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Factor Analysis and Model of Intention to Adopt Induction Stove

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Abstract. *Household dependency on Liquified Petroleum Gas (LPG) gas increased Indonesian LPG imports. Therefore, the government encourages the conversion of LPG to induction stoves. However, induction stove users are less than LPG users. LPG stoves, electric stoves, and induction have their advantages and disadvantages. Consumers have different behaviours/responses to each change because each consumer has a diverse/heterogeneous character. This study analyzes the factors influencing consumer intentions to adopt an induction stove. The method used in determining factor analysis is the Structure Equation Model (SEM). The SEM method can model a causal relationship with a complex problem and determine the percentage of influence. The analysis found that the intention to adopt an induction stove was significantly influenced by subjective norm (SN), perceived behaviour control (PBC), and attitude toward behaviour (ATT). PBC is affected considerably by Speed, Maintenance, Cost, and Product Safety. ATT is significantly affected by Speed, Cost, Maintenance, and Security. Alternative penetration policy can be carried out on product heating speed, cost, and product maintenance, which are the variables that most significantly influence the adoption of induction stoves.*

Keywords: *factor analysis, induction stoves, Structure Equation Model*

I. INTRODUCTION

Liquified Petroleum Gas (LPG) is a hydrocarbon gas produced by increasing the pressure and lowering the temperature so that it turns into liquid. The LPG marketed in Indonesia by Pertamina is a propane and butane gas mixture. LPG is used for cooking fuel. LPG users are widely used for household consumption; it is also used as fuel in the industry. LPG has the characteristics of being flammable, has a pungent odour, and is colourless. The gas is distributed as a pressurized liquid in a cylindrical tube and can evaporate and spread if released. Imports of LPG fuel have Factor Analysis, Induction Stoves, Structure Equation Model (SEM)increased in Indonesia. Imported supplies dominate LPG supply in Indonesia by 80%. Subsidies to LPG are very high, namely 60-70 trillion per year; apart from being caused by increased use, it is also caused by high import prices. Fuel use in Indonesia includes firewood, briquettes, kerosene stoves, gas stoves, and induction stoves. Over time, LPG has become Indonesia's preferred and most widely used fuel.

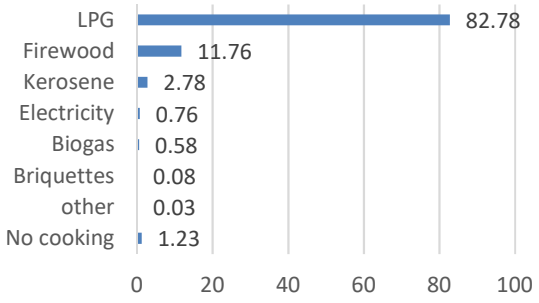

Figure 1. Household appliance/fuel use for households in Indonesia

The adoption of induction stoves in Indonesia is still low. Converting a gas stove to an induction stove can reduce gas stove users (F et al., 2022). That can have an impact on LPG imports in Indonesia. The lower use of induction stoves is due to several factors. Based on observations of consumers, several reasons are often mentioned, including product reliability and social influence. Induction stoves are considered to require a high investment cost. The use of

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induction stoves can increase the cost of electricity for each household (Hasanah & Handayani, 2016). In addition, there are also technical constraints on the household. Induction stoves require high power. Induction stoves require electricity above 900 VA to be used properly.

The household is a heterogeneous agent, having different characteristics. Character differences can influence decision behaviour in technology adoption. This study aims to identify household behaviour in adopting induction stove technology. Household behaviour can be modelled based on variables that influence behaviour by knowing the influencing variable so that household behaviour can be modelled in adopting induction stoves like a real system. This is the basis for analyzing induction stove adoption policies.

Every product of technological innovation has a different character. For example, solar panels have a different investment value than induction stoves. Consumer behaviour responses to each product will also be different. Induction stoves and gas stoves in society have various characters (Yudiartono et al., 2022). Not only the different types of products but also the behavioural responses of consumers have differences. For example, consumer behaviour in low and high-economic groups has a different response to technological changes. Another example for example, people with high environmental awareness compared to people with low environmental concern will have a different behavioural response to environmental-based technological changes. Human behaviour plays an important role in responding to technological developments, thus affecting the level of deployment or adoption of these technologies.

