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The Study of Ergonomic Kitchen Design in Malaysian Low-Cost Housing

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Abstract

The kitchen is where family members gather and household chores are primarily done. The purpose of the study is to highlight the issue of the comfort of Malaysian low-cost housing kitchens. It is the space commonly disregarded and has been a cause for health, safety, and cleanliness. To propose a better design strategy, a basic understanding of the underlying principles and design development is pertinent to extracting the key elements that make up a good kitchen. It will serve as a basis for a revised guideline for plan layout, particularly in Malaysian low-cost housings.

Keywords: Ergonomics; Kitchen Design; Low-cost; Minimal Space

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1.0 Introduction

1.1 Background

The urbanization and economic downfall on top of the current pandemic stand to exacerbate the residents' quality of living (Zainal, et al, 2020), especially concerning health and safety when comfort is not achieved at home. There were already surveys done in Malaysia on residents under the Public Housing program (Projek Perumahan Rakyat), one of the cases being in Selangor where the residents highlight how the kitchen space is unsatisfactory (Hashim, et al, 2012). Although kitchens typically reflect human behaviour and culture on food preparation, the planning layout and overall design become restricted and customary to a Western prototype on space deficiency and cost constraints. Comfort is a physical condition studied through space sufficiency, affordability, accessibility, environmental quality, and facilities (Adebayo, 2013).

Conversely, indoor environmental comfort comprises four research fields: thermal, visual, acoustics, and ergonomic (Kwong, Adam & Tang, 2009). The four factors as weighed throughout the prominent kitchen's features: Working Area, Storage, Lighting, and Ventilation. Meanwhile, kitchen ergonomics optimize movement during meal preparation and cleaning up, and minimize the stress on the human body

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when performing kitchen chores. Everyone deserves to live comfortably, even with the bare minimum. For that, this research hopes to provide a better home experience to all social groups in the future.

1.2 Problem Statement

The issue with the local context is that comfort is a privilege; not many people accept the lower-class groups predominantly. Public Housing follows a set of templates with local conditions laid down by the state authority. Nonetheless, the root of the problem with low-cost dwellings has been the same and is still not adequately addressed. A survey was done in 2012 for the low-cost residents in Kuala Lumpur and found significant dissatisfaction with their dwelling units in terms of natural lighting, space in the kitchen, clothesline, air circulation, garbage disposal, and noise (Hashim, et al, 2012). While some might afford to renovate their space or purchase home products to make room fits their needs gradually, they are only temporary solutions. The cause wastage of material avoided with proper planning. It is apparent how restrictions on cost and space are causing a vicious cycle of other social issues. This study is the first step to offering equity in ergonomic living.

1.3 Aim and Objectives

The aim is to explore the significance of domestic comfort and efficiency through the kitchen design study in Malaysian low-cost housing. Delved into the question of how a commonly disregarded dwelling space correlates to human behaviour and ergonomics, the objectives of this research include:

- To determine current kitchen conditions in low-cost housing.
- To identify and highlight strategies needed for an ergonomic kitchen design.
- To establish a better design solution accommodating the future users in our local context.

1.4 Research Method

Data collection on the impact of current kitchen designs in low-cost apartments on the resident's quality of living planned through field surveys involving interviews with architects and several residents and observational, covering spatial layout, storage, ventilation, and lighting. However, due to the ongoing pandemic and restriction of movement under the Condition of Movement Controlled Order (CMCO) by the government, the survey was done online.

2.0 Literature Review

2.1. Evolution of Kitchen Design

Since the beginning of time, kitchens are the most functional space in the house. It is an integral part of a household and evolves through time. Changing consistently with construction advancement, technology, social interaction, way of life, and trending. It influenced the shape of living conditions through chores and the ways meals were prepared. Cooking is a communal activity worldwide, but what differs is the food we prepare, thus representing the culture that comes with it.

