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Intelligent Development Trend and its Application in Housing in Johor, Malaysia

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Abstract

The global construction industry is increasingly embracing intelligent developments driven by emerging technologies, and Malaysia is actively participating in this trend by prioritizing smart cities and housing initiatives. Adoption of Intelligent Development (ID) technologies in the Malaysian construction industry faces challenges due to limited awareness, high costs, privacy concerns and unclear urbanization goals. Consequently, there are three objectives of the study carried out in this research which is to study the main ID practice in housing project trend, to identify the importance level of ID practice in housing project trend and to examine the strengthen relationship between the main ID practice with the main importance level of ID practice in housing project trend. This research focused on the housing project by developer companies around Johor Bahru as respondent. Total of housing project in Johor Bahru is 205, so the sample size is 136. The respondents were given a questionnaire by face-to-face meeting and in a link of google form through WhatsApp and Email. A total of 83 respondents (61%) had given feedback in the questionnaire. Frequency analysis was used to analyses the background of respondents while descriptive and crosstabs analysis was used to analyses the data for all objective. This research found that the main ID practice and importance level respectively sustainable design and increase security recorded as the highest frequency and importance. Meanwhile, the relationship between main practice and main importance level that strongest relationship is smart home system (SHSs) with reducing energy and lowering operational costs. Therefore, this study can help developers by emphasizing the main ID practice and main importance level of ID in housing project to enhance their housing projects. Leveraging the relationship framework for main practices with main importance level of ID provided by this study can give guideline to government and private housing developers work or cooperate closely together to adopt ID. While there are challenges to overcome, the potential long-term advantages make it a promising approach for future housing.

1. Introduction

Intelligent development (ID) is a construction industry model that integrates digital technologies, such as BIM, 3D printing, IoT, and AI, to improve efficiency, safety, and sustainability (Li *et al.*, 2022). ID in housing, known as intelligent residential areas, combines property, fire safety, services, and management through advanced network technology, creating a comfortable living environment (Wang *et al.*, 2020). Housing demand increases with population and income growth, as it fulfills the basic need for shelter (Tiun, 2013). Intelligent houses face technical challenges but are an inevitable societal trend, prioritizing energy conservation, environmental protection, and human-centered design (Wang *et al.*, 2020).

The global construction industry is experiencing a surge in demand, leading to an increased focus on intelligent development (Guo *et al*, 2020). Emerging technologies such as digitalization, computer-integrated design, data analytics, and automation are being applied to the construction industry, making intelligent development inevitable (Giel & Issa, 2013). The rise of smart cities and communities is a global trend, including in Malaysia, where the government aims to incorporate intelligent technologies into housing for improved living conditions and property management (Kumar, 2022). Despite many properties in Malaysia, only a few developers have extensive experience in developing smart cities according to the Real Estate & Housing Developers' Association (REHDA) Malaysia (Eu, 2022). Under the National Housing Policy (DRN) 2.0, the Ministry of Local Government Development (KPKT) in Malaysia aims to promote intelligent development. The objective is to equip houses with intelligent technologies to enhance residents' quality of living, provide improved monitoring capabilities, and enable better property management. The aim is to demonstrate how intelligent technologies can be integrated into a housing construction project to enhance convenience, efficiency, and sustainability for the residents (The Sun Daily, 2019).

The adoption of Intelligent Development (ID) technology in the construction industry of Malaysia faces challenges due to limited awareness and understanding among developers and potential customers (Yassin *et al.*, 2021). Barriers such as privacy concerns, cost, and reliability hinder the widespread acceptance of intelligent housing (Balta *et al.*, 2013). The adoption of ID in Malaysia lags neighboring countries, partly due to unclear goals of urbanization and perceived higher costs (Kamaruddin, Adul Hamid & Rohaizam, 2020). Conventional home systems are still prevalent, and the availability of intelligent systems is limited to custom-designed houses for high-income groups (Amin *et al.*, 2019). Despite the intelligent housing potential benefits, their adoption in Malaysia remains infancy as compared to its neighborhood countries (Ha, Ismail, & Khoo, 2020; Fahimnia, Sarkis & Davarzani, 2015). The application of home automation systems in Malaysia is still in its early stages and not readily accessible to the low-income population (Amin *et al.*, 2019). According to the research of Zainudin *et al.* (2012), it was found that the private housing developers support sustainable housing development policies in Iskandar Malaysia. There are uncertainties surrounding the success of intelligent housing in Malaysia, despite developers incorporating intelligent features in their projects. As a result, most intelligent housing constructed by private developers only includes a limited number of essential intelligent applications (Balta *et al.*, 2013). Based on Koh & Mustapa (2021), Yassin *et al.* (2021), and Kamaruddin, Adul Hamid & Rohaizam (2020) highlight the challenges, acceptable levels, benefits and aspects related to intelligent development (ID) in housing projects. However, the relationship between main ID practices and the level of importance of ID in housing project trend is unclear. Since the relationship between the main ID practices with the importance level of ID in housing project trend has still not been studied, it is appropriate to complete the results of the study.

Therefore, the objectives of this research are (i) To study the main ID practice in housing project trend in Johor, (ii) To identify the importance level of ID in housing project trend in Johor and (iii) To examine the strengthen of relationship between main ID practice with the main importance level of ID in housing project trend in Johor.

The main scope of this study is to study the ID trend and its application in housing. ID integrates intelligent technologies with the construction industry to improve efficiency and sustainability (Yan *et al.*, 2022). Therefore, the location of this study is in Johor, Malaysia. This is because the state government hopes that the Johor Smart City Blueprint 2030 will drive the agenda for all cities in the state to be ready to realize this vision by 2030 (The Sun Daily, 2022). Johor-based developer MB World Group Bhd will launch Trellis Residences, which will have a total of 1,737 units in three 29-storey towers. Larger units will come with partial furniture, ducted air conditioning and digital door locks (MB World Group, 2021). Another reason why the housing project in Johor was chosen by the researcher as the population because it ranked second in private housing projects in September 2023 in Malaysia (National Housing Department, 2023). Furthermore, this study also focuses on the housing project. Housing is important in the developing world for many of the same reasons that it is important in the developed world. Housing is a significant component of developing countries 'economies' (Gupta, 2022). The respondent for this study focusses on housing project by private housing developers. A housing developer is also a real estate company responsible for developing and constructing housing projects and raising funds for construction (Fauzi, 2017).

The research is necessary to determine the ID trends and its application in housing project. This study is significant to the following parties as follows: This study involves housing developers in the private sector in housing projects. Cost and environmental factors are also considered into the housing projects. This study is expected to help developers adopt ID and build more intelligent housing projects. Furthermore, the importance of this study for housing buyers to evaluate ahead of time when purchasing housing that uses ID. In addition, this research can help buyers understand how this intelligent technology can be used in housing. Then, it can be a guide or research for students and educators to be used in the future. The research may provide new knowledge and understanding of ID trends and their application in housing projects.

