Intelligent Air Conditioner System: User Acceptance Level of ICONS

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Abstract— This paper presents a technology acceptance research on the Intelligent Air Conditioner System (ICONS). ICONS was developed to automatically adjust the temperature of a room using fuzzy logic. A survey with a sample size of 100 respondents is designed to identify the relationship between consumers and ICONS. Analyses of the data collected for this research apply correlation and regression analysis to study the users' acceptance of ICONS. If consumers like ICONS, they tend to be more willing to purchase it. The hypothesis related to consumers' acceptance towards this product indicated consumers' positive feeling towards ICONS will influence their willingness to use ICONS. Finally it can be concluded that users will accept the use of ICONS into their household.

Keywords— Acceptance level, survey, perceived usefulness (PU), perceived ease of use (PEOU), behavioral intention (BI)

I. INTRODUCTION

Introducing a product into the marketplace requires extensive planning, advertising and risk taking. A new product market research is to be carried out before a product can be launched into the market. Researchers need to find out the user acceptance level of the public on the product, Intelligent Air Conditioner System (ICONS). ICONS, consists of two parts, the controller box connected to the air conditioner and the software programmed using the Fuzzy logic algorithm installed on a personal computer. The uniqueness of ICONS is its ability to optimize the electrical usage. An analysis of the cost and energy consumption of appliances shows that an air conditioner connected to the ICONS box and the computer would save more than 15% of the total electric bill. This innovative product can be used as an add-on to an existing and new air conditioner that does not have the inverter technology. Since this product does not exist in the market, we applied the Technology Acceptance Model (TAM) as a marketing survey to measure the acceptance level of the product. TAM is a suitable theoretical framework in information system to explain users' acceptance of technology. It is a strong predictor of intention to use the technology in various contexts [4].

II. LITERATURE REVIEW

A. Information Regarding the Technology Acceptance Model

The Technology Acceptance Model (TAM) is one of the popular extensions of Ajzen and Fishbein's Theory of Reasoned Action (TRA). TAM uses the TRA as a theoretical basis for specifying the causal linkages between consumers perceived usefulness, perceived ease of use, and user acceptance and actual usage of a particular technology [5]. The basic model of T.A.M describes a logical law of variables in which a user's behavioral intention (BI) to use a technology is mediated by the technology's perceived usefulness (PU) and perceived ease of use (PEOU). Below are the descriptions of each, following a logical low of variables:

- Perceived Usefulness (PU): 'degree to which a person believes that using a particular system would enhance his or her job performance' [2, p320].
- Perceived Ease Of Use (PEOU): 'degree to which a person believes that using a particular system would be free of effort' [2, p320].
- Behavioral Intention (BI): 'individual's interest in using the system for future work' [6, p124].



Fig. 1 Basic form of T.A.M

B. Research Hypotheses

According to Bandura [1], [2], [3] a famous psychologist who specialized in social cognitive theory, self efficacy, and social learning theory, said that people are willing to learn new behavior are influenced by overt reinforcement or punishment or observation of social factors in their respective environment. If people observe positive, results of the desired behavior, then they are more likely to adopt the behavior themselves [7]. We would like to know the relationship between consumers and ICONS. If consumers like ICONS, they will tend to be more willing to buy it and connect it to their air conditioners. The premise indicates that consumers' positive feelings about ICONS will influence their willingness to use ICONS.

 H_0 (1): Affinity with (AW) air conditioner is not positively related to perceived usefulness (PU) of ICONS.

 $H_1(1)$: Affinity with (AW) air conditioner is positively related to perceived usefulness (PU) of ICONS.

 H_0 (2): Affinity with (AW) air conditioner is not positively related to the perceived ease of use (PEOU) of ICONS.

 $H_1(2)$: Affinity with (AW) air conditioner is positively related to the perceived ease of use (PEOU) of ICONS.

 $H_0(3)$: Perceived usefulness (PU) of air conditioner will not have a positive effect on behavioral intention (BI) to use ICONS.

 H_1 (3): Perceived usefulness (PU) of air conditioner has a positive effect on behavioral intention (BI) to use ICONS.

