

## Modelling of User Perceived Flexible Housing Unit Using Means-End Chain and Conjoint Analysis

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**Abstract:** The aim of this study is modelling flexible house design by user. Apparently, all previous trails are based on designer and very few studies on user role in designing flexible housing. No studies found concerning modelling user preferences with respect to flexible house design in Malaysian context. This study attempts to fill the gap by modelling user preferences for flexible house design. To operate this investigation, a combination of Means-End Chain (MEC) research model and Conjoint Analysis (CA) has been employed. Investigations were in two stages in Universiti Teknologi Malaysia, Malaysia; Using Laddering interview with 25 respondents then evaluation by 180 respondents. Results show that model 3 is the most preferred out of the 16 models evaluated. Findings show the significance of research method as a strategy to accommodate user participation in establishing flexible house design.

**Key words:** User preferences, flexible house design, Means-End Chain (MEC), Conjoint Analysis (CA), accommodate, establishing

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### INTRODUCTION

Mostly all the previous applications of flexibility in building design are manipulating some planning, structural and constructional mechanisms of the design based on designer perception and researcher findings as referred by Alaraji and Jusan (2014, 2015).

A number of concerned theories and models are performed to identify attributes of flexibility in building design and sometimes in housing design. For example, Open Building plan (OB) is considered as the most flexible model of building design which gives opportunity for user to involve in installing and modifying Furniture, Fixture, Equipment (FFE) (Kendall, 1999; Kendall and Teicher, 2000). This model is more applicable for apartment than for single housing design. Friedman (1994) refers to Extendable Core plan (EC) as another model of flexibility in house design. This model concerns with specific attribute of flexibility. These two models accommodate specific type of user participation in house design after occupancy based on designer perception. Despite the wide application of these flexible models, a question remains on whether the flexible attributes are reflecting the end user's preferences.

This study is attempting to fill the gap in the body of knowledge by firstly, eliciting flexible attributes in house design based mainly on user's preferences and perception. Secondly, these preferences then are categorised, mapped and modelled in order to establish options of flexible house design as perceived by users.

**Flexibility in design:** Till and Schnieder (2005), Schneider and Till (2005) assume that flexibility in design encourages user participation. However, the participation tends to be influenced by mechanisms and attributes applied in the housing unit design that are based mainly on designer's perception.

Several researchers have suggested mechanisms, attributes and models of flexibility in building design based on designer perception and focusing on specific attributes. Changing the function of a building as Bell *et al.* (1996) consider as a form of housing modification can be considered as the lowest form of flexibility. Schneider and Till (2005) refer to the relation between flexibility in design and amount of space, the location of services, construction techniques being used and shape of space as indications of flexibility in housing design. Greden and Glicksman (2005) focuses on the cost to do renovations or moving into another place as indication of flexibility in design. Beisi (2004) assumes that flexibility in building design is achieved by using flexible furniture and demountable or flexible walls, so that, user can change spaces whenever he/she wants without additional cost. Jusan (2010a, b) indicates flexibility in the form of constructional sequence which allows the end users to involve in decision making at certain stage.

Shneider and Till (2005) refer to the 'incomplete building' as another concept of flexibility which is related to the concept of open building. This concept is based on building as an open space and to be filled by user.

Freidman (1994) suggests building has three types according to the level of flexibility, the maximum flexibility where the base building is separated from the infill. User here is supposed to control the interior of his house after occupancy, like the case of OB. Secondly is the built-in type where user has chances to modify but within the boundary of his part and without affecting the whole building. The third type is the conventional design which gives no chances for user participation.

It seems that all these concepts and applications of flexibility in building design is mainly based on findings of researchers and designers perception and rarely including user participation in the stage of establishing the attributes of flexible building design.

**User participation:** Literature shows that user participation may carry out in different stages of design process and take different forms. Jusan (2010a, b) assumes that active participation is still the ideal approach in decision making where in some cases it takes the form of post occupancy modification.

Granath (2001) posits that user participation in early stages of design may facilitate participation later on. Jusan (2010a, b) focus on the important role of user participation in construction stage of house design process because it will avoid the unnecessary modification after occupancy.

'Initial flexibility' is considered as flexible design strategy which insures user involvement before occupancy. Here, designer presented a number of alternatives of house design to the users before occupancy, so that, each user can choose what the most suitable alternative.

All these concepts and other suggestions about user participation in house design are based on the 'Representative' or 'Alternative' forms of participation because of the assumption of designers that users do not know about design (Lawson, 2001).

