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“Sustaining the  
Resilient, Beautiful and Safe Cities  
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## IDENTIFYING HOUSE ELEMENTS FOR SMART HOME APPLIANCES (SHA) ADAPTATION IN FUTURE HOMES OF MALAYSIA: THE RESEARCH METHODOLOGY

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### *Abstract*

Currently, global homeowners have encountered modern and sophisticated electrical appliances that ease their daily domestic lifestyles, including cooking, washing, and other household chores. The advancement of these technologies in the domestic sector has led to easier and more convenient lifestyles, which create a high-technology lifestyle for homeowners, which leads to complexity in house design and the need for advancement in house element integration for smart use in the house. However, the issue of adaptation of the newest appliances with the current house elements is minimally being explored, since most researchers are more focusing on the smart house concept, rather than focusing on typical houses that need to be integrated with these smart appliances. There is a need to determine the significant locations inside these typical houses that will provide an efficient and strategic way of incorporating the house elements according to the needs of the appliances. The latest Smart Home Appliances (SHA) may have various sizing, weight, and function, which can be controlled remotely through the Internet of Things (IoT), where these appliances need a proper location to receive better networking coverage. Therefore, this paper seeks to discuss a research methodology in identify significant house elements for SHA adaptation in future typical homes. An exploratory mixed-method research design has been selected for this paper involving (i) survey research which distributed questionnaires to a panel of experts and (ii) a case study with the aid of systematic observation. An observation checklist has been derived from the panel of expert results in listing the current trend of house elements. Consequently, this paper will assist related researchers in making informed decisions about method selection and deployment in their related study towards finding the best solution to adapt these SHA at a typical house in Malaysia.

**Keywords:** *Appliances, Smart Home Appliances (SHA), Internet of Things (IoT), Future Typical Homes, Research Methodology.*

### INTRODUCTION

The systematic, theoretical analysis of the procedures used in a field of research is known as methodology. It includes the theoretical examination of the body of procedures and rules related to a field of knowledge (Bernard, 2018). It frequently includes ideas like stages,

paradigms, theoretical models, and quantitative or qualitative methodologies. The research methodology is crucial in guiding the researcher to complete their study (Mohajan, 2017). In this paper, a methodology was approached by using a questionnaire to find the house element for Smart Home Appliances (SHA) adaptation in future homes.

A few problems of the current situation on the implementation of SHA on the house element have been carried out by literature review which are, high energy bills (Qarnain et al., 2020), adaptation of new appliances (Rahman et al., 2017), energy wastage (Hassan et al., 2014) (Rahman et al., 2016), the increase of carbon dioxide emissions (Mori et al., 2020), increasing spending as income, no implementation of energy efficiency (Rahman et al., 2016), changes in social and cultural (Patnaikuni et al., 2013) and awareness of people (Rahman et al., 2016)(Sharma et al., 2017).

The objective of this paper is to discuss the suitable methodology to find the best solution to achieve the research question. This paper describes the research technique and design that was used on this topic. It is the most critical component and the backbone of the research framework that the methodology is used (Tobi & Kampen, 2018). The first section of this chapter begins with an overview of the research approach, systematic literature review, and data gathering methods used in this research and followed by the technique of the pilot research discussed in the second part. Section three contains procedures for conducting both a pilot survey and a distributing questionnaire using offline and online methods by using Google Form. Several approaches have been employed throughout the research, including data collection for both primary and secondary data.

## LITERATURE REVIEW

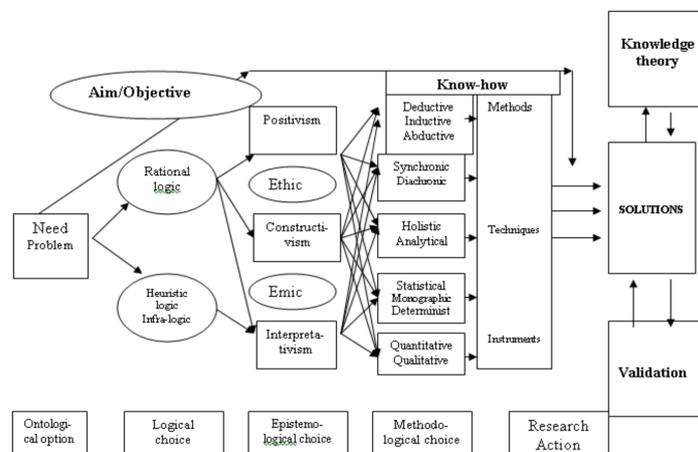
### Methodological Choice

Although the methodology has a normative component, a research's methodological choice does not follow rigid patterns. The methodological option is just that an option; it presupposes a choice from a predetermined portfolio of laws, norms, techniques, and tools. The choice or preference may be made based on logic or chance.

The methodological option enables a researcher to develop a research plan that is suitable for the issues that must be resolved as well as the goals and assumptions made by the investigation. The methodological element of the strategy is crucial because it anticipates the likelihood that the intended actions will be carried out as intended in order to solve the problem and verify the results (see figure 1).

