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Factors of Spatial Modification in Terraced Houses: A Pilot Study

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ABSTRACT

Terraced houses are a popular type of housing development in Malaysia, particularly in urban areas. Terraced houses are significant in Malaysia because it offers affordable, efficient land use in densely populated areas and enhancing community living. However, modifications to the layout are necessary to ensure houses remain practical, energy-efficient, and adaptable to changing needs. In terms of design, Malaysian terraced houses follow standard residential designs. However, inadequate spaces and unsatisfied homeowners' desires often lead them to modify their units with either major or minor modifications. Therefore, this study aimed to identify factors influencing space modification in terraced houses. Taman Pagoh Jaya, Johor, was chosen as the location for this study. The data was collected quantitatively using a questionnaire survey method with 20 respondents, and the study sample was selected using purposive sampling specific to single-story terraced houses that had undergone modifications. The data analysis technique for objective (1) uses a one-way ANOVA test to show seven household profiles for the sample of the study, which is the number of households, household income, number of children, number of years occupied, number of rooms and vehicle and floor plan approved by the Local Authority (LA) with the extent to which the modification directly affected by the factors that contribute to the modification of space in a terraced house. The data analysis technique for objective (2) uses descriptive statistical analysis by looking at the mean score which showed the lowest level of homeowner perception of the spatial function effectiveness before modification, with a mean score of 2.10 which disagreed with the inappropriate area of the kitchen. The highest level of homeowner perception which they were satisfied with the results of home space modification with a mean score of 4.35. The Pearson correlation coefficient used to analyse objective (3) showed a relationship between the 'factors that contribute to the modification of space in terraced houses' with the 'perception of the results of their modification' with a p-value of 0.000. In conclusion, based on the findings of physical modification, spatial modifications are still being carried out to fulfil the homeowner' needs.

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1. Introduction

Terraced house modification is a popular phenomenon in Malaysia. According to Saji [1] and Saad [2] modification can occur either horizontally or vertically. In Malaysian terraced houses, horizontal expansion is only allowed in the front or back, and there is insufficient space for the extension to be useful. Vertical extension is considerably more potent than the horizontal extension. Due to the fact that horizontal extension can only add 20% to 30% to the fundamental construction, while vertical expansion can achieve 100% to 200% by adding one or two storeys. Local authorities' guidelines apply when vertical expansion is required. Any modification should consider ventilation, lighting, drainage, and the rights of neighbours. Nonetheless, regulated modifications that adhere to the established guidelines should be implemented.

The design of terraced houses in Malaysia looks almost the same and is often stereotyped. Terraced houses in Malaysia commonly have similar designs primarily for cost efficiency. Developers prefer standardized layouts to save on construction costs and make homes more affordable for a broader range of potential buyers. Furthermore, terraced houses in Malaysia often feature similar designs due to the tropical climate, with features like large windows for ventilation, overhanging roofs for shade, and open layouts to promote airflow and cooling. According to Saruwono *et al.,* [3], the housing units in Malaysian cities are monotonous and repetitive, arranged in straight rows. According to informal observations, homeowners make modifications to their houses sooner or later, even before they move in. In terraced housing neighbourhoods, the uniform design of units creates a monotonous visual environment, leaving individual homeowners feeling their houses lack distinct identity unless house numbers. In a modern and developing country like Malaysia, where societal advancement aligns with Maslow's hierarchy of needs, residents seek to reflect their image and aesthetic tastes through their homes and they have a tendency to pursue modification due to limited involvement in the initial purchase process [3]. Figure 1 shows the layout of Taman Pagoh Jaya Phase 1 and the typical layout of a single-story Malaysian terraced house as well. Every homeowner tends to modify the space in their home to suit their needs. According to Umar Raji [4], the spatial modification of terraced houses in Malaysia is developing on a regular basis to satisfy the needs of house owners, such as offering appropriate home spaces, fulfilling the owner's needs or living style, and acting as an investment. He also believes that property maintenance and enhancement may increase the value and quality of life. According to Sazally *et al.,* [5], the top five components of modification in the front half of the house are the car porch area, painting, grill, gate, and pavement, while the top five components of modification in the back half of the house are an additional kitchen, painting, grill, flooring, and door.