Far from user participation in design, the user feel loosing perceived control over his living environment, since, there might be many determinants and constraints which makes users unsatisfied (Proshansky *et al.*, 1976; Lang, 1987). Veitch and Gifford (1996) assumes that providing sufficient choices can increase perceived control and then lead to better well-being environment.

Differences between architect and non-architect in perceiving building design has led to integrate between user and designer's design preferences. So, establishing models of flexible house design based on user perception and preferences can be considered as an active mode of user participation in design.

**Modifiability and user participation:** Considering Omar *et al.* (2010, 2012)'s assumption that one design fit all is not proper, may lead to an assumption that a flexible

design solution in a housing scheme may not be the solution for all situation. Providing more choices in living environment can increase user's perceived control and then achieve person-environment congruence (Veitch and Gifford, 1996). Flexible building design is defined as the environment that can be adapted to user future needs and an approach to achieve Person-Environment Congruence (PEC) (Zesiel, 1974). Therefore, consideration of flexibility in design process refers to exploring possibility of user participation in making decision about space where they live and use.

The modification may take different forms like repainting walls as part of the infill part or adding additional space horizontally or vertically. Also, it varied from including designer in part of the modifications work or not at all and then the user can do it alone. These acts are considered as ways of personalization (Jusan, 2007, 2010a, b). Also, Jusan (2010a, b) refers to other types of modifications which may include finishes, window and door design, garden and gate design. All these modifications for effective results, should be in the form of active participation (direct involvement of users in the making of their homes). Flexible house design may include a number of attributes that define different levels of flexibility. Otherwise, if the users find no chances to do any modification in their houses, they will have to leave to another place and will face again the same options. This study suggest that flexible house design should accommodate a preferred mode of user participation and to achieve this flexible house design should be based on user perception of flexibility and how it may cope with their needs as shown in Fig. 1a participation which take the form of renovation in house design whenever needs change.

There is an urgent need to evaluate housing flexibility based on user perception to identify their preferences. Literatures on this aspect are very little. Previous works on this regard are mostly referring to building physical components (Veldhuisen *et al.*, 1987; Bell *et al.*, 1996; Schneider and Till, 2005; Jia, 1995). For example, Greadtes evaluates flexibility in building design based on flexibility of installation of building equipment. To obtain results that are more practically relevant to end users, the assessment of flexibility should be done based on user's perception and preferences.

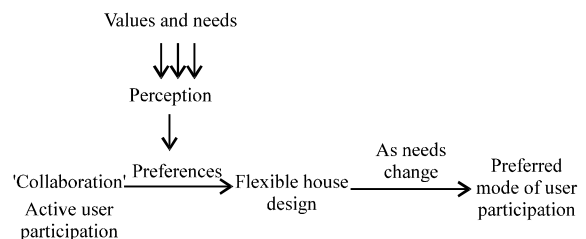


Fig. 1: User participation and flexible house design

**MATERIALS AND METHODS**

To achieve the main objectives of this study, the researchers use a combination of two methods: qualitative and quantitative which are laddering interview and ranking questionnaire. Two models are used; Means-End Chain (MEC) and Conjoint Analysis (CA) research models. Literature shows that MEC and CA research models have been used separately and differently in architectural and housing research and rarely used together. However, Krystallis (2001, 2005) and Krystallis and Ness (2005) employed a combination of MEC and CA to study user preferences in food marketing research.

The researchers of this study identified the potentials of using this combination to explore user perception and model user preferences of flexible house design as in Fig. 2. The researchers use MEC of Jusan (2007, 2010a, b) in order to elicit user stated preferences for attributes of flexibility in house design. Findings from using MEC indicate respondent’s preferences for a list of flexible attributes in house design which considered as not sufficient to define flexible house design. Since, house is seen as a product with a set of attributes (Collen and Hoekstra, 2001; Jusan, 2010a, b), CA is used to transform user stated preferences into the form of models of single house design unit. Then CA is used to evaluate the effectiveness of these models of flexible house design based on user perception and choice behaviour.

**Means-End Chain (MEC):** The purpose of using interview or a qualitative method is “To provide illumination and understanding of complex psychological issues and are most useful for answering humanistic ‘Why?’ and ‘How?’ questions” (Marshall, 1996). Another indication of the benefit of using this method is more related to investigating people life and situations (Vaus, 2002). Using MEC in this study is to elicit user stated preferences for flexible attributes of house design based on user values and motivations to choose specific attributes (Gutman, 1982; Reynolds and Gutman, 1988; Collen and Hoekstra, 2001; Jusan, 2007, 2010a, b).

