Determining Determinants and Barriers that Influence Smart Home Appliances Adoption Intention Using the Behavioral Reasoning Theory Method

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Abstract. In today condition, the adoption of Smart Home appliances in Indonesia is not as powerful as expected. As one of the countries with largest number of internet users in the world, Indonesia was initially expected to create a promising market for IoT, especially for the IoT home appliance. However, the country's average revenue per Smart Home built is only estimated to amount USD 40.77 when the worldwide average revenue is predicted to generate USD 392.62. Applying Behavioral Reasoning Theory approach, this research examined the relative influence of context-specific reasons, which are both "reasons for" and "reasons against" in forecasting individual's attitude and intentions in adopting the Smart Home appliances to reduce the market decline. This study surveys 518 active internet users in Indonesia and the researchers use PLS-SEM to evaluate hypotheses and measure the relationship between one variable to another. The findings of the study demonstrate that both "reasons for" and "reasons against" create a significant influence on the Smart Home appliances adoption intention. As the result, among the "reasons for", Convenience serves as the top determinant for Smart Home appliance adoption intention while among the "reasons against", Traditional Barrier acts as the most influencing variable against Smart Home appliance adoption intention. This study also confirmed that attitude and value of openness to change significantly influence the "reasons for" and "reasons against" adoption of Smart Home appliances.

Keywords: Behavioral Reasoning Theory (BRT), Internet of Things (IoT), Adoption Intention, Barriers to adoption, Smart Home appliances

1 Introduction

Smart Home is one of the primary and fastest-growing subindustries among the IoT industry [1][2]. The most appealing advantage of this IoT involvement in a household is the global-scale economic attractiveness and energy efficiency [3][4]. The automation features enabled them to turn off home appliances such as lamp and air conditioner automatically without direct human involvement [5]. Imagining that this technology is being used in a ten-story building, this innovation will be able to suppress a huge amount of electricity consumption. A study by McKinsey [6] also said that these IoT-enabled energy management systems are predicted to create a global economic impact of USD 50 billion to USD 110 billion by 2025.

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Indonesia, as one of the countries with largest internet users in the world, is expected to create a promising market for these IoT appliances [7]. Following that, prior study by Ma et al. [8] predicted the Smart Home appliances is capable to generate a large business market. Telecommunication companies and giant technology retail, such as Erajaya Group also expecting the same result during 2021 [9][2]. Statistically, Statista [10] notes that the market revenue of IoT home appliance industry in Indonesia is predicted to reach USD 297 million. Until today, there are several famous brands that already launch their Smart Home appliances, named Philips, Google, Apple, Samsung, until Xiaomi. However, although numerous advantages are being offered and famous brands are taking part in the Smart Home appliances penetration, it turns out that this Smart Home appliances in Indonesia is still not yet a thing [11][12].

According to global statistic report, the worldwide average revenue per Smart Home appliances built currently is around USD 392.62 [13][14][15]. Meanwhile, Indonesia's average revenue per Smart Home appliances built is only USD 40.77. This number is surprisingly low, especially compared to other similar developing countries, for example Malaysia, where it is counted that the average revenue reach USD 209.81 [10]. The data emphasize that current potential growth of the IoT home industry in Indonesia does not represent a tremendous growth and not as powerful. If the lack of market studies continues to be neglected here, there will be a possibility for the Smart Home appliances to experience an unending market decline. Seeing that phenomenon, thus a qualified study is needed to reveal the determinant and barriers that influence adoption of the IoT home appliances.

From previous studies, there are numerous methods that can identify the factors that influence adoption intentions for new technology. Some of them are the Theory of Planned Behaviour (TPB), the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Behavioural Reasoning Theory (BRT) Method. However, among those, the Behavioural Reasoning Theory (BRT) Method stood out the most as it can reveal the underlying linkage towards intention and focused on two main variables in a single framework, which are the reasons to adopt and reasons not to adopt when the rest of the theories did not analyse reasons behind why people want to adopt and why people are reluctant to buy at the same time.