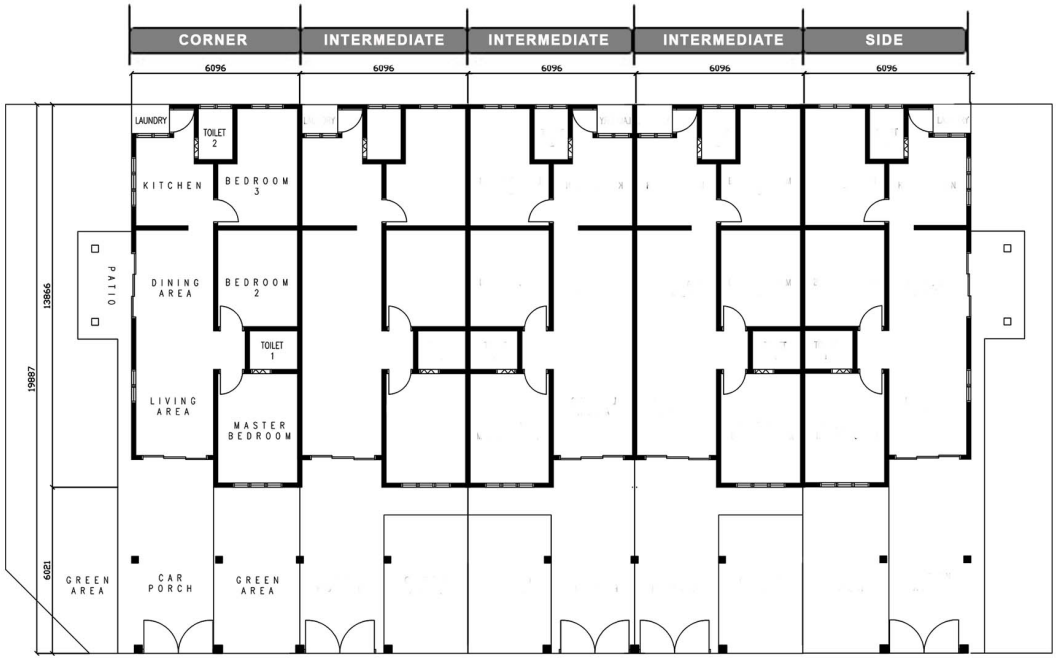

Fig. 1. A typical layout of a Malaysian single-story terraced house (Taman Pagoh Jaya Layout)

There are several theories explaining the reasons for the modification. It is widely acknowledged that a resident's housing alteration reflects their personality, interests, lifestyle, values, tastes, lifestyle and social status [1,6-8,21]. Homeowners modify their houses for a variety of reasons, such as aesthetic appeal, functional demands, or personal needs [5]. Moreover, the personalisation of space caters to each family member's preferences and habits, which represent their unique character, as well as to the surroundings [9]. This study will examine factors that influence homeowners to modify their houses.

The terraced house's floor layout is basically the same, and the view of the front facade is monotonous and repetitive. It was discovered that the terraced house design has adopted a style that appears to be the same every year and is frequently repeated. This is supported by the findings of Omar *et al.,* [10], which found that the typical spatial characteristics of Malaysian terraced houses have not changed significantly. To confirm this, sales brochures from new house developments around Malaysia were examined.

In order to create a more functional space for their needs, homeowners are willing to give up other unused spaces in the house. In Taman Pagoh Jaya Phase 1's floor plan, there is a laundry area in the back, which is considered less functional because there is already a drying space in the front of the house. The typical homeowner enlarges this area to accommodate a larger kitchen. However, improper spatial modifications to terraced buildings will have a slew of negative consequences for homeowners, the neighbourhood, and the local council or local authorities. According to Mohamed Sabri, the situation of houses being illegally modified without proper authorization from local authorities can lead to various risks, jeopardize resident safety, and disrupt the sustainability of the neighbourhood. Illegal modifications may result in increased shadows, diminished natural lighting, and changes in ventilation patterns. These modifications can have an adverse impact on the overall microclimate within the community and even affect the energy efficiency of neighbouring residences. There are four common types of violations that frequently occur:

i. insufficient access to natural light and ventilation
ii. inadequate wastewater disposal systems

iii. encroachment onto road reserves
iv. failure to comply with minimum building setback regulations.

To address these issues, local authorities must respond to such illegal modifications by taking legal actions, imposing fines, addressing code violations, and addressing safety concerns [11]. According to Omar *et al.,* [10], terraced house modifications will take up approximately 40% of the available space, while extension and the addition of new terraces will increase the terrace's area by 26%. Furthermore, according to the article, some homeowners may sacrifice space for other purposes, such as expanding their living room to create two sitting areas. Typically, homeowners will enlarge their living room to include the porch by reducing the size of the porch and increasing the size of the living room.

Low levels of satisfaction lead to homeowners modify their houses to meet their specific needs. Each homeowner has their own requirements and needs based on the number of households, the number of years occupied, and a variety of other factors. According to previous research by Musa and Yusuf [12], a sample of 196 respondents were used to determine locals' satisfaction with housing quality in three areas: physical housing, infrastructure, and environment. The results indicated that 14.8% of respondents were not satisfied with the number of bathrooms, 36.2% responded with 'Not Sure' when asked about the adequacy of their home's square footage, and 15.8% gave a similar response regarding the size of their dining room. As we already know, the homeowner's uncertain response may indicate a high probability of future modifications.