Poot describes house as not just a place to eat, sleep and live but also a place of comfort and safety. Since, house consists of a number of spaces with different function, it can be described as a “Complex product”. In parallel, Collen and Hoekstra (2001) and Jusan (2010a, b) refer that the house consists of a set, collection or bundles of attributes. Collen and Hoekstra (2001) refer to the significance of using CA method to study bundles of attributes that define house in addition to the fact that the house is a ‘Heterogeneous product’ which refer to house’s various number of attributes.

**Conjoint Analysis (CA):** Collen and Hoekstra (2001) consider CA as one of the user choice models that is used when there is a large number of attributes. Zinas and Jusan (2010) describe CA as “Algebraic choice model”. The CA method is used based on hypothetical models and focus on measuring user’s stated preferences

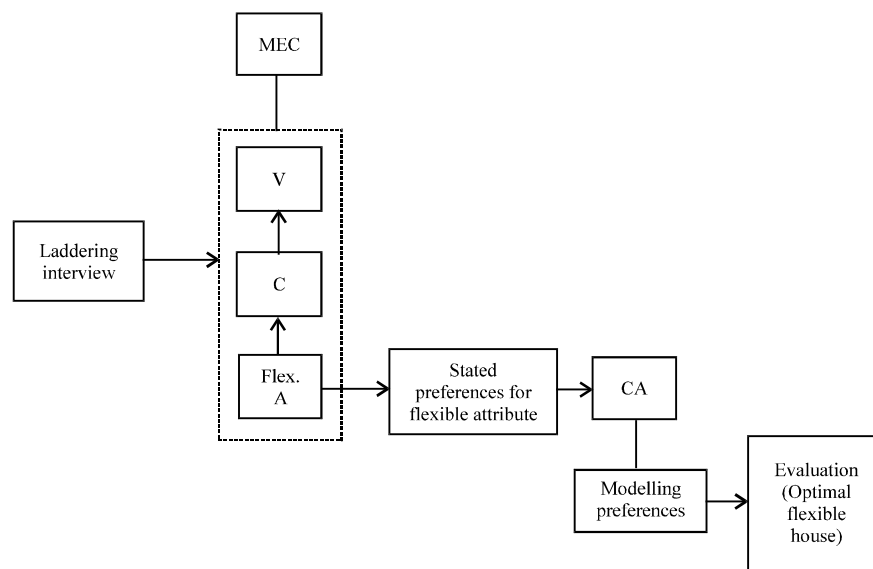


Fig. 2: Conceptual framework

**Table 1: The eight most preferred flexible attributes in house design (derived from HVMs)**

Expected mode of user participation (8 most preferred flexible attributes)					
'Motivation' or 'do it yourself design' (everyday activity) user	'Motivation' or 'protective' (renovation) user	Emancipation (renovation) user+designer	Levels	Associated values	
Modifiability of Furniture (MFA)			Living room	Hedonism (HE)	
			Master bedroom		
			House bedroom	Family Security (FS)	
			Bedroom		
			Living room	Self-Direction (SD)	
			House, bedroom		
			Living room	Hedonism (HE)	
			Bedroom, kitchen		
			ENlarging room (EN)	Kitchen, bedroom	Hedonism (HE)
				Living room	
Merging living and dining Room (MER)			Dining room	Hedonism (HE)	
Modifiability of Window (MWS)			House, living room	Hedonism (HE)	
			Adding room with changing house plan (ADD-on)	Family Security (FS)	
			Renovation of Equipment (RE)	Hedonism (HE)	
			Kitchen, house	Family Security (FS)	

(Collen and Hoekstra, 2001; Molin *et al.*, 2001; Timmermans *et al.*, 1994; Dijkstra *et al.*, 2003; Alaraji and Jusan, 2014). In parallel, Orme (2010) refers that CA is used to estimate user stated preferences and to predict choice behaviour.

The researchers of this study choose to use these two models of MEC and CA in a complementary way as shown previously in Fig. 2 as a strategy to establish flexible house design based on user perception.

**Data collection:** For data collection, a random purposive sample of 25 respondents are selected to do the Laddering or in-depth interview as part of MEC stage. The average time of each interview is about 1 h. All respondents are Malaysian, well educated, 17 married and 8 single. All interviews took place inside Universiti Teknologi Malaysia (UTM) Campus in Malaysia during Feb, 2012.

Another random sample of 180 respondents was selected to answer the ranking evaluation of CA method. All respondents are Malaysian, well educated (working staff at Universiti Teknologi Malaysia or post graduate students), 44% married and 56% single. 51% are female and 49% male. Steps of data collection of this study are.