Behavioural Reasoning Theory (BRT) itself is another model extension of traditional behavioural intention theory, beside the TRA and the TPB. Westaby [16] explained that the major difference between BRT and previous behavioural models is that BRT identify new linkage of underlying intentions by providing comprehensive understanding of an individual's decision making by involving context-specific reasons that functions as crucial variables among consumers' values, attitude, and behaviour. In the BRT model, these dimensions will be set as the higher order construct and serve as a distinguish between pro-con, benefit-cost, and facilitator-constraint factors [17]. This decision is also suggested by Lewin [18] which mentioned that field theory recommend a study to have two opposite dimensions in performing any behaviour. Thus, bellows are the research questions that will be discussed in this study.

RQ1. What are the determinant and barriers that influence the intention to adopt Smart Home appliances?

RQ2. What are the most important reasons among "reasons for" and "reasons against" that affect the Smart Home appliances adoption intention?

2 Method

After assessing prior literature that use the BRT framework that assess the technology adoption [19][20][21]. Here is the proposed framework:

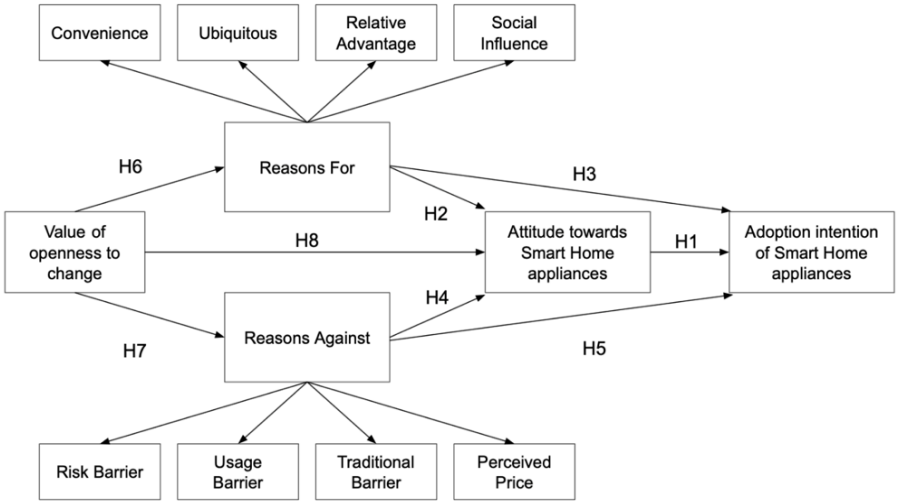

Fig. 1. Conceptual Framework

Thus, followings are the hypothesis in this research:

H1. Individual's attitude towards Smart Home appliances will influence their adoption intention

H2. Individual's reasons for adoption of Smart Home appliances will positively influence their attitude towards Smart Home appliance

H3. Individual's "reasons for" Smart Home appliances will directly (positively) influence their adoption intention for Smart Home appliances

H4. Individual's reasons against adoption of Smart Home appliances will negatively influence their attitude toward Smart Home appliances

H5. Individual's "reasons against" Smart Home appliances will directly (negatively) influence their adoption intention for Smart Home appliances

H6. Individual's value will positively influence their "reason for" Smart Home appliances

H7. Individual's value will negatively influence their "reason against" Smart Home appliances

This research uses quantitative method by spreading online questionnaires. The research scope will be for Indonesian internet user aged between 20-55 years old. The respondent is also limited to those who domiciled in West Java, Central Java, East Java, and DKI Jakarta.