2. Literature Review

2.1 ID Practice in Housing Project

(a) Smart Home System (SHSs)

A smart home is a residence that uses internet-connected devices to enable the remote monitoring and management of appliances and systems, such as lighting and heating (Shea, 2020). A smart home is a multi-field technology integration system that incorporates computer, communication, electrical circuit design, and medical treatment technologies. It fulfills user-defined settings for lighting, fire safety, health, and kitchen gas control, effectively integrating diverse subsystems to significantly enhance people's quality of life (Lv, 2016).

(b) Energy-Efficient Design

Various energy efficiency parameters must be considered in the design of residential projects. Therefore, the most effective energy efficiency parameters are thermal insulation, application of lighting options to save energy, application of passive solar energy, application of natural ventilation, production of clean electricity. Therefore, it is the responsibility of housing developers to consider optimizing energy parameters to improve housing development (Roufechaei, Bakar & Tabassi, 2014).

(c) Intelligent Security System

Intelligent security systems, utilizing remote control and wireless internet applications, are beneficial for both residential and industrial purposes (Mallesham, Kamalakar, & Indira, 2016). By integrating devices like video surveillance, intrusion alarms, and smart door locks, these systems enhance the security of homes. Real-time monitoring and alerts, along with mobile and computer connectivity, enable residents to stay informed about their home's security status (Wang *et al.*, 2020). However, with increased connectivity, robust cybersecurity measures are crucial to protect data and privacy. Implementing encryption, secure authentication, and regular software updates helps safeguard against cyber threats in housing projects (Ejidike & Mewomo, 2023).

(d) Intelligent Building Management

Intelligent building management systems serve as a central control point for monitoring and managing various components of a building, aiming to optimize user comfort, energy consumption, and overall efficiency (Naji, Meybodi & Moghaddam, 2011). With the increasing complexity of modern buildings, these systems encompass not only traditional elements like security, HVAC, power, and lighting but also internet access, Wi-Fi coverage, and entertainment systems (Joseph, 2018). Implementing intelligent building management systems in housing projects helps optimize energy usage, reduce maintenance costs, and enhance safety and security for residents (Security Industry Association, 2018). The system acts as a bridge for effective communication between the residential area and its surroundings, managing internal and external interactions through modules like information management, parking lot management, fire safety, smart home, and property management (Cui, 2016).

(e) Intelligent Community Management

Intelligent communities hold significant potential for future development, as they adopt sustainable practices through an integrated management system (Tang, 2022). This system effectively utilizes communication networks and various intelligent applications to enhance all aspects of residents' lives, as proven by extensive experiments (Zhang & Jiang, 2019). It encompasses modules such as property management, video monitoring, lighting control, personnel positioning, entrance guard control, irrigation, household monitoring, and alarm systems (Zhang & Jiang, 2019).

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(f) Data Analysis and Intelligent Decision-Making

Big data analytics is revolutionizing decision making in IoT, enabling analysis of connected device data. It enhances energy management by providing consumers with power consumption details (Andersen, Ashbrook & Karlborg, 2020). Additionally, data science and predictive analytics transform the real estate industry, improving processes such as pricing, marketing, and development efficiency. Insights from data science aid in meeting housing demand and revolutionizing the way homes are built, leased, and sold (Chegut, 2020). IoT technologies and Big Data enable large-scale monitoring and control of household energy consumption through wireless sensors (Al-Ali *et al.,* 2017).

(g) Sustainable Design

Developers are increasingly prioritizing sustainable design in housing projects, incorporating elements like recycled materials, maximizing natural light, and integrating green roofs and walls to minimize environmental impact (Zainudin *et al.,* 2012). In the United Arab Emirates, cities like Abu Dhabi and Dubai have implemented green building codes and regulations, such as the Estidama Pearl program, to create sustainable cities aligned with the country's expansion (Awadh 2017). Sustainable housing design emphasizes energy efficiency, environmental protection, and other key factors to promote a greener and more sustainable future (Almusaed, & Almssad, 2022).

2.2 The Importance Level of ID in Housing Project

(a) Cost Savings

Intelligent development (ID) can reduce overall costs by incorporating energy-efficient appliances, smart thermostats, and building automation systems. The life-cycle cost savings, improved human performance, and enhanced reputation associated with green development are tangible benefits (Nalewaik & Venters, 2009). ID enables cost reduction through optimized control, communication, and management systems, minimizing fixed costs, maintenance expenses, and productivity losses (Doukas *et al.*, 2007).

(b) Energy saving and Sustainability

The implementation of a computerized building system leads to significant reductions in energy consumption and carbon footprint. Energy efficiency has become a crucial aspect of real estate and facilities management due to rising energy concerns and advancements in cost-effective technologies (Siew, Balatbat & Carmichael, 2013). For lighting framework, vitality sparing can be up to 75% of the first circuit load, which speaks to 5% of the absolute utilization of the private and business divisions. Vitality sparing potential from water warming, cooling or boiling water creation can be up to10% which speaks to up to 7% of the vitality utilization of private and business area (Clements-Croome, 2014).

(c) Increased security

Intelligent development can enhance security features in a housing project. Smart home technology can allow residents to monitor their homes from anywhere, increasing their sense of security (Chan *et al.*, 2009, Nyborg & Røpke, 2011). ID technologies offer more reliable security than traditional, manually operated security systems. Smart security gadgets such as door sensors, alarm systems, security cameras, and video doorbells help warn building owners about the various threats to their property (Bowers, 2022).

(d) Increased property value

According to an article written by Savina D'souza, a mortgage team leader & business development officer, an ID technology enabled home can increase the property value anywhere from 3% to 5%. An improvement in technology and sustainability leads to a higher property value as the building now can be certified on a higher level growing rental rates by up to 24.9% compared to a conventional building. Saidur *et al.* (2011) uncovered that introducing innovation to meter and screen vitality utilization has a normal recompense time of under a half year.

(f) Green House Gas Benefits

Ozone depleting substance emanation decreases correspond to decrease in vitality use. Savvy structures add to the decrease in vitality use, in business, modern, institutional, and private areas (Ghaffarian *et al.*, 2012). Reducing greenhouse gas emissions can be achieved by better insulating housing and buildings, switching from polluting (though cheap) coal to natural gas or renewable energy (Lazarus & Van Asselt, 2018). Intelligent applications are developed to efficiently integrate such renewable energy resources with flexible storage systems (Ahmed *et al.*, 2021).

(g) Intelligent City

When each structure in a city is intelligent, the city is canny (Tauheed *et al.*, 2007). The emergence of smart buildings is driven by the need to lower costs, optimize workforce, enhance service levels, and solve problems proactively. As urbanization continues, smart buildings will improve quality of life and productivity in cities (Yang, 2012).

(h) Efficiency equals Savings

Operational efficiency is a significant advantage of smart building adoption. By providing building operators with valuable data to enhance energy usage, sustainability, occupant comfort, and automation, they can effectively reduce operational costs (Dounis *et al.*, 2011). Up to 30 percent of structure upkeep expenses can be decreased with shrewd structure arrangements. As postulated by Ning, Sandborn & Pecht (2013), an appropriately structured and worked framework will be productive and spare expenses.

