unpredictable characteristics. Different methods have been developed to solve multi-criteria analysis problems. According to Mulliner *et al. (2013),* the most frequently used methods include UTA, MACBETH, AHP, TOPSIS, PROMETHEE, TACTIC, VIMDA, RNIM, ELECTRE and COPRAS. Since there are a lot of MCDM methods available in practice, the researcher should choose the most suitable methods to be applied in the study.

Literature shows that most researchers in the field of property and built environment use the multi-attribute Complex Proportional Assessment (COPRAS) method in solving the decision-making problems. The use of the COPRAS method is to rank and select the optimal alternatives based on the chosen criteria by the survey. Given the above, the aim of the study is to focus on the applicability of COPRAS method in assessing housing affordability in Malaysia. The research will adopt COPRAS as a tool that can be used to assess sustainable housing affordability based on a criteria system developed by the authors and validated by professionals (Mulliner *et al.,* 2013). According to Kaklauskas *et. al.* (2007), COPRAS method is done under a fuzzy environment with the help of multiple decision makers. In processing the numerical values for each alternative, COPRAS method is usually assumed to be accurate. This method adopts direct and comparative dependence of the weight and utility degree of investigated versions. A structure of attributes effectively described the alternatives and also values and weights of the attributes. Podvezko (2011) also mentioned that COPRAS is used for multi-criteria evaluation of both maximizing and minimizing criteria values. A full criteria analysis of various factors that influence sustainable housing affordability will be provided in this paper.

5. Theoretical Framework

Based on literature above, the following factors have been established for the purpose of the survey (Figure 1). The main factors include condition, marketing, facilities, environmental, layout and accessibility. The sub-factors are allocated in Figure 1 next to each of the main factors. The identifictation of these factors establishes the theoretical framework of the research.

Figure 1: Theoretical framework



6. Research Methodology

The scope of the study is limited to the Klang Valley because this area constitutes almost half of the total amount of residential construction stocks in Malaysia (Ministry of Finance's Valuation & Property Services Department, 2013). A total of 657 Questionnaires were distributed to residents within the age of between 20 to 34 years in 5 distinct areas in Klang Valley namely Petaling Jaya (17.9%), Kuala Lumpur (20.2%), Klang (21.4%), Shah Alam (19.4%) and Putrajaya (21.2%). The criteria set for the respondents are they must be between the age of between 20 to 34 years old. The main reason for focusing on this particular group is because most of them falls under the middle-income group and are the likely persons to rent in the housing market. Therefore, the purpose of these questionnaires is to verify and elicit respondents opinion on what factors constitutes as being important in addressing sustainable housing affordability.

There is a total of 32 factors (Figure 1) considered to be relevant in assessing sustainable housing affordability. These factors have been established from a thorough review of existing literature. Respondents distinguish each factors based on its relative importance toward sustainable housing. Responses are ranked on a five-point Likert scale. Likert scale was used because of its simplicity in expressing respondent level of agreement.

Analysis begins with reliability test towards 32 variables which generate Cronbach's Alpha value. It follows by mean score observation for the whole data set. This step follows by the division of sub-set data according to the research area.

The data were analysed using COPRAS method which involves a series of calculation (Kaklauskas *et al,* 2007, Dey *et al.,* 2011; Kaklauskas *et al.,* 2005; Mulliner *et al.*, 2013; Zavadskas *et al.*, 2008) as described below.

The following formula is used by taking the overall mean score to allow direct comparison between all factors:

$$w_{ca} = \frac{\bar{\omega}_{ca}}{\sum_{a=1}^{n} x_{ca}} x_{ca}$$

Where x_{ca} is the value of the c-th criterion of the a-th options, and w_{ca} is the weight of the p-th criterion.