Table 1. Measurement variable

Variable		Measurement Items	Resource
Reasons For: Convenience	CN1	In my opinion, Smart Home appliance is a convenient and practical way of completing house chores	Claudy et al. [22], Gupta and Arora [23] and Sivathanu [21]
	CN2	In my opinion, Smart Home appliance saves time and effort in completing home chores	
	CN3	In my opinion, Smart Home appliance makes daily life easier	
Reason for: Ubiquitous	UQ1	I think that Smart Home appliance will help because it can keep me updated about my home condition anytime *Example: A Smart Thermostat help notify user about the temperature in the living room anytime*	Gupta and Arora [23], Pillai and Sivathanu [24] and Sivathanu [21][25]
	UQ2	I think that Smart Home appliance can allow me to access information related to my home product anytime *Example: Through Smart Hub, user can monitor whether the air conditioner (AC) is on or off*	
	UQ3	I think that Smart Home appliance can help me doing home chores regardless of where I am, including when I am outside the home *Example: Through Smart Lighting, user can turn on the porch light through my smartphone even though the user is not home*	
Reason for: Relative Advantage	RA1	I think that Smart Home appliance has more advantages	Gupta and Arora [23], Pillai and Sivathanu [24] and Sivathanu [21][25]
	RA2	I think that Smart Home appliance takes less time and effort	
	RA3	I think that Smart Home appliance offers greater value to manage home	

Variable		Measurement Items	Resource
		effectively	
Reasons For: Social Influence	SF1	Individuals that are close to me feel that I should consider to start using Smart Home appliance	Pillai and Sivathanu [24]
	SF2	I am motivated to own a Smart Home appliance because of the influence of people around me	
Reasons Against: Risk Barrier	RB1	I think that my stored information in Smart Home appliance are not safe and secure	Dhir et al. [26], Gupta and Arora [23] and Sivathanu [21]
	RB2	I fear that my personal information that is collected by the Smart Home appliances can be misused	
	RB3	I am worried if while using the Smart Home appliance, the recorded data about my home appliance may be lost and stolen	
	RB4	I am concerned that the Smart Home appliance may not give as many benefits as I expected beforehand	
Reasons Against: Usage Barrier	UB1	Smart Home appliance seems not easy to operate	Gupta and Arora [23], Pillai and Sivathanu [24] and Sivathanu [21]
	UB2	Smart Home appliance are difficult and cumbersome to use	
	UB3	Smart Home appliance are only for technology savvy people	
Reasons Against: Traditional Barrier	TB1	I will avoid the usage of IoT in controlling my household appliance as I am not really familiar with it	Gupta and Arora [23], Pillai and Sivathanu [24] and Sivathanu [21]
	TB2	I am satisfied by using the home appliance manually than newer ways of monitoring and controlling home appliance	
	TB3	I feel hesitant in using IoT to control	

Variable		Measurement Items	Resource
		my home appliance as I fear to make mistakes	
	TB4	I feel that the Smart Home appliance will not match the traditional home appliances that I already own	
Reasons Against: Perceived Price	PP1	I feel that the price of Smart Home appliance is very high	Pillai and Sivathanu [24]
	PP2	I feel that the expenses (such as electricity bills and maintanance) will be high for Smart Home appliance	
Value of Openness to Change	VO1	I always look for or try new things	Claudy et al. [22], Pillai and Sivathanu [24] [20] and Sivathanu [21]
	VO2	I am brave and tend to take risks	
	VO3	I am open for any new experiences	
Attitude	ATT1	Using any Smart Home appliance is a good idea	Claudy & Peterson [27], Dhir et al. [26], Pillai and Sivathanu [24][20] and Sivathanu [21]
	ATT2	Smart Home appliances will offer a lot of benefits or advantages	
	ATT 3	Smart Home appliance has an overall positive effect on its user life	
Adoption Intention	AN1	I will use Smart Home appliance for doing home chores in the future	Claudy et al. [22], Pillai and Sivathanu [24][20] and Sivathanu [21]
	AN2	I can see myself using the Smart Home appliance in the near future	
	AN3	I intend to use Smart Home appliance in the future	

3 Result and Discussion

In total, there are 518 respondents that filled the questionnaires and all of them met the respondent criteria requirements. Next, Partial Least Square was utilized to discover the casual modelling in the conceptual framework.