Elicitation of flexible attributes by using Laddering interview. The interview focus on asking respondents what they prefer based on their perception and “Why it is important to you?” question.

**Coding data:** All interviews were recorded and transcribed in order to be analysed properly. Each attribute which was suggested by respondent has given a code. Researchers used 22 codes for attributes of flexibility in house design, according to repeated and/or

important meaning within a word, phrase or sentence (Zhang and Wildemuth, 2009; Jusan, 2007, 2010a, b).

**Performing Summary of Implication Matrix (SIM):** This matrix contains decimal numbers; To the left reflects the number of times each element connected with other element directly. The number to the right reflects the number of times each element connect with other element indirectly.

**Constructing Hierarchical Value Map (HVM):** During interviews, respondents have talk about a list of attributes of flexibility for each space in the house and in the house as one. Since that, the researchers constructed HVM for each space in the house separately and in the house as a whole. This study adapts 4 as a proper cut-off level to draw the HVMs.

From the values of perceptual orientation pathways which derived from each HVM, the direct and indirect relations between each attribute and value has been estimated to identify the significant eight preferred attributes of flexibility and their levels. These attributes reveal that user’s perceptions of flexibility in house design in Malaysia is mainly motivated by their needs and tendency to change and renovate their houses easily and significantly influenced by their values. Table 1 shows how respondents connect between expected house renovations with their preferences for flexible attributes which also indicates the preferred mode of participation when needs change.

CA full profile method joints the effects of a number of flexible attributes and their levels. These attributes that elicited from MEC stage as the eight most preferred attributes are influenced by user values as shown in Table 1 which reveal the results of MEC stage.

**Table 2: Models of flexible house design**

Model number	Attributes
1	Modifiability of furniture (bedroom), enlarging room (bedroom), Modifiability of wall color (bedroom) modifiability of floor covering (living room), merging living and dining rooms (permanent). Modifiability of window size (living room). Renovation of equipment (house) no possibility of adding room
2	Modifiability of furniture (whole house), enlarging room (kitchen), modifiability of wall color (bedroom), modifiability of floor covering (living room), merging living and dining rooms (temporary), modifiability of window size (whole house). Renovation of equipment (kitchen) no possibility of adding room
3	Modifiability of furniture (whole house), enlarging room (kitchen), modifiability of wall color (whole house), modifiability of floor covering (Bedroom), merging living and dining rooms (temporary), modifiability of window size (living room), renovation of equipment (kitchen), possibility of adding room
4	Modifiability of furniture (master bedroom), enlarging room (bedroom), modifiability of wall color (whole house), modifiability of floor covering (bedroom), merging living and dining rooms (permanent), modifiability of window size (whole house), renovation of equipment (Kitchen) no possibility of adding room
5	Modifiability of furniture (master bedroom), enlarging room (dining room), modifiability of wall color (bedroom), modifiability of floor covering (bedroom), merging living and dining rooms (temporary), modifiability of window size (house), renovation of equipment (house), possibility of adding room
6	Modifiability of furniture (bedroom), enlarging room (dining room), modifiability of wall color (house), modifiability of floor covering (living room), merging living and dining rooms (temporary), modifiability of window size (living room), renovation of equipment (kitchen), possibility of adding room
7	Modifiability of furniture (whole house), enlarging room (living room), modifiability of wall color (whole house), modifiability of floor covering (living room), merging living and dining rooms (permanent), modifiability of window size (whole house), renovation of equipment (Whole house), possibility of adding room
8	Modifiability of furniture (living room), enlarging room (living room), modifiability of wall color (bedroom), modifiability of floor covering (Bedroom), merging living and dining rooms (permanent), modifiability of window size (living room), renovation of equipment (kitchen), possibility of adding room
9	Modifiability of furniture (living room), enlarging room (dining room), modifiability of wall color (house), modifiability of floor covering (Living room), merging living and dining rooms (permanent), modifiability of window size (house), renovation of equipment (kitchen) no possibility of adding room
10	Modifiability of furniture (living room), enlarging room (bedroom), modifiability of wall color (living room), modifiability of floor covering (Living room), merging living and dining rooms (temporary), modifiability of window size (house), renovation of equipment (houses), possibility of adding room
11	Modifiability of furniture (house), enlarging room (dining room), modifiability of wall color (living room), modifiability of floor covering (Bedroom), merging living and dining rooms (permanent), modifiability of window size (living room), renovation of equipment (house) no possibility of adding room
12.	Modifiability of furniture (bedroom), Enlarging room (kitchen), Modifiability of wall color (house), Modifiability of floor covering (bedroom), Merging living and dining rooms (permanent), Modifiability of window size (house), Renovation of equipment (house), possibility of adding room
13	Modifiability of furniture (master bedroom), enlarging room (living room), modifiability of wall color (house), modifiability of floor covering (Living room), merging living and dining rooms (temporary), modifiability of window size (living room), renovation of equipment (house), no possibility of adding room
14	Modifiability of furniture (living room), enlarging room (kitchen), modifiability of wall color (house), modifiability of floor covering (Bedroom), merging living and dining rooms (temporary), modifiability of window size (living room), renovation of equipment (house), no possibility of adding room
15	Modifiability of furniture (master bedroom), enlarging room (kitchen), modifiability of wall color (living room), modifiability of floor covering (Living room), merging living and dining rooms (permanent), modifiability of window size (living room), renovation of equipment (kitchen), no possibility of adding room
16	Modifiability of furniture (bedroom), enlarging room (living room), modifiability of wall color (living room), modifiability of floor covering (Bedroom), merging living and dining rooms (temporary), modifiability of window size (house), renovation of equipment (kitchen) no possibility of adding room