Summation of weighted normalizes decision-making matrix is obtained by calculating the sums of both positive and negative alternatives. The sums of S_{+q} of attributes with larger values are preferable (optimization direction is maximising). Similarly, the sums of S_{-q} of attributes with smaller values are preferable (optimization direction is minimising). For example, the lower the negative (minimising) values for house price, the better indication for sustainable housing affordability. Likewise, the higher the positive (maximising), the better indication for sustainable housing affordability. The formula to calculate the sums are as follows:

$$S_a^+ = \sum_{s_c = +} w_{ca}$$

$$S_a^- = \sum_{s_c = -} w_{ca}$$

The relative significance Q_a of each option, based on positive (+) and negative (-), are calculated using the formula below:

$$Q_a = S_a^+ + \frac{S_{min}^- \sum_{a=1}^{n} S_a^-}{S_a^- \sum_{a=1}^{n} \frac{S_{min}^-}{S_a^-}} = S_a^+ + \frac{\sum_{a=1}^{n} S_a^-}{S_a^- \sum_{a=1}^{n} \frac{1}{S_a^-}}$$

Where the minimum values S_a^- are cancelled, the higher value corresponds to a more sustainable housing affordability. In this stage, prioritisation is determined by whichever has the largest Q_a. Q_{max} is the optimal value and the best among all alternatives. Options are ranked from highest to lowest of relative significance Q_a.

The degree of utility is determined by comparing each option by the one option with $Q_{max.}$ The area with the highest degree of utility ($\check{u}_a$ = 100%) represent area that most satisfies sustainable housing affordability. Other options will show a utility values ranging between 0%-100% that become indicators of the worst to the best-case scenario. The degree of utility $\check{u}_q$ of the options Q_a is calculated using the following formula:

$$\check{u}_a = \frac{Q_a}{Q_{max}} 100\%$$

The above steps will be used in the analysis to obtain the final result of sustainable housing affordability in the study area (Section 7)

7. Analysis and Results

As discussed in Section 6, the geographical area of study has been divided into five main regions namely Petaling Jaya **(a_1)**, Kuala Lumpur **(a_2)**, Klang **(a_3)**, Shah Alam **(a_4)** and Putrajaya **(a_5)**. Two categories of respondent have been established comprising the markets for owner occupier and renter (user). The steps of analysis using COPRAS method has been described in Section 6.

7.1 Respondents' Profile

Table 1 shows the characteristic of respondents used in the analysis. Distribution of respondents is divided almost equally between the five regions where each region represents circa 20% share of total respondents. Cross tabulation shows significant characteristics of the respondents namely employment sector, sex, marital status, qualification, age, income, household size and working experience. There are 425 (42.5%) government's employees 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%) are divorced. The distribution of male-female is almost equal to 49.6% (496 respondents) and 50.4% (504 respondents) respectively.

Table 1: Respondent Profile

Profile	Profile Characteristic	Your Age				Total by characteristic	Total by profile
		< 21 Years (4.1%)	21-25 Years (30.8%)	26-30 Years (42.3%)	31-34 Years (22.9%)		
Area of Residence (%)	Petaling Jaya	0.3	5.1	10.1	2.4	17.9	100
	Kuala Lumpur	0.6	7.5	8.6	3.5	20.2	
	Klang	1.5	5.4	7.8	6.6	21.4	
	Shah Alam	0.5	6.2	6.8	6.0	19.4	
	Putrajaya	1.2	6.6	9.0	4.4	21.2	
Employment Sector (%)	Government	0.5	11.7	18.4	9.3	39.9	100
	Private	3.5	18.9	24.2	13.5	60.1	
Sex (%)	Male	1.4	14.8	22.0	10.1	48.2	100
	Female	2.7	16.1	20.3	12.7	51.8	
Marital Status (%)	Single	3.8	27.4	23.5	5.4	60.1	100
	Married	0.3	3.3	18.7	16.9	39.2	
	Divorced	0.0	0.2	0.2	0.5	0.8	
Highest Qualification (%)	Diploma	1.1	13.4	14.0	8.4	36.8	100
	Bachelor	0.3	10.0	16.9	6.4	33.6	
	Master	0.0	0.5	2.6	1.2	4.3	
	PhD	0.0	0.0	0.2	0.0	0.2	
	Others	2.6	7.2	8.8	6.5	25.1	
Age of Spouse (%)	< 21 Years	1.3	1.6	1.3	0.7	4.9	100
	21-25 Years	0.0	6.2	6.9	0.3	13.4	