In a country of multiple races, food is a part of Malaysia's identity. Understanding the fundamentals of household layouts requires analysing the countries' races and cultures, which help shaped the cuisines we have today. With traditional delicacies passed down through generations, some people might still practice the same cooking method despite living in the modern city. The kitchen space reflects the culture and economic status. Therefore, in the early days, kitchens mainly revolve around cooking utensils. As the hearth of the house evolves, so does the space. A traditional Indian kitchen of a commoner would have a small hearth in the corner of the house working with only a few utensils without any storage (Decor, 2017), whereas the Chinese kitchen relies on a stove, Chinese table and utensils with food and water storage (Tao, et al, 2019). In the Malay traditional houses, the kitchen with a stove mounted on the table top with storage space for cooking utensils. Additional cookerries are hung on the walls or cantilevered shelves installed between the posts. However, they have a cupboard to keep their food for the second serving. Although the advantage of the kitchen positioned at the back, offers privacy and convenience for space expansion during social events, the layout only works for standalone structures like bungalows or villas. Public housing might require a different arrangement altogether.

2.2 Scientific Organisation of Chores in Kitchens

Estimating the kitchen's traffic flow is considered one of the most critical issues related to the design or organization of the kitchen, which establishes the necessity of the kitchen triangle (McLellan, 2003). The work sequence defined in this situation is the activity arrangement that varies between food storage, preparation, washing, cooking, serving, eating, and even the possibility of cross circulation.

In Figure 1, the thick lines indicate the main activities, and it is apparent how cross-circulation is present in between. The progression of order is usually in a clockwise direction from left to right, but this is not always true as left-handed people prefer an anticlockwise approach (Baden-Powell, 2005). Based on the diagram of the work sequence above, the three activities which describe three significant components are the refrigerator, the cooker, and the sink.

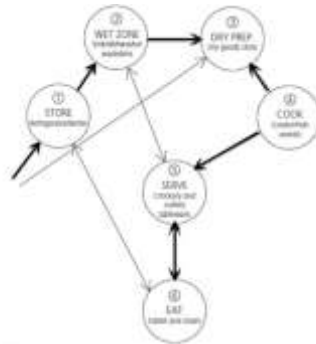


Figure 1: Diagram of work sequence in the kitchen.
(Source: Baden-Powell, 2005)

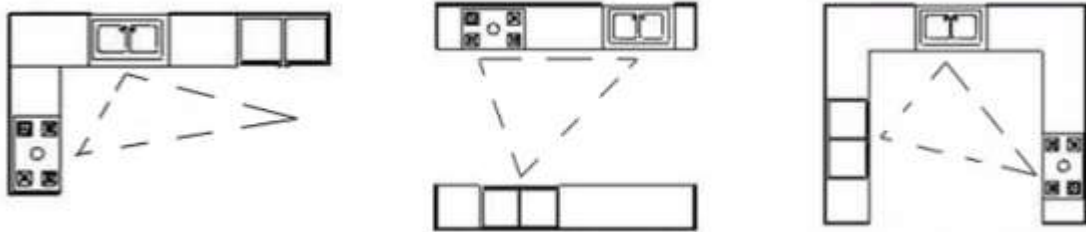


Figure 2: Different layout configurations with invisible triangle lines implying how the appliances are interconnected.
(Source: Baden-Powell, 2005)

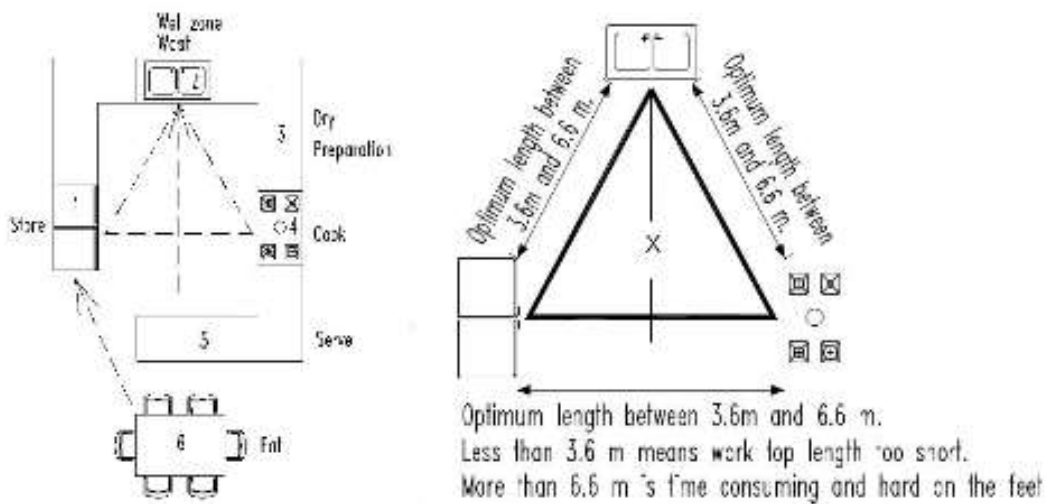


Figure 3: Plan demonstrating work sequence and kitchen triangle.
(Source: Baden-Powell, 2005)