(i) Reducing energy and lowering operational costs

Expanding vitality utilization and rising power costs are pushing building proprietors to receive shrewd structures arrangements that can robotize control frameworks and empower them to evade vitality wastage (Perez-Lombard, Ortiz & Pout, 2008). For example, about 54% of the vitality utilization in US private structures is expected to HVAC frameworks, and about 6% to fake lighting, while in business structures HVAC and counterfeit lighting frameworks represent 40%and 15% of vitality utilization, individually. Upgradeable programming replaces resolute, cabled, and tedious undertakings. There will be less requirement for costly staff that investigates nonstop (Siano, 2014).

(j) Improving quality of life

Concordia University's research found that people prefer practical ID technology services that enhance quality of life, such as fire and security systems. They also liked features like automatic lighting, keyless locks, remote programming, and selling energy back to the grid. Wireless technology was praised for its efficiency and space-saving advantages. ID technology was seen to have the potential to increase leisure time, save money, make life easier, and provide support for assisted living for the elderly and those with disabilities. The study reveals that ID in housing embrace significant potentials towards achieving comfort, security, independent lifestyle and enhanced quality of life (Ghaffarianhoseini *et al.*, 2017).

(k) Building and asset performance (easier maintenance and repairs)

Implementing an automated asset management system can yield a quick return on investment by effectively measuring property lifecycle and preventing costly repairs. Maintenance, as defined by British Standards, aims to ensure safety, protect property value and maintain function. By employing a reliable system, such as the security system approach, lies can be clarified naturally while fulfilling their function and maintaining a desirable appearance. (Bohm & Peat, 2010).

(l) Improved occupant comfort, productivity, and health

This is an obvious one: when a building can keep its tenants comfortable, healthy, productive and happy, the more likely it is that they will thrive and stay (Klein *et al.*, 2012). Tenant well-being and solace might be improved in intelligent structure and obligation decreased through the decrease or end of lethal or destructive substances, which may bring about diminished non-appearance and turnover (Koga, Lehman & CxA, 2008). A building integrated with intelligent systems can provide a cost-effective environment while it maximizes occupant efficiency and needs and creates a healthy living and working environment by being responsive and flexible enough to adapt to future changes (Bicer & Halicioglu, 2022).

3. Research Methodology

3.1 Research Design

Research design, according to Yin (2015), is a strategic plan guiding the entire research process to attain its objectives. Creswell & Poth (2016) emphasize that research design encompasses the journey from problem discovery to question formulation, data collection, analysis, and report writing. It is a continuous process culminating in research conclusions.

(a) Procedure of Research

The procedure of research that applies to conducting this research as shown in Appendix A. There are 5 phase that conduct in this research. All the phase generally represents overall process in the research.

(b) Respondent

This research used Table of Krejcie & Morgan (1970) in determining the sample size. In addition, the population in this research is the housing project in Johor by developer companies as well as population size is estimated at around 205 projects in Johor Bahru based on the list of private projects in Malaysia in September 2023. Therefore, the sample size is around 136 (Refer to Appendix B)

(c) Research method

In this study, questionnaire is a specific instrument or tool for collecting data. The questions in this research questionnaire are divided into three sections, which are Section A: Respondent Background, Section B: Main ID practice in housing project trend and Section C: Importance level of ID in housing project trend. Researchers used Likert scales in Section B and Section C. In this part, a 5-point Likert Scale was used to assess the developer's level of alignment. The Likert scale assessed for the first objective is frequency while the Likert scale assessed for the second objective is level of importance.

3.2 Pilot study

The researcher had conducted a pilot study before performing the full study and distributing the questionnaire to the respondents. In the pilot study, a total of 6 respondents in Johor had answered the questionnaire provided. According to Bullen (2021), the number of flexible respondents is between 5 and 10.

(a) Reliability analysis

Cronbach's alpha was used to determine the reliability of the multi-question Likert scale survey. These questions assess hidden or unobservable latent variables, such as a person's conscientiousness, neuroticism, or openness (Glen, 2023). The following rule of thumb: "$\alpha > 0.9$ – excellent, $\alpha > 0.8$ – good, $\alpha > 0.7$ – acceptable, $\alpha > 0.6$ – questionable, $\alpha > 0.5$ – poor, $\alpha < 0.5$ – unacceptable". According to the reliability analysis results of the collected data, Cronbach's Alpha is 0.951, as shown in Table 1, which indicates that the questionnaire has high reliability and the items have high internal consistency.

Table 1 *Reliability test*

Number of Questions	Number of Respondents	Alpha Cronbach's Value
98	6	0.951

3.3 Data Collection

The data was collected and gathered by way of an online questionnaire distributed among 136 housing projects in Johor. The questionnaire was designed by manual form set (face to face meeting) and online by using the google form. The link of google form shared on the platform such as WhatsApp and Email.

3.4 Data Analysis

The collected data was analysed by using Statistical Package for Social Sciences (SPSS) software. Data from section A (Background of the respondents) were analysed using frequency analysis. Meanwhile, section B (Main ID Practices in Housing Project Trends), and section C (Level of Importance of ID in Housing Project Trends) were analysed by using descriptive analysis. Cross-tabulation (Crosstab) was used to analyse objective 3 which is examine the strength of relationship between the main ID practices with main importance levels of ID in housing project trend in Johor. The cross-tabulation method is suitable for researchers to use to help answer all questions related to the relationship between two variables. The measurement relationship and strength used were the strength of 0.5 and the approximate significant of 0.05 (Chua, 2011).

4. Results and Discussion

The results and discussion section presents data and analysis of the study. In total, 83 sets of questionnaires were returned with responses and answers from the respondents. All of the returned questionnaires were used for data analysis purposes.

(a) Section A: The Background of Respondents

Table 2 shows a summary of the data analysis for Section A. As can be seen from Table 2, the proportion of male respondents is higher than that of female respondents, with a total of 61 respondents (73%). Respondents aged 30 to 49 have the highest proportion, accounting for 55%, equivalent to 46 respondents. The highest ethnic group is Chinese, with 58%, nearly 48 people. In addition, the highest proportion of respondents with the highest educational level is Bachelor, at 86%, with 71 people. The highest service years in the construction industry are between 11 to 20 years, accounting for 40% with a total of 33 respondents. Finally, project managers and engineers have the highest proportion of professional titles at 34%, equivalent to 28 respondents.

Table 2 *Summary of data analysis in Section A*

No.	Respondent Background	Frequency	Percentage (%)
1	Gender		
	Male	61	73.5
	Female	22	26.5
2	Age		
	18-29 years old	34	41.0
	30-49 years old	46	55.4
	50-59 years old	3	3.6
	60 years old and above	0	0
3	Race		
	Malay	33	39.8
	Chinese	48	57.8
	Indian	2	2.4
	Other	0	0
4	Highest Qualifications		
	Primary/Secondary	0	0
	Diploma	7	8.4
	Bachelor	71	85.5
	Masters/Ph.D.	5	6.0
	Other	0	0
5	Years of service in the construction industry		
	Between 1 to 5 years	26	31.3
	Between 6 to 10 years	16	19.3
	Between 11 to 20 years	33	39.8
	21 years and above	8	9.6
6	Job title		
	Director	6	7.2
	Project Manager	28	33.7
	Engineer	28	33.7
	Architect	12	14.5
	Other	9	10.8

(b) Section B: The Main ID Practice in Housing Project Trend in Johor

Based on Table 3, the mean scores are divided into three levels for classification and interpretation. A score of 1.00 to 2.33 represents a low average, a score of 2.34 to 3.66 represents a medium average, and a score of 3.67 to 5.00 represents a high average.

