RESEARCH ARTICLE

APPLICATION OF LOGISTIC REGRESSION EVALUATE DETERMINATIVE FACTORS IN CONSUMERS' CHOICE OF AIR CONDITIONING PRODUCTS

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ABSTRACT

Over the past decades, the competition of household air conditioning products has become sharp in Taiwan. The life-cycle of a producthas reached its maturation. Moreover, as the global trend of micro-profits arrives, many brands including some famous and other ordinary ones have been created by enterprises. This trend not only leave an enterprise no other choices but to adjust its very own constitutions(such as the transformation of its interior procedures, reducing its own operating costs, and innovating a new product), but also renew its selling strategy in order to raise its market share.For example, due to the rapid revolution of technologies, the consuming culture has also undergone a lot of changes. Because the consumers are easily influenced by mass media and commercial advertisements, a totally different consuming culture might have been formed. Owing to this fact, consumers might have lowered their loyalties to a brand such that an entrepreneur must apply the following strategies to regain his winsome advantages over his competitors, e.g. taking cost-driven leadership,making product-differentiation, or using focused strategy. The research method of the present study took Linear Probability Model and distributed 600 questionnaires to related consumers in the northern, central and southern parts of Taiwan. The purpose of this research is to understand what important factors there are and among which what is the most crucial factor aslong as a consumer purchase a new air conditioner, in order to give some advice to the relevant producers. The studying result shows that under the significance level (i.e. p=0.05), whether the following ten factors have obvious effects on a consumer's buying activity of an air conditioner in a household: (1) types of air conditioners, (2) brands of air conditioners, (3) the person who made the decision of purchase, (4) the preferred brands, (5) the "Green factor", i.e.whether an enterprise is environmentalfriendly or not, (6) health and safety considerations, (7) quality-or service-related factors, (8) promotion, (9) locality, and (10) annual income of a family.

INTRODUCTION

The penetration of air conditioner in Taiwan has highly reached 96% or above. As far as the status quo of the market of family-owned air conditioner, circa 900,000 pieces are sold each year, with its output value equivalent of more than 20 billion NTD. However, owing that the saturation of this market has reached its peak and that the product-technology has come to its maturation, the growth rate of this market is not obviously high. From the perspective of the current market in Taiwan, the growth-peak has been passed. Nevertheless, due to the sharp competition among different enterprises in the market and whose innovations, the average sales growth comes to 5%. In a time of flourishing economics, consumers tend to change their due-concerns as it comes to buying a new product. Under such an ongoing changing consuming cultural climate and the influence of mass media with the accompanied commercial strategies and allures of the latter, discrete consuming groups are generating a totally different consuming cultures than before. Based on the total effect of such changes, the number of brands consumers choose has enormously

increased, causing their arbitrary abandoning some non-brand products according to such unfamiliar reasons as prices, quality, functions and so on. Moreover, a consumer's purchasing behavior is conceived of as an intervening process that as he or she trying to satisfy his or her needs and desires by seeking, selecting, purchasing, utilizing and assessing the due products or services, including both his or her subjectively mental activities and physical dealing with things in ordinary lives (Kotler, 2000). As to the purchasing behaviors on the one hand they concern the individual consumer's ones, which are to satisfy his own, her own, or familial needs in everyday life, and on the other hand are targeted on the ensuing decision-making activities of an enterprise, whose various apparent behaviors during purchasing its preferred goods or services are intended to meet the production needs. Furthermore, an individual's purchasing behavior originates from the purchasing process of a system and is affected by a variety of either endogenous or exogenous variables. The complexity and the variety of buying behavior of consumers bring questions and challenges to the selling aspect of a manufacturer. To the best of the selling aspect of a manufacturer, it is very critical for him to grasp the decision-making process and the relevant factors that influence the process of his clients. Thus, the present study intends to proceed by constructing some models, analyzing their crucial but also influential factors on clients'

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buying behaviors so as to deeply understand the key variables on consumer's side that determine whether a client buy some product or not, founding upon quantitative basis; therefore, the teleology of my current study is to help an enterprises to envision its relevant strategies that cope with their organization targets, environmental characteristics and any timely tendency.