The purpose of this study was to identify factors of spatial modification in terraced houses. The objectives of this study are:

i. to identify factors that influence homeowners to modify existing terraced houses
ii. to assess the homeowners' perceptions of:
    - the spatial function effectiveness (before modification)
    - the results of spatial modification
iii. to investigate the relationship between ‘factors that cause homeowners to modify the house’ with their ‘perceptions of the results of their modification’.

Exploring the often gap and overlooked realm of long-term impacts, research on factors of house modifications influence from homeowners' well-being and satisfaction could provide valuable insights. Investigating whether these modifications lead to sustained improvements in quality of life, satisfaction, the adaption of green building concepts, and changes in social dynamics over time is crucial. A longitudinal perspective would contribute to a comprehensive understanding of the enduring effects of house modifications. Despite frequent proposals for flexible plans, their implementation lacks seriousness among practitioners. It is essential to emphasize the importance of flexible plans and comprehensively list their positive and negative effects. This approach could particularly benefit individuals from the middle-income group, ensuring a positive impact on their housing experiences.

2. Methodology

2.1 Data Collection

The quantitative approach was applied in this research. In the survey approach, a questionnaire is used to determine differences between individuals and opinions that cannot be observed. This study is based on a questionnaire survey of Taman Pagoh Jaya residents in Johor (Phase 1). Taman

Pagoh Jaya, Johor, consists of 3 phases and Phase 1 was the early phase of development. The collection included intermediate, end lot, and single-story low-cost terraced houses, which were selected through purposive sampling, observations, and surveys. Additionally, some notes were taken to gather information from the residents of the residential area for the purpose of conducting this study.

The number of respondents who have modified the space of their units is 20 respondents. During the field survey, respondents were chosen by going from house to house. In some cases, respondents were given a set amount of time to respond, with the questionnaire administered later, as agreed upon by the respondents. As a result, 20 questionnaires were obtained and analysed. A questionnaire with five sections and questions with scaled responses was created to assess respondents' perceptions of the questionnaire. The Statistical Package for the Social Sciences (SPSS) software was used to complete the analysis for this study. This study employs the methodology flowchart depicted in Figure 2.

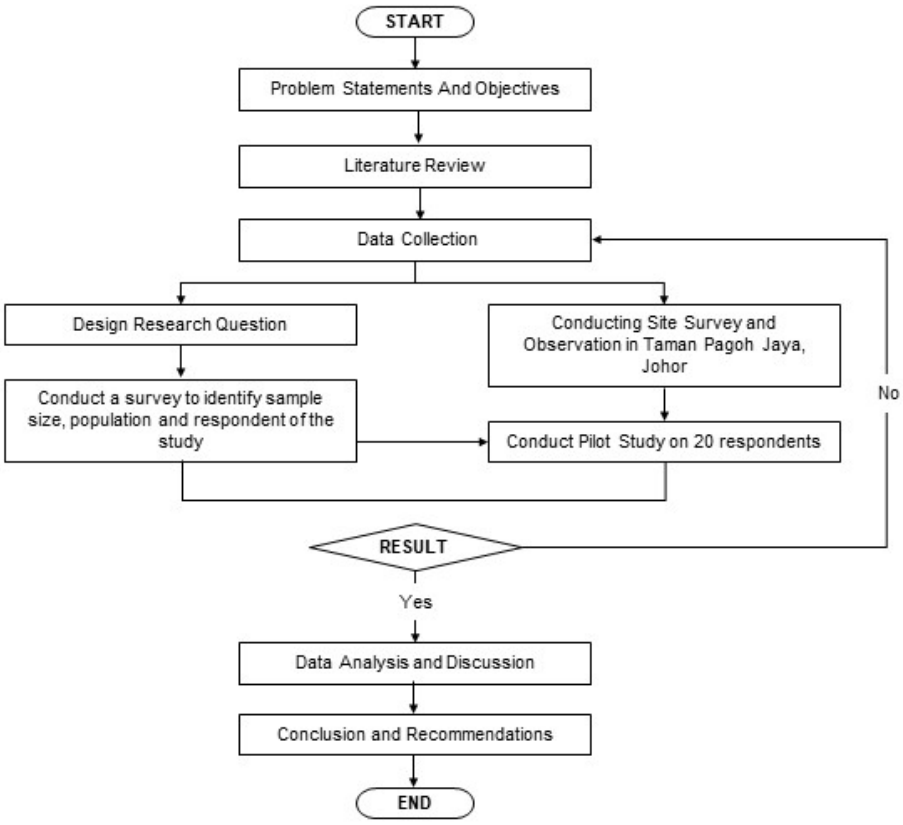

Fig. 2. Flowchart of Methodology

2.2 Pilot Study

Pilot studies are usually recommended by academics and consultants to address a wide range of issues, including the development of preliminary scales and instruments [13]. The principal objective of conducting a pilot study is to assist researchers in avoiding beginning a big investigation without fully grasping the methods involved. Essentially, a pilot study is initiated to avert the emergence of critical deficiencies within a study that would be simultaneously resource-intensive in terms of time and finances [14]. The overall population of single-story terraced houses in Taman Pagoh Jaya is 264 houses with 182 houses having undergone the modification (front and back modification). 99 houses