Figure 4: Sample layouts of small kitchens.
(Source: Nowakowski, 2015)

Another criterion for ensuring a comfortable workflow is installing countertops between the main work hubs, as displayed in the diagrams. The study also adds that the area of the triangle covering anything more than 18.84 m² would be distressing (Tehrani, 2012). All three side lengths should not be less than 3.6m or more than 6.6m long. A shorter distance would provide inadequate working space, whereas if it is too long, making the procedure slow and tiring (Baden-Powell, 2005).

2.3 Modern-day kitchens

In today's digital era, kitchen designs are still evolving every day. Developing technologies is implemented through planning, components, and facilities (Tehrani, 2012). Nowadays, significant innovations ranging from prefabricated cabinets to energy-efficient multifunctional appliances made available to assist the users. While some might use it to their advantage in utilizing kitchen space, kitchens are more aesthetic, and these products come with a price that not everyone can afford.

The inclusion of members carrying various household activities alongside meal preparation turns a modern-day kitchen into a social space. One thing resolved is how the work zone arrangement along the walls causes the user to work with their back against the room, consolidating the isolation of the user (Nowakowski, 2015). The island layout is used relatively in big spaces but can also be in small kitchens opened into the living area.

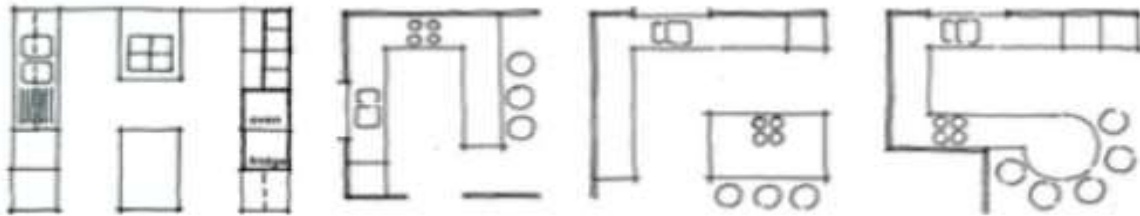


Figure 5: Outline of a multifunctional island kitchen and a small laboratory kitchen with an island opening into a living room. (Source: Nowakowski, 2015)

2.4 Low-cost Housing in Malaysia

The government established the design of a low-cost house that must at least have a minimum built-up of 67.8 m² in 2002. It comprises three bedrooms, a living room, a kitchen, and a bathroom (Ghani & Choong, 1997). Not only because of cost restrictions and space deficiency but space explicated allocated for efficiency. Efficient preparation of meals and other kitchen chores require appropriate spatial arrangements, especially in small kitchens where spaces are occupied by furniture and mechanical devices (Nowakowski, 2011).

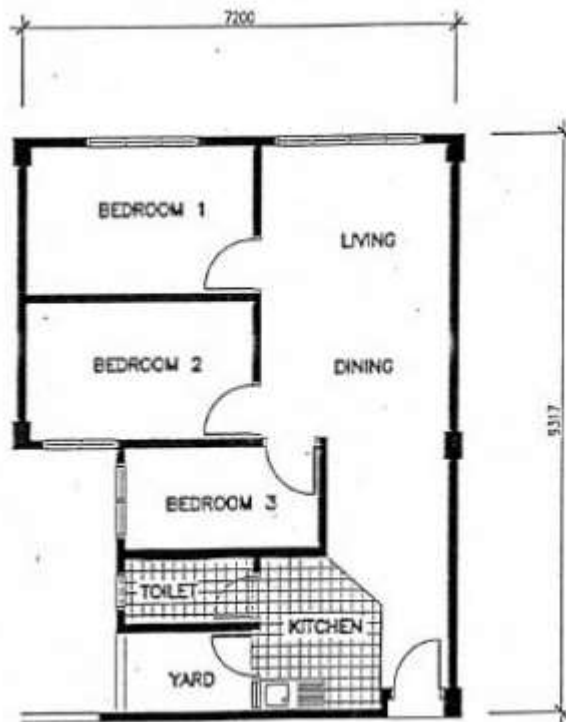


Figure 6: A typical layout plan for Low-cost Flat. (Source: National Housing Department (2006), JPN Standard Plan 2000)

In 2011 to examine the design quality of People's Housing Project low-cost high-rise flats developed by the National Housing Department in Kuala Lumpur, the quality function deployment method is used to analyse the current status of selected users. The study revealed descending qualities with issues related to habitability, suitability, defects, lack of maintenance, and physical safety of the occupants. Respondents commented that the existing kitchen size of 4.515 m² is too tiny to function.