Literature Review

Process of consumer decision making: Among all countries in the globe, research on consumer purchasing behavior allows an enterprise to compare and quantify its related development. By capturing which factors are most effective on consumer behavior, an enterprise can assure itself that its strategies target on the key demands of its consumers and thereby be tailored for them. Therefore the connotations of "consumer behavior" refers to "an individual's behavior directly getting or utilizing some goods or services, including those processes that cause or lead to such decision." (Engel, Blackwell and Miniard, 1990)Besides, a consumer behavior is formed under a certain of circumstances unto a certain of specific products. That is to say, a buying behavior changes if its corresponding product changes, varied products; considering still further, even with the same product, its consumer behavior differs if its users differ (Hawkins *et al.,* 1996).

Related overview of decision making: When making a purchasing decision, consumers search information in advance before making the decision of purchasing. Assael (1998) stated in his book that eight factors cause the search of information: (1) high involvement, (2) high perceived risk, (3) lack of product knowledge and experience, (4) specific purchase goal, (5) more time for making buying decision, (6) high prices, (7) more product differences between brands, (8)cost-effective information searching. Mowen and Minor (2002) pointed that after a consumer understands his problem, he will start the process of information search to get product knowledge for his problem. Both Mowen and Mino think that consumers interiorly use previous related product and service knowledge from their long term memory, they also collect information from external sources like friends, advertisements, product packing, consuming research or the salespeople. Butter and Peppar (1998) thought the traditional evaluation of information originates from past experience, marketing and promoting, consuming groups, research agencies and reputations. Schiffman (2001) pointed that consumers tend to make a list of brand names under consideration and establish evaluation criteria to make buying decisions. The final result displays in their consuming behavior.

MATERIALS AND METHODS

Linear Probability Model: Linear probability model applies binary dummy variable regression of 0 and 1, and categorizes past consumers into two groups. Buying air conditioners (Yi = 1) and non-buying air conditioners (Yi = 0). The regression equation after applying linear probability model is: We can use the following regression model to show the two categorical dependent variables:

Among them:

$X_i = (HA, HS, HB, \cdots)$: The attribute of observation variable

$\beta = (\beta_0, \beta_1, \beta_2, \cdots)$: Parameter estimation

Y_i : 0 or1; 0 means other, 1 means buying HWARIN air conditioners

ε_i : The expectation of independent random variable is 0,

So $E(Y_i) = \beta' X_i$

Let $P_i = P(Y_i = 1)$, P_i is the probability of event happening $1 - P_i = P(Y_i = 0)$, $1 - P_i$ is the probability of event not happening

Then $E(Y_i) = 1 \cdot P_i + 0 \cdot (1 - P_i) = P_i$

As a result, we can explain the above regression model as the probability of event happening (Y_i =1) under the attribute of known individual (X_i). Mathematically, it is just like changing discontinuous variables into continuous ones in order to be analyzed by traditional multiple regression analysis. Considering the range of probability is between 0 and 1, the new model should be:

$$P_i = \beta' X_i \text{ , when } 0 < \beta' X_i < 1$$
$$P_i = 1 \text{ , when } \beta' X_i \geqq 1$$
$$P_i = 0 \text{ , } \beta' X_i \leqq 0$$

Reconsidering the probability distribution of ε_i : When X_i is fixed(known), the distribution of ε_i equals to the distribution of Y_i . $E(\varepsilon_i) = 0$, so

$$E(\varepsilon_i) = (1 - \beta' X_i) \cdot P_i + (-\beta' X_i) \cdot (1 - P_i) = 0$$
$$\therefore P_i = \beta' X_i \qquad 1 - P_i = 1 - \beta' X_i$$
And $E(\varepsilon_i)^2 = (1 - \beta' X_i)^2 \cdot P_i + (-\beta' X_i)^2 \cdot (1 - P_i)$

$$= (1 - \beta' X_i)^2 \cdot P_i + (-\beta' X_i)^2 \cdot (1 - \beta' X_i)$$
$$= (\beta' X_i) \cdot (1 - \beta' X_i) \cdot [(1 - \beta' X_i) + (\beta' X_i)]$$
$$= P_i \cdot (1 - P_i)$$
$$= E(Y_i) \cdot (1 - E(Y_i))$$

It shows that the variance of ε_i is Heteroscedastic. Because of that, if Linear Probability Model is applied to analyze two categorical dependent variables, the defects are:

1. 1. ε_i is non-normal distribution (Heteroscedastic), so applying Ordinary Least Squares will lose its effectiveness of parameters. Although we can apply Weighted Least Squares to clear Heteroscedastic, indeed, it shows irrational negative consistent estimate of variance of weight.
2. The worst defect is that the estimate of dependent variable might fall outside of (0.1), which disagrees with the expectation of conditional probability $E(Y_i|X_i)$.