identified have modified their units front and back (major) and the rest 83 houses have modified only their awning at the front lawn (minor). Using Raosoft, an online sample size calculator, 79 respondents were selected from the 99 houses as the recommended sample size. This study adapted the sample size for a pilot study according to [13,15,16], who recommended that 10 to 30 participants have several practical advantages, including simplicity, easy calculation, and the opportunity to test hypotheses for pilots in survey research. The instrument for data collection is then designed based on Saunders *et al*., study [17]. The final respondents for this pilot study are 20 respondents. Table 1 shows the calculation description for the pilot study sample size for this study.

Table 1
Pilot study sample size calculation

	Overall Population	Modified Houses Major (Front and Back) Minor (Awning Alteration)		Raosoft Calculator 95% confidence level 5% margin of error	Pilot Study (sample size) [13,15, 16] 10-30 Respondents
No. of Houses	264	182	99 (Major) 83 (Minor)	79 (recommended)	20

2.3 Research Criteria

This research mainly focuses on single-story terraced houses because any modifications will be more apparent when there is a physical change to the exterior from the original terraced house plan [1].

i. Criteria for selecting a terraced housing area in Taman Pagoh Jaya, Johor:
   - The house has undergone space modifications;
   - Low-cost terraced house;
   - Single Story Terraced Houses.

ii. Criteria for selecting respondents:
   - To eliminate bias, residents are chosen at random for surveys;
   - Residents of different ages and socio-economic status are surveyed in order to ensure a representative cross-section of the housing area population.

2.4 Questionnaire Development

Respondents complete the questionnaire to provide information on their current status, attitudes, and perspectives. This research's questionnaire design was based on a previous study [1]. The query has been formulated about the spatial modification within the homeowners' terraced houses. There are four sections to the questionnaire: A, B, C and D.

Section A consists of eight questions about the homeowner's profile as shown in Table 2.

Table 2
Code for Part A Household Profiles Questionnaire Survey Questions

Code	Households Profile Questionnaire Survey Questions
A1	Number of households
A2	Household income
A3	Number of children
A4	Races
A5	Number of years residing
A6	Number of rooms
A7	Number of vehicles
A8	Floor plan approved by the local authorities

Section B consists of fifteen questions about the reason that lead to the modification of space in terraced houses as shown in Table 3.

Table 3
Code for Part B Questionnaire Survey Questions

Code	Factors That Contribute to Modification of Space in Terraced Houses	Categories of Factors
B1-i	I modified my house because I have stable financial	Values
B1-ii	I modify my house because it is better and cheaper than buying a brand-new house	Values
B2-i	I modified my house to obtain a better and beautiful façade.	Tastes
B2-ii	I did not modify my house in order to maintain the standard repetitive design	Tastes
B3-i	I modified my house because I was influenced by the surrounding	Social Status
B3-ii	I modified my house because I had no choice (I did not want to move because I am attached to the house	Personality
B3-iii	I modified my house because I am well aware of the regulations set by the authorities regarding house modification	Personality
B3-iv	I modified my house because I support housing modification and renovation	Personality
B4-i	I modified my house to maintain the house and avoid obsolescent	Lifestyle
B4-ii	I modified my house to cater for the growing number of households	Lifestyle
B4-iii	I modified my house to expand certain spaces in my house	Lifestyle
B4-iv	I modified my house to eliminate certain spaces in my house	Lifestyle
B4-v	I modified my house to divide certain spaces in my house	Lifestyle
B4-vi	I modified my house to extend certain areas	Lifestyle
B4-vii	I modified my house to rearrange certain spaces in my house	Lifestyle

Section C consists of twelve questions about the homeowners' perceptions of the spatial function effectiveness as shown in Table 4.

Table 4
Code for Part C Questionnaire Survey Questions

Code	Homeowners' Perception of The Spatial Function Effectiveness	
C1-Ai	The number of bedrooms in my house is sufficient.	Before House Modification
C1-Aii	The number of bathrooms and toilets in my house is sufficient.	
C1-Bi	The width of bedrooms in my house is appropriate.	
C1-Bii	The width of living room in my house is appropriate.	
C1-Biii	The width of dining room in my house is appropriate.	
C1-Biv	The width of kitchen in my house is appropriate.	
C1-Bv	The width of bathrooms and toilet in my house is appropriate.	
C1-Bvi	The width of patio at my house is appropriate.	
C1-Bvii	The width of car porch in my house is appropriate.	
C2-i	I convert my dining room into my children's sleeping area.	In terms of space adaptation
C2-ii	I use the living room as the guest's sleeping area and my children's sleeping area.	
C2-iii	I convert my laundry into utility space.	