SPSS Version 20, conjoint analysis-orthogonal plan is used to generate the possible combinations of flexible attributes and their levels that were elicited from the MEC stage. Levels here refer to different spaces in house. The result is 16 models of flexible house design from the combination of the eight attributes of flexibility and their levels. Each model contains the same eight attributes of flexibility but with different levels. These models are coded from flexible house 1-16 as shown in Table 2.

The 180 respondents are asked to evaluate and rank these models of flexible house from the most preferred to the least preferred based on their perception.

After data collection from the CA stage, all data are analysed using the SPSS conjoint analysis. Descriptive statistics-compare means are used to identify any significant relation between demographic characteristics of respondents and the utility values of each model. Average utility score and frequencies are used to measure respondent stated preferences for models of flexible house design. Relative importance is identified for each level and attribute of flexibility and for each respondent's answer. For the purpose of this study, the researchers refer only to the relative importance of the main attributes of flexibility.

## RESULTS AND DISCUSSION

**Results from MEC:** For the purpose of this study, the researchers show a summary result from all HVMs as clarified in Table 1. Results of MEC elicited eight preferred flexible attributes in house design based on user perception that are influenced by three main values. In parallel to Jusan (2007, 2010a, b) results, the results of this stage show that respondents consider some spaces in a house more than others. Here, respondents consider some spaces to be more flexible and in different levels than other spaces. These attributes are also considered as indication of people intention to modify house design to cope with their changing needs.

There are a number of studies that concern with forms of modifications and renovation in house design in Malaysia. Omar *et al.* (2010, 2012) conclude that adding extension to the house is the most preferred form of modifications in Malaysian houses. Saruwono *et al.* (2012) argue that Malaysian families give more consideration to the living room; Its layout and furniture arrangement because they spent most of their time in this space and gather in occasion. Saji (2012) assumes that most of the modifications made in Malaysian terrace house design are: increasing number of bedroom, widening living room, dining and kitchen. However, the results of MEC stage of this study show that respondents consider different spaces and other attributes of flexibility or modification in house design.

Jusan (2007, 2010a, b) and Saji (2012) highlight the importance of modifying porch and house Façade. In contrast to the findings of these studies, the results of this study show that respondents are less interested in having flexibility in outdoor spaces and house façade in comparison with their high concern on having flexible attributes inside house.

Modifiability of Furniture (MFA) is one of these eight attributes of flexibility that was highly preferred and associated with some values. This main attribute was highly preferred specifically in living room, Master bedroom, bedroom and in house as a whole. These four spaces were considered as the levels of (MFA) attribute.

The second most preferred attribute of flexibility is (EN) which is the possibility of enlarging specific rooms in a house. These spaces were considered as the main levels of these attributes such as kitchen, bedroom, master bedroom, living room and dining room.

The third most preferred attribute is Modifiability of Floor Covering (MFC) which was preferred mostly in living room, bedroom and kitchen. Then (MWC): Modifiability of Wall Color or possibility to repaint was

preferred as flexible attribute in specifically living room, bedroom and in the house as a whole. This attribute was suggested by respondents as one of the important flexible attributes. Table 2 shows that (SD) Self-Direction is the significance value that influenced respondent preferences for this attribute. Interviews showed that this attribute was most preferred to satisfy good feeling specifically in social occasions when family tend to be in good looking and new shape to guests. Besides, this attribute of modifiability of wall color was highly preferred because of its effects that hopefully take place with the minimum cost in comparison with other attributes. This could be considered as the main motivation for this choice.