	26-30 Years	0.3	2.6	30.1	8.2	41.2	
	31-34 Years	0.0	1.3	8.2	21.6	31.0	
	35-40 Years	0.0	0.3	2.3	5.2	7.8	
	41-45 Years	0.3	0.0	0.0	0.3	0.7	
	> 51 Years	0.0	0.0	0.3	0.7	1.0	
Household Income Per Month (%)	< RM 1,500	3.6	17.8	11.9	3.8	37.1	100
	RM 1,501 - RM 2,500	0.2	7.7	10.6	5.9	24.3	
	RM 2,501 - RM 3,500	0.0	2.9	7.5	6.0	16.4	
	RM 3,501 - RM 4,500	0.0	0.9	4.7	2.3	7.8	
	RM 4,501 - RM 5, 500	0.0	0.2	1.8	1.4	3.3	
	RM 5,501 - RM 6,500	0.0	0.3	1.5	1.5	3.3	
	RM 6,501 - RM 7,500	0.2	1.2	4.2	2.1	7.7	
Number of Persons in Household (%)	< 2	0.9	8.5	8.4	3.4	21.2	100
	2	0.3	2.6	7.1	3.7	13.8	
	3	0.5	4.8	11.0	5.0	21.2	
	4	0.9	2.9	7.6	6.7	18.1	
	5	0.3	5.6	3.9	2.9	12.7	
	> 5	0.9	5.7	4.5	1.9	13.0	
Years Working Experience (%)	< 1 Year	2.6	10.3	2.3	0.5	15.6	100
	1-5 Years	1.2	19.2	23.6	3.5	47.5	
	6-10 Years	0.3	1.1	15.3	12.9	29.5	
	11-15 Years	0.0	0.2	1.1	4.7	5.9	
	16-20 Years	0.0	0.0	0.0	1.1	1.1	
	> 20 Years	0.0	0.0	0.2	0.3	0.5	

7.2 Reliability Test

The reliability test was conducted using Cronbach's Alpha approach (Table 2). The table shows that all the 32 variables used in measuring sustainable housing affordability are reliable, where the indicated values of Cronbach's Alpha are more than 0.75. Only a 'condition factor' has indicated 0.74 which refer to house quality (0.61), house finishes (0.60) and exterior condition (0.75)

Table 2: Reliability Test

		Cronbach's Alpha	Cronbach's Alpha
Condition factor	House Quality	.616	.742
	House Finishes	.599	
	Exterior Condition	.745	
Marketing factor	House Price	.860	.854
	House Type	.824	
	House Design	.820	
	Property Interest	.838	
	Interior Features	.816	
	Age of the House	.828	
	Theme or Concept	.850	
Facilities factor	Security	.776	.804
	Availability Waste Management	.722	
	Available of Child Care	.795	
	Electric Supply	.729	
Environmental Factor	Environmental Quality	.845	.866 .808
	Traffic Congestion	.840	
	Density	.842	

	View	.845	
	Safety Level	.841	
	Exterior Condition	.848	
Accessibility Factor	Near to Commercial Area	.779	.808
	Near to Hospitals	.766	
	Near to Post Office	.765	
	Near to Entertainment	.777	
	Near to Transportation	.774	
	Near to Place of Worship	.876	
	Near to Education	.779	
Lay-out factor	Position of House in Layout Plan	.904	.904
	Size of Built-up Area	.867	
	Size of Land Area	.865	
	Built-up Area	.870	
	Topography	.904	

7.3 Assessing Housing Affordability and Sustainability Factors

Table 3 shows the overall mean score and the relative weight given to each factor (formula discussed in Section 6). The highest score obtained was for electric supply (4.3055) whereas the lowest was for theme and concept (3.6303). Meanwhile, the highest and lowest weighted were also Electric Supply (3.41) and Theme and Concept (2.87).