Induction stoves and solar panel technology are both engaged in the electricity sector with household consumers. In the diffusion of solar panel products, there are decision variables in the technology adoption process, including social, behavioural, economic, and environmental (Robinson & Rai, 2015). Social variables explain that there is an interaction that is able to increase the attitude of the agent. This increase is due to the interaction between non-adopter agents/people who have not used the product and agent adopters/people who use the product ((Briguglio & Formosa, 2017). The behaviour variable is modelled by the Theory of Planned Behaviour. The economic variable explains the level of payback period approved by the agent or household. The environmental variable describes the level of importance of concern for the environment. In addition, several independent variables, namely the status of home ownership (Zhang et al., 2016). Homeownership status is a consideration in adopting household technology.

The development of social influence models is explained by giving multilevel effects. For example, neighbours with a farther radius have less influence than neighbours that are closer (Zhang et al., 2014). Not only social factors but also decisions are influenced by advertisements that aim to increase technology adoption (Zhao et al., 2011). The effect of social interaction and Household income become the independent variables that influence the decision to adopt technology in the household. A large income allows consumers to adopt household appliances more easily (Palmer et al., 2015).

Consumer decision-making can be predicted based on the probabilities obtained from variable values using the logistic regression method (Lee & Hong, 2019). The variables that influence technology adoption are physical, economic, technical, demographic and social. Physical variables include the type of building and the area of the house obtained from the statistical geographic information service (SGIS). Thus technical variables affect a person's decision to adopt the technology. The economic variable is explained by the payback period expected by the agent/consumer. Demographics include the price of houses in the area, the length of time the house has lived and the level of population density. Another technical variable is the potential number of kWh that can be installed on the agent's house. The social variable describes the number of adopters within a certain radius.

Research on technology adoption was also carried out in Norway with a product, space

heating technology. Factors that influence a person's decision to adopt an electric/induction stove are socio-demographic factors, communication between households, perceptions of the importance of heating system attributes, and the decision strategy adopted all influence homeowners in Norway (Sopha et al., 2010). Apart from these factors, researchers developed psychological factors in decision-making. The decision to adopt a heating system is influenced by psychological factors, environmental paradigms and characteristics of the heating system (Sopha & Klöckner, 2011). The methods used in modelling are very diverse, including Regression, Structure equation model (SEM), Unified Theory of Acceptance and Use of Technology (UTAUT) (Hanantyo et al., 2022) and agent-based modelling (ABM) (Maya Sopha et al., 2011). Each method has its strengths and weaknesses. Regression and SEM can identify causal relationships between influencing variables. SEM is able to identify the complex structure of a system (Abdul et al., 2022). This method has been used in research, such as the influence on the adoption or use of mobile banking and the influence of industry readiness in dealing with and implementing manufacturing and process technologies in Nepal (Xiao & Han, 2016).

II. RESEARCH METHOD

The general research subjects chosen were the people in Banyumas. The research subjects are people who own a house/place to live and cooking equipment. The object of research is the induction stove used in households. This research was conducted within one year in 2022. The research tools and materials used for this research were as follows:

MS Software. Excel: Software MS. Excel is used to help process output data processing and facilitate tabulation of data.

SEM-PLS: is software to facilitate structure equation modelling. This modelling can identify an excellent causal relationship.

This research has several stages of work; the following is a description of the steps of the study:

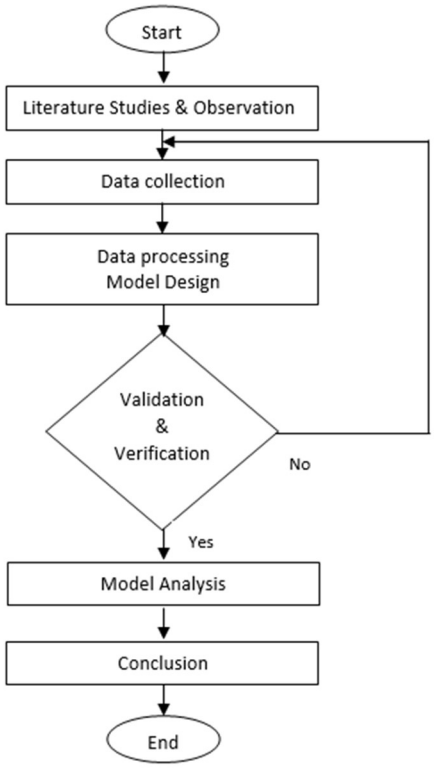

Figure 2. Flowchart

1. Literature review & observation: An observation and literature review determined the research topic and several research problem formulations and objectives. The proposed alternative solutions are based on the results of the literature review. Literature studies are obtained from books, journals, and papers related to research topics to understand the theoretical basis of the problem. The literature study shows that previous researchers have successfully developed several models, so they become a reference for further model development.
2. Data collection: data collection was carried out using a questionnaire supported by literature studies. This stage aims to collect the data needed to build the model.
3. Data processing and model design: at this stage, process the data that has been collected according to the method and software used. The output of this stage is a model that

describes a causal relationship between variables that influence consumer behaviour in the adoption of induction stoves.

4. Model verification and validation: The verification tests were carried out to evaluate the measurement and structural models. The validation stage is used to build confidence in the representation model level of the existing system.
5. Model analysis & conclusion: the output of this stage is the most influential variable in increasing the adoption of induction stoves. Recommendations are based on analysis of the relationship between variables dependent & independent of adopting induction stoves. It also recommends appropriate policies to increase the adoption of induction stoves.

Table 1. Variable Questionnaire

Variable	Statement
Intention (INT)	I am interested in using an induction stove.
	I will use an induction hob in the future (3 months)
ATT	It would be better/beneficial if I used an induction stove.
	Using an induction stove is more valuable.
PBC	If I want an induction stove, I can get it easily.
	If I use an induction hob, I can easily use it.
SN	My neighbors are happy/supportive when I use an induction stove.
	My family is happy/supportive when I use an induction stove.
Cost (B)	The price of induction stoves and their devices (induction pans, etc.) is low.
	The cost of electricity used is affordable/economical.
Safety (AM)	Induction stove is safe to use for users.
Clean (BR)	Induction stoves are easy to clean
	The induction stove is not easy to dirty.
Maintenance system (RW)	Maintenance of an induction stove is easy to do yourself
	Induction stoves service centers are everywhere.
Heating Speed (CP)	induction stove fast in heating food

III. Result and Discussion

Behaviour is described by the theory of planned behaviour (TPB), which consists of intention (INT), attitude toward behaviour (ATT), Perceive Behaviour Control (PBC), and Subjective Norm (SN). Other variables that indirectly influence the intention to adopt technology include Cost (B), Product maintenance (RW), Product cleanliness (BR), Heating speed (CP), and Security (AM). These variables will be tested for the relationship and influence on the main variable intention. This study analyzes the behaviour of Banyumas households in adopting induction stoves using a questionnaire with several statements describing the respondent's condition.

The number of samples in this study is 110 households in Banyumas. Gas stove users dominate respondents. The age of the respondents was dominated by the age of 40-50 years, as much as 43%. The majority of 50% of respondents' income is less than Rp. 2. 000.000,. The electric power used by 51% of respondents is 900 VA. And the level of education is dominated by high school graduates at 55%.

The following hypotheses are proposed:

1. H0: There is no effect significantly on the cost to ATT
   H1: There is an effect significantly on the cost to ATT
2. H0: There is no effect significantly on the safety to ATT
   H1: There is an effect significantly on the safety to ATT
3. H0: There is no effect significantly on cleanliness to ATT
   H1: There is an effect significantly on cleanliness to ATT
4. H0: There is no effect significantly on heating speed to ATT
   H1: There is an effect significantly on heating speed to ATT
5. H0: There is no effect significantly on the maintenance system to ATT
   H1: There is an effect significantly on the maintenance to ATT

