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Exploration of Homeowners' Perception Towards Green Homes Features

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Abstract

Green homes concept implementation is one of strategies to increase energy and water efficiency in residential buildings. Currently, the concept of green homes has been adopted by the public and promoted by the government because of its benefits. Utilization of green home features is known to benefit the environment and occupants. However, as the number of green home users increases, the adoption acceleration of green home features has barriers. Homeowners' perceptions of green home features determine homeowners' attitudes toward utilizing these features. This research aims to identify the hindering factors of green home feature adoption by exploring homeowners' perceptions. The green home features such as smart lighting and sensor, energy-efficient labeled appliance, photovoltaic panel, water meters, dual-flush toilet, and rainwater harvesting are reviewed. Data was gathered using an online open questionnaire and analyzed using grounded theory method. Result shows green homes features' adoption barriers consist of technical aspects, product availability, economics, knowledge, regulation, and motivation.

INTRODUCTION

Currently, the energy crisis and water scarcity become global concerns. This phenomenon is triggered by rapid population growth, dependence on non-renewable energy, and climate change (UN-Water, 2014). In Indonesia, electrical energy and water demand increases in every year (PT PLN, 2022) (World Bank, 2021). In addition, Indonesia's electrical energy production is still dominated by fossil fuels (PT PLN, 2022). Meanwhile, domestic water sources are dominated by groundwater sources usage (World Bank, 2021). This increases vulnerability to the country's energy crisis and clean water crisis in several regions.

In the last decade, global awareness regarding energy and water issues has increased. Nations worldwide continues to strive to develop contextual and effective strategies. Some strategies are energy conservation and efficiency efforts, water conservation, encouraging the use of renewable energy sources, and the use of alternative water sources for the building sector (UN-Water, 2014).

Residential sector consumes the largest electrical energy (IEA, 2020) and the third largest water consumption of total world water consumption (Madias & Szymkowiak, 2022). Therefore, residential sector is considered to have great potential for handling the energy and clean water crisis. One of strategies to encourage energy and water conservation in the residential sector is to implement green homes features. In Indonesia, guideline for implementing green homes is provided in the Greenship Homes assessment tool that developed by Green Building Council Indonesia (GBCI). This tool is an assessment system that aims to facilitate the achievement of green homes implementation in Indonesia (GBC Indonesia, 2023).

Based on the Theory of Planned Behavior, intention is the main factor that influences a person to take an action. Intention indicates how much a person wants to try and how much effort is planned to try to perform a certain behavior. Intention is influenced by attitude factors towards behavior, subjective norms, and perceived behavioral control. Meanwhile, attitude is closely related to knowledge. The inference process from assessing the relevance of attitudes to behavior tends to be influenced by the content and knowledge structure underlying the attitudes (Fabrigar et al., 2006).

People act on things based on the meaning of that thing for them and the meaning is derived from social interactions and modified through interpretation (Blumer, 1986). Homeowners' actions regarding green homes features are influenced by intentions (Ajzen, 1991). Intentions are influenced by the homeowners' assessment of the action. Attitude formation is formed from an inference process which is influenced by attitude-relevant beliefs and experiences (Fabrigar et al., 2006). Previous research stated that there was a relationship between homeowners' knowledge of green homes features and the benefits of the features and the level of willingness to pay (Aulia et al., 2015; Hossain et al., 2022a; Kota et al., 2022). In addition, consumption perceptions, context, tariffs, affordability, loyalty, pro-environmental norms, and trust influence the willingness to utilize features (Fan et al., 2014) (Gilbertson et al., 2011) (Barberán et al., 2022) (Haryadi et al., 2021)(Horne et al., 2021). Therefore, identifying homeowner's perception of green homes features is important to determine the acceptance of the features.

Currently, research regarding perceptions of green homes features in Indonesia is not available yet. This research aims to determine hindering factor of green homes features adoption and satisfaction in utilizing green homes features. Identification of hindering factors was obtained through exploring homeowners' perceptions of green homes features. The green homes features observed are features derived from Greenship Homes v.1.0 belonging to Green Building Council Indonesia (table 1). The research uses grounded theory methodology to reveal the behavioral meaning of a phenomenon. It is hoped that the research results can be used as consideration by various related sectors, especially policy makers and industry.

Table 1. Selected Green Homes Features Derived from Greenship Homes v 1.0

Greenship Homes V.1.0		**Observed Features**
Categories	**Criterias**	
Energy Efficiency and Conservation	Artificial Lighting	Smart Lighting and Sensor
	Energy Efficient Appliances	Energy Efficient Label
	Renewable Energy Resources	Photovoltaic Panel
Water Conservation	Water Meter	Water meter for each primary source
	Water saving fixture	Water saving closet
	Rainwater Harvesting	Rainwater Harvesting

METHODS

Instrument Development

The research used an online open questionnaire. The questionnaire consists of a group of questions about respondent attributes and questions about green homes features. The respondent attribute question group consists of age group, domicile, education, income, residential function, and installed electrical power. The green homes feature question group is a piping question type (Figure 1). Respondents who can provide answers regarding perceptions of features are respondents who know the features. Perceptions are divided into two groups, namely the perceptions of respondents who have experience and respondents who have no experience.

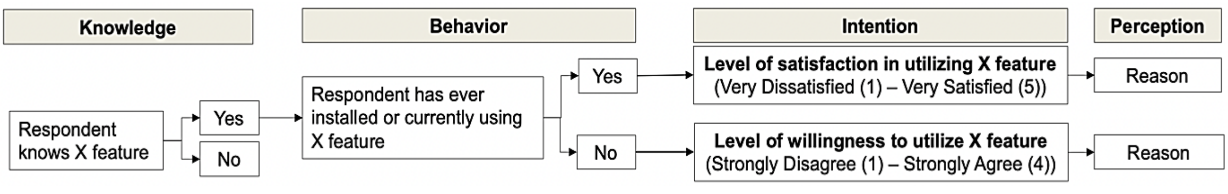


Fig. 1. Questionnaire Structure

Data Collection Procedure

Questionnaires were distributed online using a non-random sampling method. The respondent criteria are as follows:
1) minimum 21 years old,
2) own a landed house
3) have occupied the residence for at least 1 year, and
4) has responsibility for residential management or development decisions.