Table3: The sustainable housing affordability factor and weightage

Factor in assessing sustainable housing affordability	Mean	Weight, w
House Price	4.2918	3.402464
House Quality	4.2064	3.33476
House Type	3.8998	3.091693
House Finishes	3.8376	3.042382
House Design	3.7727	2.990931
Interior Features	3.6976	2.931393
Position House in Layout Plan	3.8288	3.035406
Size of Built-up Area	3.8924	3.085827
Size of Land Area	3.8784	3.074728
Built-up Area	3.9101	3.099859
Age of the House	3.8571	3.057841
Topography	3.8	3.012574
Property Interest	3.9969	3.168672
Near to Commercial Area	3.8938	3.086937
Near to Hospitals	3.9727	3.149487
Near to Post Office	3.7538	2.975947
Near to Entertainment	3.6404	2.886045
Near to Transportation	4.0562	3.215684
Near to Place of Worship	4.0228	3.189205
Near to Education	3.9848	3.15908
Near to Workplace	4.0504	3.211086

Environmental Quality	4.1472	3.287828
Security	4.0973	3.248268
Traffic Congestion	4.0303	3.195151
Density	3.8255	3.032789
View	3.8106	3.020977
Exterior Condition	3.9712	3.148298
Availability Waste Management	4	3.17113
Safety Level	4.2382	3.359971
Theme or Concept	3.6303	2.878038
Available of Child Care	3.8374	3.042224
Electric Supply	4.3055	3.413325

7.4 Normalisation of Decision Matrix

The initial matrix for using COPRAS method is obtained and shown in Table 4. The table indicates the mean score and weightage for each individual option. Each of the mean score in Table 4 is essential for the next step (Table 5).

Table 4: Initial Matrix for COPRAS

		Alternative, a				
Criteria, c	Weight, w	a_1	a_2	a_2	a_2	a_2
House Price	3.402464	4.3109	4.4701	4.4610	4.2460	3.9710
House Quality	3.33476	4.1949	4.3731	4.3333	4.1111	4.0143
House Type	3.091693	3.9748	3.9925	3.9149	3.7619	3.8561
House Finishes	3.042382	3.8655	3.8657	3.9291	3.7381	3.7842
House Design	2.990931	3.8655	3.7313	3.8794	3.6587	3.7286
Interior Features	2.931393	3.7059	3.6391	3.8936	3.6080	3.6286
Position House in Layout Plan	3.035406	3.8824	3.8955	3.8582	3.7063	3.8000
Size of Built-up Area	3.085827	3.8655	3.9179	4.0213	3.8333	3.8143
Size of Land Area	3.074728	3.7966	3.8731	4.0496	3.8968	3.7626
Built-up Area	3.099859	3.8403	3.9015	4.0993	3.8720	3.8201
Age of the House	3.057841	3.8571	3.7955	4.0213	3.8175	3.7857
Topography	3.012574	3.6780	3.6667	3.9716	3.8387	3.8214
Property Interest	3.168672	3.8136	3.9851	4.2270	4.0242	3.9051
Near to Commercial Area	3.086937	3.8908	4.0522	3.9220	3.7760	3.8214
Near to Hospitals	3.149487	3.8403	4.1866	3.9574	3.9127	3.9500
Near to Post Office	2.975947	3.6303	3.8258	3.8440	3.6111	3.8286
Near to Entertainment	2.886045	3.4915	3.6642	3.6950	3.5794	3.7429
Near to Transportation	3.215684	3.9580	4.3507	3.9504	4.0397	3.9783
Near to Place of Worship	3.189205	4.2881	4.0000	3.8156	4.0079	4.0435
Near to Education	3.15908	3.8824	3.8806	3.9716	4.0000	4.1714
Near to Workplace	3.211086	4.1092	4.0970	3.9929	4.1040	3.9632
Environmental Quality	3.287828	4.1525	4.2612	4.1489	4.1667	4.0143