Seven questions in Section D (Table 5) inquired about the homeowners' perceptions of the outcomes of their spatial modification. Sections B, C and D have closed-ended questions that require respondents to select their factors of influencing and level of satisfaction using a Likert scale.

Table 5
Code for Part D Questionnaire Survey Questions

Code	Homeowners' Perception of The Results of Their Modification
D1	I might modify my house again in the future
D2	After my home modification, it has accommodated my household
D3	Modification of house space is necessary because in my opinion, the previous space design was inappropriate
D4	The modification of the house space is necessary to reflect my taste towards aesthetical design
D5	Modification can utilize the space in my house that is not needed
D6	The modification of the space simplifies my daily life in doing housework
D7	I am satisfied with the outcome after the house modification

2.5 Result Indicator

The coefficient alpha, denoted by the symbol "α," assumes values within the range of 0 to 1 and serves as a quantitative measure of internal consistency for a given set of test items. Table 6 shows the result indicator for the range of reliability and its coefficient of Cronbach's Alpha.

Alpha is expressed as a number between 0-1

Closer to 1 = Higher internal consistency. (If test items are correlated to each other, Alpha increases).

Closer to 0 = Lower internal consistency. (Tests that are too short have reduced alpha values).

Table 6
Range of reliability and its coefficient of Cronbach's Alpha

Cronbach's Alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.8 > \alpha \geq 0.9$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

The value of Cronbach's Alpha for this pilot study is 0.700. The questionnaires are highly correlated with high internal consistency. The items have a high consistency value, and the items are considered to be appropriate. The result is shown in Table 7.

Table 7
Reliability statistic using Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
0.70035	42

3. Result and Discussion

3.1 The Factors that Contribute to Modification of Space in Terraced Houses

Based on Moidunny [18], the interpretation of the mean score says that the mean score value between 3.21 to 4.20 is high and the interpretation of the mean score says that the mean score value between 2.61 to 3.20 is medium. The findings in Table 8 show that the respondents chose items B1-i, B1-ii, B2-i, B3-ii, B3-iii, B3-iv, B4-i, B4-ii, B4-iii, B4-iv, B4-v, B4-vi and B4-vii with mean score value of 3.55, 4.30, 3.30, 3.95, 3.30, 3.80, 3.50, 3.55, 4.15, 3.50, 3.85, 4.20 and 3.55 indicated as 'High'. The rest of the respondents chose items B2-ii and B3-i with mean score values of 3.05 and 2.85 indicated as 'Medium'.

Table 8
Mean Score Values of Factors that Contribute to Modification of Space in Terraced Houses

Item	Mean	Level
B1-i	3.55	High
B1-ii	4.30	High
B2-i	3.30	High
B2-ii	3.05	Medium
B3-i	2.85	Medium
B3-ii	3.95	High
B3-iii	3.30	High
B3-iv	3.80	High
B4-i	3.50	High
B4-ii	3.55	High
B4-iii	4.15	High
B4-iv	3.50	High
B4-v	3.85	High
B4-vi	4.20	High
B4-vii	3.55	High

A one-way ANOVA test was conducted to answer the research question regarding the factors that encourage homeowners in Taman Pagoh Jaya to modify their houses. The relationship between 'household profile' and ‘factors that contribute to the modification of space in terraced houses' is summarized in Table 9.

The mark (X) indicates that the two variables are mutually influence each other, and it is considered significant. Only A4, which represents 'race' in the study sample profile, is not affected by any factors contributing to the modification of space in terraced houses. Household profile A1, representing the number of households, shows a relationship with the B4-ii factor of lifestyle (I renovate the house to accommodate the growing number of households) with a p-value less than 0.05. The lifestyle factor indicates that respondents in Taman Pagoh Jaya modified their houses to accommodate their growing number of households. Household income (A2) is affected by the B3-iv factor of personality which is ‘I renovate the house because I support home renovation/modification’ with a p-value of 0.016. Household profile A3, representing the number of children, shows a relationship with the B1-i factor of value, which is 'I renovate my home because I have stable finances,' with a p-value of 0.030. Next, household profile A5 (number of years of occupying the house) is affected by the B4-i factor of lifestyle which is ‘I renovate the house to maintain it / avoid obsolescence’ with the p-value 0.019. The number of rooms (A6) shows a relationship between B4-ii factor of lifestyle (I renovate the house to accommodate the growing number of households) with a p-value of 0.002. Additionally, the number of vehicles (A7) is also affected by the B4-vi factor which is ‘I modified my house to extend certain areas’ with a p-value of 0.041. Lastly, household profile A8 (My home has an approved floor plan from the council) has affected the factor of lifestyle B2-ii which is ‘I don't renovate the house to maintain its uniform design’ with a p-value of 0.011.