Table 3 *Assessment level based on mean score*

Mean Score Range	Level	Classification
1.00-2.33	Low	(Not Agree/ Not Helpful/ Unsatisfied/ None/ Sometimes/Not Sure)
2.34-3.66	Moderate	(Agree/ Helpful/ Satisfied)

3.67-5.00	High	(Strongly Agree/ Fully Satisfied/ Really Helpful)

Based on Table 4, the majority of respondent achieved the high frequency level that the ID practice in housing project trend is sustainable design with the highest mean value, 3.6787. Then followed by intelligent security system with a mean of 3.2410 and at a moderate frequency level. Next, frequency level for intelligent community management is at moderate with 3.2078. Energy-efficient design (3.1759), smart home system (SHSs) (3.1165) and intelligent building management (3.1132) are the ID practice in housing project and these three practices are at moderate frequency level. The lowest frequency for the ID practice is data analysis and intelligent decision-making with a mean of 2.7671 but the frequency level is still at moderate level.

Table 4 *Mean analysis of ID practice in housing project trend in Johor*

No	Practices	Mean	Frequency Level	Ranking
Smart Home System (SHSs)		3.1165	Moderate	5
1.	Internet-connected devices enable remote monitoring of systems	3.1205	Moderate	5
2.	Internet-connected devices enable remote management of systems	3.0723	Moderate	7
3.	Multi-field technology integration system	3.0843	Moderate	6
4.	Satisfies the user-defined settings of people's living habits	3.0482	Moderate	8
5.	Automation of various functions	3.1325	Moderate	4
6.	Remote control of various functions	3.1687	Moderate	1
7.	Control home devices through mobile phones	3.1687	Moderate	1
8.	Control home devices through tablets	3.1687	Moderate	1
9.	Control home devices through voice assistants	3.0482	Moderate	8
Energy-Efficient Design		3.1759	Moderate	4
10.	Thermal insulation	3.1084	Moderate	4
11.	Application of lighting options	3.2410	Moderate	1
12.	Application of passive solar energy	3.1807	Moderate	2
13.	Application of natural ventilation	3.1807	Moderate	2
14.	Production of clean electricity	3.1687	Moderate	3
Intelligent Security System		3.2410	Moderate	2
15.	Wireless internet applications	3.2048	Moderate	3
16.	Video surveillance	3.1325	Moderate	4
17.	Intrusion alarm	3.3133	Moderate	1
18.	Intelligent door lock	3.3133	Moderate	1
Intelligent Building Management		3.1132	Moderate	6
19.	Information management module	2.9759	Moderate	5
20.	Parking lot management module	3.1205	Moderate	3
21.	Fire safety management module	3.1807	Moderate	1
22.	Smart home management module	3.1807	Moderate	1
23.	Property management module	3.1084	Moderate	4
Intelligent Community Management		3.2078	Moderate	3
24.	Property management system	3.1446	Moderate	5
25.	Video monitoring system	3.1084	Moderate	8
26.	Lighting control system	3.3735	Moderate	2
27.	Property management personnel positioning system	3.1205	Moderate	6
28.	Intelligent entrance guard control system	3.2410	Moderate	3
29.	Village green irrigation systems	3.1205	Moderate	6
30.	Household monitoring system	3.1566	Moderate	4
31.	Alarm system	3.3976	Moderate	1
Data Analysis and Intelligent Decision-Making		2.7671	Moderate	7
32.	Big data analytics	2.7590	Moderate	2
33.	Internet of Things (IoT)	2.8675	Moderate	1
34.	Data science	2.6747	Moderate	3
Sustainable Design		3.6787	High	1
35.	Maximize natural light	3.7470	High	1
36.	Incorporating green roofs	3.5783	Moderate	6
37.	Incorporating green walls	3.6265	Moderate	5

38.	Reduce the environmental impact of projects	3.6747	High	4
39.	Environmental protection	3.7470	High	1
40.	Using recycled materials	3.6988	High	3

According to the analysis of the research, the ID practices in housing project is sustainable design with the highest mean value, 3.6787. These findings are in line with previous studies which show that developers are increasingly focused on sustainable design when building housing projects. They are using recycled materials, designing housing to maximize natural light, and incorporating green roofs and walls to reduce the environmental effect of their projects (Zainudin *et al.*, 2012). Meanwhile, the lowest mean of the ID practice in housing project trend is 2.7671, which is data analysis and intelligent decision-making. This is because majority of the respondents believe data analysis and intelligent decision-making are used less in housing projects. Thus, the first objective which is to study the main ID practice in housing project trend in Johor.

(c) Section C: The Main Importance Level of ID in Housing Project Trend in Johor

Based on Table 5, increase security was achieved high importance level by respondents with the highest mean value, 4.1205. Then followed by building and asset performance with a mean of 4.1084 and high importance level. Improving quality of life, cost savings and improved occupant comfort, productivity, and health was also achieved high importance level which the mean is about 4.0994, 4.0924 and 4.0637 respectively. Furthermore, energy saving and sustainability and increased property value are in the same mean value, 4.0482 and at high importance level. Efficiency equals savings (4.0465) and greenhouse gas benefits (4.0080), these two are in importance level are also high. Reducing Energy and lowering operational costs is second lowest with a mean of 3.9864. The lowest importance is intelligent city with a mean of 3.9679 but the importance level is still at high level.

Table 5 *Mean analysis of the main importance level of ID in housing project trend in Johor*

No	Item	Mean	Importance Level	Ranking
Cost Savings		4.0924	High	4
1.	Reduce the overall cost of building	4.0964	High	2
2.	Save money on utility bills	4.0723	High	3
3.	Reduce maintenance costs	4.1084	High	1
Energy Saving and Sustainability		4.0482	High	6
4.	Establishment of a computerized structure framework	4.0361	High	2
5.	Reducing energy consumption	4.0843	High	1
6.	Ensuring a healthy indoor environment with an optimal design	4.0241	High	3
Increased Security		4.1205	High	1
7.	Monitor homes from anywhere	4.1446	High	1
8.	Increasing sense of security	4.1325	High	2
9.	Smart security gadgets help warn building owners	4.1084	High	3
10.	The various threats to property	4.0964	High	4
Increased Property Value		4.0482	High	6
11.	Higher levels of certification available	4.0482	High	2
12.	Rental rate increases	4.0120	High	4
13.	Introducing innovation to the meter	4.0482	High	2
14.	Introducing innovation to screen vitality utilization	4.0843	High	1
Greenhouse Gas Benefits		4.0080	High	9
15.	Ozone depleting substance emanation decreases	4.0361	High	2
16.	Savvy structures	3.9518	High	5
17.	Reducing greenhouse gas emissions	4.0843	High	1
18.	Better insulating housing	3.9880	High	4
19.	Switching from polluting coal to natural gas	4.0361	High	2
20.	Switching from polluting coal to renewable energy	3.9518	High	5
Intelligent City		3.9679	High	11
21.	More extensive dream of shrewd urban communities	4.0723	High	1
22.	City framework is overseen more keenly	3.9277	High	5
23.	Streamline labour usage	3.9639	High	2
24.	Improve administration level	3.9157	High	6