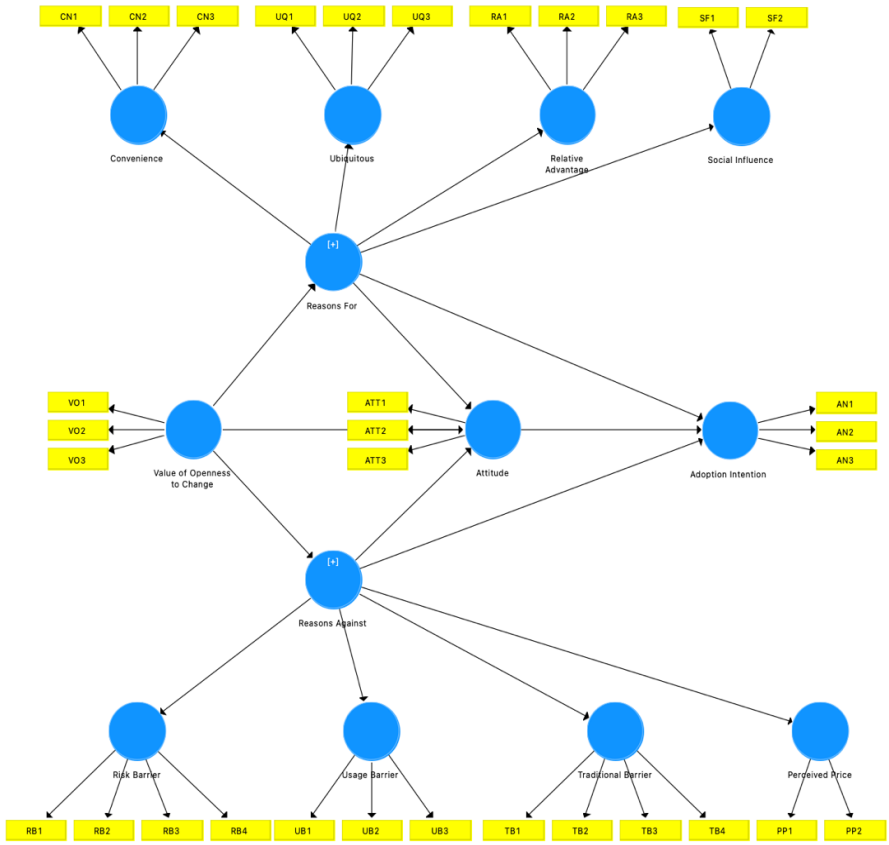

Fig. 2. PLS-SEM Original Construct

However, as this study use the Hierarchical Component Model, thus the construct be will assessed using the disjoint two approach, which means the author will separate the measurement of lower and higher order construct. The first assessment is used to test the lower construct, as shown in fig 3.