6. H0: There is no effect significantly system on the cost to PBC
   H1: There is an effect significantly on the cost to PBC
7. H0: There is no effect significantly on the safety to PBC
   H1: There is an effect significantly on the safety to PBC
8. H0: There is no effect significantly on cleanliness to PBC
   H1: There is an effect significantly on cleanliness to PBC
9. H0: There is no effect significantly on heating speed to PBC
   H1: There is an effect significantly on heating speed to PBC
10. H0: There is no effect significantly on the maintenance system to PBC
    H1: There is an effect significantly on the maintenance system to PBC
11. H0: There is no effect of ATT significantly on the Intention
    H1: There is an effect of ATT significantly on the Intention
12. H0: There is no effect of PBC significantly on the Intention
    H1: There is an effect of PBC significantly on the Intention
13. H0: There is no effect of SN significantly on the Intention
    H1: There is an effect of SN significantly on the intention

The SEM-PLS was used to answer the hypothesis and analyze alternative policies to increase the adoption of induction stoves.

Evaluation of the Measurement Model (Outer Model)

The measurement model shows the results of the validity and reliability tests. In this validity test, two types of evaluation, namely Convergent Validity measurement models with items that have values based on the correlation between item scores and construct values. The AVE factor, composite reliability, measures the Convergent Validity Index.

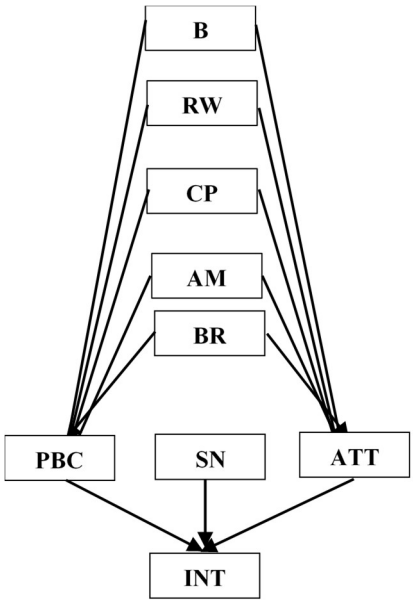

Figure 3. Conceptual Model

Table 2. The AVE & composite reliability

Variable	*Composite Reliability*	*Average Variance Extracted (AVE)*
ATT	0,94	0,89
Cost (B)	0,95	0,91
Intention (INT)	0,91	0,84
Safety (AM)	1,00	1,00
Cleanliness (BR)	0,85	0,73
Heating Speed (CP)	1,00	1,00
PBC	0,96	0,92
Maintenance system (RW)	0,93	0,87
SN	0,92	0,86

The validity and reliability criteria are seen from a variable's reliability value and each variable's Average Variance Extracted (AVE) value. The variable is highly reliable if the composite reliability value is above 0.7 and the AVE is above 0.5. Based on the table above, all variables meet composite reliability because their values are above the recommended figure, above 0.7, which meets the reliability criteria.

In the outer model, we determined Factor Loading. The factor loading value shows the correlation between the indicator and the construct. An indicator with a low loading value indicates that the indicator does not work in the