**Figure 1**

*Methodological construction of a research strategy*



(Zait & Zait, 2009)

### ***Research Problem Definition***

The methodological choice of our strategy is significantly influenced by the study subject. The research problem is a logical claim that describes, defines, and exposes the key components of the situation, state of affairs, conundrum, contradiction, etc. together with the background information and conditions required for its identification. The research issue may be theoretical (construction or reconstruction, theory development or creation, contradiction, paradox, or theoretical inconsistency, etc.), practical or applied (social demand, business or organizational need for effective solutions in challenging situations, anticipation needs, etc.), or have a combination of these characteristics (apply, develop or reconsider statements and theories through the finding and valorization of specific solutions, testing, validation, generalization, etc.) The choice of the research problem is a crucial phase in the research process, with the effectiveness of this decision having a significant impact on the subsequent steps, outcomes, and success (knowledge, information relations, availability, etc.) (Snyder, 2019).

### ***The Logical Option***

refers to the method of putting together the explanation, understanding, description, or prediction needed to solve the problem. There are two options available at this level: rational scientific logic and heuristic infra-logic.

The scientific logic (the knowledge one) proposes a logical progression of the approach, within an anticipated succession and with conclusions, analyses, generalizations, explanations, or solutions in compliance with specific rules, principles, and methodological prescriptions, invoking techniques and instruments selected by reporting to prior knowledge about the field, problem, or theories of reference. Popper's proposal for a "Logic of research," (Popper, 2015). Popper views the research method as a theory of scientific method that deals with how scientific enunciations should be dealt with following goals and objectives. This specific research logic may be viewed as the theoretical underpinning of the rational method in scientific inquiry.

### ***The Epistemological Choice***

Positions the study to the issue and the way it is resolved, leading to the formation of the key steppingstones for the future strategy. The positivist, constructivist, or interpretativism paradigms can theoretically be used to realize the epistemological perspective. A combination of paradigms could be used as well, but doing so is actually rather challenging. It is nevertheless possible to do so at various phases of the research strategy by making significant adjustments at the principles level. In scientific inquiry, positivism is still regarded as the ideal paradigm. In fields and circumstances where deterministic causation is dominant and for which a theoretically axiomatic system is already specified and constructed, the premises for the implementation of research in a strictly positivist environment can be achieved (Zait & Zait, 2009). When a few principles are upheld at once, researcher can therefore discuss a positivist paradigm, a positivist setting, and/or a positivist approach:

1. The analyzed events or facts being examined are apart from the researcher.
2. The researcher is objective toward the manner of realization of the research, as well as toward the results.
3. The demonstration of truth or correctitude can be realized based on hypothetic-deductive logic.
4. The approach is realized through concepts that allow measurement, quantitative forms, and a formal logical and abstract operationalization.
5. A significantly large number of observations (data, facts, events) is necessary for theoretical generalization (the final aim of the positivist approach).

6. It is possible to use the reductionist argument (simplification, modeling, and schematization) in favor of comprehension and justification via decomposition, analysis, and synthesis.

Constructivism is founded on the representativeness principle (Zait, 2015) and provides the foundation for a pragmatic approach that looks for practical answers to practical problems. Constructivism is founded on some additional concepts in addition to representativeness, which holds that the arrangement of our representations of a world created by our own experiences produces concrete reality (Eriksson, 1997).

1. Since knowledge allows us to become aware of what is conceivable and to generate new possibilities, the reality is the product of successive changes (a "constructed universe").
2. The researcher and the subject of his investigation have an impact relationship that is objectively required.
3. Argumentation can be used to understand and explain, leading to believable answers.
4. To achieve a convenient relationship between a certain issue and a specific intervention project, actions or action strategies are required.

A form of constructivism known as interpretivism holds that the researcher and his study object are two distinct but interdependent real-world entities. Elements of constructivism can be found, more or less explicitly, among other ideas (Ron, 2004):

1. Invoking those experiences is the only way to gain knowledge of reality because it is a deliberate construction resulting from successively lived experiences (phenomenological approach);
2. Truth is the product of well-carried out objectives and can be derived from the comparison (interpretation) of the research object and the researcher's life experience;
3. The objectives are understanding and the imposition of that understanding and the matching between object and experience is relative and subjective.

While using the emic approach, particular or individual studies are carried out to extract particular elements that are characteristic for such a level, the ethic technique allows us to acquire generally applicable results. The ethic method has a broad meaning that is based on the researcher's produced objective autonomous logic and is thus independent of the subject (reality), offering explanations, causality, etc. The emic approach's goal is focused on the closeness of the object (or reality), and it is founded on a logic unique to that object or reality, which is, by definition, interpretative.

### ***The Methodological Reference***

Establishes the essential benchmarks for how to describe, explain, and comprehend. The first of these landmarks are those that define the problem and research approach's guiding philosophy, concepts, and broad guidelines. These methodological components, which collectively are referred to as "method" represent the anticipation of how the rationing process will be developed (creating hypotheses, anticipating solutions, estimating, predicting, etc.), the vision of the field, problem, and analyzed sector (whole/detail/global/analytical/sequential/casuistic; evolutive /dynamic /static/punctual, etc.), and the position toward the object of the research (extern, Therefore, the methodological approach can be abductive, deductive, or inductive as a means of realization (Zait & Zait, 2009):

1. Abduction is the inference of a cause from an outcome ; it admits multiple explanations for those reasons and may lead to inaccurate results; the syllogism, which Aristotle first used, in which a major assumption is taken to be true and a minor premise to be merely likely.
2. Deduction: deriving a conclusion from an assertion; deriving a conclusion from what is assumed; a correct deduction ensures that a conclusion is true as long as it is founded on accurate premises.
3. Induction is the inference of a likely outcome from a large number of potential states and the inference of likely antecedents as a result of the observation of numerous outcomes. Induction requires empirical evidence to be true.