Modifiability of Window Size (MWS) was suggested by respondents as one of the most preferred attributes of flexibility in house design. This attribute had two main levels; Living room and the house as a whole where each associated with satisfying the value of family security. This attribute was chosen to achieve healthy environment in house and more secure living environment for kids and for the whole family.

Respondents also referred to an important attribute which is the possibility of merging two rooms into one (MER). They preferred it in two application; Costs little by using flexible partition and by using flexible or demountable walls which can be installed and removed easily to totally separate or to merge between the two spaces. These two explanations are translated into two main levels as temporary and permanent possibilities of merging.

Choosing of possibility of adding additional room (Add-on) was preferred as another attribute of flexibility and associated with Hedonism (HE) value. Respondent's explanations on this attribute indicated two main levels of yes/no preference for adding new space.

In-home equipment is considered as one of the main attributes in house (Jusan, 2007; Sadalla *et al.*, 1987). Possibility to renovate in-home equipment easily was one of the main concerns of interviewees as a preferred attribute of flexible house design. This attribute was highly preferred for the whole house and specifically for kitchen space in order to satisfy value of family security.

**Results from CA:** Literature shows that here is no clear procedure to categorize the results of ranking. However, each study that used CA adapts a specific categorization. Pieng considers the first 5 profiles with the highest values of utilities as the most preferred or most important profiles. Krystallis (2001, 2005) and Krystallis and Ness (2005) assume a categorization for the results of ranking into three groups; Most important, intermediate and least important profiles.

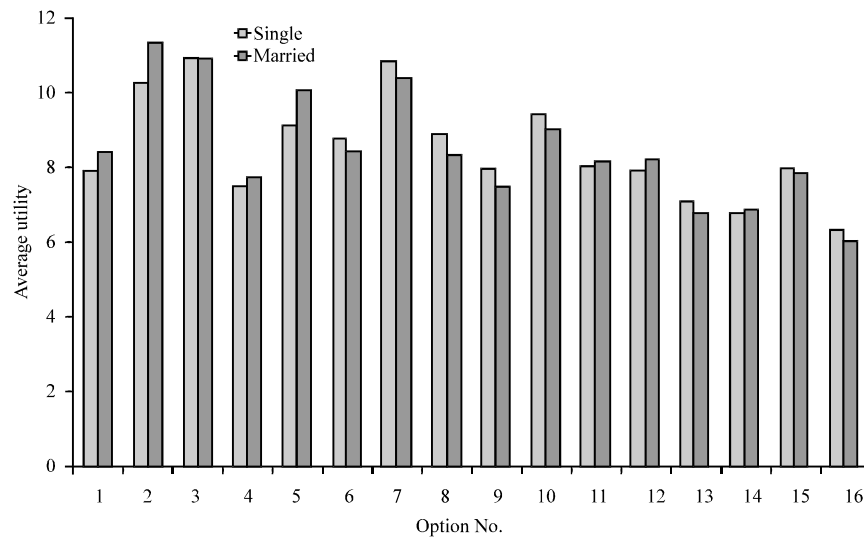


Fig. 3: A comparison between preferences of married and single respondents for options of flexible house design

This study considers the most important model based on its relation with each of the demographic variables such as age, gender, marital status and education. For the purpose of this study, the researchers choose marital status as one of the main variables that influenced respondent choice behaviour.

**Ranking results:** The results of utilities and average score rank and the results that are gained from compare means show that there is a relation between marital status and respondent choice and preferences for flexible house design. There is 44.4% of respondents married and 55.6% single of the whole selected sample. Figure 3 shows that married respondents highly preferred model 2 of flexible house design. Model 2 consists of eight flexible attributes, as shown in Table 2.

Two of the most important flexible attributes that distinguish this model are related to flexibility of kitchen. This is an indication of the importance of this space in house for married respondents more than single, that agree with the results from the MEC stage. Interviewee stated that kitchen is the place where parent find a time to talk while they cook. Friedman (2001, 2002) posits that “The range of activities that take place in the kitchen also make it a high-priority space for choice and adaptability”. Model 2 of flexible house includes possibility to Enlarge (EN) kitchen space, so that, parent can have enough space to talk while cook together. People prefer to modify the size of kitchen especially in occasion when family gather and more than two persons sit in kitchen to cook and talk. In parallel to results by Jusan (2010a, b) which highlight the significance of this space for family. Also, Saji (2012) considers kitchen, in Malaysian houses as a

significant place where most modifications occur there. Another attribute related to kitchen is the possibility to Renovate Equipment (RE). This attribute also important for family more than single, since, most parent prefer to have safe and better functional kitchen. It seems that modifications and renovations in house design influenced respondent perception and then choice of flexibility in house design.