25.	Improve personal satisfaction	3.9639	High	2
26.	Improve the profitability of the nation	3.9639	High	2
Efficiency Equals Savings		4.0465	High	8
27.	Operational proficiency	4.1205	High	1
28.	Improve vitality use	4.0241	High	5
29.	Improve maintainability	4.0602	High	3
30.	Upgrade occupant comfort	4.0723	High	2
31.	Bring more noteworthy robotization	4.0120	High	6
32.	Appropriately structured	3.9759	High	7
33.	Appropriately worked framework	4.0602	High	3
Reducing Energy and Lowering Operational Costs		3.9864	High	10
34.	Receive shrewd structures arrangements	4.0120	High	1
35.	Robotize control frameworks	3.9759	High	4
36.	Empower to evade vitality wastage	4.0000	High	2
37.	Upgradeable programming	3.9880	High	3
38.	Less requirement for costly staff	3.9639	High	5
Improving Quality of Life		4.0994	High	3
39.	More efficient use of space	4.0964	High	4
40.	Fewer wires	4.1205	High	2
41.	Fewer cables	4.1566	High	1
42.	Fewer clutter	4.1084	High	3
43.	Programmed remotely via mobile phone	4.0723	High	7
44.	Increase leisure time	4.0843	High	6
45.	Provide support for assisted living for the elderly	4.0602	High	8
46.	Provide support for assisted living for those with disabilities	4.0964	High	4
Building and Asset Performance		4.1084	High	2
47.	Reduce costly repairs later	4.1807	High	1
48.	Secure the well-being of inhabitants	4.0964	High	3
49.	Secure security of inhabitants	4.0964	High	3
50.	Hold estimation of venture	4.0602	High	5
51.	Keep up the structure in a condition	4.1084	High	2
Improved Occupant Comfort, Productivity, and Health		4.0637	High	5
52.	Reduce lethal substances	4.0843	High	3
53.	Reduce absences	4.0482	High	5
54.	Provide a cost-effective environment	4.1325	High	1
55.	Maximize occupant efficiency	3.9880	High	7
56.	Creates a healthy living	4.0964	High	2
57.	Creates a healthy working environment	4.0602	High	4
58.	Being flexible to adapt to future changes	4.0361	High	6

According to the analysis of the research, the importance level of ID in housing project trend is increased security with the highest mean value, 4.1205. Therefore, the findings relate to the research of Chan *et al.* (2009) and Nyborg & Røpke (2011), ID can improve security features in a housing project. Residents can monitor their homes from anywhere with smart home technology, increasing their sense of security. ID technologies offer more reliable security than traditional, manually controlled security systems. Smart security devices that may alert building owners to potential threats to their property (Bowers, 2022). Meanwhile, the lowest mean is 3.9679, which is intelligent city. This is because respondents considered the concept of intelligent city to be less popular or less important than other attributes or characteristics surveyed. Thus, the second objective is to identify the main importance level of ID in housing project trend in Johor.

(d) Section D: Strength of Relationship Between the Main ID Practices with Main Importance Level of ID in Housing Project Trend in Johor

Based on DeFranzo (2010), approximate significance for the variable's must < 0.05 and the value < 0.5 to show there is a relationship between the variables and there is a strong or a weak relationship (refer Table 6). The approximate significance is related to variables. There are two types of hypotheses in this study which are H0 and H1. H0 is there is no relationship between ID practice with main importance level of ID in housing project trend in Johor by developers. While the H1 is there is a relationship between ID practice with main importance level of ID in housing project trend in Johor by developers.

Table 6 *Crosstab analysis*

Appr. Significant (Relationship)	Value (Strength)	Explanation
< 0.05	< 0.5	There is a relationship between the variables and the relationship is strong (H1 is accepted)
> 0.05	> 0.5	There is no association between the variables and the relationship is weak (H0 is accepted)

Table 7 shows the value and approximate significance of the relationship between the practice and importance level. The first practice is sustainable design. The strongest value is increased security with a value of 0.2240, less than 0.5 and the approximate significant is 0.0420 less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, for the weakest value is increase property value with a value of 0.1790 less than 0.5 and the approximate significant is 0.1060 more than 0.05. This result can be concluded as the hypothesis is rejected (H0). The second practice is intelligent security system. The strongest value is increased security with a value of 0.2320, less than 0.5 and the approximate significant is 0.0350 less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, the weakest value is cost savings with a value of 0.1950 less than 0.5 and the approximate significant is 0.0780 more than 0.05. This result can be concluded as the hypothesis is rejected (H0). The third practice is intelligent community management. The strongest value is reducing energy and lowering operational costs with a value of 0.2450, less than 0.5 and the approximate significant is 0.0260, less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, the weakest value is improving quality of life with a value of 0.2050 less than 0.5 and the approximate significant is 0.0630 more than 0.05. This result can be concluded as the hypothesis is rejected (H0). The fourth practice is energy-efficient design. The strongest value is increased property value and greenhouse gas benefits with the same value of 0.2290, less than 0.5 and the approximate significant is 0.0370, less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, for the weakest value is improving quality of life with a value of 0.1950 less than 0.5 and the approximate significant is 0.0780 more than 0.05. This result can be concluded as the hypothesis is rejected (H0). The fifth practice is smart home system (SHSs). The strongest value is reducing energy and lowering operational costs with a value of 0.2180, less than 0.5 and the approximate significant is 0.0480 less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, the weakest value is efficiency equals saving with a value of 0.1940 less than 0.5 and the approximate significant is 0.0790 more than 0.05. This result can be concluded as the hypothesis is rejected (H0). The sixth practice is intelligent building management. The strongest value is improved occupant comfort, productivity, and health with a value of 0.2310, less than 0.5 and the approximate significant is 0.0360 less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, the weakest value is cost savings with a value of 0.2010 less than 0.5 and the approximate significant is 0.0690 more than 0.05. This result can be concluded as the hypothesis is rejected (H0). The seventh practice is data analysis and intelligent decision-making. The strongest value is intelligent city with a value of 0.2260, less than 0.5 and the approximate significant is 0.0400 less than 0.05. This result can be concluded as the hypothesis is accepted (H1). Meanwhile, the weakest value is cost savings with a value of 0.1990 less than 0.5 and the approximate significant is 0.0710 more than 0.05. This result can be concluded as the hypothesis is rejected (H0).