Security	3.248268	4.1176	4.3881	4.0284	4.0323	3.9286
Traffic Congestion	3.195151	3.9664	4.2015	4.0426	4.0000	3.9357
Density	3.032789	3.8655	3.8507	3.7447	3.7840	3.8857
View	3.020977	3.8487	3.8284	3.8511	3.6984	3.8214
Exterior Condition	3.148298	3.9916	3.9776	3.9504	3.9520	3.9857
Availability Waste Management	3.17113	3.8644	4.1418	4.0071	4.0480	3.9286
Safety Level	3.359971	4.2605	4.5522	4.1986	4.2080	3.9857
Theme or Concept	2.878038	3.7143	3.6343	3.6170	3.5079	3.6786
Available of Child Care	3.042224	3.8220	3.7910	3.8085	3.7600	3.9929
Electric Supply	3.413325	4.2542	4.5113	4.3901	4.2619	4.1071

Table 5 shows the summation of normalised decision matrix by calculating the sums of both positive and negative alternatives (discussed in Section 6).

Table 5: Normalized decision matrix

Criteria, c	e	Alternative, a				
		a_1	a_2	a_3	a_3	a_5
House Price	-	0.68352123	0.70876342	0.7073206	0.67323091	0.62962787
House Quality	+	0.66529625	0.69355814	0.687246	0.65200587	0.63665373
House Type	+	0.63019155	0.63299783	0.6206946	0.59643695	0.61137206
House Finishes	+	0.61307266	0.61310438	0.6231597	0.59286688	0.60017839
House Design	+	0.61290025	0.59162196	0.6151042	0.58011076	0.59119386
Interior Features	+	0.58800172	0.5774028	0.6177834	0.57246828	0.57573681
Position House in Layout Plan	+	0.61563128	0.61770855	0.6117939	0.58770715	0.60256513
Size of Built-up Area	+	0.61320586	0.62151836	0.6379213	0.60809779	0.60508371
Size of Land Area	+	0.60238883	0.61452672	0.6425312	0.61828709	0.5969942
Built-up Area	+	0.60944385	0.6191561	0.6505464	0.61447454	0.60623817
Age of the House	-	0.61183469	0.60206336	0.637881	0.60555312	0.60050883
Topography	-	0.58389616	0.58210225	0.6305063	0.60940789	0.60666145
Property Interest	+	0.6055649	0.63279753	0.671209	0.63900626	0.62009426
Near to Commercial Area	+	0.61712093	0.64272064	0.6220696	0.59891247	0.60611338
Near to Hospitals	+	0.60941074	0.6643645	0.6279931	0.62089977	0.62681885
Near to Post Office	+	0.57650457	0.60755067	0.6104409	0.57345554	0.60799532
Near to Entertainment	+	0.55448336	0.58190976	0.5868011	0.56844272	0.59440807
Near to Transportation	+	0.62768726	0.68996436	0.626482	0.64064381	0.63090657
Near to Place of Worship	+	0.67851958	0.63293261	0.6037544	0.63418265	0.63981575
Near to Education	+	0.61613645	0.61585079	0.6302925	0.63479956	0.66200072
Near to Workplace	+	0.65108059	0.64914757	0.6326535	0.65025668	0.62794768
Environmental Quality	+	0.65816472	0.6753935	0.6575941	0.6604154	0.63626024
Security	+	0.65260153	0.69547328	0.6384642	0.63908227	0.62264678
Traffic Congestion	-	0.62906389	0.66635033	0.6411491	0.63439279	0.62419492
Density	-	0.61280074	0.61045449	0.5936502	0.59988048	0.61600306
View	+	0.61039659	0.60717704	0.6107772	0.58655929	0.60606686
Exterior Condition	+	0.63285272	0.63063307	0.6263206	0.62657429	0.6319173
Availability Waste Management	-	0.61303532	0.65704112	0.6356728	0.642161	0.62321979