Flexibility in kitchen is considered as the first priority that influences choices of married respondents. Another attribute is Modifiability of Furniture (MFA) in order to change look and change mood from time to time. This was preferred for the whole house and specifically in occasions to personalize houses where people want to show something new for the guest. Aragones *et al.* (2010) refers to the important role of decoration in making changes and personalizing house. Beisi (2004) assumes that using flexible furniture and demountable walls may achieve flexibility in house design. The results show that married respondents preferred this attribute for the whole house and not for specific space because of its influence and cost nothing.

Married respondents prefer the attribute of merging dining and living (MER) in a temporary way by using Flexible Walls (Flex W) to satisfy sufficient space for family. Living room is considered as a communal space and a space for family representation (Cemons *et al.*, 2004, Jusan, 2010a, b), since that, married respondents considered this space through another flexible attributes which is Modifying Floor Covering (MFC). This model also includes Modifiability of Window Size (MWS) satisfy better and healthy environment in house. Possibility of changing wall

colour (MWC) of specifically bedroom where kids spent most of their time is one of the main attributes of model 2.

The results of average utility score show that single respondents choose model 3 as the first and most preferred flexible house. This model includes two main flexible attributes related to bedroom that reflect single respondent choice and priorities. Single respondents who are all university students, spend most of the time in their bedrooms to study, sleep and work as concluding from interviews.

Another attribute of flexibility that influenced single respondent's choice is the possibility of adding a room (Add-on) because single respondent has desire to enlarge their space or adding another space to include all his belongs like; Books, furniture, cloth and other related possessions in his bedroom. Results from interviews showed that besides respondent preferences to add another room is their desire to get a separate room for each boys and girls or separate room for each kid in order to achieve privacy. In parallel, Aragonés *et al.* (2010) posits that “Children and adolescents project themselves in their bedrooms. Bedrooms are therefore, area of house

where they exteriorize themselves; They can personalize a bedroom and enjoy a certain degree of autonomy in it”.

**Choice and preferences for flexible attributes:**

Calculations of the relative importance, Fig. 3 show that the most important attributes as perceived by respondents are firstly the Modifiability of Furniture (MFA) and possibility of Enlargement a room (EN). These two attributes have the highest relative importance of 25.7% for MFA and 19.6% for EN. Other important attributes such as Modifiability of Wall Color (MWC) with relative importance of 16.1%, adding a room (Add-on) with 12.4%, merging two rooms into one (MER) with 7.8% and modifiability of window size with relative importance of 6.3%. The least important attributes are Renovation of Equipment (RE) and Modifiability of Floor Covering (MFC).

Comparison of the two results includes the ranking of the most important eight attributes from MEC and the ranking of the highest relative importance of attributes indicated in CA method as shown in Fig. 4 and Table 3. It can be concluded from the comparison that in contrast with the results derived from MEC which refer to the MFC