Table 9
Summary of the Relationship Between Household Profiles and Factors That Contribute to Modification of Space in Terraced Houses

		Factors That Contribute to Modification of Space in Terraced Houses														
	Factors	B1-i	B1-ii	B2-i	B2-ii	B3-i	B3-ii	B3-iii	B3-iv	B4-i	B4-ii	B4-iii	B4-iv	B4-v	B4-vi	B-vii
Household Profiles	A1										X					
	A2								X							
	A3	X														
	A4															
	A5									X						
	A6										X					
	A7														X	
	A8				X											

Seven household profiles for the sample of the study, which is the number of households, household income, number of children, number of years occupied, number of rooms and vehicles and floor plan approved by the Local Authority (LA) have a positive relationship between factors of values, tastes, personality, lifestyle that contribute to the modification of space in terraced houses. Meanwhile, a relationship doesn’t exist between the household profile of race and any factors that contribute to the modification of space in terraced houses.

3.2 Assessment of Homeowners' Perception of Modify Existing Terraced Houses Due to Spatial Effectiveness and Perception After Modification

Based on the mean score shown in Table 10, it can be observed that respondents chose items C1-Bi, C1-Bii, C1-Biii, C1-Bvii and C2-iii for homeowners' perceptions of the spatial function effectiveness with mean score values of 3.75, 3.65, 3.70, 3.80 and 3.25. This interpretation of the mean score says that the mean score value between 3.21 to 4.20 is high [19]. In addition, respondents chose items C1-Ai, C1-Aii, C1-Bv and C1-Bvi for homeowners' perceptions of the spatial function effectiveness with mean score values of 2.80, 2.90, 3.15 and 3.15. This interpretation of the mean score says that the mean score value between 2.61 to 3.20 is medium. Lastly, respondents chose items C1-Biv, C2i and C2-ii with mean score values of 2.10, 2.45 and 2.60 indicated as low as per interpretation by Mikhaleva *et al.,* [19] that mean range of 1.00 to 2.60 as low. Item C1-Biv has the lowest mean with a mean score reading of 2.10, and respondents said that they disagree with the inappropriate area of the kitchen.

Table 10
Mean Score of Homeowners' Perception of The Spatial Function Effectiveness

Item	Mean	Level
C1-Ai	2.80	Medium
C1-Aii	2.90	Medium
C1-Bi	3.75	High
C1-Bii	3.65	High
C1-Biii	3.70	High
C1-Biv	2.10	Low
C1-Bv	3.15	Medium
C1-Bvi	3.15	Medium
C1-Bvii	3.80	High
C2-i	2.45	Low
C2-ii	2.60	Low
C2-iii	3.25	High

The mean score in Table 11 shows that respondents chose D7 for the highest score value of 4.35 as strongly agreed that they were satisfied with the results after the house modification. Item D5 indicated a high mean score value of 4.10 as strongly agreed that modification can utilize the space in-house that is not needed. Followed by item D3, a mean score value of 4.00 with a response that strongly agreed that modification is necessary due to inappropriate previous space design. On the other hand, the rest of the respondents chose items D1, D2, D4 and D6 with mean score values of 3.70, 3.60, 3.75 and 3.80. Therefore, it indicates that respondents' perceptions of Taman Pagoh Jaya are more likely to support the modification.

Table 11
Mean Score of Homeowners' Perception of The Results of Their Modification

Item	Mean	Level
D1	3.70	High
D2	3.60	High
D3	4.00	High
D4	3.75	High
D5	4.10	High
D6	3.80	High
D7	4.35	High

3.3 The Relationship Between Factors That Contribute to Modification of Space in Terraced Houses with Their Perceptions of the Results of Their Modification

There is a relationship between 'factors that contribute to the modification of space in terraced houses' with their 'perceptions of the results of their modification' with a p-value of 0.000 from Pearson correlation: 0.352 which is considered a moderate relationship occurred as shown in Table 12.

Table 12
Pearson Correlation Coefficients for Reason and Perception

		Reason	Perception
Factors	Pearson Correlation	1	.352
	Sig. (2-tailed)		.000
	N		20
Perception	Pearson Correlation	.352**	1
	Sig. (2-tailed)	.000	
	N	20	

**. Correlation was significant at the 0.01 (2-tailed) level

From Table 13, the p-value of "FACTORS" is statistically significant at the .001 level against "PERCEPTION", which means there is a relationship between these variables. The limitation of space in some of the smaller terraced houses affected the family significantly even after modifications, such as the lack of natural light and ventilation, as well as concerns about family and neighbour privacy, leading to an ongoing process of behavioural modification [20]. Agreed with this statement, no matter how good architects and designers are, houses will still be personalized or modified according to each person's needs [21]. Future terraced house designs should address these issues to enhance the quality of life and reduce the number of unnecessary modifications made by homeowners. If respondents' desire to modify the space is high, then the expected perception of the results of home modification will be low.