Distribution of questionnaires was carried out for 12 days (26th February – 9th March 2023). The total data collected was 179 answers with the distribution of respondent attributes as in Figure 2.

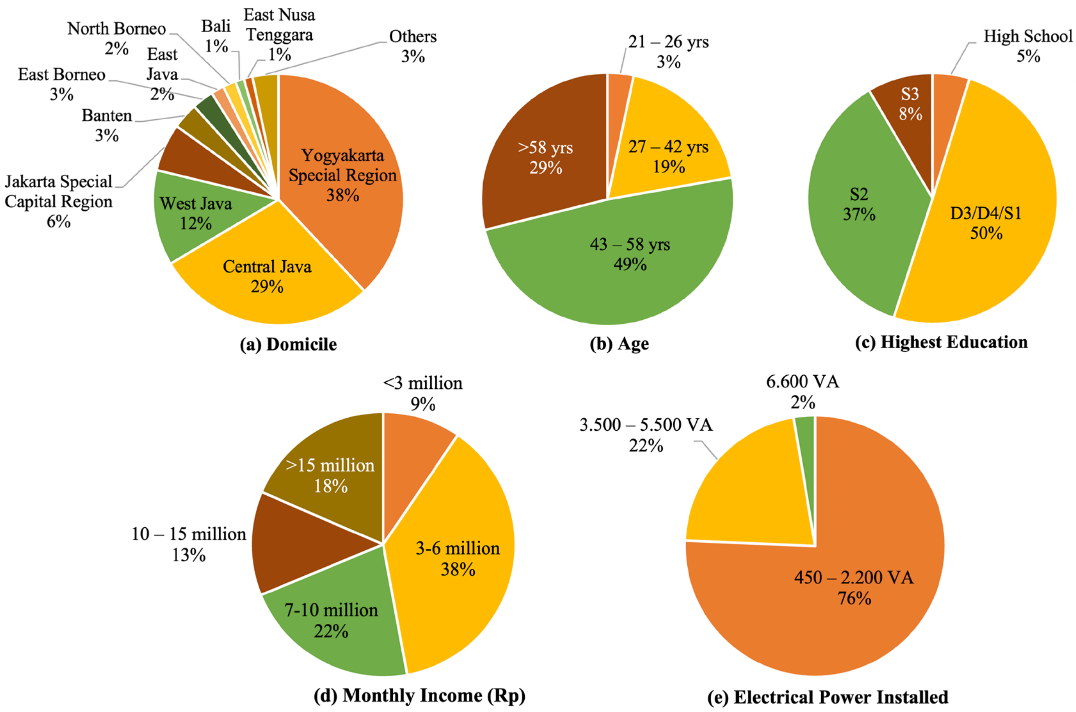


Fig. 2. Attributes of Respondents (a) Domicile (b) Age (c) Highest Education (d) Monthly Income (e) Electrical Power Installed

Data Analysis Methods

Data were analyzed using the Grounded Theory Method (GTM) (Creswell, 2012). GTM is a qualitative method for codifying and categorizing data to produce theory. Researchers are provided with methodological tools to construct meaning from research findings through a three-phase coding method. Coding methods allow for a progressive and verifiable mechanism for establishing codes, their origins, relationships with each other, and integration that produces themes to build meaning.

In this research, GTM consists of 3 stages:

1) Open coding
   Open coding consists of two stages. The first stage is identifying segments of meaning from the text and determining the code that represents that meaning. Identification of meaning segments is grouped into two groups, namely negative polarization meaning and positive polarization meaning. In this research, only the negative polarization group is analyzed. Negative polarization is a meaning that is considered as factors of unwillingness to adopt and utilization dissatisfaction. The second stage is grouping similar codes into sub-categories and categories.
2) Axial coding
   Axial coding aims to reveal the relationship between hindering factor categories and features using multi-correspondence factor analysis. Correspondence results are visualized using the hierarchical clustering analysis method.
3) Selective coding
   The results of axial coding are brought to a higher level of abstraction through steps that lead to elaboration and formulation of the story of the case. This stage produces a hypothetical model of hindering factor of willingness to adopt and hindering factor of utilization satisfaction.

RESULTS AND DISCUSSION

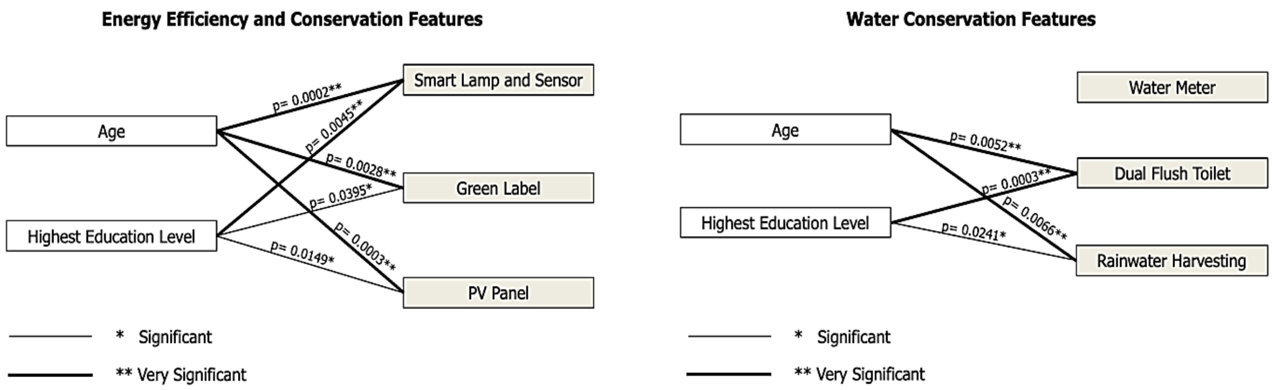
Table 2 depicts the number of respondents who know the feature and the number of respondents who have adopted the feature. The number of respondents who adopted the feature illustrates respondents who knew about the feature and then decided to use the feature. The results show that each feature is known by 58-87% of the 179 respondents. However, from the number of respondents who knew about the feature, the total feature adoption rate ranged from 12-88%.