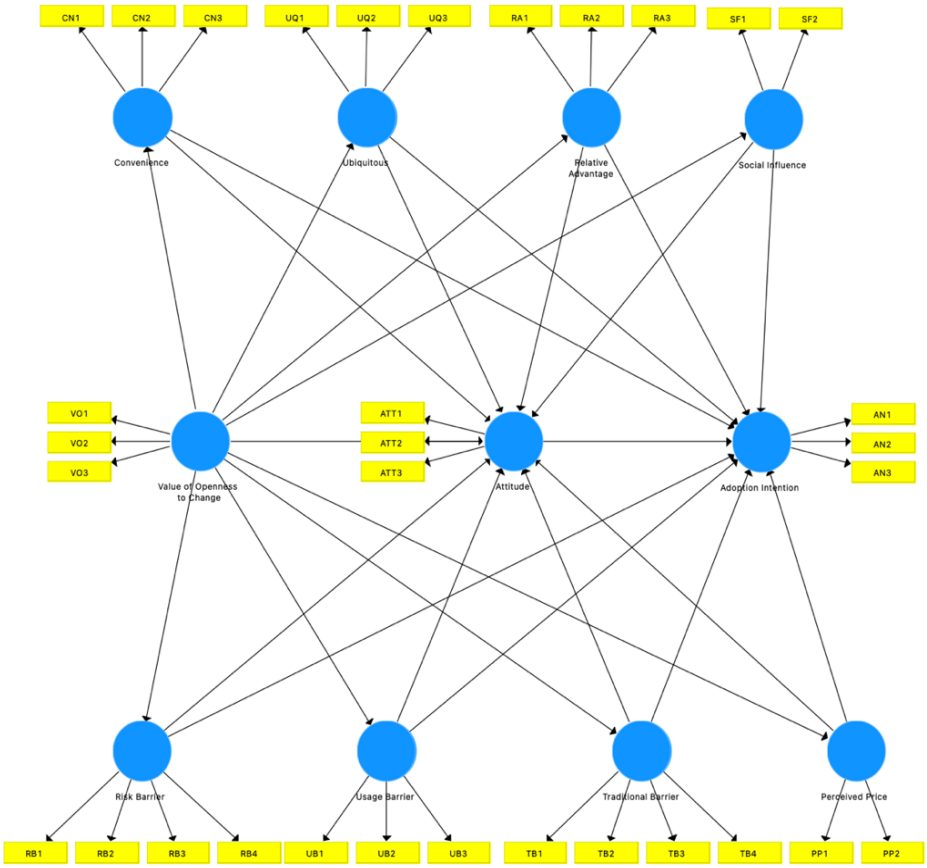

Fig. 3. PLS-SEM Lower Order Construct

As result, the lower construct passed all of the requirement of measurement model. All of the outer loading and composite reliability exceed the requirement of 0.7 and AVE for all variables exceed 0,5. Every latent variable's AVE square root also all higher than the corelation between variables and the VIF are all below 5, indicating that the construct is reliable and valid with no collinearity issue [28]. This study then followed by bootstrapping procedure towards the higher order construct to test relation between variables.

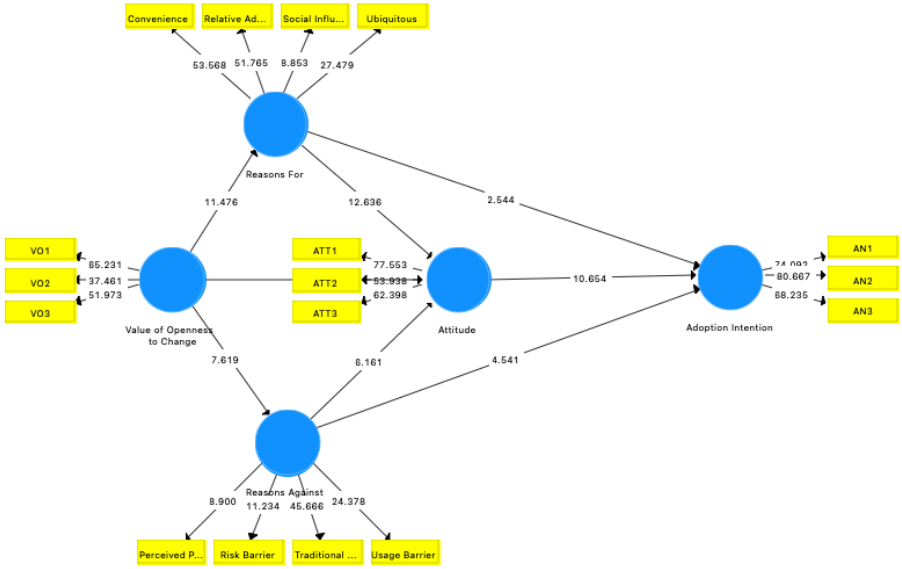

Fig. 4. Bootstrapping Result

From the fig. 4, it can be concluded that all the T-value are greater than 1.96. Slight difference of score in the figure and in the table is tolerable as bootstrapping result always vary each time it is being run; thus, it can be said that the model is empirically supported.