Safety Level	+	0.67508401	0.72130441	0.6652758	0.66676529	0.63154145
Theme or Concept	+	0.58890688	0.57622278	0.5734798	0.5561819	0.5832466
Available of Child Care	+	0.60640125	0.60148277	0.6042593	0.59656429	0.63351637
Electric Supply	+	0.67462193	0.7153923	0.6961727	0.67584298	0.65129513

The sign (+/-) indicated that the greater / lesser criterion value satisfies sustainable housing affordability

7.5 Measurement of Sustainable Housing Affordability

Having utilized the COPRAS method (Subsection 7.1-7.4), the final result was obtained as shown in Table 6. The table shows two categories of sustainable housing affordability mainly for owner occupier and renter markets. The location that best describes the factors in sustainable housing affordability is **a_5** (Putrajaya) as reflected in utility degree of 100%. The second best factor is **a_1** (Petaling Jaya) where the housing affordability can only be sustained for the renter market. The next best in ranking would be **a_4** (Shah Alam) with utility degree of 99.92% followed by **a_2** (Kuala Lumpur) at 99.85%. **a_3** (Klang) is the lowest in ranking as reflected in utility degree of 99.83%.

Overall, each of the regions produces the ability rate of more than 99% and comparable to each other. However, this ability levels had been measured in two conditions, namely the ability to buy a home (owner occupation) and capabilities to rent a house (renter). In terms of home ownership, Klang (**a_3**) recorded the highest rate of 55.6% whereas Putrajaya (**a_5**) recorded the lowest rate of 19.1%. However, Putrajaya (**a_5**) displays the highest ability to rent a house at 80.9%, and the lowest is Klang (**a_3**) at 44.4%. In other words, Putrajaya (**a_5**) can sustain its housing affordability in the renter market rather than the market for an owner occupier. This is because Putrajaya (**a_5**) is mainly occupied by government's employees, but the price of houses is extremely high. The result shows that Klang (**a_3**) is the best region for owner occupier market where its housing affordability can be sustained as compared to other regions.

Table 6: Selected Sustainable Housing Affordability area

	Criteria, c	a_1	a_2	a_3	a_4	a_5
Sustainable & Affordable measurement	S+	15.99961	16.52191	16.39082	15.99104	16.03861
	S-	3.734152	3.826775	3.84618	3.764626	3.700216
	Q_a	84.75624	84.66392	84.64514	84.72537	84.79122
	Priority	**2**	**4**	**5**	**3**	**1**
	U_a (%)	99.96	99.85	99.83	99.92	100.00
Ownership Status	Owner	44.1%	33.1%	55.6%	40.5%	19.1%
	Renter	55.9%	66.9%	44.4%	59.5%	80.9%

8. Conclusions

With the overall rising price of house and cost of living, we are compelled to find alternatives or options among the many few choices left. Regularly, the decision-making process is long and perilous with nothing else to base upon other than price and household income. It is time alternative to put out for better understanding and discriminating the market according to what is being the most important to individual and/or society.
This paper adequately explicates the necessity to shift our emphasis from the traditional price-income-cost genre towards sustainability-quality-affordability value. Housing is one aspect of people's life but unfortunately, it roles cannot be controlled by the individual. The market players, namely the government, the private developers and potential owners/buyers must make a distinction between low-cost housing (cheaper price with low quality) and sustainable housing affordability (reasonable price with income surplus), as this issue is very complicated as we delve deeper into the topic. The bottom line is, with cooperation between the market players, we could arrive at sustainable housing affordability outside the limitation of simply a housing cost. Local authorities could use the same methodology for the proper planning of urban dwellings. Private developers, on the other hand, may use the result to find an alternative area to be developed, along with what could be improved to increase its appeal to larger group of middle-income purchasers. The results and method presented could also be used by the public at large in determining and deciding the best area to own a house according to their preference.

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