2.5 Key factors when designing in Small Spaces

The kitchen design is modified to fit the setting; instead, it should be adapted to the user because the human body is constantly in the equation of movement abilities (Strangeland, 2011). It is imperative to create a working space that limits movement to ensure the highest efficiency, thus making the kitchen applicable to all users in a household. Nowakowski (2017) explained how the ergonomic requirements of a kitchen concern only four constituents: Storage size and proportion, Workflow organization, Room Lighting, and Maintaining comfortable microclimate conditions for ventilation to eliminate accident-causing threats.

2.5.1 Storage Space



Figure 7: Example of wall-mounted shelves that save space but display clutter.
(Source: Author, 2021)

For many years, furniture was stacked to the ceiling to maximize storage space within the kitchen. Many questions arise about the volume as the priority of lifestyle shifts (Tehrani, 2012). Storage is an area in the kitchen that needs a clever arrangement solution (Spechtenhauser, 2006). Mounted shelves could be an option to provide a storage solution on walls without taking up the workbench or cupboards. Fixed-in cabinets also cost more than the removable and lightweight fittings.

2.5.2 Spatial Layout

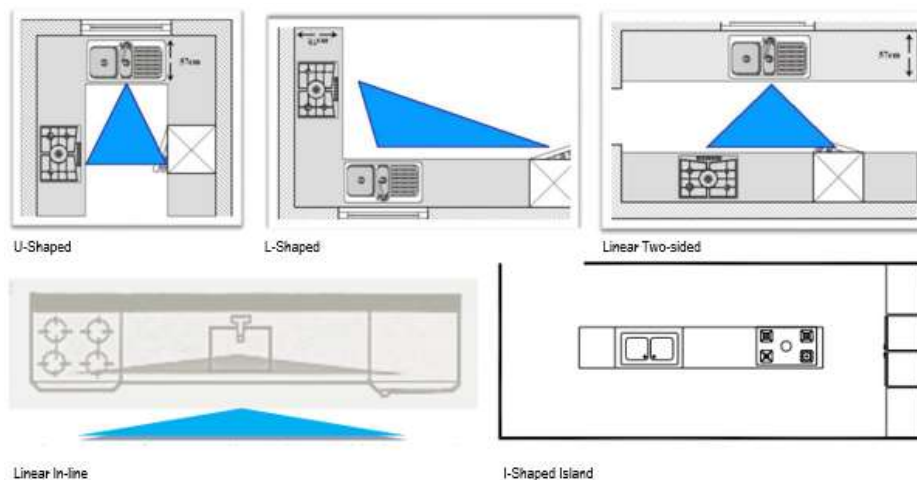


Figure 8: Typical kitchen designs / layout.
(Source: Adams, 2011)

As explained previously, the importance of the working triangle and understanding these basic principles of a kitchen layout helps to take much of the mystery out of the design process (Wallender, 2010). The formula guarantees efficiency and comfort for the user used as a template for many years. Siegfried Giedion mentioned in his book *The Rule of Mechanization*, that using streamlined shapes in household appliances was considered a visual synonym for speed, efficiency, and mechanization (Giedion, 1987). Streamline refers to the shapes and ensures continuity and fluency of performed activities of a person (Lupton & Miller, 1996). The typical kitchen designs are Linear In-line, two-sided, L-shaped, U-shaped, and an island.

2.5.3 Lighting and Ventilation

Lighting and ventilation are other vital factors to provide optimum microclimate conditions in ensuring comfort in the workspace and eating area (Nowakowski, 2015). One of the essential things to consider is the positioning of the hob and extractors to maintain the efficiency of a kitchen to prevent cooking odours and steam from encroaching on other living areas.