Next, the table below will exhibit the calculation result for hypothesis testing. As all of the p-values are below 0.05, then all hypothesis in this research is significant.

Table 2. The Result of Hypothesis Testing

Hypothesis	Structural Path	Original Sample (O)	T Values	P Values	Result
H1	Attitude -> Adoption Intention	0,532	10,654	0,000	Accepted
H2	Reasons For -> Attitude	0,455	12,636	0,000	Accepted
H3	Reasons For -> Adoption Intention	0,113	2,544	0,011	Accepted
H4	Reasons Against -> Attitude	-0,193	6,161	0,000	Accepted
H5	Reasons Against -> Adoption Intention	-0,141	4,541	0,000	Accepted
H6	Value of Openness to Change -> Reasons For	0,440	11,476	0,000	Accepted
H7	Value of Openness to Change -> Reasons Against	-0,323	7,619	0,000	Accepted
H8	Value of Openness to Change -> Attitude	0,286	7,574	0,000	Accepted

After testing the hypothesis, the next phase is evaluating the strength of each latent variable's relationship by comparing the Model's F Square Effect Size [28]. This assessment aims to evaluate how useful every construct is for the adjustment of the model. The table below will show the result of F Square calculation.

Table 3. The Result of F Square Calculation

	Adoption Intention	Attitude	Reasons Against	Reasons For
Adoption Intention				
Attitude	0,284			
Reasons Against	0.031	0.068		
Reasons For	0.014	0,342		
Value of Openness to Change		0,130	0,117	0,239

In addition, as this study use the Hierarchical Component Models, to discover the most important "reasons for" and "reasons against", the second order factor loading is being assessed.

Table 4. The Second Order Factor Loading

	Original Sample (O)	T Values	P Values
Convenience <- Reasons For	0,851	57,107	0,000
Ubiquitous <- Reasons For	0,752	25,656	0,000
Relative Advantage <- Reasons For	0,833	52,811	0,000
Social Influence <- Reasons For	0,471	9,022	0,000
Risk Barrier <- Reasons Against	0,590	11,220	0,000
Usage Barrier <- Reasons Against	0,777	25,340	0,000
Traditional Barrier <- Reasons Against	0,876	49,051	0,000
Perceived Price <- Reasons Against	0,557	9,579	0,000

From the table, it can be identified that Convenience with score of 0,851 as the most important indicators among the Reasons For variables and followed by Relative Advantage with score of 0,876. On the other hand, it is confirmed that among Reasons Against variables, Traditional Barrier and Usage Barrier are the top indicators.

3.1 Individual's attitude towards Smart Home appliance will positively influence their adoption intention

Attitude has the biggest effect on Adoption Intention, indicated by the effect size of 0,284 that is greater compared to the other variables. Furthermore, this hypothesis is accepted and shows that an individual's psychological tendency of favourability or unfavorability towards the Smart Home appliances is the main determinant for them to have the intention to adopt Smart Home appliances. This result is linear with earlier studies Claudy et al. [22] Dhir et al.

[26] Gupta and Arora [23] Sivathanu [21] which posit that positive attitude towards Smart Home appliances resulted in a positive intention to adopt the Smart Home appliances, and vice versa.

3.2 Individual's reasons for the adoption of Smart Home appliance will positively influence their attitude towards Smart Home appliance and the adoption intention

H2 and H3 both confirmed the positive relationship of "reasons for" towards attitude and adoption intention of Smart Home appliances. These findings are linear with prior studies by Dhir et al. [26], Gupta and Arora [23] and Sivathanu [21]. In this study, "reasons for" identified as a variable that has lowest direct effect on adoption intention as the "reasons for" only generates effect size of 0,014. Contrary to that, "reasons for" is identified as the variable that has the biggest effect on an individual's attitude. This statement is proven through the effect size of 0,342. However, both are still confirmed to influence a positive impact towards adoption intention of Smart Home appliances.