Energy-saving labeled equipment, dual flush toilets, water meters, and smart lamps features adoption rate are more than 50%. Meanwhile, features that are not widely adopted are photovolatic panels (PV Panels) and rainwater harvesting. Energy-saving label features, dual flush toilets, and water meters are features that many respondents are aware of and have adopted. PV panels are a feature that is little adopted but is the second most widely known feature.

Table 2. Frequency of respondents who know the feature and respondents who use the feature

Features	Knowing the Features		Using Features	
	Frequency	Percentage	Frequency	Percentage
Water Meter for Every Primary Sources	155	87%	104	67%
Photovoltaic Panel	152	85%	18	12%
Smart Lighting and Sensor	147	82%	76	52%
Energy Efficient Labeled Appliances	133	74%	117	88%
Closet Dual Flush	127	71%	87	69%
Rainwater Harvesting	104	58%	24	20%

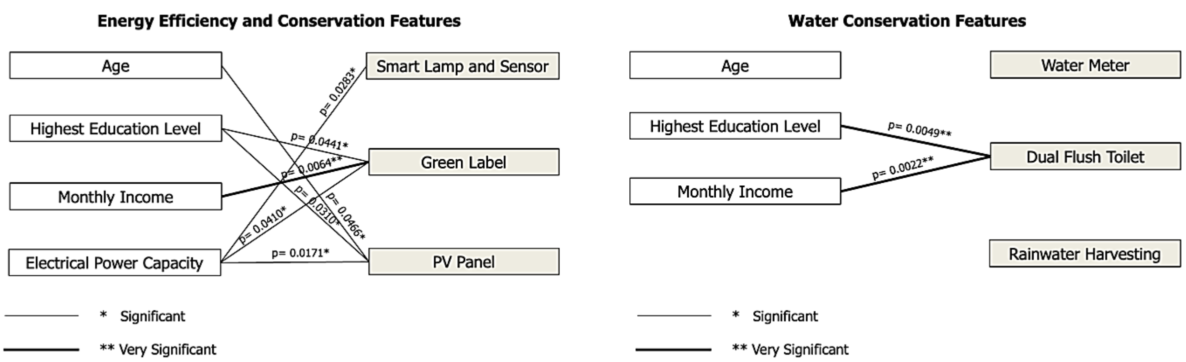
Figure 3 illustrates the tendency of respondents' answers based on age group and highest level of education regarding knowledge of features. The results show that only the water meter feature has no variation in answers. This means that the water meter feature is a commonly known feature for all age and education groups. In addition, ANOVA analysis shows that the millennial, gen Z and gen Y age groups tend to be aware of the observed features. Meanwhile, the baby boomer generation tends not to know the observed features. Based on educational group, the result pattern is that the higher the level of education, the more likely respondents' answers are to know the features.



(a) (b)

Fig. 3. Analysis of Feature Knowledge Variation based on Age and Education Factors using OneWay ANOVA (a) Energy Efficiency and Conservation Features (b) Water Conservation Features

Figure 4 delineates the inclination of respondents' responses based on their attributes concerning feature utilization. The findings indicate that as the installed electricity power increases, there is a corresponding greater likelihood of utilizing energy efficiency features. Additionally, a positive correlation is observed between higher education levels and an increased tendency among respondents to use energy-efficient labeled appliances, PV panels, and dual toilets. Similarly, elevated monthly income corresponds to a heightened propensity among respondents to use energy-efficient labeled appliances and dual flush toilets.



(a) (b)

Fig. 4. Analysis of Feature Utilization Variance based on Respondent Attribute Factors using OneWay ANOVA; (a) Energy Efficiency and Conservation Features; (b) Water Conservation Features

Unwillingness of Features Adoption Factors and Features Utilization Dissatisfaction Factors

Open coding reveals respondents' perceptions of features based on the reasons of their unwillingness to adopt and dissatisfaction of feature utilization (table 3 and 4). The results of open coding produced 12 categories of factors that hinder the desire to adopt and 11 categories of factors that hinder satisfaction. Each category has sub-categories that explain the sub-hindering factors of each feature.

Table 3. Sub-categories of Features Adoption Barriers

Category \ Feature	Smart Lighting and Sensor	Energy Efficient Appliances	PV Panel	Water Meter	Dual Flush Toilet	Rainwater Harvesting
Not Required Yet	1) No urgency		1) No urgency 2) Low electricity usage	1) No urgency	1) No urgency	1) No urgency
Quality of Utility Availability				1) Groundwater is free of charge		1) Cheap rates per cubic meter 2) Availability of clean water is good
Economic Barrier	1) High initial costs 2) Investment unfeasibility		1) High initial costs 2) High maintenance costs 3) Unfeasible investment	1) High initial costs 2) Investment unfeasibility	1) High initial costs	1) High initial costs 2) High maintenance costs 3) High operational costs
Regulatory Barrier			1) Utilization Intensity Limitation			1) There is no standardization of product installation yet
Homeowner Character					1) Consumer rigidity	
Knowledge Limitation	1) House condition is not suitable	1) Knowledge of technology effectiveness and efficiency	1) Installation knowledge 2) Operational knowledge 3) Maintenance knowledge 4) Regulation knowledge 5) Knowledge of investment feasibility 6) Knowledge of technology effectiveness and efficiency	1) Function and benefit 2) Water meter is only for company water sources 3) Measuring the amount of water is not necessary	1) Knowledge of technology effectiveness and efficiency	1) Functions and benefits 2) Installation knowledge
Difficulty	1) Installation difficulty 2) Operational difficulty		1) Installation difficulty 2) Operational difficulty 3) Maintenance difficulty 4) Complicated understanding	1) Operational difficulty		1) Installation difficulty 2) Operational difficulty 3) Maintenance difficulty 4) Complicated understanding
Context Mismatch			1) House condition is not suitable (structure) 2) House condition is not suitable (surrounding condition)			1) House condition is not suitable (limited space)
Market Conditions		1) Limited product alternatives	1) Limited product availability			
Poor Quality	1) Poor durability 2) Poor reliability					
Poor Performance	1) Poor performance (lack of control)	1) Poor performance			1) Poor performance (flushing quality is not good)	1) Poor performance (poor water quality)
Technological Innovation	1) Unattractive technology					1) Unattractive technology