The way a scientific approach is realized (data collection, handling, analysis, interpretation, and generalization) might be quantitative, qualitative, or a combination of the two, establishing what we refer to as "scientific research technique" in the broadest sense possible. Quantitative methods advocate an objective view of reality using exact methodologies and tools while making use of general logical conclusions to arrive at explanations or falsifiable forecasts. Following what may be observed, directly or indirectly, for individual or small group manifestations, qualitative approaches involve interpretation, typically subjective, drawing on naturalist descriptions, relationships between person and object, etc. Through a process known as "methodological triangulation," the two methodologies can be combined.

In terms of methodology, options include synchronic, transversal, or cross-sectional (at a specific moment in time or over a very short period) and diachronic or longitudinal (in evolution, over long periods); holistic (at the system level), individual, or particular; analytical, general, or sequential; experimental, cvasi-experimental, or simulation; etc. In many research scenarios, triangulation is feasible or advised. Regardless of the approach researcher take, it is typically valid throughout the entire study project, including all phases such as data identification and collection, treatment, analysis, findings derivation, and solution/theoretical generalization.

### ***Research Realization***

Implies a research plan with stages, tactics, and means of completion during the project period. The logical option or choice (rational-scientific or heuristic/infrasonic), the epistemological choice (emic/ethic or positivism/constructivism/interpretivism), and the methodological choice (inductive/abductive/deductive, quantitative/qualitative, etc.) determine the proposed algorithm of research and the content of the research plan in terms of activities, means, and resources. For a heuristic approach, the structure will be flexible and continuously adaptable in response to partial or intermediate results, new elements discovered along the way, objective or subjective interventions, etc. In contrast, for a rational approach, the research algorithm and the strategy's content will be required to be conceived with a rigorous, precise structure.

### ***Validation***

Validation is the last stage of a study, meaning that the method used to solve problems is actually put into practice. Before being given to experts or target audiences, before being acknowledged as suitable for a theoretical reconstruction, as solutions, as generalizations, as new meanings, etc., the produced results need to be validated. They must be subjected to specialized testing and validation processes. The theory of knowledge, which admits, recognizes, and imposes - as credible - the outcomes of specific research, is connected with validation, just as philosophy, stance, accomplishment style, etc. are with other theories of

knowledge. The methods used to validate research findings are both broad and specialized. It includes (Zait & Zait, 2009):

1. Internal: theoretical (Intra and inter) and/or empirical (through raportation to facts);
2. External: realized by confrontation with other results, other situations, other methods, other specialists who have done similar research, on the same subject, in similar contexts, etc.

The particularity of validation is imposed by the characteristics and skills of the researcher, the characteristics unique to each approach, and the nature of the theory or science for which the research is conducted. Procedures and tests for validity and reliability are particular to quantitative or qualitative approaches to test the relevance of the chosen methodology.

### Smart Home Appliances (SHA)

Smart Home Appliances (SHA) are devices that allow the property owner to monitor and control their home, and to use the appliances smartly through a central control that can be managed remotely (Pino, 2021). Air conditioning, refrigerators, televisions, and other household equipment account for a large portion of domestic electricity use. These appliances must be integrated with the ability to monitor and, possibly, remotely control their electricity usage to support sustainable usage (SmartGrid.Gov, 2021). Below is the list of smart home appliances that are easily found in the modern house nowadays (see Table 1).

**Table 1**

*General Smart Home Appliances (SHA) in a Modern House in Malaysia*

Living Room	Bedroom	Bathroom	Kitchen and Dining Area	Energy Management
Smart Lighting	Smart Lighting	Smart Mirror	Smart Water Tap	Solar Panel and Battery
Robot Vacuum	Hair Dryer	Water Heater	Air Fryer	Remote Monitoring
Wireless Charger	Night Light	Smart Toilet	Food Processor	Smart Power Control
Wi-Fi Router	Pc and Laptop	Smart Lighting	Water Filter	Sensor System
Cloud Storage	Air-conditioning system and Electric Fan	Hair Dryer and Shaver	Smart Cook	Smart Meter
Flat Screen TV	Gadget Charger	Exhaust Fan	Smart Lighting	LED and Smart Lighting
Speaker system			Exhaust Fan	
Massage Machine			Oven and Microwave	
Air Filter				
TV Box				
Air-conditioning system and Electric Fan				

*Sources: Samsung (2021), SenHeng (2021), Xiaomi (2021), Qualcomm (2021), LG (2021), SmartRuma (2021), TAOS (2021), Ayla (2020), Investopedia (2021), Otelco (2021).*

In the recent decade, technology, global communications, and networking have all improved significantly. These technical manifestations paved the way for future home design solutions and encouraged designers to research the impact of incorporating smart solutions into parts of house elements (The interior design academy, 2019). This practical approach resulted in a significant improvement in overall building sustainability. On a bigger scale, this design strategy will conserve global resources while also promoting healthy, beneficial, and comfortable surroundings. It also promotes the advancement of modern lives.