3.3 In reverse, individual's reasons against of Smart Home appliances will negatively influence their attitude and adoption intention toward Smart Home appliances

H4 and H5 assessed the negative relationship between "reasons against" towards attitude and adoption intention. Both hypotheses are accepted as it generates minus score of 0,193 and 0,141 respectively. These finding consistent with previous literature [24][20]. Interestingly, compared to the "reasons for", the "reasons against" have stronger direct effect size on adoption intention of Smart Home appliances (0,031). However, when the study connected all the bootstrapping result by involve the F square effect through other variables such as attitude, "reasons against" turns to have a much lower effect compared to the "reasons for". In fact, "reasons against" is identified to give the smallest effect size (0,068) on attitude towards Smart Home appliances. Thus, this study concludes that "reasons against" is relatively weaker than "reasons for" in terms of influencing the adoption intention variables.

3.4 Individual's value positively influences their "reason for" Smart Home appliances. Whereas it negatively influences their "reason against" Smart Home appliances

H6 and H7 evaluated the relationship between value towards "reasons for" and "reasons against". The individual's value in this study is represented using the Value of Openness to Change. Both hypotheses are accepted as the path coefficient generate positive score for "reasons for" but negative score for "reasons against", which are 0,440 and -0,323 respectively. These findings support present literature [21] and could be interpreted that both reasons are significantly influenced by individual value. Therefore, value can be stated to have an important antecedent as it directly influences individuals reasoning regarding their adoption intention towards Smart Home appliances.

3.5 Individual's value positively influences their attitude towards Smart Home appliances

H8 examined the relationship between individual's value towards attitude and it turns out that value have medium size effect on attitude (0,130). Furthermore, the path coefficient

shows a positive score which means the hypothesis that predict value create positive influence towards attitude is accepted and also linear with prior studies [24][25].

4 Conclusion

This study objective is to identify factors affecting the intention to adopt the Smart Home appliances and also to determine the most influencing "reason for" and "reason against" adoption intention. More specifically, following are the results that answer this study's research questions:

4.1 What are the determinant and barriers that influence the intention to adopt Smart Home appliances?

It is concluded that all variables in this model are confirmed as factors that influence the Smart Home appliances adoption intention. Specifically, it is revealed that the determinant towards the intention to adopt the Smart Home appliances are individual's attitude towards the Smart Home appliances itself, individual's value of openness to change and lastly the individual's "reasons for" adoption with the context-specific reasons consist of Convenience (CN), Ubiquitous (UQ), Relative Advantage (RA), and Social Influence (SF). Whereas barriers towards intention to adopt the Smart Home appliances is the "reasons against" adoption, with the context-specific reasons consist of Risk Barrier (RB), Usage Barrier (UB), Traditional Barrier, and also Perceived Price (PP).

4.2 What are the most important reasons among "reasons for" and "reasons against" that affect the Smart Home appliances adoption intention?

Out of the "reasons for" adoption, the Convenience serves as the top determinant to adopt the Smart Home appliances. Whereas the top barrier that against the intention to adopt Smart Home appliances among is the Traditional Barrier.

This study reveals that attitude towards Smart Home appliances create the highest effect on adoption intention. Thus, it is recommended for marketers to focus on creating a positive image of the product to build a favourable attitude among the market. Supporting that, it is identified that "reasons for" create higher impact towards attitude compared to the "reasons against". Therefore, marketers are highly encouraged to highlight the benefits of Smart Home when communicating the targeted market, as this study confirms that major reasons for someone to have the adoption intention is the advantages that it offers such as convenience. Moreover, this study also confirmed that someone's value creates a positive effect towards someone attitude. Thus, this study also suggests marketer to create appealing strategies that can trigger people's openness to new experience as it could help to reduce potential scepticism towards the existing Smart Home appliances on the market and eventually lead to an increasing intention to adopt the Smart Home appliances. On the other hand, although the effect is relatively small, for further strategy marketers are also encouraged to create advertisement that can could touch the public pain point towards Smart Home while intensively emphasizing the "reasons for". The recommendation was built as this research confirmed both "reasons for" and "reasons against" create a significant impact towards the adoption intention, with "reasons for" is identified to be more impactful compared to the "reasons against" through attitude as mediator. Moreover, as this study shows that people with any age, gender, domicile, and monthly expenditure from the descriptive analysis result