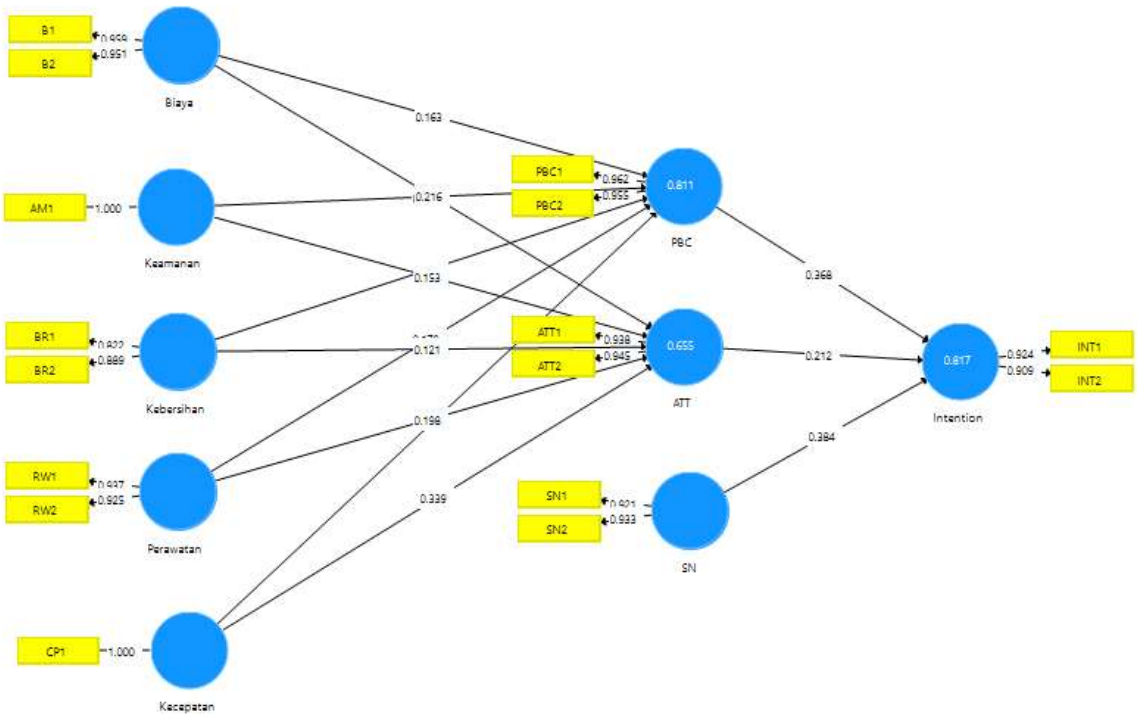

Figure 4. Outer Model

measurement model. Expected loading values are more than 0.7. In the outer model, we determined Cross Loading.

Based on the results of the estimated loading factors in the table below, the item values produced by the construct meet the standard convergent validity values because all factors are more than 0.7. Thus, it can be concluded that all constructs are valid.

Evaluation of the Structural Model (Inner Model)

R-Square is used to measure the predictive power of a structural model. R-Squares explain the effect of certain exogenous latent variables on endogenous latent variables and whether they have a substantive effect. R-squares values of 0.67, 0.33, and 0.19 indicate robust, moderate, and weak models.

The R-Squares test results show that the R-Squares intention value is 0.817. The value indicates that the ATT, PBC, and SN variables have an effect of 81.7%. And the rest is influenced by other variables outside the variables in this study.

Table 3. Loading Factor

Indikator		Loading Factor
Safety (AM)	AM1	1,000
Attitude (ATT)	ATT1	0,938
	ATT2	0,945
Cost (B)	B1	0,959
	B2	0,951
Cleanliness (BR)	BR1	0,822
	BR2	0,889
Heating Speed (CP)	CP1	1,000
Intention (INT)	INT1	0,924
	INT2	0,909
PBC	PBC1	0,962
	PBC2	0,955
Maintenance system (RW)	RW1	0,937
	RW2	0,925
Subjective Norm (SN)	SN1	0,921
	SN2	0,933