Table 13
Summary of Correlation for Reason and Perception

	REASON	
	Pearson Correlation**	Sig.
FACTORS	1	0.000**
PERCEPTION	.352	0.000**

**. Correlation was significant at the 0.001 (2-tailed) level

4. Conclusion

The findings for Objective 1 can be summarized that lifestyle factors can affect the profile of households such as the Number of households, Number of years residing, Number of rooms and Number of vehicles to carry out modifications to their homes. Lifestyle factors are significant contributors to the influences on modifications due to the life cycle. This includes factors such as an increase in family members and improvements in the economy, which encourage households to stay longer and adapt their residences to meet current needs. For instance, some households may seek additional bedrooms and an increase in the number of owned vehicles. Personality factors are seen to have a positive relationship with household income. Homeowners with personality are inclined and willing to take risks and make modifications when their household income increases and they support modifications to improve the overall comfort of life. Value factors demonstrate a positive relationship with the household profile, which is the number of children, which means that homeowners modify their homes because they have stable finances and can support the number of children in addition to increasing the value of the home. Tastes factors of homeowners who refuse their houses to have a repetitive design contributes towards house modifications and these modifications have a relationship for homeowners to have house plans approved by local authorities. The process of obtaining building approval plans usually involves compliance with development regulations, so tastes need to be aligned with the prevailing regulations to ensure that modifications go smoothly and legally.

Findings for Objective 2 show that before the modifications were made, homeowners were very dissatisfied with the kitchen area. They had also used the living room and dining room as a bed for the children due to space constraints in the house. Homeowners also sacrificed laundry space for utility space. Many homeowners are dissatisfied with the size of kitchens in terraced houses nowadays due to the growing need for more functional and spacious cooking areas to match modern lifestyles. The dissatisfaction arises because the current kitchen sizes often don't meet these practical demands. People express their satisfaction after modifying their houses because such modifications address specific needs and preferences that may have been unmet by the original design. The findings also reveal that after carrying out the modification, the homeowner was very satisfied and supported the modification because customizing a house resulted better suit their lifestyle, aesthetic preferences, and functional requirements can lead to a sense of ownership and comfort.

According to the research findings for Objective 3, there is a relationship between 'factors that contribute to the modification of space in terraced houses' and 'perceptions of the results of their modification.' This relationship can be attributed to the idea that when homeowners actively modify their living spaces to better align with their needs, it enhances their perception of how well those spaces' function. This occurs because the modifications are tailored to address specific shortcomings, resulting in an improved match between the space and its intended use. Consequently, these modifications lead to a more positive perception of how effectively the space serves its purpose.

Green building aims to use less water, energy, and construction costs by improving the efficiency of building systems, reducing the negative impact on the environment. It focuses on three pillars for overall sustainability, considering environmental, economic, and social factors [22]. People are interested in green buildings because regular construction harms the environment, leading to increased awareness about adopting eco-friendly practices. Recent literature covers various aspects of green building, including challenges, incentives, stakeholder issues, pricing, and energy efficiency. While experts and government bodies are recognized for promoting green buildings, there's still limited research on the public's willingness to buy environmentally friendly residential [23]. Malaysia has significant environmental issues with eight million tons of annual construction waste. Implementing the green building concept is crucial to address this, leading to a healthier environment with reduced building operation costs, lower maintenance fees, and improved energy efficiency [22]. The implications for housing design and policy suggest a need for flexible home designs that adapt to changing lifestyles, align homeowner preferences with regulatory processes, and focus on functional layouts and also achieving the green building concept. Ensuring homeowner satisfaction through customization and addressing space constraints is crucial. Overall, these findings underscore the importance of aligning housing with individual needs and preferences, promoting both homeowner comfort and long-term property value. This research underscores the significance of understanding the homeowners' needs for their living spaces and offers valuable insights for shaping the future of housing design and policies. Future research in this area could explore innovative design solutions and regulatory frameworks to facilitate homeowners' effective modifications, ultimately contributing to higher overall satisfaction in terraced house living.

5. Recommendations

Based on the thorough investigation and discussions, a set of recommendations has been developed for homeowners to consider before starting to modify works in their houses. One critical component is determining homeownership eligibility for making modifications. This entails engaging with relevant authorities because any changes to a terraced house must adhere to legal restrictions. The most important step is also the selection of a properly registered contractor. It is critical to ensure that the selected contractor is registered with a recognised professional institution, such as the Malaysian Construction Industry Development Board (CIDB). This preventative strategy is critical to avoiding future issues and protecting against instances when changed areas may be required. Homeowners should consult experienced professionals like architects, interior designers, and contractors for house modifications. These experts follow legal regulations and offer extensive knowledge, material selection skills, experience, and creative ideas in their field.

The basic common legal compliance for the homeowner is to be aware of the requirement stated in Uniform Building By-Law 1984 (UBBL 1984). Refer to the UBBL 1984, submissions for building modifications, including room subdivisions, it is essential to accurately depict the areas of the existing structure earmarked to be demolished. These plans should encompass all existing surface and foul water drainage systems, staircases, windows, doors, and openings designed for natural light and ventilation. Governmental regulations governing home modifications typically revolve around four key aspects: minimum standard setback, height restrictions, story limitations, requirements for adequate light and ventilation, and the assurance of structural integrity in the proposed changes.