To develop future homes that can integrate with SHA, it is critical to have timely, accurate, and finely grained data on a building's operations, such as energy usage and occupancy living lifestyles. As a result, the more data a building management system has, the more potential optimizations it will be able to identify and implement to improve its performance.

In an ideal world, each of a building's electrical loads would consistently send accurate power data in real-time to a building management system with the aid of IoT. However, issues arise since the users are unaware of the load on their home appliances which may result in energy demand (Barker et al., 2015). Therefore, it is important to allow the building users to understand the adaptation of SHA into the house elements with the category of the function for Smart Devices (See Table 2).

**Table 2**

*The Category of the function for Smart Devices*

<b>The Category of Function</b>	<b>Smart Devices</b>
Welfare	Health monitor, personal trainer
Entertainment	TV, video, games, theatre
Environment	Lighting, heating, cooling control
Security	Simulated occupancy, property monitoring
Communication	Videophone, home calendar, a reminder
Green	Smart Energy System (Solar Energy, Smart Meter, Smart Grid)

*(Mahamuni, 2015)*

Through the use of sensing devices, the Internet of Things (IoT) technology connects all things to the Internet and provides intelligent identification and administration. RFID (Radio Frequency Identification Devices), infrared sensors, GPS, and laser scanners are some examples of information sensing devices. To enable remote perception and control, they are all connected to the Internet. IoT is extensively used in smart homes, intelligent fire control, intelligent transportation, environmental protection, government work, public security, senior care, personal health, and other areas. A specific network that is capable of intelligent recognition, placement, tracking, monitoring, and management is represented by the network in the diagram.

The demands on people's living conditions are continuously rising as a result of the growth of the economy and the emergence of an information-based society. It is becoming more and more important to construct intelligent neighborhoods and smart homes based on the use of information technology. Radio frequency identification (RFID), sensor, nano, and intelligence embedded technologies are the main IoT technologies. Among them, the RFID serves as the IOT's networking core and backbone. To implement the information infrastructure data collecting, this topic will use RFID as a passive data-gathering technology.

Outside of Malaysia, networking is currently primarily developed and used in developed countries. The initial research focus was on bar codes, such as RFID applications in commercial retail and logistics, but in recent years, applications have begun to expand to

include environmental monitoring, biological and medical treatment, intelligent infrastructure, etc. "wisdom the Earth" is a defining characteristic of the United States. The European IoT action plan, South Korea's u-Korea policy, and Japan's u-Japan all aim to foster the widespread adoption of a new generation of IT technologies. China has initiated a significant amount of research and application work and is presently supporting the development of IoT at full throttle, including the national science and technology strategy and the industrial standard of things for networking (Li & Yu, 2011).

Malaysia, one of the rapid development countries, has changed the modern lifestyle, especially home appliances. From manual washing machines to semi-auto washing machines to fully auto washing machines, it is one example of a modern lifestyle that changed year by year. These changes in lifestyles have also affected appliances and technology. However, the issue of the adaptation of the newest appliances with the current house elements is yet to be explored. There is a need to determine the significant appliances inside the house that will provide an efficient and strategic way of utilizing the latest appliances. The latest SHA may have various sizing, weight, and function, which can be controlled remotely through IoT, where these appliances need a proper function and demand that need to fit in every room in the house (Rahman et al., 2017). Furthermore, the public's expectations and lifestyles have changed, however, the house that people are living in now has the challenge to embark on the trend of future homes (Sharma et al., 2017). Consequently, the need to find the most significant SHA is necessary for a future home in Malaysia.

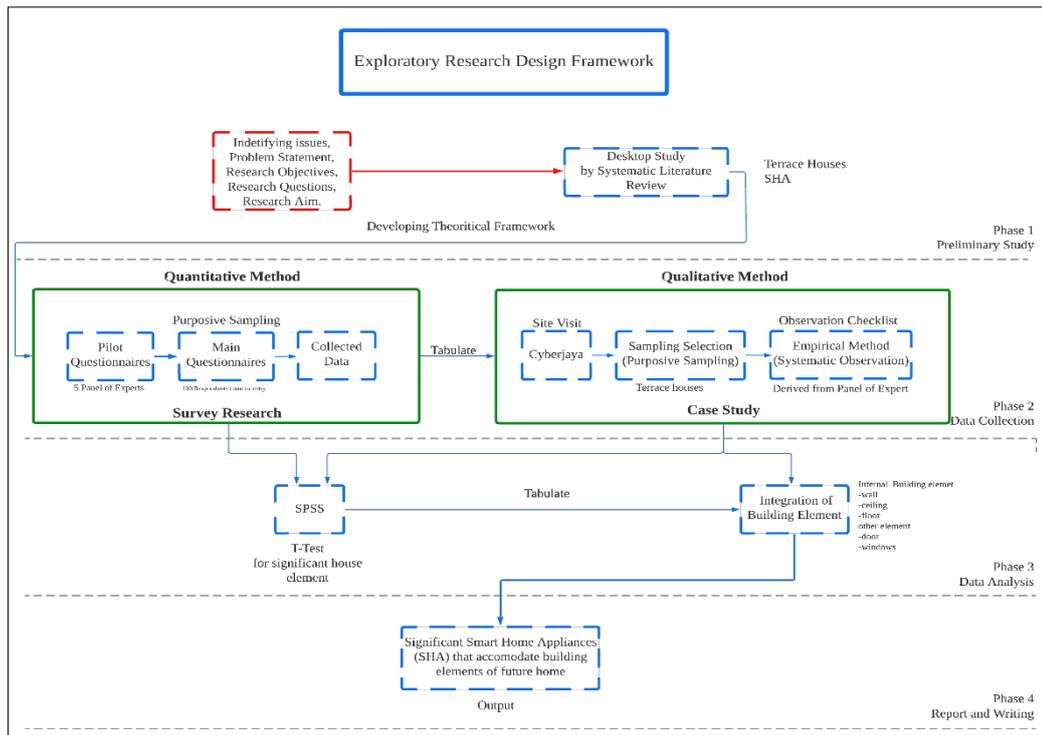
Moreover, the current global COVID-19 pandemic, which influences people's lifestyles and working arrangements, has increased the energy consumption in every home (Qarnain et al., 2020). The better future home will accommodate significant SHA that can be used by the residents, whilst maintaining the power output and the efficiency of the energy usage.