Table 4. Sub-categories of Features Utilization Dissatisfaction

Category \ Feature	Smart Lighting and Sensor	Energy Efficient Appliances	PV Panel	Water Meter	Dual Flush Toilet	Rainwater Harvesting
Economic Barrier	1) High initial costs	1) High initial costs 2) High maintenance costs	1) High initial costs		1) High initial costs	
Regulation Barrier			1) Utilization Intensity Limitation 2) Regulation ambiguity			
Knowledge Limitation		1) Installation knowledge		1) Water meter is not related to water saving 2) Water meter is only for company water sources	1) Function and benefit 2) Technology effectiveness and efficiency	1) Functions and benefits
Difficulty	1) Maintenance difficulty		1) Installation difficulty 2) Operational difficulty 3) Permission difficulty			
Distrust		1) Information credibility 2) Proving efficiency difficulty				
Context Mismatch	1) Climate unsuitability					
Market Condition		1) Limited product alternatives 2) Limited category of labeled appliances				
Poor Quality	1) Poor durability 2) Poor reliability	1) Poor durability 2) Poor product quality	1) Poor durability	1) Poor durability 2) Poor reliability 3) Connection leaks	1) Poor durability	
Poor Performance					1) Poor performance (Cleanliness flushing quality)	1) Poor performance (poor water quality)
Benefit Has Not Felt Yet		1) Benefit has not felt yet		1) Water saving benefit has not felt yet 2) Subscription quota system	1) Water saving benefit has not felt yet	
Technology Innovation						1) Unattractive technology

Correspondence Analysis between Features and Hindering Categories

Figures 5 – 8 show the results of the correspondence between features and categories. Figure 5 and 6 illustrates the correspondence of factors inhibiting the desire to adopt feature. Meanwhile, figure 7 and 8 illustrates the factors of dissatisfaction with feature utilization. Correspondence analysis consists of contingency analysis and hierarchical clustering. Mosaic plot contingency analysis depicts the frequency distribution of correspondence coincidences per feature. Meanwhile, hierarchical clustering describes correspondence based on all features.

Correspondence per feature of adoption intention barriers (Figure 5) shows that “economic barrier” and “knowledge limitation” have the highest total number of coincidences. Coincidence of “economic barrier” occurs in dual flush toilet, PV panels, rainwater harvesting, smart lighting and sensors, and water meters. The highest coincidence occurs in the PV panel. Meanwhile, “knowledge limitation” occurs in all features. The highest coincidence occurs in the water meter feature and followed by PV Panel.

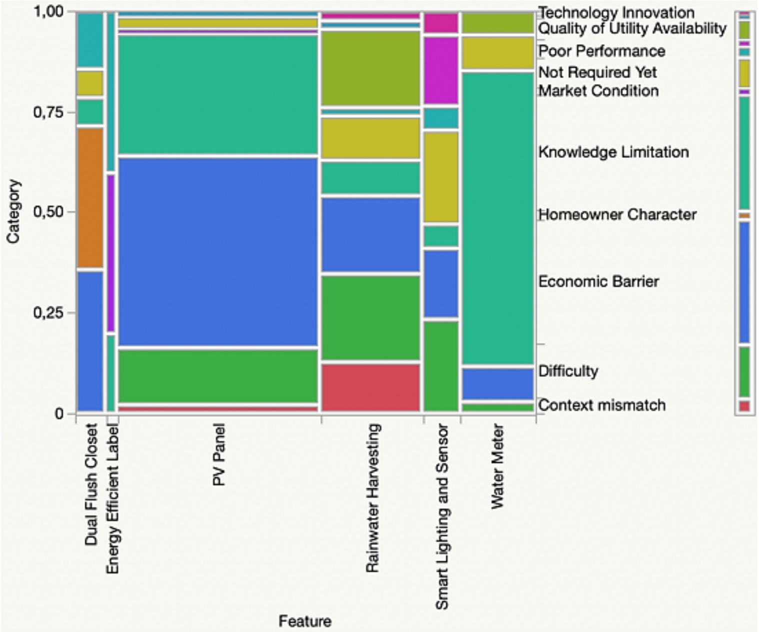


Fig. 5. Contingency Analysis of Factors Barriers toward Intention to Adopt, P<0.0001**

The overall correspondence (Figure 6) generates five clusters. Each feature has a different cluster of closeness hindering factors, except for PV panel and water meter features. These two features share similar hindering factors closeness, namely "economic barriers" and "knowledge limitation".