 H_0 (4): Perceived ease of use (PEOU) of air conditioner will not have a positive effect on behavioral intention (BI) to use ICONS.

 H_1 (4): Perceived ease of use (PEOU) of air conditioner will have a positive effect on behavioral intention (BI) to use ICONS.

 $H_0(5)$: User behavioral intention (BI) to use ICONS will not have a positive effect on the purchase intention (PI) of ICONS.

 $H_1(5)$: User behavioral intention (BI) to use ICONS will have a positive effect on the purchase intention (PI) of ICONS.

C. Research Methodology

A survey was developed to test the expected relationship. Due to time constraints, respondents were selected using convenient sampling. There were 100 respondents of the survey. The survey consisted of 20 questions, divided into 4 parts. The first part consisted of 6 questions used to capture respondents' demographics information for example, age, gender, income etc. Table 1 shows all of the data collected in the first part of the survey. The second part of the survey consisted of 4 questions used to gather data about respondents' air conditioner usage. The third part consisted of 5 questions, used to measure the respondents' knowledge of artificial intelligence. The last part consisted of questions sub-divided into two to five sub-questions. This section was the most important in the questionnaire. It measured consumers' acceptance level of ICONS using the following variables: affinity with air conditioner (AW), perceived usefulness (PU), perceived ease of use (PEOU), behavioral intention (BI) to use, and purchase intention (PI). All the variables were assessed on a seven point scale (1 = strongly disagree, 7 = strongly agree).

Table 1 summarizes the respondents' demographics. From the total respondents of 100, 72% are male and the rest are female. Forty-three percent of the respondents are single, where as 57% are married.

TABLE 1 RESPONDENTS' DEMOGRAPHICS DATA

Variable	Category	Frequency	Percentage (%)
Gender	Male Female Total	72 28 100	72% 28% 100%
Marital Status	Single Married Divorcee Widow Separated Total	43 57 0 0 0 0 100	43% 57% 0% 0% 0% 100%
Age	$21 \sim 30 \\ 31 \sim 40 \\ 41 \sim 50 \\ 51 \sim 60 \\ 61 + \\ Total$	30 47 13 10 0 100	30% 47% 13% 10% 0% 100%
Employment Status	Self employed Salaried Unemployed Retired Student Total	7 70 0 2 21 100	7% 70% 0% 2% 21% 100%
Monthly Income	Below RM 1999 RM 2000 ~ 3999 RM 4000 ~ 5999 RM 6000 ~ 7999 Over RM 8000 Total	56 33 4 3 4 100	56% 33% 4% 3% 4% 100%
Education Level	Secondary school Certificate/diploma Bachelor's degree Master's degree PhD/post doctorate Total	12 16 70 2 0 100	12% 16% 70% 2% 0% 100%

The age group 20 to 30 years old were 30% of the sample, age 31 to 40 were 47%, age 41 to 50 were 13% and age 51 to 60 were 10%. The salaried employee category showed the highest frequency, which is 70 people, followed by 21 students, 7 self employed and 2 people retired. The monthly income category for salary below RM 1999 contained 56 people, the salary range RM 2000 to RM 3999 contained 33 people, and 4 people each fell in salary ranges of RM 4000 to

RM 5999 and above RM 8000. Educational levels were bachelor's degree 70%, diplomas and certificates 16%, secondary schools 12% and 2% with a master's degree.

Table 2 shows the respondents' awareness about Artificial Intelligence (AI) and software that can control the air conditioner. From the table, we can see that 90% of the respondents own a personal computer, and 10% do not. There are 2 people who self-identify in the expert category, 13% in the master category, 63% in the intermediate category, and 22% in the beginner category.