## **METHODOLOGY**

This section goes through the process of acquiring the data for this study in great depth. It emphasizes the data sources as well as the survey design, which includes the sampling plan and method of data processing. The procedures involved were precisely planned out and executed in a systematic way to achieve a high level of reliability and validity. A collection of clear guidelines and methods used to direct research and evaluate knowledge claims are referred to as a methodology (Gounder, 2012). The approach utilized in this study was to combine the findings' dependability and the study's validity based on selected case studies. As a result, this part focuses on the research technique used in this study to meet the research objectives. This section describes the tools that were used to measure the study's numerous variables.

There are 4 phases of research design for this research which are preliminary study, data collection, data analysis, and report and writing phase. This research methodology, involving an exploratory research design approaches (Boru, 2018) was explained by this well-structured figure below:

**Figure 2**  
Research Methodology Process



**Phase 1: Preliminary Study**

The preliminary phase is identifying all the research issues, research objectives, and research questions. This phase will discuss the current terrace houses and the SHA, which will be carried out by a Systematic Literature Review. Furthermore, this data will be used for developing the theoretical framework for the next phase.

**Identifying the Issues**

A few issues have been carried out by the literature review which are, high energy bills, an adaptation of new appliances, energy wastage, the increase of carbon dioxide emissions, increased spending as income, no implementation of energy efficiency, changes in social and cultural, and awareness of people. Therefore, it is a significant move to explore the connection of Cyberjaya Township with the evolution of the Malaysian future homes and the adaptation of smart home appliances since this town has a fundamental application to the latest trend of future lifestyles. A strong linkage needs to be discovered between the smart home appliances adaptation and the house elements in Cyberjaya to adapt to the new normality of future homes. Below is the issue that was mentioned by the previous writer.

**Table 3**  
*Preliminary Study - Identification of Issues*

<b>The Issue</b>	<b>High energy bills</b>	<b>Adaptation of new appliances</b>	<b>Energy wastage</b>	<b>Increase in carbon dioxide emissions</b>	<b>No implementation of energy efficiency</b>	<b>Changes in social and cultural</b>	<b>Awareness of people</b>
Mentioned by	(Qarnain et al., 2020)	(Rahman et al., 2017)	(Hassan et al., 2014)	(Mori et al., 2020)	(Rahman et al., 2016)	(Patnaikuni et al., 2013)	(Sharma et al., 2017)
	(Dillman & Heinonen, 2022)	(Zhang et al., 2022)	(Tolba & Al-Makhadmeh, 2021)	(Lin & Benjamin, 2019)	(Kim & Lim, 2021)	(GhaffarianHoseini et al., 2013)	(Rahman et al., 2016)
	(Boogen et al., 2022)	(Ayub et al., 2022)	(Castangia et al., 2022)	(Atmaca et al., 2021)	(Koide et al., 2022)	(Guo et al., 2018)	(Qureshi et al., 2022)
	(Lim et al., 2022)	(Kuppa et al., 2022)	(H.S. & Ramaiah, 2022)	(Awan et al., 2022)	(De Boeck et al., 2015)	(Cappa et al., 2020)	(Hossain et al., 2020)
	(Geraldi & Ghisi, 2022)	(Leal Filho et al., 2022)	(Krishnamoorthy et al., 2021)	(Soltani et al., 2020)	(de Melo et al., 2013)	(Vega et al., 2015)	(Challa & Soujanya, 2020)
	(Bouscasse et al., 2022)	(Mehra et al., 2022)	(Driss et al., 2021)	(Mahalik et al., 2022)	(Toor et al., 2019)	(Grottera et al., 2018)	(Khan et al., 2020)
	(Simões & Leder, 2022)	(Freier & Loessl, 2022)	(Chauhan et al., 2022)	(Han et al., 2022)	(Carbonare et al., 2021)	(Liu & Lu, 2020)	(Chawla et al., 2020)
	(Pais-Magalhães et al., 2022)	(Wu et al., 2022)	(Xu et al., 2020)	(Fisch-Romito, 2021)	(Jiang et al., 2004)	(Voskamp et al., 2020)	(Makhadmeh et al., 2019)
	(Chappin et al., 2022)	(Shi et al., 2022)	(Gunarathna et al., 2022)	(Marrasso et al., 2019)	(Ibrahim et al., 2020)	(Yi & Peng, 2019)	(Azizi et al., 2022)
	(Angelis et al., 2022)		(Murray et al., 2016)	(Yu et al., 2019)	(Mbungu et al., 2020)		(Yang et al., 2020)