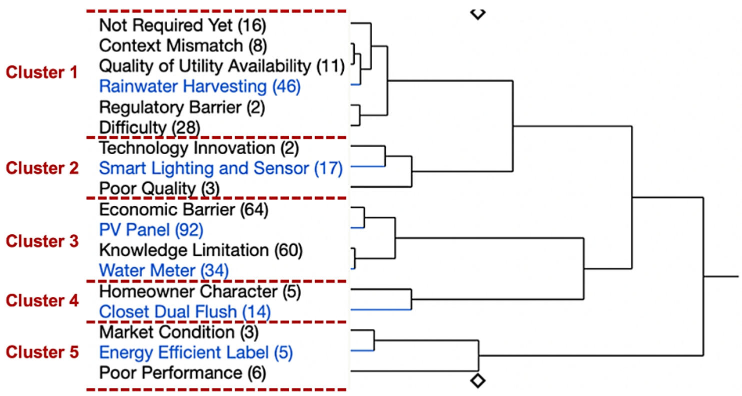


Fig. 6. Hierarchical Clustering of Factors Barriers toward Intention to Adopt

Correspondence per feature of utilization dissatisfaction factors (Figure 7) show that "poor quality", "knowledge limitation", and "benefits has not felt yet" factors have the highest total number of coincidences. The "poor quality" factor occurs in all features and the highest coincidence occurs in the smart lighting and sensor features. The "knowledge limitation" factor occurs in the dual flush toilet, rainwater harvesting and water meter features. The coincidence of this factor is the highest coincidence for the rainwater harvesting and water meter features. Meanwhile, the "benefit has not felt yet" factor coincidence in the dual flush toilet, energy efficient label appliance and water meter features.

The overall correspondence of utilization dissatisfaction factors (Figure 8) generates four utilization dissatisfaction clusters. It depicts that dual flush closet, water meter and rainwater harvesting features share similar hindering factors. Meanwhile, the energy efficient label appliances, smart lighting and sensors, and PV panel features have different clusters of utilization dissatisfaction factor.

The smart lighting and sensor features have the same barriers to adopt and dissatisfaction factors as "poor quality" and "technological innovation". The perception of "poor quality" is a factor that appears in the results of partial and overall correspondence. Meanwhile, in the experienced respondent group, the "poor quality" perception factor had the highest incidence rate.

Energy-efficient labelled appliance's adoption barrier and dissatisfaction factor is "market condition". Meanwhile, another dissatisfaction factor is the "distrust" factor. If we look at the partial correspondence result, the "distrust" factor is the most significant barrier factor of adoption and satisfaction. Apart from that, "benefit has not felt yet" is also significant in inhibit adoption and satisfaction.

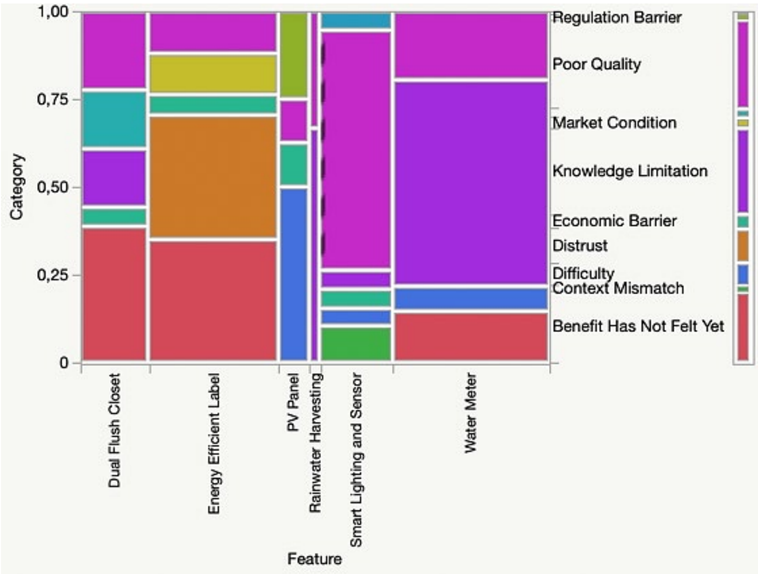


Fig. 7. Contingency Analysis of Utilization Dissatisfaction Factors, P<0.0001**

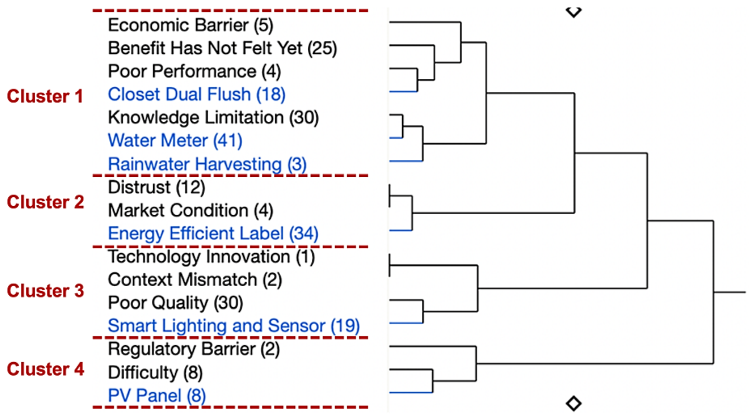


Fig. 8. Hierarchical Clustering of Utilization Dissatisfaction Factors

PV Panel feature has different categories of adoption barriers and dissatisfaction factor. Adoption barriers consist of "economic barrier" and "knowledge limitation". These two factors appear in the overall and partial correspondence results. In the partial correspondence results, the two factors have a high frequency of coincidence. This shows that both factors are very significant in describing adoption barrier of PV panel feature. Meanwhile, the dissatisfaction factor consists of "difficulty" and "regulatory barrier".

The water meter feature for all primary water sources feature's adoption barrier and dissatisfaction factor is "knowledge limitation". This factor has the highest frequency of coincidence. This means that the "knowledge limitation" factor is a significant obstacle. Meanwhile, other adoption hindering factor is "economic barrier". The dissatisfaction factor is "benefit has not felt yet".