TABLE 2 RESPONDENTS' AWARENESS OF AI AND SOFTWARE

Variable	Categories	Frequency	Percentage (%)
Do you have a personal computer?	Yes No Total	90 10 100	90% 10% 100%
What is your level of understanding on AI?	Expert Master Intermediate Beginner Total	2 13 63 22 100	2% 13% 63% 22% 100%
Have you heard about software that can control the air conditioner?	Yes No Total	12 88 100	12% 88% 100%
Do you think an Artificial Intelligent (AI) based air conditioner would perform better than an Inverter Technology air conditioner?	Yes No Total	92 8 100	92% 8% 100%
Would you be willing to buy the software if it would cut down more than 15% of electrical consumption?	Yes No Total	79 21 100	79% 21% 100%

Eighty-eight percent of the total respondents have not heard about software that can manipulate air conditioners, whereas 12% had heard about it. Ninety-two percent of respondents believed that AI technology can perform better than Inverter technology based air conditioner, 8% of the total respondents do not think so. Seventy-nine percent of the respondents are willing to buy the software if it helps to reduce more than 15% of their total electricity usage.

III. RESULT AND DISCUSSION

A. Hypothesis Testing

The hypotheses of this survey were tested using correlation and regression analysis. The values shown in Tables 3 and 4, helped us to determine whether the hypotheses assumed earlier are supported or not. Table 4 shows R-Square values that indicate the direction of relationship between the dependent variables and independent variables. The value of

R ranges from 1.0 to -1.0 [8]. The absolute value of R indicates the strength of the relationship: the higher the absolute value, the stronger the relationship. Besides R-Square, we also look at the factor adjusted R-Square. Adjusted R-Square is used to measure the proportion of the variation in the dependent variable accounted for by the explanatory variables [9]. The rough interpretation of the Adjusted R-Square is: if it is above 0.25, then 25% of the dependent variable can be explained by variation in the independent variable.

Returning to the five hypotheses made, the adjusted R-Square value for $H_1(1)$ (affinity with (AW) air conditioner is positively related to the perceived usefulness (PU) of ICONS which is 0.054. For $H_1(3)$ (perceived usefulness (PU) of air conditioner will have a positive effect on the behavioral intention (BI) to use ICONS) it is 0.049. For $H_1(5)$ (user behavioral intention (BI) to use ICONS will have a positive effect on the purchase intention (PI) of ICONS) it is 0.038. For $H_1(2)$ (affinity with (AW) air conditioner is positively related to the perceived ease of use (PEOU) of ICONS) the value is 0.032.

TABLE 3 MATRIXES OF CORRELATIONS

		PU	AW	PEOU	BI	Ы
PU	Pearson Correlation	1	.253(*)	.128	.243(*)	.189
	Sig. (2-tailed)		.011	.205	.015	.060
	Ν	100	100	100	100	100
AW	Pearson Correlation	.253(*)	1	.204(*)	.170	.253(*)
	Sig. (2-tailed)	.011		.042	.092	.011
	Ν	100	100	100	100	100
PEOU	Pearson Correlation	.128	.204(*)	1	.025	.055
	Sig. (2-tailed)	.205	.042		.804	.586
	Ν	100	100	100	100	100
BI	Pearson Correlation	.243(*)	.170	.025	1	.219(*)
	Sig. (2-tailed)	.015	.092	.804		.029
	Ν	100	100	100	100	100
PI	Pearson Correlation	.189	.253(*)	.055	.219(*)	1
	Sig. (2-tailed)	.060	.011	.586	.029	
	Ν	100	100	100	100	100

* Correlation is significant at the 0.05 level (2-tailed).

For H_1 (4) (perceived ease of use (PEOU) of air conditioner will have a positive effect on the behavioral intention (BI) to use ICONS) the value is 0.010. The correlation for the above matrixes for Table 3 is significant at the 0.05 level (2-tailed).

Table 4, shows the Coefficient Beta values for the hypotheses. Standardized regression coefficients are used to compare the contribution of variance for the dependent variables within the model. Often the independent variables are measured in different units. The standardized coefficients attempt to make the regression coefficients more comparable. H_1 (1) shows the highest Coefficient Beta value at 0.428, followed by 0.371 for H_1 (5), 0.209 for H_1 (2), 0.135 for H_1 (3), and 0.023 for H_1 (4). Table 4 shows all the correlation values among all the variables. The significant level for a variable is below 0.05, meaning that there is only a five percent probability that the independent variable does not influence the dependent variable in the reported fashion.