Table 4. R Square

	R Square	R Square Adjusted
ATT	0,655	0,639
Intention	0,817	0,812
PBC	0,811	0,802

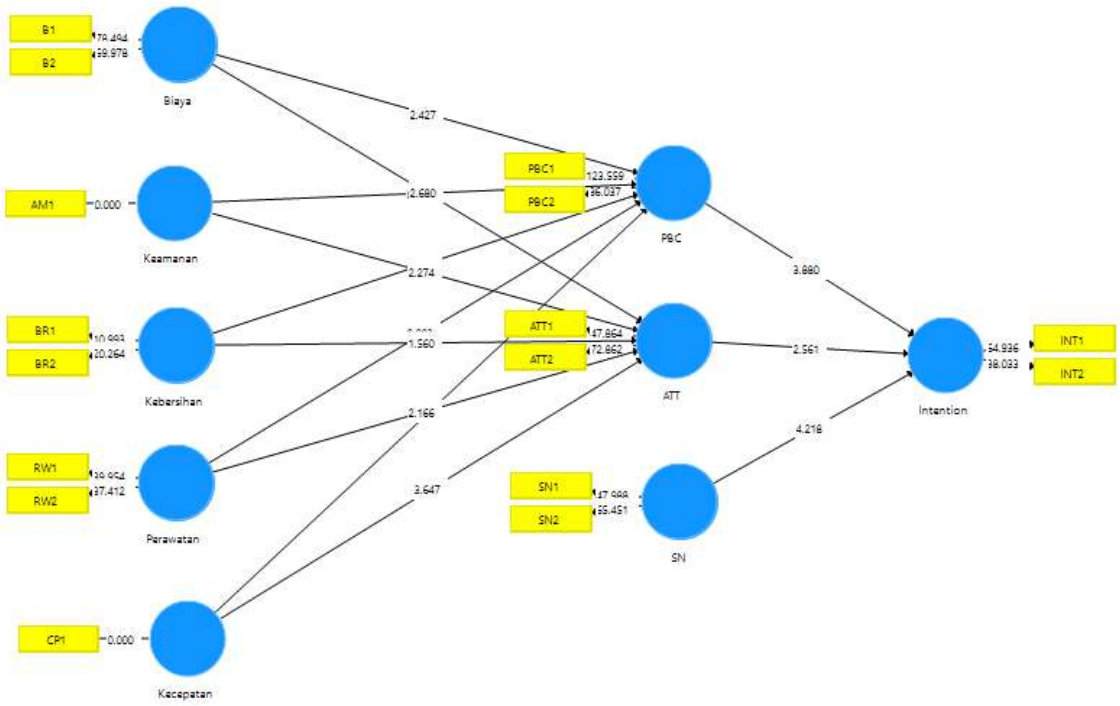

Figure 5. Inner Model

The R-Square ATT value is 0.655, indicating that cost, maintenance, cleanliness, safety, and heating speed affect 65.5%. And the rest is influenced by other variables outside the variables in this study. The PBC R-Squares value is 0.811, indicating that the variables of cost, maintenance, cleanliness, safety, and heating speed affect 81.1%. And the rest is influenced by other variables outside the variables in this study.

Table 5. P Value

Link Variabel Korelasi	P Values
ATT -> Intention	0,011
Cost -> ATT	0,008
Cost -> PBC	0,016
Safety -> ATT	0,023
Safety -> PBC	0,511
Cleanliness -> ATT	0,119
Cleanliness -> PBC	0,598
Heating Speed -> ATT	0,000
Heating Speed -> PBC	0,000
PBC -> Intention	0,000
Maintenance system -> ATT	0,031
Maintenance system -> PBC	0,023
SN -> Intention	0,000

Hypothesis testing

The hypothesis is accepted or rejected by the significance value between constructs, t-statistics, and p-values. The measurement estimates, and standard errors are no longer calculated with statistical assumptions but based on empirical observations. In the bootstrap resampling method in this study, the hypothesis is accepted if the significance value of the p-value is less than 0.05, then H0 is rejected and vice versa.

Based on the P-value for each correlation, the correlation whose p-value is less than 0.05 is the relationship between cleanliness to PBC, cleanliness to ATT, and safety to PBC. Meanwhile, other relationships show a p-value of less than 0.05, which means that it rejects H0 or has a significant influence.

Influence Percentage

The percentage of influence explains how much the attribute affects the variable. The percentage is obtained by multiplying the path coefficient and the Latent Variable Correlation—the following results from the percentage of influence and sequence of variables on other

variables. Speed (CP), Cost (B), and Maintenance are the most influential attribute of Attitude and PBC. Meanwhile, on the intention variable, the subjective norm is the most substantial variable in influencing.

Table 6. Influence Percentage of ATT

Variable	ATT	Ranking
B	14%	2
AM	8,9%	4
BR	6,3%	5
CP	23%	1
RW	12%	3

Table 7. Influence Percentage of PBC

Variable	PBC	Ranking
B	10,5%	3
AM	2,6%	4
BR	1,4%	5
CP	54%	1
RW	11,7%	2

Table 8. Influence Percentage of INT

Variable	INT	Ranking
PBC	31,4%	2
ATT	17,2%	3
SN	33,1%	1

Discussion

The theory of Planned Behaviour is an idea that can explain a person's behaviour directly or indirectly to get information and insight from an activity. The approach often used to describe behaviour is the theory of reasoned action (TRA). The theory of planned behaviour continues the theory of reasoned action, which includes measurements in belief control and perceived belief control (PBC).