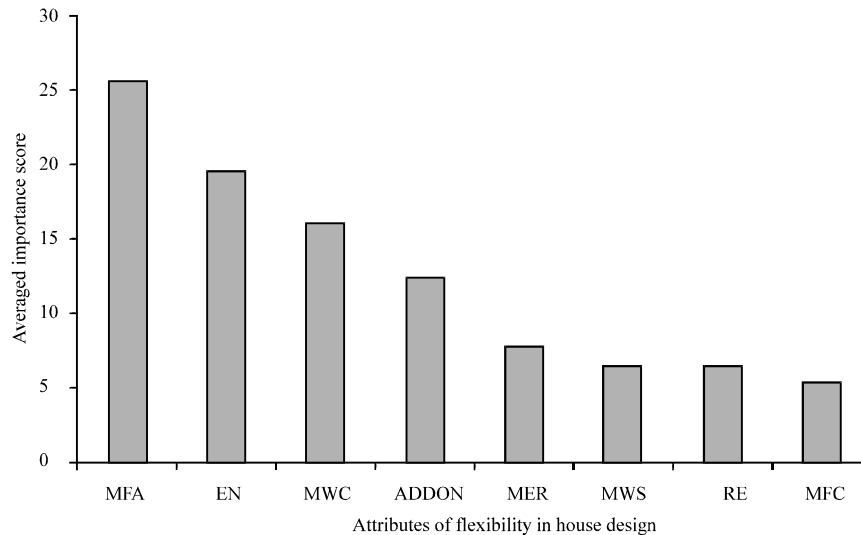


Fig. 4: Relative importance of flexible attributes in house design

Table 3: A comparison of arrangement of important attributes in MEC and CA

Arrangement	Arrangement of important attributes of flexibility: MEC stage	Arrangement of important attributes of flexibility: CA stage	Relative importance: CA stage
1	MFA	MFA	25.749
2	EN	EN	19.681
3	MFC	MWC	16.111
4	MWC	Add-on	12.477
5	MER	MER	7.806
6	MWS	MWS	6.371
7	RE	RE	6.359
8	Add-on	MFC	5.447



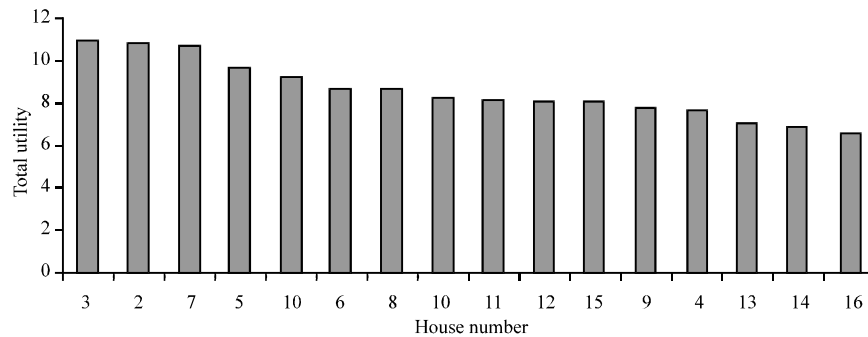


Fig. 5: Total utility of flexible house models, the researchers

attribute as the third most important attribute, CA results show that this attribute is the least preferred by respondents.

**Choice and preferences for flexible house design:** Finally, utility calculations are done in CA to measure user preferences and identify the most important attributes of flexibility which influenced respondent choices. In addition, these statistics identified the overall evaluations of the 16 house design models as clarified in Fig. 5. This Fig. 5 shows that the most five preferred models of flexible house design are 3, 2, 7, 5, 10. It can be seen that this result is the output of respondent's choices which were influenced by some demographic factors like marital status and other demographic factors.

The CA results show that all the eight attributes of flexibility and their levels were differently perceived by the respondents according to user priorities. The evaluation process show users choice behaviour for models of flexible house design. They considered the model that contains the largest number of preferred flexible attributes and least number of not preferred attributes as their first priority. For example, respondent might think about flexibility in kitchen design as the first priority and specifically its equipment and floor covering and give second or less concern to floor covering of bedroom. Then respondents will make like trade-off and choose the model of flexible house design which contains these attributes together. Then respondents rank this option as number 1 and consider it as the optimal flexible house design model that satisfies their expectations.

### CONCLUSION

Major findings of this study highlight the significance of manipulating Means-End Chain (MEC) and Conjoint Analysis (CA) research models in exploring user perception of flexible house design. The results suggest that MEC research model is able to establish user

preferences for a list of flexible attributes. Using the same research model, user preferences elicited from the laddering interview were categorized and mapped. Conjoint Analysis (CA) was later employed to transform these preferences into a number of flexible house design models. The entire process of eliciting user preferences, modelling preferences and then evaluating models by users themselves has two indications. Firstly that establishing flexible house design should be based on user perception. Literature shows that there are many studies established flexible design models based on designer perception and little or no studies based on user perception to achieve flexibility in house design. In the stage of MEC Model respondents perceive flexibility in house design through a list of flexible attributes. Their perception was influenced by their values. In the stage of CA respondents face their preferences in the form of models of flexible house design. Their perception and choice behaviour were influenced by their intentions and priorities to modify and easy renovate their actual houses.

Secondly, it indicates the necessity to facilitate active user participation in order to achieve flexibility in house design. Generally, 'User participation' in house design in Malaysian mass housing is mostly passive or takes the form of representative or alternatives perceived to be appropriate by the architects. The 'flexibility' (if any) is a strategy where the designers make a number of house design alternatives, based on their assumption on user needs and user are assumed to be able to choose the one that suit his/her needs. In this way, user participation after occupancy would be limited or may be difficult to accommodate. Through user perceived flexibility, flexible house design would be more relevant to the needs of the end users. The development of the flexible housing unit based on user perception can be considered as a form of active user participation at design stage. This will lead to achieving preferred flexibility in house design which in turn facilitates active user participation in future.

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