From the issue in table 3, 3 questions were carried out to be discussed in this paper. These 3 questions are (1) What are the criteria for Future Homes in Malaysia? (2) What are the types of Smart Home Appliances (SHA) that can be connected to future homes in Malaysia? (3) What are the significant Smart Home Appliances that can accommodate in building elements of Cyberjaya's future homes?. These 3 questions will be approached through the function of that approach as mentioned in the table below.

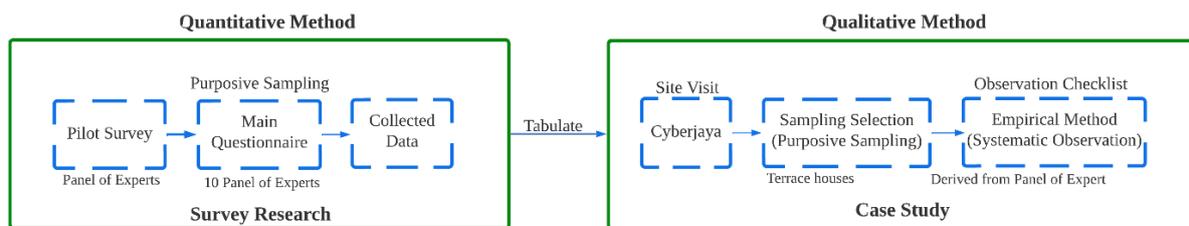
**Table 4**  
*The Discussion of Research Approaches related to the Issues*

Inquiries about the Issues	Research Approaches (Deductive)	Function
1. What are the criteria for Future Homes in Malaysia?	Desktop Study through Systematic Literature Review	-To provide an exhaustive summary of the available literature relevant to a research question
2. What are the types of Smart Home Appliances (SHA) that can be connected to future homes in Malaysia?	-Pilot Questionnaires -Main Questionnaires 100 respondents	-To determine whether the topic is feasible but also an opportunity to test the questionnaire.
3. What are the significant Smart Home Appliances that can accommodate in building elements of Cyberjaya's future homes?	-Case Study (Cyberjaya) -Systematic Observation -Validation: Panel of Expert	-To explore the answer based on real-world subjects.

**Phase 2: Data Collection**

**Figure 3**

*Data Collection Process*



**Data Collection Phase**

The data collection phase is divided into 2 stages, which are the survey research stage and the case study stage which involves a mixed-method approach. Combining and integrating qualitative and quantitative research methods into one study is known as mixed methods research. Although researchers have long combined qualitative and quantitative data, it wasn't until the 1980s that current conceptualizations of mixed methods research began to take shape. Over the past few years, mixed methods research has grown quickly, becoming a research approach with a symbol of quality (Molina-Azorin, 2016).

**Survey Research Stage**

This phase of the research will be obtained through the main questionnaire survey for a panel of experts in the smart housing industry. Before the main questionnaire was distributed,

a pilot survey will be made accordingly to ensure the questions are reliable to the current industry.