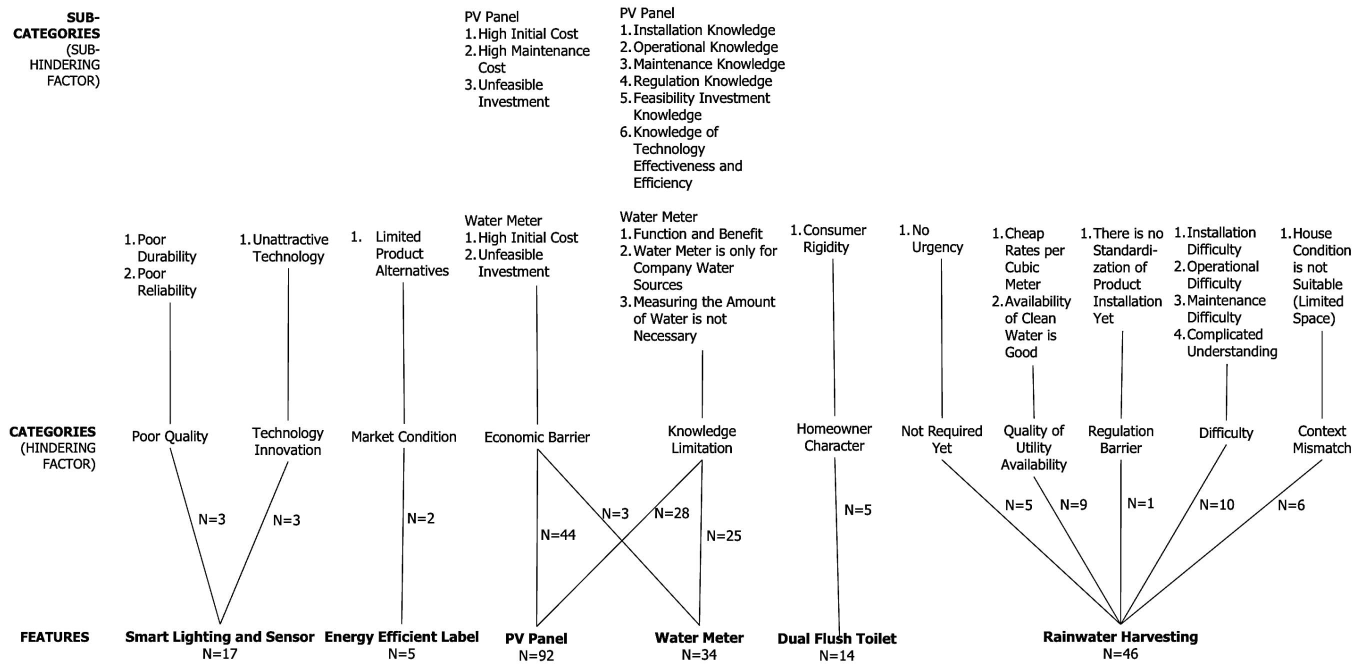
The dual flush toilet feature has different adoption barrier and dissatisfaction factor. Adoption barrier is "homeowner character". This factor is the highest coincidence frequency. The other highest partial coincidence factor is "economic barrier". Dissatisfaction factor based on overall correspondence are "economic barrier", "knowledge limitation", "benefit has not felt yet", and "poor performance". Based on partial correspondence, the four factors coincide. The "benefits have not been felt" factor has the highest frequency of coincidences. Meanwhile, the "economic barrier" factor has the lowest frequency of occurrence.

Rainwater harvesting feature has different adoption and satisfaction inhibitor factors. Adoption barriers consist of "difficulty", "quality of utility availability", "context mismatch", "not required yet", and "regulation barrier". In partial correspondence, the "regulation barrier" factor has the least frequency of coincidences. This means that "regulatory barrier" is not very significant. Meanwhile, the most significant factor is "difficulty" followed "quality of utility availability" and "economic barrier". The dissatisfaction factors in the overall correspondence are "knowledge limitation" and "poor performance." Based on partial correspondence, the "knowledge limitation" factor is the most significant factor.

Hypothesis Model of Green Homes Features Adoption Barrier and Utilization Satisfaction Barrier

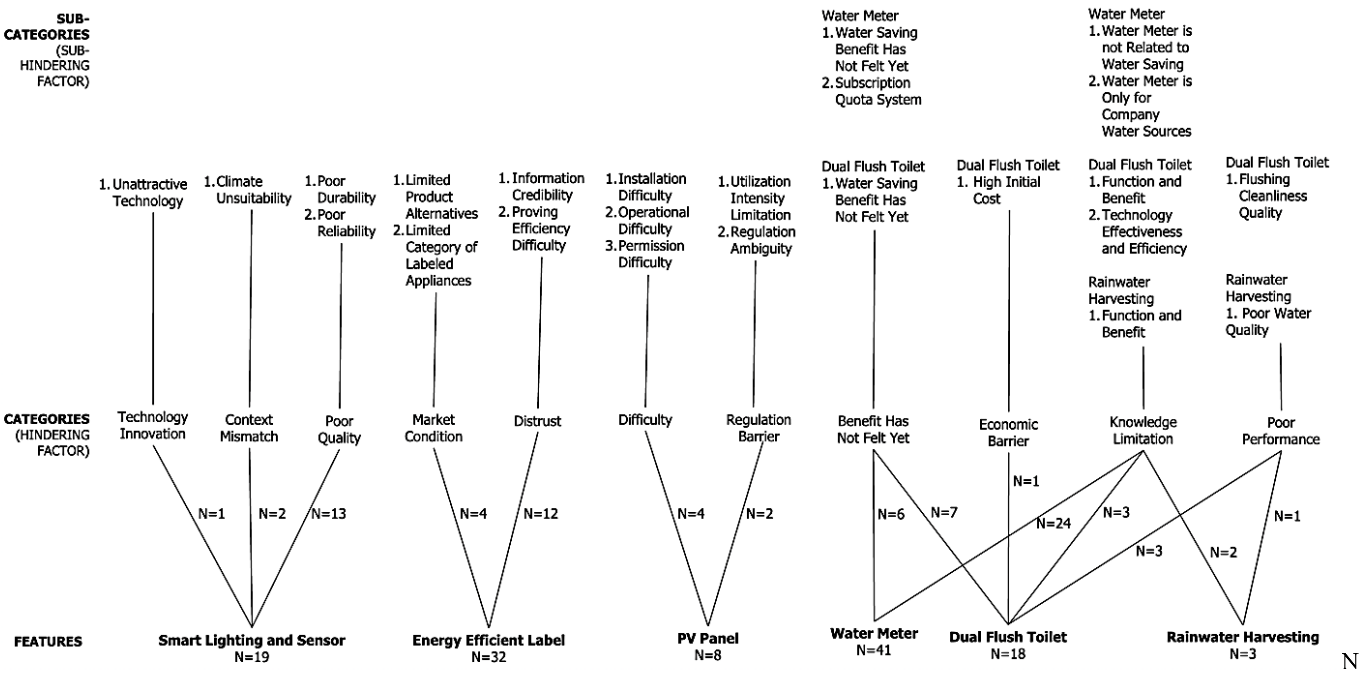
Figure 9 and 10 illustrate the relationship between features and categories (hindering factor) and sub-categories (sub-hindering factor). Figure 9 illustrates the factors that hinder respondents' desire to switch to using features.