generates similar intention level to adopt the smart home appliances, thus it is considered as fine if marketers create strategies for the market as a whole, not segmented. Following is more detailed marketing strategy being recommended in this study to increase the "reasons for" and to decrease the "reasons against":

Companies are suggested to create a mass marketing or advertising that could intensively deliver benefits information relevant to these factors such as emphasize the appliance's ability to make user daily life easier, timesaving, and offer greater value to manage home efficiently compared to the conventional appliances. Following that, companies are also encouraged to improve the ubiquitous Ness feature inside the Smart Home appliances as it also confirmed as another "reasons for" adoption. The improvement could be in a form of a more accurate information about the real-time energy use that can be accessible anytime and anywhere.

This study also reveal that people consider the use of Smart Home appliances based on social influence. Therefore, it is important for marketers to create strategy that can trigger the current user to spread positive word-of-mouth regarding the appliances and recommend it to their social circle. For instance, as the behavioural analysis also found that there are many users that has multiple Smart Home appliances, it indicates that people would love to do a repurchase. From this, marketers could offer discount for next payment if that consumer gives testimonial in social media about their previous buy.

For further strategy, companies can also increase the intention to adopt by triggering the "reasons against" adoption. This study found that people are reluctant to adopt the Smart Home appliances due to the unfamiliarity with the IoT involvement in the household and also due to the satisfaction of current appliances. To decrease this traditional barrier, companies are suggested to emphasize a more appealing feature compared to the conventional one. For instance, emphasizing the feature like "extra suction with 4x air power" can increase the intention to adopt Smart Robot Vacuum. Also, it is also suggested for companies to include the consideration of current tradition of an individual in doing home chores whenever creating a decision so that it would not lead to another cultural conflict.

Next, it is also confirmed that people have problem in adapting to use the Smart Home appliances and think that it is hard to operate and only compatible for technology savvy individuals. Therefore, it is important for marketers to overcome these usage barriers, for example by creating commercial ads that demonstrate the easy way to operate these smart appliances and may use character does not have high knowledge of technology as cast. Next, another factors that influence the low adoption intention of Smart Home appliances is the risk barrier. To overcome this, companies are suggested to improve the provider's security service reputation. However, although this study confirmed that risk barrier is one of the barriers against adoption, it is contrary with the prior study that risk barrier is considered the most influencing factors among "reasons against". This strategy may happen due to the high-rate awareness about the appliances benefit, which reduce people concern towards the safety risk.

Lastly, high price is considered as another constraint that influence the low adoption in Smart Home appliances. In this case, companies can try to adopt Bardi's marketing strategy, considering that the brand is chosen as the most owned among respondents, by joining electronic sales campaign by e-commerce and offer appealing discounts to overcome the perceived price barrier. Besides, applying this strategy also make the product information to be more accessible which then potentially create a positive image among the public.

For future research, it is suggested to extend the scope of the region to generalize the results. Other than that, future research may also involve the analysis of another behavioural factors considering that the result might varies according to the population's technological savviness, educational background, or even culture. Also, future research is recommended to

utilize the use of mixed method, which is qualitative approach in a form of interview to extract a more accurate "reasons for" and "reasons against" insights from the specified market. Finally, as this study only studied the Smart Home appliances as a whole, author suggests future research to extend the study by deepen a more specified Smart Home appliances, such as Smart Speaker, Smart Thermostat, until Smart Lock.

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