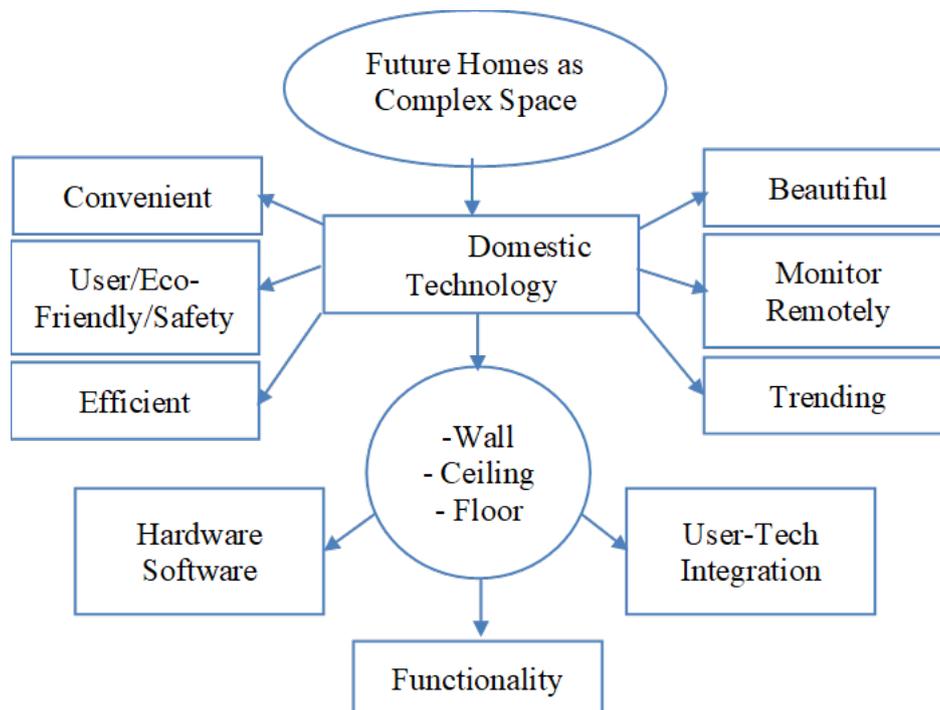
### ***Pilot Survey***

A pilot survey is a scaled-down version of a full-scale study or a test run conducted in advance of the full test (Memon et al., 2020). This is also known as a 'feasibility' test. It can also refer to the pre-testing of certain research instruments, such as questionnaires or interview schedules (Fraser et al., 2018). The pilot test is try-out by the expert to critique the questionnaire, hence the main question can be updated accordingly. This pilot survey will make the main question more reliable according to the current situation of the industry, especially in Malaysia. This pilot test will be carried out by 6 numbers of a panel of experts. This panel of experts has been filtered accordingly to their working or business experience, as to achieve a deep understanding of this topic. The 6 numbers panels are significant according to (NCSS, 2016).

The questionnaire in this research is divided into two phases: a pilot survey and the main questionnaire. The pilot survey sought to determine the quality of the question and the reliability to ask the question. While the main questionnaire might be adjusted according to the result made of the pilot survey. The primary goal of this research is to determine the significant home elements of Cyberjaya's future homes in adapting Smart Home Appliances (SHA).

**Figure 4**

*The Conceptual Framework*



The development of this pilot survey (questionnaire) is based on the conceptual framework shown in Figure 3.

The adoption of a smart home can affect the life of home buyers financially and non-financially. There are various previous studies have highlighted the benefits of the smart home concept. According to Rashidah, the main perceived advantage of a smart home is convenience. The concept of automation which enables the homeowner to control almost everything from

the gadget has led to the energy-efficient and helps to save loads of money over time. As the home is equipped with an automation system integrated into the smartphone, the concept basically will enhance the communication among the household as it user friendly to use, efficient, as well as simplify the daily activities. Smart home appliances also are a new kind of design and they keep growing time by time according to world life trends. The benefits of a smart home can be enjoyed by the large community as a whole, where the concept may provide comfortable living space, improving security and safety (Rasyidah et al., 2020).

This SHA will be installed on the housing element which are the wall, ceiling, and floor according to the hardware/software allocation, functionality itself, and the user-tech integration.

### **Sampling Selection (Purposive Sampling)**

100 questionnaires have been collected by purposive sampling chosen for this research to get a more accurate answer. An updated questionnaire from the pilot survey has been distributed to the panel of experts that fulfill the required criteria for this research. The requirement for panel of expert criteria are:

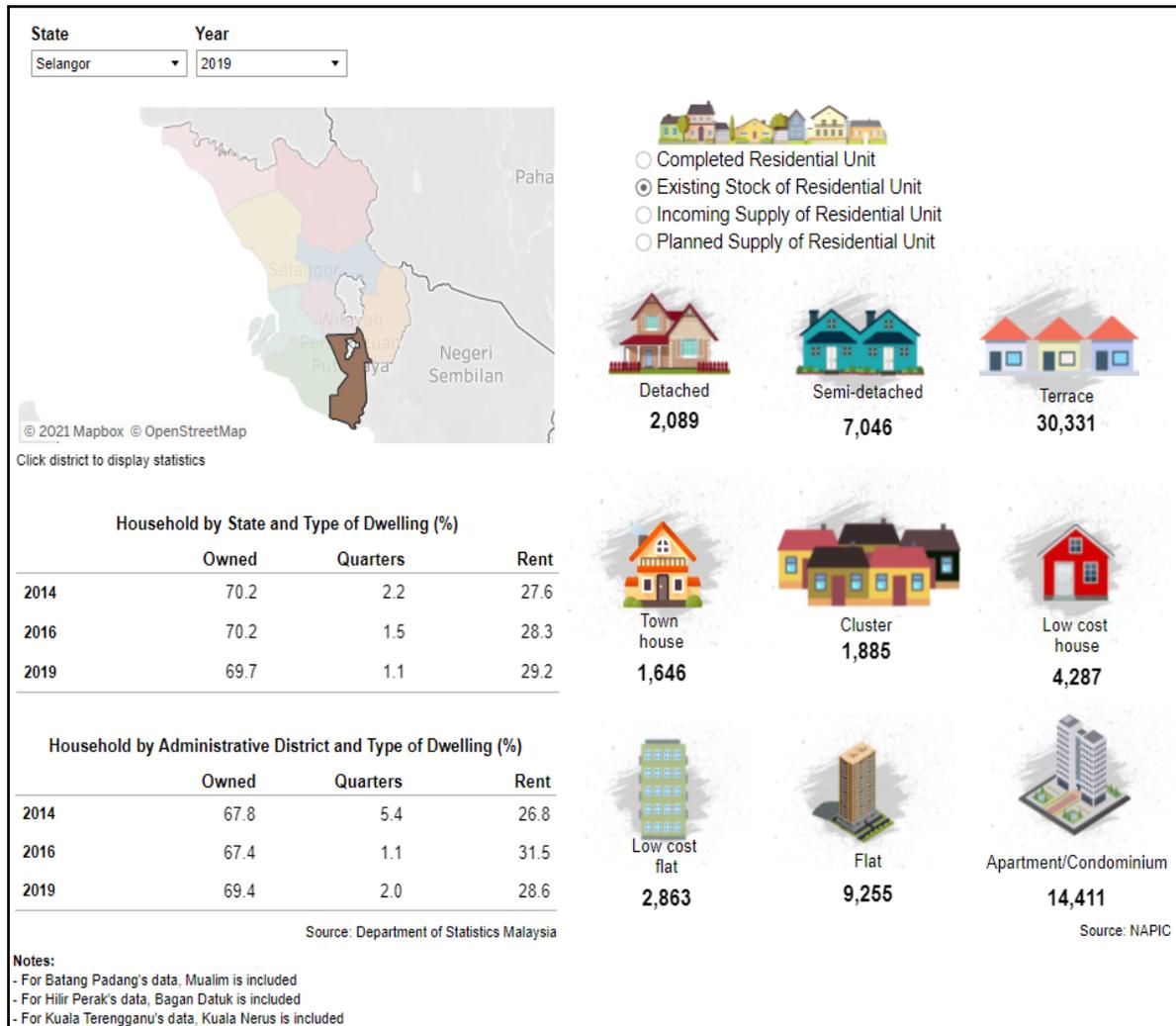
1. Experience more than 5years in a related field
2. Expose to Cyberjaya construction
3. Expose to the needs of the future home
4. A good reputation of the company/industry
5. Have at least a qualification of a Diploma