TABLE 4 REGRESSION ANALYSIS

	H ₁ (1)	H ₁ (2)	H ₁ (3)	H ₁ (4)	H ₁ (5)
Independent Variable	AW	AW	PU	PEOU	BI
Dependent Variable	PU	PEOU	BI	BI	PI
R-Square	0.064	0.041	0.059	0.001	0.048
A. R-Square, q ₀	0.054	0.032	0.049	0.010	0.038
F-Statistic	6.696	4.241	6.130	0.062	4.923
p-value	0.011	0.042	0.015	0.048	0.029
Coefficient Beta	0.428	0.209	0.135	0.023	0.371
Durbin Watson	0.675	0.569	1.843	1.918	0.386

'The F statistic is the regression mean square (MSR) divided by the residual mean square (MSE). If the significance value of the F statistic is smaller than 0.05 then the independent variables are able to explain the variation in the dependent variable. If the significance value of F is larger than 0.05 then the independent variables do not explain the variation in the dependent variable, and the null hypothesis that all the population values for the regression coefficients are 0 is accepted' [8,p3].

The Durbin Watson Statistic is a statistical test used to detect the presence of autocorrelation in the residuals from a regression analysis. The Durbin Watson Statistic can range from 0 (in the case of serial correlation of +1.0) to 4 (in the case of serial correlation of -1.0). If the regression has no serial correlation, then the regression residuals will be uncorrelated through time and the value of the Durbin Watson statistic will be equal to 2. If the regression residuals are positively serially correlated, then the Durbin Watson statistic will be less than 2. If the regression residuals are negatively serially correlated, then the Durbin Watson statistic will be greater than 2 [10].

TABLE 5 SUMMARY OF TESTING RESULTS FOR HYPOTHESES

Hypotheses	p-value	Result
H_1 (1): Affinity with (AW) air conditioner is positively related to the perceived usefulness (PU) of ICONS.	0.011	Support
H_1 (2): Affinity with (AW) air conditioner is positively related to the perceived ease of use (PEOU) of ICONS.	0.042	Support
H_1 (3): Perceived usefulness (PU) of air conditioner will have a positive effect on behavioral intention (BI) to use ICONS.	0.015	Support
H_1 (4): Perceived ease of use (PEOU) of air conditioner will have a positive effect on behavioral intention (BI) to use ICONS.	0.048	Support
H_1 (5): User behavioral intention (BI) to use ICONS will have a positive effect on purchase intention (PI) of ICONS.	0.029	Support

A Durbin Watson value is less than 2.0. This means the regression residual for the five hypotheses are positively serially correlated and have no problem of auto-correction. In other words, the analysis satisfies the assumption of independence of error. If p-value is less than 0.05 then it is not significant and the null hypotheses are rejected. The results shown in Table 4 and Table 5 support all five research hypotheses as follows: $H_1(1)$, affinity with air conditioner will be positively related to the perceived usefulness of ICONS (r=0.428, p=0.011), $H_1(2)$, affinity with air conditioner will be positively related to the perceived ease of use of ICONS (r=0.209, p=0.042), H₁ (3), perceived usefulness of air conditioner will have a positive effect on behavioral intention to use ICONS (r=0.135 p=0.015). H_1 (4), perceived ease of use of air conditioner will have a positive effect on behavioral intention to use ICONS (r=0.023, p=0.048), H₁ 5), behavioral intention to use ICONS will have a positive effect on purchase intention of ICONS (r=0.371 p=0.029).

IV. CONCLUSION

Based on the result of this study, the level of acceptance of the innovative product, ICONS is considered low. This is due to the fact that presently such a product does not exist in the market therefore the awareness for this product is low. On the other hand, the respondents' feedback shows positive behavioral intention to use ICONS. Based on the finding, consumer behavior intention to use ICONS was positively related to perceived usefulness and perceived ease of use of the system. Hence, we believe ICONS cost saving features and the fact that it is user friendly are two of the factors that can help ICONS gain market credibility.

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