Table 7 *Relationship analysis for main practices and main importance levels*

Main practice	Main importance level	Approx. Sig	Value	Hypothesis	Ranking
Sustainable Design -Maximize natural light	Increased Security - Monitor homes from anywhere	0.0420 (Yes)	0.2240 (Strong)	H1	1
	Building and Asset Performance - Reduce costly repairs later	0.0030 (Yes)	0.3230 (Strong)	H1	9
	Improving Quality of Life - Fewer cables	0.0010 (Yes)	0.3520 (Strong)	H1	10
	Cost Savings - Reduce maintenance costs	0.0070 (Yes)	0.2920 (Strong)	H1	6
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.0090 (Yes)	0.2840 (Strong)	H1	4
	Energy Saving and Sustainability - Reducing energy consumption	0.0150 (Yes)	0.2660 (Strong)	H1	2
	Increased Property Value	0.1060	0.1790	H0	-

	- Introducing innovation to screen vitality utilization	(No)	(Strong)		
	Efficiency Equals Saving - Operational proficiency	0.0080 (Yes)	0.2900 (Strong)	H1	5
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.0030 (Yes)	0.3220 (Strong)	H1	8
	Reducing Energy and Lowering Operational Costs - Receive shrewd structures arrangements	0.0110 (Yes)	0.2780 (Strong)	H1	3
	Intelligent City - More extensive dream of shrewd urban communities	0.0030 (Yes)	0.3210 (Strong)	H1	7
Intelligent Security System - Intelligent door lock	Increased Security - Monitor homes from anywhere	0.0350 (Yes)	0.2320 (Strong)	H1	1
	Building and Asset Performance - Reduce costly repairs later	0.0020 (Yes)	0.3350 (Strong)	H1	6
	Improving Quality of Life - Fewer cables	0.1380 (No)	0.1640 (Strong)	H0	-
	Cost Savings - Reduce maintenance costs	0.0780 (No)	0.1950 (Strong)	H0	-
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.0080 (Yes)	0.2900 (Strong)	H1	5
	Energy Saving and Sustainability - Reducing energy consumption	0.1160 (No)	0.1740 (Strong)	H0	-
	Increased Property Value - Introducing innovation to screen vitality utilization	0.0290 (Yes)	0.2400 (Strong)	H1	3
	Efficiency Equals Saving - Operational proficiency	0.0140 (Yes)	0.2690 (Strong)	H1	4
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.2220 (No)	0.1360 (Strong)	H0	-
	Reducing Energy and Lowering Operational Costs - Receive shrewd structures arrangements	0.1080 (No)	0.1780 (Strong)	H0	-
	Intelligent City - More extensive dream of shrewd urban communities	0.0340 (Yes)	0.2330 (Strong)	H1	2
Intelligent Community Management - Alarm system	Increased Security - Monitor homes from anywhere	0.0200 (Yes)	0.2550 (Strong)	H1	3
	Building and Asset Performance - Reduce costly repairs later	0.0250 (Yes)	0.2470 (Strong)	H1	2
	Improving Quality of Life - Fewer cables	0.0630 (No)	0.2050 (Strong)	H0	-
	Cost Savings - Reduce maintenance costs	0.2720 (No)	0.1220 (Strong)	H0	-
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.0180 (Yes)	0.2580 (Strong)	H1	4
	Energy Saving and Sustainability - Reducing energy consumption	0.0130 (Yes)	0.2710 (Strong)	H1	5
	Increased Property Value - Introducing innovation to screen vitality utilization	0.0960 (No)	0.1840 (Strong)	H0	-
	Efficiency Equals Saving - Operational proficiency	0.1100 (No)	0.1770 (Strong)	H0	-
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.0960 (No)	0.1840 (Strong)	H0	-
	Reducing Energy and Lowering	0.0260	0.2450	H1	1

	Operational Costs - Receive shrewd structures arrangements	(Yes)	(Strong)		
	Intelligent City - More extensive dream of shrewd urban communities	0.0020 (Yes)	0.3370 (Strong)	H1	6
Energy-Efficient Design - Application of lighting options	Increased Security - Monitor homes from anywhere	0.0940 (No)	0.1850 (Strong)	H0	-
	Building and Asset Performance - Reduce costly repairs later	0.0360 (Yes)	0.2310 (Strong)	H1	3
	Improving Quality of Life - Fewer cables	0.0780 (No)	0.1950 (Strong)	H0	-
	Cost Savings - Reduce maintenance costs	0.0960 (No)	0.1840 (Strong)	H0	-
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.0780 (No)	0.1940 (Strong)	H0	-
	Energy Saving and Sustainability - Reducing energy consumption	0.0040 (Yes)	0.3100 (Strong)	H1	5
	Increased Property Value - Introducing innovation to screen vitality utilization	0.0370 (Yes)	0.2290 (Strong)	H1	1
	Efficiency Equals Saving - Operational proficiency	0.0810 (No)	0.1930 (Strong)	H0	-
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.0370 (Yes)	0.2290 (Strong)	H1	1
	Reducing Energy and Lowering Operational Costs - Receive shrewd structures arrangements	0.0820 (No)	0.1920 (Strong)	H0	-
	Intelligent City - More extensive dream of shrewd urban communities	0.0070 (Yes)	0.2940 (Strong)	H1	4
Smart Home System (SHSs) - Remote control of various functions	Increased Security - Monitor homes from anywhere	0.1300 (No)	0.1680 (Strong)	H0	-
	Building and Asset Performance - Reduce costly repairs later	0.0180 (Yes)	0.2590 (Strong)	H1	3
	Improving Quality of Life - Fewer cables	0.2870 (No)	0.1180 (Strong)	H0	-
	Cost Savings - Reduce maintenance costs	0.0980 (No)	0.1830 (Strong)	H0	-
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.3690 (No)	0.1000 (Strong)	H0	-
	Energy Saving and Sustainability - Reducing energy consumption	0.3950 (No)	0.0950 (Strong)	H0	-
	Increased Property Value - Introducing innovation to screen vitality utilization	0.0250 (Yes)	0.2470 (Strong)	H1	2
	Efficiency Equals Saving - Operational proficiency	0.0790 (No)	0.1940 (Strong)	H0	-
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.1750 (No)	0.1500 (Strong)	H0	-
	Reducing Energy and Lowering Operational Costs - Receive shrewd structures arrangements	0.0480 (Yes)	0.2180 (Strong)	H1	1
	Intelligent City - More extensive dream of shrewd urban communities	0.0120 (Yes)	0.2750 (Strong)	H1	4
Intelligent Building	Increased Security - Monitor homes from anywhere	0.0020 (Yes)	0.3420 (Strong)	H1	8