3.0 Research Method

A quantitative approach to data collection is taken through a series of questions proposed by considering the kitchen features that make up an ergonomic kitchen as the parameters. Theoretically, face-to-face interviews and observational home studies assessing each user's preference are more suitable, but online surveys were conducted as an alternative due to the current pandemic situation.

3.1 Questionnaire

The questionnaire was prepared using Google Form before distributing and sharing via every online media and mobile application (Whatsapp, Telegram, Facebook, Instagram). The survey is done in the two most common languages spoken by Malaysians, Malay, and English, those who might not receive any formal education. By the end of the survey, results will then be used for the designers to improve the state of future kitchens of low-cost housing.

3.2 Measuring Instrument

The questionnaire structure type is mainly the closed question type with multiple-choice answers and Likert scale questions for the respondents. One example of the closed question in the form is "What is the best kitchen layout for you?" with diagrams attached for the respondents to identify which layout they prefer relative to their needs. On the other hand, the rating scale is used to rate the level of satisfaction related to their experience.

3.3 Target Group

This study focused on the residents who are staying in low-cost housing. Those who qualified for low-cost housing are the ones with a median wage below RM5,000. Based on the Department of Statistics Malaysia (DOSM), this group of people is classified as B40, an income category that earns below the average rate and is in the bottom 40% of the country's population. With no limitation to gender, age, race, or marital status, this study is to determine whether any particular demography affects the design of the said kitchen.

3.4 Variables

Variables are essential to determine the feasibility of the subject. In this case, the variables set were the three qualities stratified into three parts of the survey, i.e., Spatial Layout, Storage space, and Room Ventilation & Lighting. Hence, it is possible to redirect the user's response into proving if they struggle with discomfort in their existing kitchens.

3.5 Procedure

Based on the information gathered from Literature Reviews, the questionnaire is proposed and revised several times before being distributed. The questionnaire consists of several sections according to the variables stated based on the kitchen space's essential qualities. The data gathered is then analysed in the form of charts, tables, and a summary of the opinions listed with findings discussed in the following section.

3.6 Limitations of the study

The focus group is the low-cost housing occupants of high-rise flats. However, due to the Covid-19 pandemic and the restriction of movement, the survey has to be online. This somehow limits the number of respondents due to the lack of infrastructure and computing knowledge among the residents. Therefore, the online survey was carried out to include the landed low-cost properties as well.

3.7 Significance of the study

The outcome provides a better understanding to architects/designers for their future design of low-cost housing concerning kitchen ergonomics. And the findings will provide the housing authority with some guidance towards establishing better housing guidelines for the low-cost housing units.

4.0 Results and Discussion

4.1 Background Information

The survey has attracted 147 respondents from various backgrounds belonging to the B40 group. The questionnaire starts with the housing type that the respondents reside in, followed by age, gender, race, and marital status. The number of respondents staying in a landed development surpasses the number of respondents living in a tower block up to 20%. While 23.9% live in apartments, only 16.9% of respondents stay in flats.

Table 1: Housing typology and ownership

Typology	Single Storey Terraced		Double Storey Link		Multi Storey Flat/Apartment	
	No.	%	No.	%	No.	%
	34	23.1	53	36.1	60	40.8
Ownership status	Tenant		Owner			
	No.	%	No.	%		
	69	46.9	78	53.1		

Table 2: Respondents' Demographic

Gender	Male		Female		Not disclosed			
	No.	%	No.	%	No.	%		
	50	34.0	95	64.6	2	1.4		
Age Group	Below 29		30-49		50-69		Above 70	
	No.	%	No.	%	No.	%	No.	%
	106	72.1	31	21.1	10	6.8	0	0.0
Race	Malay		Chinese		Indian		Others	
	No.	%	No.	%	No.	%	No.	%
	142	96.6	1	0.7	1	0.7	3	2.0
Marital status	Single		Married		Divorcee			
	No.	%	No.	%	No.	%		
	79	53.7	66	44.9	2	1.4		
Dependents	None		1-4		More than 5			
	No.	%	No.	%	No.	%		
	72	49.0	58	39.4	17	11.6		
Employment status	Working		Self-employed		Student		Pensioner	
	No.	%	No.	%	No.	%	No.	%
	103	70.1	20	13.6	19	12.9	5	3.4

A considerable number of respondents are below 29 years old, female, and from the Malay community. As for marital status, the percentage was almost equal between married and single, but the majority have little to no dependents pertinent to the existing data of the average Malaysian household.