### ***Selecting the Case Study – Cyberjaya***

For the case study stage, Cyberjaya was selected because it is one of the forefront cities of the smart city concept in Malaysia. Cyberjaya remains a national driver and model city for Malaysia in drafting and formalizing Smart City policy documents at the city-authority level, state, and national level (Cyber Park Kerala, 2020). In Cyberjaya, for example, few smart areas in this township link ICTs and intelligent systems, such as smart lighting, district cooling system, solar panels, electric vehicle, Cyberjaya WiFi, and integrated security (Sepang Municipal Council, 2017).

For example, Tamarind Suites SoFo is in Cyberjaya, which has a good, favorable, and integrated environment that is suited for the construction of residential regions., not to forget Cyberia Smarthomes and Gardenview Residence. Therefore, it is a significant move to explore the connection of this township with the evolution of Malaysian future homes and the adaptation of smart home appliances. A strong linkage needs to be discovered between the smart home appliances adaptation and the house design elements in Malaysia, for example, wall, floor, and ceiling elements to adapt to the new normality of lifestyles. Figure 4 shows the data trend on the justification to select the suitable types of houses for this research.

**Figure 5**  
*Houses in Sepang District*



(DOSM, 2019)

For this research, the Department of Statistics Malaysia (DOSM) stated that the total number of landed houses in Sepang in 2019 is 47,284 houses that consist of detached houses (2,089), semi-detached houses (7,046), terrace houses (30,331), townhouses (1,646), cluster (1,885) and low-cost houses (4,287). The total of strata houses is 26,529 houses that consist of low-cost flats (2,863), flats (9,255), and apartments/condominiums (14,411). Cyberjaya is a city with a science park as the core that forms a key part of the Multimedia Super Corridor in Malaysia. It is in Sepang District, Selangor. Terrace houses in Cyberjaya have been chosen as an indicator to check and provide the solution to these issues. This research is focusing on a typical design terrace house in Cyberjaya. It is because of the number of terrace houses in most of the houses in Sepang District (DOSM, 2019).

**Table 5**  
*Total Houses in Sepang*

	<b>Total Number</b>	<b>Percentage</b>
Total Houses	73,813	100.00%
Total Strata	26,529	35.94%
Total Landed	47,284	64.06%

**Table 6**  
*Total Landed Houses in Sepang*

	<b>Total Number</b>	<b>Percentage</b>
Total Landed	47,284	100.00%
Detached	2,089	4.42%
Semi-Detached	7,046	14.90%
Terrace	30,331	64.15%
Town House	1,646	3.48%
Cluster	1,885	3.99%
Low-Cost House	4,287	9.07%

**Table 7**  
*Total Strata Houses in Sepang*

	<b>Total Number</b>	<b>Percentage</b>
Total Strata	26,529	100.00%
Low-Cost Flat	2,863	10.79%
Flat	9,255	34.89%
Apartment/Condominium	14,411	54.32%

According to the tables above, the terrace landed house is chosen to be a case study in this research paper. This is because landed houses are the majority of strata houses. Terrace houses also have 64% of the total number of landed houses in Sepang. The total number of these terrace houses is 30,331 houses and the total of houses in Sepang is 73,813, which is 41% of the total houses in Sepang. This shows a significant target of sampling for Cyberjaya in selecting terrace houses for the main case study. Further study will be explored in the future in conjunction with this type of housing to justify the suitable application of SHA to this type of house.

## CONCLUSION

The finding shows that a mixed-method approach is the most suitable methodology for this paper. Although there are a lot of other methods in the world of knowledge, this one is the most appropriate according to the discussion in the section above. This methodology hopefully is used by other writers as a guideline for their further research and analysis on designing an appropriate research methodology.

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Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim  
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Cawangan Perak



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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

**SITI BASRIYAH SHAIK BAHARUDIN**  
Timbalan Ketua Pustakawan

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*Setuju.*

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