Figure 10 illustrates the factors of respondent dissatisfaction with feature use. Results show that each feature has different factors.



N = Coincidence Frequency

Fig. 9. Hypothesis Model of Green Homes Feature Adoption Barrier



N = Coincidence Frequency

Fig. 10. Hypothesis Model of Dissatisfaction Factor in Utilizing Green Homes Feature

Smart Lighting and Sensor

"Poor quality" and "technological innovation" inhibit willingness of adoption and utilization satisfaction. The perception of "poor quality" is the most significant factor. The perception of "poor quality" consists of product durability and reliability. Meanwhile, technological innovation is considered less attractive. These findings are in line with previous studies. Performance expectations are a critical thing that determines the market success of smart lighting products (Juric & Lindenmeier, 2019). Where performance expectations are related to perceived reliability (Yang et al., 2018) (Park et al., 2018) (Balta-Ozkan et al., 2013) and perceived of enjoyment. Perceived enjoyment is defined as the extent to which smart technology is accepted as "playful" and "enjoyable" (Davis et al., 1992).

Therefore, development recommendations need to focus on technological and user-oriented development (Park et al., 2017).

Another factor of dissatisfaction is climate unsuitability. Based on the content analysis, perception of climate unsuitability refers to incompatibility of sensor technology with climate conditions so that sensor reliability is low. This is still related to perception of reliability. Therefore, it can be concluded that product quality factors, especially sensor reliability, are critical factors that can become adoption barrier of smart lighting and sensor.

Energy-efficient Labeled Appliance

The "distrust" factor is the most significant factor of dissatisfaction. This factor is related to the dissatisfaction factor in the "benefit has not felt yet" category. The energy efficiency label describes the energy performance of the product and aims to build awareness of product selection (Weil & McMahon, 2003 in (Isaac et al., 2021)). The essence of energy-efficient labeling is to make it easier for costumer to evaluate products. However, the result of open coding shows that distrust refers to the perception that information is not credible and proving label claims is difficult. This finding is in line with previous research. Trust towards information credibility is critical (Hossain et al., 2022b).

Energy-efficient labeled appliance is feature that is widely known and used. However, the findings of the distrust factor indicate that the function of energy-efficient labeling on appliance has not achieved its goals. This shows the need for the role of public education so that people can be convinced by the labeling system.

Another factor found was "market condition" factor. This factor inhibits adoption and satisfaction of energy efficient labeled appliance. Based on the results of open coding, the "market condition" factor describes a positive attitude towards labeled equipment features but has shortcomings in terms of limited product alternatives and limited categories of labeled appliance. This deficiency hinders respondents in optimizing the adoption of labeled appliance. Based on the theory of stages of consumption decision-making, the availability of product alternatives allows consumers to consider alternatives that best suit expectations (Assael, 1987). The decision results provide a sense of satisfaction because consumers believe that the product chosen is the best.

Photovoltaic Panel

PV panels are the second most widely known feature but have the lowest frequency of use. Its adoption is linked with the level of education and electrical power capacity. As in Haryadi et al's findings, the higher the level of education, the more likely respondents are to apply PV (Haryadi et al., 2021). Apart from that, the results of the variance analysis show that the higher the electricity power capacity, the greater the tendency for PV application. This may indicate that the intention to adopt PV panels is influenced by the intensity of electricity consumption. However, to be able to adopt PV panels, complex understanding skills are required so that the tendency to adopt PV panels is carried out by respondents with higher education.

The findings in the variance analysis pattern are similar to the finding "knowledge limitation" in the adoption barrier. This factor consists of knowledge of installation, operations, maintenance, regulations, technology effectiveness, and investment feasibility. General knowledge influences the desire to adopt technology. Dissemination of information regarding investment feasibility, technical installation, maintenance, permission procedure is predicted to increase the desire for adoption. By convincing the public that PV panels have greater benefits than the effort required and providing education regarding PV panel technical matters, it will increase perceived usefulness and perceived ease of use. These two aspects will increase technology uptake (Davis, 1989).

Another finding of adoption barrier is "economic barrier". This barrier consists of high initial cost, high maintenance cost, and unfeasible investment. These findings are in line with previous studies. Economic factor is a significant barrier (Sulaiman et al., 2014) (Horne et al., 2021). High investment cost and initial cost become an economic barrier (Parker, 2008)(Muhammad-Sukki et al., 2011)(Wolske et al., 2018). Moreover, (Alrashoud & Tokimatsu, 2019) also found investment unfeasibility as barrier. Therefore, incentive strategies can be one of solution to increase interest in PV Panel adoption (Hsu, 2012).

Dissatisfaction of PV Panel utilization is influenced by "difficulty" and "regulation barrier". Respondents who have experience using PV panel feel the installation, operation, and permission are complicated. Moreover, "regulation barrier" factor increases PV Panel utilization difficulty. Regulation barriers consist of regulation abiguity and utilization intensity limitation. Based on the results of open coding, regulation ambiguity contains several applicable regulations that conflict each other.