The majority of Local Authorities' websites must provide the public with accurate and straightforward information on house modification procedures. Simple and straightforward infographics help the public understand guidelines better than text-heavy booklets that can be difficult to understand. Local government websites such as Dewan Bandaraya Kuala Lumpur (DBKL)

and Majlis Bandaraya Shah Alam (MBSA) are good examples of useful graphic information. It is critical that each Local Authority's website be enhanced in order to achieve consistency and synchronisation among them.

Future considerations for terraced house design may have a collaboration among architects, developers, and homebuyers to produce flexible terraced house floor plans. While this approach may lengthen the design process, it leads to homeowner satisfaction and reduces the need for future modifications. Offering multiple flexible floor plan options at similar costs empowers buyers to select the best-fit layout and make controlled, cost-effective adjustments as needed, minimizing neighbourhood impact. Diverse household types, such as elderly couples, single persons, families with children, and extended families, have different spatial needs. Research shows that homeowners tend to make modifications to align with evolving life cycle requirements. The Flexible Plan proposal needs consideration due to its minimal modifications and enhanced space efficiency according to household preferences. Figure 3 illustrates the 'Flexible Plan' concept, aimed at minimizing modification costs and maximizing the area's functionality for four household categories. The red dashed line in the figure indicates only the structures that require demolition.

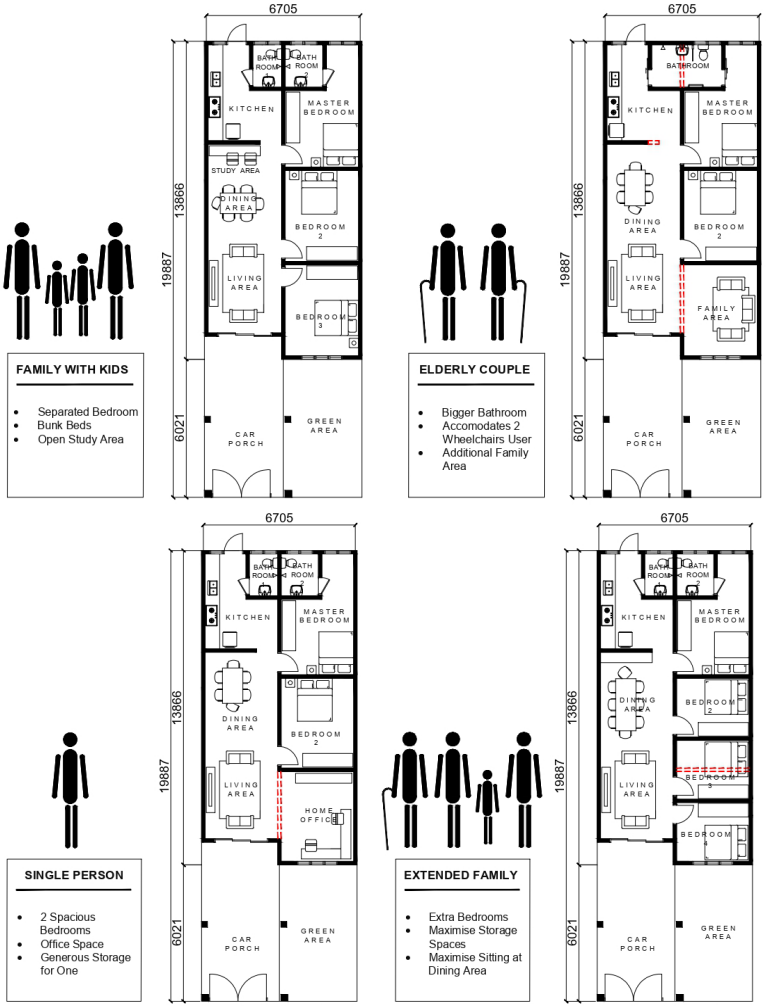

Fig. 3. Flexible Plan for 4 categories of households

The study on spatial modification in terraced houses underscores the significant impact of science and technology on home improvements. Key drivers for modifications include financial stability, aesthetic and functional enhancements, lifestyle changes, and regulatory compliance. Technological

considerations are paramount, focusing on energy efficiency, ventilation, lighting, and structural integrity. Green building concepts are essential, aiming to reduce environmental impact and operational costs by using sustainable materials and enhancing energy efficiency. Proper modifications ensure sufficient natural light and ventilation, while unauthorized changes can jeopardize safety and structural integrity. Future housing designs should incorporate flexibility, allowing for customization to meet individual needs and preferences. This approach promotes homeowner satisfaction and sustainability. The integration of green building principles further enhances the environmental and economic viability of housing. In conclusion, scientific and technological factors are crucial in achieving effective, safe, and sustainable spatial modifications in terraced houses.

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