House ownership and employment status as contributing factors in determining the resident's understanding of comfort level in kitchens. Essentially, people who rent might not be too concerned about the kitchen space and prefer it to be open and adaptable since they are only temporarily staying. However, there are also cases where people rent because they cannot afford to own them, so fixed cabinets are a better option for the convenience of the occupants. The survey shows that most respondents are the owners of their homes, with 70.1% having a stable income from employment.

4.2 Lifestyle

The lifestyle of dining out is no longer attainable due to the current pandemic and work-from-home situation, thus affecting the increment of hours people spent in the kitchen as compared to the olden days. Nowadays, even with a full-time job, people still find time to cook at home, and 62.6% prefer heavy cooking rather than light cooking. It proves the importance of an ergonomic cooking area because more people spend their day in the kitchen as a communal area rather than in other parts of the home.

Table 3: Time spent in the kitchen.

Time spent in the kitchen	Seldom (once a day)		Normal 2 – 3 times a day		Regularly 4 – 5 times a day					
	No.	%	No.	%	No.	%				
	13	8.8	51	34.7	83	56.5				
Meal preparation	Light cooking		Heavy cooking							
	No.	%	No.	%						
	55	37.4	92	62.6						
Regularity guest coming over	Once a week		Once a month		2 – 3 times a year		4 times a year (seasonal)		Never	
	No.	%	No.	%	No.	%	No.	%	No.	%
	14	9.5	25	17.1	38	25.8	61	41.5	9	6.1

The survey shows how frequently the respondents have guests since it has become a tradition for Malaysians to hold open houses, especially during cultural celebrations. The chart implies that over 41.8% of respondents invite people seasonally, 9.6% of respondents

have visitors weekly, and a handful of respondents do not have guests. This is probably due to the shortage of space, which they feel could not accommodate the people coming over.

4.3 Issues

The survey tells us that 69.4% of the respondents are concerned with their storage space in kitchens. One of the primary vital components of kitchen design, many would resort to having a typical kitchen cabinet or open shelf to keep their items. Even from the open-ended question on getting the respondent's opinions on solving the storage issue that they faced, the majority had suggested pre-install fixed cabinets. A provisional alternative would be frequent spring cleaning to get rid of unwanted items.

Between the two storage options provided, open or closed cabinets, the majority preferred the closed built-in cabinets to conceal the clutter behind opaque panels, automatically making the kitchen visually cleaner. A large number of closed cabinets are costly and may cause the kitchen to look dense (Riley K. 2017).

Table 4: Problems faced

Facing storage problem	Yes		No					
	No.	%	No.	%				
	102	69.4	45	30.6				
Most items occupying the kitchen	Plastic container		Pots & Pans		Plates & Saucers		Cutleries	
	No.	%	No.	%	No.	%	No.	%
	50	34.0	64	43.6	25	17.0	8	5.4
Problems with waste disposal	Yes		No					
	No.	%	No.	%				
	85	57.8	62	42.2				
Problems with smoke and odour	Yes		No					
	No.	%	No.	%				
	104	70.7	43	29.3				

Another habit that makes storage issues more acute is that many households love to keep recycled plastic containers. It is proven when 39% of the respondents claimed that their containers occupying the space. The extra kitchen appliances like a wok, pestle, and mortar used to prepare Malaysian dishes, also require extra storage spaces.

Our next question is whether the respondents faced any problem of food waste leaking and creating an unpleasant smell passing the corridor and affecting other spaces. Although the occupant lacks hygiene, we believe improper kitchen layout planning could be another factor in unsanitary homes. Results show that 57.8% answered "Yes".

While the majority received sufficient natural lighting in their kitchens, some respondents still struggle with low light and poor ventilation. Some 70% of the respondents have a problem with smoke and smell trespassing through other spaces. It proves how the spatial planning according to the work sequence of the kitchen triangle is significant.

4.4 Spatial Preferences

Based on the five kitchen layouts used over the years, this section asks which layout the respondents prefer. Options given were the Linear in line, Two-sided table, L-shape, U-shape, and Island with diagram attachment. A substantial result of 52.4% chose to work with an Island compared to the other layouts.