Water Meter

Water meter is the most widely known and widely used feature of respondents. The tendency to adopt water meter for all primary water sources is not influenced by the attributes of education level, age and income. So it can be concluded that water meters are a commonly known feature. However, the finding shows that the most significant adoption barrier is "knowledge limitation". Knowledge limitation with the greatest frequency is the perception that water meters are only for the company water source. Another limitation is related to the function and benefit of water meter and measuring water is not related to water savings.

The focus of water saving goals is groundwater conservation (Moglia et al., 2018). Water meters for all primary water sources function is to provide feedback on water use so that homeowners can monitor and save water. Lack of feedback, education, and awareness of water use in the home can be a factor in perceptions of water use that are not in accordance with water use behavior (Beal et al., 2013). Incorrect perception of water use can have an impact on water wasting behavior (Fan et al., 2014). In addition, (Seyranian et al., 2015) stated that knowledge deficit about water use can lead to water waste. Therefore, building public knowledge about the importance of saving water and educating them on the functions and benefits of water meters is necessary.

Another dissatisfaction factor is "benefit has not felt yet". This factor consists of the perception that the benefits of saving water are not felt and some of them is due to using the subscription system. The perception of the absence of water saving benefit can be related to the "knowledge limitation". If consumers do not know the function and benefits of water meter, consumers are not aware of the benefits they receive.

Another adoption barrier is "economic barrier". Economic barriers consist of high initial cost and investment unfeasibility (Moglia et al., 2018) (Tom Le Quesne et al., 2011) (Turner et al., 2005). In content analysis, high initial cost refers to additional cost that are unaffordable for respondents. Meanwhile, the perception of investment unfeasibility refers to the costs incurred not being commensurate with the benefits to be obtained. These findings show that the focus of respondents' expectations of benefits is economic benefits. Therefore, environmental awareness regarding water conservation is needed to foster pro-environmental behavior (Fielding et al., 2012).

Dual Flush Toilet

The adoption barrier of dual flush toilet is "homeowner rigidity". Indonesia has a culture of using squat toilets, while respondents' perceptions regarding dual flush toilets are associated with sitting closet. Where the sitting closet is considered western culture (Martosenjoyo, 2016). The cultural change from squatting to sitting toilets can cause stress (Rad, 2002). In addition, based on open coding results, respondents tend to prioritize comfort over water saving performance.

The dissatisfaction factors are "benefit has not felt yet", "economic barrier", "knowledge limitation", and "poor performance". The unfelt water saving benefit can be related to to knowledge limitation regarding technological efficiency. Respondents tend to be aware of the water savings potential. However, it is difficult for respondents to feel the benefits because respondents do not have knowledge regarding the saving value. The economic barrier in the form of high initial costs is related to the price of the closet which is considered more expensive than a conventional closet. Apart from that, respondents thought that to get a closet with good performance, high costs were required. Costs such as the economic burden of purchasing conservation equipment need to be accepted as affordable (Lee & Paik, 2011 in (Straus et al., 2016))

Rainwater Harvesting

Adoption barriers consist of "not required yet", "quality of utility availability", "regulation barrier", "difficulty", and "context mismatch" factors. The "regulation barrier" factor is the lack of standardization of product installation. The "difficulty" factor refers to the complexity of installation, operation, maintenance, and understanding technology. The "context mismatch" factor is that the condition of the house is not compatible due to limited space.

The "not required yet" factor is the perception that there is no urgency to use rainwater harvesting. The "quality of utility availability" factor consists of cheap rates per cubic meter and good availability of clean water. These two factors can be interrelated. The perceived water tariff factor will influence how a person treats water at all sources (Barberán et al., 2022) (Fornarelli et al., 2022). In addition, geographical conditions influence water conservation behavior (Araya et al., 2020)Respondents who are in drought-prone locations and experience water scarcity will change their water consumption behavior and tend to carry out greater water conservation (Gilbertson et al., 2011).

The dissatisfaction factors are "knowledge limitation" and "poor performance". The knowledge limitation is related to functions and benefits. Meanwhile, performance related to water quality is not as good as primary water sources.

CONCLUSION

Inhibitors of green homes features adoption and satisfaction consist of technical aspects, market availability, economic, knowledge, regulation, and user characteristic. Each feature has different hindering factors.

1. Smart Lighting and Sensor is related to technical aspect, especially reliability and technological innovation that can meet user expectations. Therefore, the role of industry is needed to develop their product.
2. Energy-efficient labeled appliances are associated with distrust. Therefore, education regarding the benefits of labeling and labeling systems is important. This is expected to increase public trust.
3. PV Panels are related to limited knowledge, economic barriers, difficulty, and regulations. PV Panels are a feature that is widely known but difficult to implement due to the complexity and cost. These obstacles need to be resolved in parallel through collaboration between industry, government, and related institutions.
4. Water meters are related to a limited understanding regarding the benefit of water meters as a savings tool. Apart from that, education regarding the importance of saving water also needs to be promoted.
5. Dual flush toilets relate to the homeowner's character and technical performance. Therefore, industrial innovation is needed regarding product development.
6. Rainwater harvesting is dominated by difficulty, context incompatibility, lack of urgency, and quality of utility availability. This feature is less popular because it is considered that there is no urgency.

Based on these findings, apart from requiring product development, subsidy mechanisms, and technical education, the most effective way is to ensure the benefits received. Another important thing is to increase environmental awareness. By increasing environmental awareness, electricity and water conservation attitudes will increase voluntary, including through the adoption of green homes features.

This research uses a grounded theory method approach with a piping question system. This question system eliminates respondents who do not know the features so that the amount of perception data does not always amount to 179 respondents. In addition, the grounded theory method aims to produce hypotheses about factors that cause unwillingness to adopt and dissatisfaction with feature use based on perception. Therefore, to strengthen the findings, further quantitative studies are needed to verify the results.

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