Management - Fire safety management module	Building and Asset Performance - Reduce costly repairs later	0.0140 (Yes)	0.2690 (Strong)	H1	6
	Improving Quality of Life - Fewer cables	0.1990 (No)	0.1420 (Strong)	H0	-
	Cost Savings - Reduce maintenance costs	0.0690 (No)	0.2010 (Strong)	H0	-
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.0360 (Yes)	0.2310 (Strong)	H1	1
	Energy Saving and Sustainability - Reducing energy consumption	0.0160 (Yes)	0.2640 (Strong)	H1	5
	Increased Property Value - Introducing innovation to screen vitality utilization	0.0280 (Yes)	0.2410 (Strong)	H1	2
	Efficiency Equals Saving - Operational proficiency	0.0260 (Yes)	0.2440 (Strong)	H1	3
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.0180 (Yes)	0.2590 (Strong)	H1	4
	Reducing Energy and Lowering Operational Costs - Receive shrewd structures arrangements	0.0720 (No)	0.1990 (Strong)	H0	-
	Intelligent City - More extensive dream of shrewd urban communities	0.0020 (Yes)	0.3330 (Strong)	H1	7
Data Analysis and Intelligent Decision-Making - Internet of Things (IoT)	Increased Security - Monitor homes from anywhere	0.0050 (Yes)	0.3060 (Strong)	H1	3
	Building and Asset Performance - Reduce costly repairs later	0.3430 (No)	0.1050 (Strong)	H0	-
	Improving Quality of Life - Fewer cables	0.6970 (No)	0.0430 (Strong)	H0	-
	Cost Savings - Reduce maintenance costs	0.0710 (No)	0.1990 (Strong)	H0	-
	Improved Occupant Comfort, Productivity, and Health -Provide a cost-effective environment	0.2470 (No)	0.1280 (Strong)	H0	-
	Energy Saving and Sustainability - Reducing energy consumption	0.0180 (Yes)	0.2600 (Strong)	H1	2
	Increased Property Value - Introducing innovation to screen vitality utilization	0.1370 (No)	0.1640 (Strong)	H0	-
	Efficiency Equals Saving - Operational proficiency	0.2700 (No)	0.1220 (Strong)	H0	-
	Greenhouse Gas Benefits -Reducing greenhouse gas emissions	0.2830 (No)	0.1190 (Strong)	H0	-
	Reducing Energy and Lowering Operational Costs - Receive shrewd structures arrangements	0.3550 (No)	0.1030 (Strong)	H0	-
	Intelligent City - More extensive dream of shrewd urban communities	0.0400 (Yes)	0.2260 (Strong)	H1	1

Since there is still no study analysing the relationship between these two objectives, the researcher has achieved the third objective which is to examine the strength of relationship between main ID practices and the main importance level of ID in housing project trend in Johor. Based on research of Koh & Mustapa (2021); Yassin *et al.* (2021) and Kamaruddin, Adul Hamid & Rohaizam (2020) shows that it is an unclear relationship between the main ID practices with the importance level of ID in the housing project trend. Besides that, Figure 1 shows the main ID practice with main importance level of ID in housing project trend in Johor. Researcher can conclude that not all main ID practices have a correlation with the main importance level given.

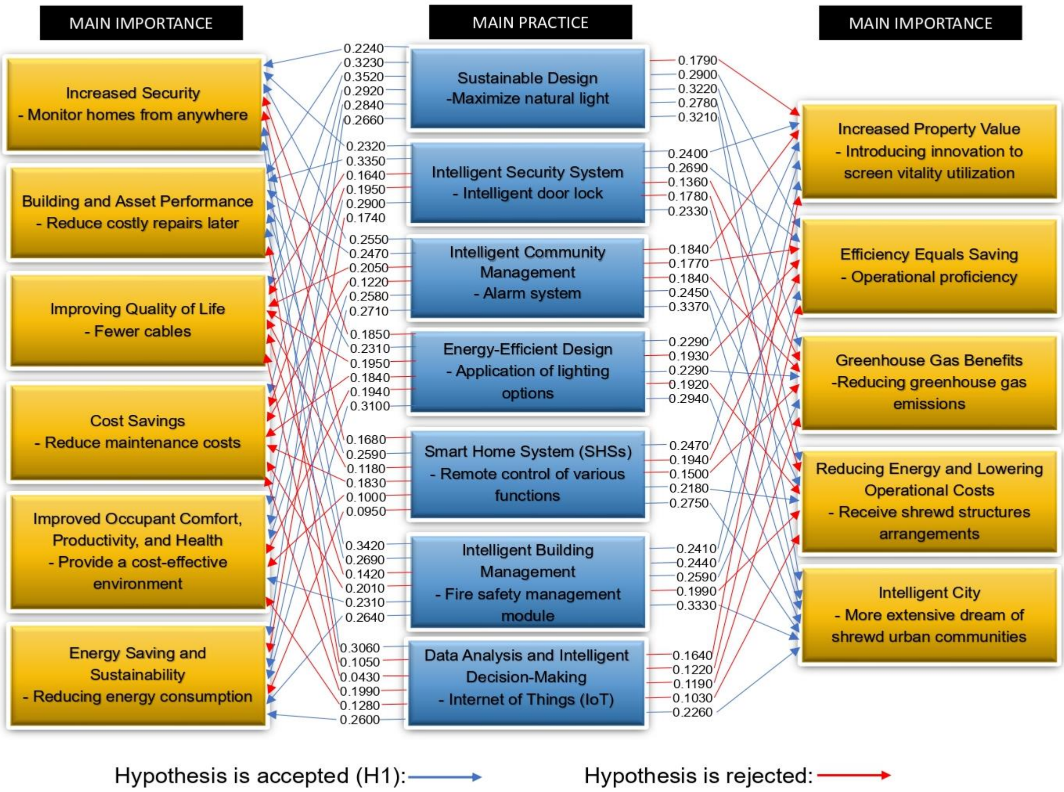

Fig. 1 *Relationship analysis diagram for main practices with main importance levels*

5. Conclusion

The findings of this study have demonstrated that the objectives of this study have been successfully accomplished through the utilization of the outcomes of the data analysis obtained from questionnaires that have been returned. Achievement of objectives is crucial to ensure the success of the study. Based on the completed study, the researchers found that the main ID practice and importance level respectively sustainable design and increase security recorded as the highest frequency and importance. The researchers also found that not all practices are associated with a given importance. Only 42 out of 77 correlations were achieved in this study. As a conclusion, leveraging the relationship framework for main practices with main importance level of ID provided by this study (refer Fig. 2). It is hoped that government and private housing developers will work or cooperate closely together to adopt intelligent development. While there are challenges to overcome, the potential long-term advantages make it a promising approach for future housing. Implementing ID in housing projects is the future of the construction industry. If ID can be used properly in housing projects, the construction industry has the potential to achieve a higher level of prosperity and success.