Table 5: Preferences

Preferable storage solution	Closed & Built-in cabinet		Open shelves & Portable cabinet							
	No.	%	No.	%						
	90	61.2	57	38.8						
Preferred kitchen layout	Linear		Linear 2-sided		L-shaped		U-shaped		Island	
	No.	%	No.	%	No.	%	No.	%	No.	%
	2	1.3	12	8.2	34	23.1	22	15.0	77	52.4
Lighting preference	Natural		Artificial							
	No.	%	No.	%						
	112	76.2	35	23.8						

Due to the limited amount of daylight received, most respondents rely on artificial lighting. Fluorescent lamps are cost-efficient, however, there is the possibility of toxic chemical exposure. Some 76.2% of the respondents prefer to work with natural lighting for its ceaseless advantage in health and productivity.

4.5 Satisfaction Levels

The survey was done to rate the people's satisfaction with their current kitchen with five (5) being most satisfied. The results show that more than three-quarters of the respondents were more than pleased, but several people still felt dissatisfied. About 80.8% of the

respondents expressed their satisfaction with working in the current kitchen. Many were satisfied with the thermal comfort level in the kitchen (85.7%), and 77.5% of them acknowledged that the natural lighting level in their kitchens is satisfactory.

Table 6: Satisfaction levels

	Very Dissatisfied		Dissatisfied		Acceptable		Satisfied		Very Satisfied	
	No.	%	No.	%	No.	%	No.	%	No.	%
Satisfaction level working in the kitchen	4	2.8	24	16.6	62	42.1	44	29.7	13	9
Level of thermal comfort in the kitchen	7	4.8	14	9.5	61	41.5	47	32.0	18	12.2
Level of Natural lighting received	11	7.5	22	15.0	34	23.1	55	37.4	25	17.0

5.0 Conclusion

Kitchens play an important role in households and have made progress from being isolated to a communal area. As a result, designing a kitchen involves more than just a technical exercise that considers prospective modifications and technological advancements. The design should consider the consumers' philosophy of life and the possibilities of lifestyle and social relationship modifications. In the low-cost housing kitchens, the challenge is the limited kitchen space, hence, storage space is paramount. People are so fixated on thinking that adding shelves would instantly solve the issue, but it does not. It usually ends up in two ways; either wasted areas or even narrower kitchen space. Even though there are already numerous storage solutions, none seem to completely solve the issue because they do not fit the local context and people. Malaysians have extra and heavier kitchen appliances; logically, they need preinstall cabinets that could also be dismantled for other purposes.

Designing is never a one-size-fits-all solution. With all the problems being highlighted, now a solution is put forward in response to the third and final objective. The designers should consider the spatial layout and the problem with food waste passing through living areas, hence, considering having a designated rubbish area close to the exit.

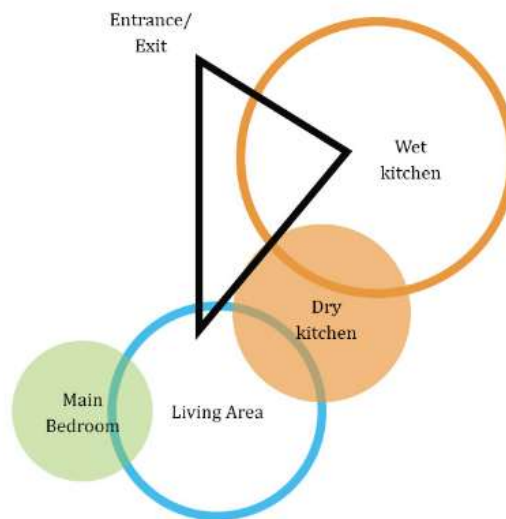


Figure 9: Proposed housing layout diagram.

Figure 9 shows an ideal Bubble Diagram of the kitchen located within a typical housing unit. The living area should act as a transitional space linking to all other spaces, and the wet kitchen should have direct access to the entrance/exit. The bedrooms could be slightly away from the kitchen. Therefore, it is safe to conclude that the objectives of this research have been achieved to aid the designers as part of their kitchen design strategy for future reference.

5.1 Future study

To have added value to data collection, respondents are to categorize according to their kitchen floor area. This is to verify whether or not the limitation of space in Malaysian low-cost housing affects kitchen ergonomics. In conclusion, this study has already laid the foundations for aiding designers to make the three factors a priority as part of their kitchen design strategy and soon establish a new and updated design guideline, particularly for Malaysia's low-cost housing.

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