Attitude towards behaviour is an important variable that explains a person's positive or negative feelings if they have to carry out the behaviour to be determined. Cost, Safety, Speed , and Maintenance significantly influence the attitude variable on adopting induction stoves. As for cleanliness does not affect it significantly. The speed of the stove in delivering heat is considered the most influential factor. Research shows that currently, gas stoves have the highest speed in heating products/food. In contrast, induction stoves are slower than gas stoves. It causes gas stoves to be more profitable than induction stoves, along with costs. Induction stoves have an expensive investment cost compared to gas stoves. Therefore gas stoves are considered more profitable than induction stoves. Policies that can be implemented to increase the adoption of induction stoves are increasing product quality regarding the heating speed. And provide an economical price related to the stove and operational costs or cheaper electricity costs / promotion (Simamora & Siregar, 2022). Induction stove subsidies and reduced electricity costs for users can increase the intention to adopt induction stoves.

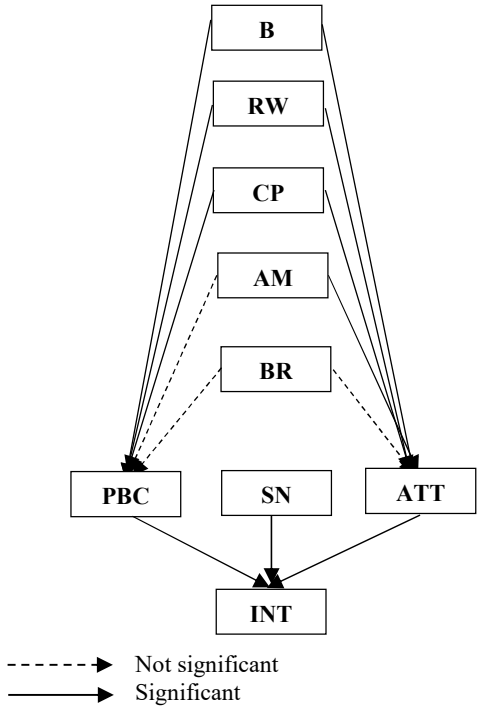

Figure 5. Model Significance

Subjective norms are perceptions of other people's beliefs that will fulfil an interest in carrying out the behaviour under consideration. Subjective Norm has the greatest percentage in influencing intention, meaning that in the adoption of an induction stove, the influence of subjective is very strong. Households will intend to buy a product if the social environment encourages them to buy or adopt an induction stove.

Perceived behavioural control is an individual's view of their ability to perform the desired behaviour. PBC is defined as a variable that complicates and facilitates the adoption of induction stoves. Variables that affect PBC include Maintenance, Speed, and Cost. As for cleanliness and safety, it doesn't affect it significantly. Heating speed gets the first rank as a variable that affects PBC. The speed of heating will make it easier for users to cook; the higher of heat speed, is better. Easy maintenance and the existence of a service centre can increase a person's intention to adopt an induction stove. Policy alternatives to increase the intention to adopt induction stoves are to improve product quality in terms of the ease and speed of heat transfer. Then make products that are easy to maintain or conduct outreach regarding the ease of maintenance of induction stoves. As well as increasing the existence of service centres that make it easier for users to maintain induction stoves.

IV. CONCLUSION

Subjective norms, perceived behaviour control, and attitude toward behaviour significantly influence the intention to adopt induction stoves. Subjective norms are the most variable influencing the intention to adopt an induction stove. Cost, product security, hating speed, and maintenance system significantly influence attitudes toward behaviour. In contrast, cleanliness does not affect attitudes toward behaviour. The most influencing variables, respectively, are heating speed and cost. The heating speed, cost, and maintenance significantly affect perceived behaviour control. In contrast, cleanliness and safety do not significantly influence perceived behaviour control. Variable heating speed and maintenance were the most influence perceived behaviour control. Based on the analysis of these factors, alternative policies were made to increase the adoption of induction stoves. The alternative policy is to increase the heating speed, reduce investment and operational costs, and simplify system maintenance. Subjective norms have a significant influence, so the power of the social environment, including neighbours, family, influencers, and the government, is needed to increase the adoption of induction stoves.

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