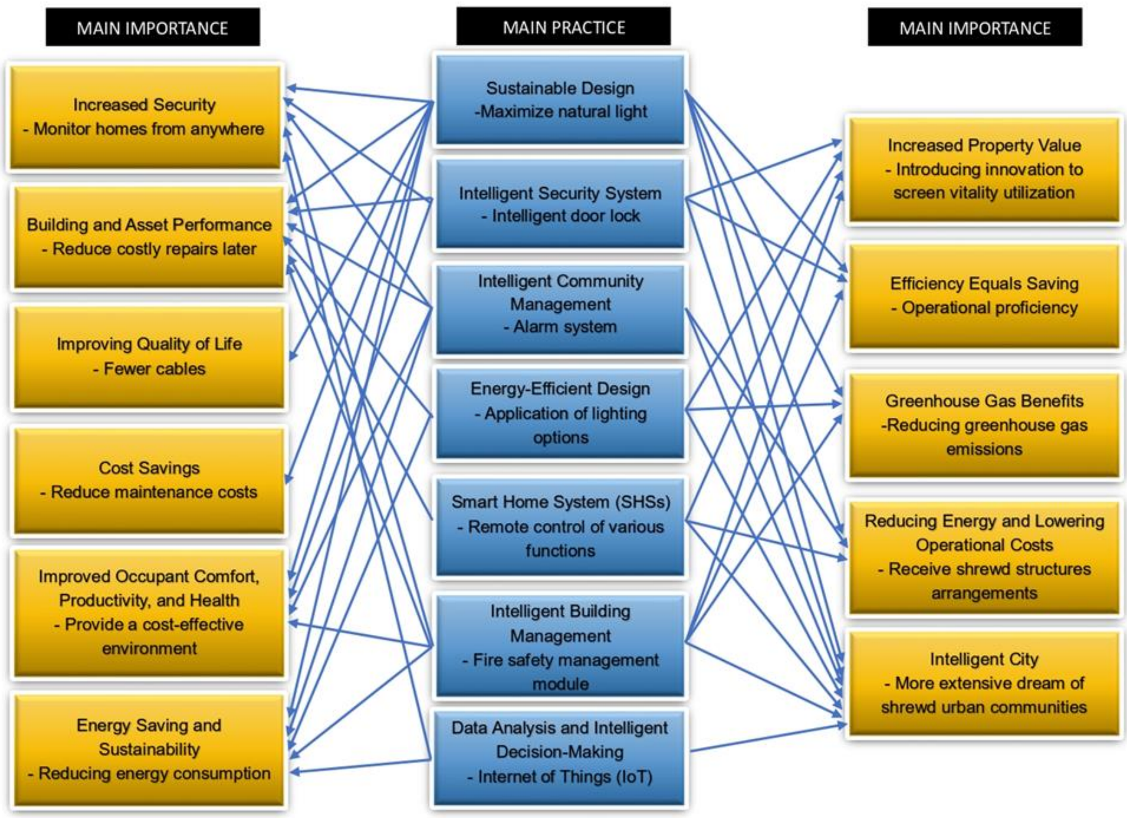

Fig. 2 *Relationship framework for main ID practices with main importance levels of ID in housing project in Johor*

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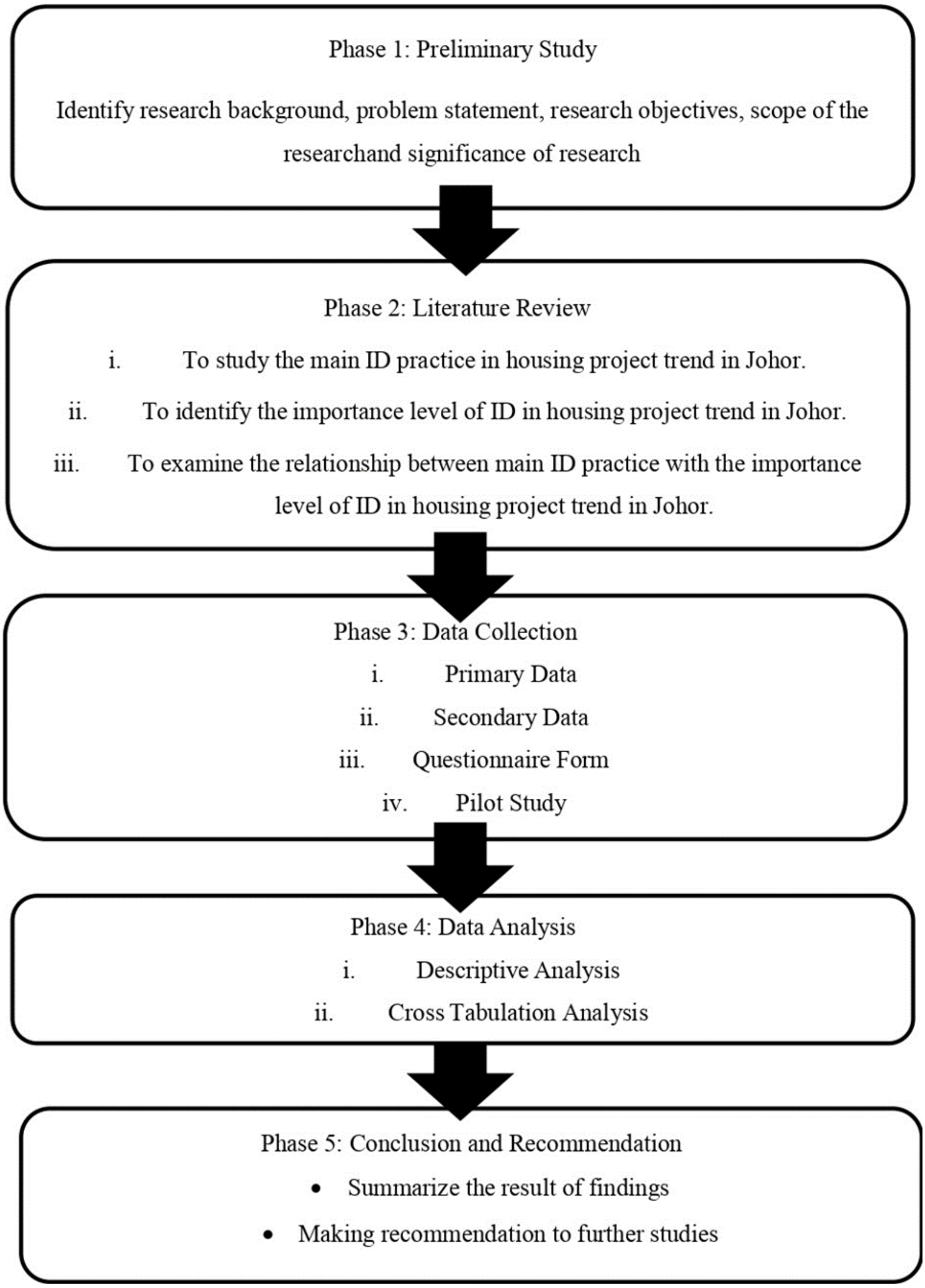
Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Alvin Goh Wei Yang, Rozlin Zainal;* ***data collection:*** *Alvin Goh Wei Yang;* ***analysis and interpretation of results:*** *Alvin Goh Wei Yang;* ***draft manuscript preparation:*** *Alvin Goh Wei Yang, Rozlin Zainal, Mohd Hilmi Izwan Abd Rahim, Hamidun Mohd. Noh. All authors reviewed the results and approved the final version of the manuscript.*

Appendix A: Procedure of Research



Appendix B: Table Population (N) and Sample (S)

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

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