The regression model is:

Y = β$_0$+β$_1$HA + β$_2$HS + β$_3$HB + β$_4$HD + β$_5$BF + β$_6$BB + β$_7$GF+ β$_8$HF + β$_9$FOF + β$_{10}$PF + β$_{11}$QSF + β$_{12}$SPF + β$_{13}$SF + β$_{14}$A$_1$+β$_{15}$A$_2$ +β$_{16}$A$_3$+β$_{17}$B$_1$+β$_{18}$B$_2$+β$_{19}$B$_3$+β$_{20}$C$_1$+β$_{21}$C$_2$+β$_{22}$C$_3$

Among the analysis, the explanatory variable is if the consumer bought a HWARIN air conditioner or not. (Y=1,

means s/he bought a HWARIN air conditioner before; Y=0, means s/he did not buy any HWARIN air conditioner.)

HA：How many air conditionersthere are at home
HS：What types of air conditioners there are at home
HB：What brands of air conditioners are at home
BD： Who made the final decision when buying a new air conditioner for the family
BF：The considerations of purchasing air conditioning products
BB： Top priority brands when buying air conditioning products
GF： The environmentally-friendly (Green) factor
HF： The health and safety factor
FOF： The function and appearance factor
PF： The price factor
QSF： The quality and service factor
SPF： The special promotion factor
SF： The space factor
$A_1 \sim A_3$：Age
$B_1 \sim B_3$：Residence

FINDINGS AND ANALYSIS

The descriptive statistics of basic information: 200 questionnaires were issued separately in the north, the central and the south parts of Taiwan with a total of 600 questionnaires from April 1st to April 14th in 2018. Valued 600 questionnaires were analyzed using SPSS and the result was given in Table 1 below.

The research results were analyzed as follows:

1. The consumers bought HWARIN air conditioners before: Yes for 50%; No for 50%.
2. How many air conditioners are at home now: The highest was 34.2% which means 4 air conditioners; the second highest was 30.3% which means 3 air conditioners.
3. What types of air conditioners at home: Both window type and wall split type accounted 47.0% which was the highest; the second highest was wall split type only which was 44.5%.
4. What brands are the air conditioners at home: The highest 50.0% was HWARIN whereas Hitachi was the second highest with 12.5%. This result was limited because the questionnaires were issued by resellers of HWARIN to survey those who already bought HWARIN air conditioners before. It explained the high percentage of HWARIN.
5. Who made the decision of purchasing air-conditioning products: After family discussion was the highest 50.2%; the second highest 30.2% was the consumers' own decision.
6. The considerations of purchasing air conditioning products: 30.7% of the consumers surveyed focused on the energy efficiency and 16.5% of them thought quality and service was their main concern.

Top priority brands when buying air conditioning products: The first priority was HWARIN which was 50.2% and second choice was Hitachi with 12.7%.

The regression analysis of the determinative factors that influence consumers' consumption of air conditioners: This research analyzed the results of the questionnaires by SPSS. The explained variable was if the consumers bought HWARIN air conditioners and to figure out its correlation with consumers' opinions of buying air conditioners and the factors that influenced purchasing, which included environmentally-friendly(Green) factor, health and safety factor, function and appearance factor, price factor, quality and service factor, special promotion factor and space factor. Furthermore, this research established the regression model that explained the influence of variables on buying HWAEIN air conditioners. The result was tested by different analyses to prevent any influence of variables on it so it became meaningless. Moreover, to get the best regression model that well explained the correlation of variables on buying HWARIN air conditioners. The best regression model is:

$$Y = \beta_0 + \beta_1 HA + \beta_2 HS + \beta_3 HB + \beta_4 HD + \beta_5 BF + \beta_6 BB + \beta_7 GF + \beta_8 HF + \beta_9 FOF + \beta_{10} PF + \beta_{11} QSF + \beta_{12} SPF + \beta_{13} SF + \beta_{14} A_1 \beta_{15} A_2 + \beta_{16} A_3 + \beta_{17} B_1 + \beta_{18} B_2 + \beta_{19} B_3 + \beta_{20} C_1 + \beta_{21} C_2 + \beta_{22} C_3$$

Table 2 shows that the regression equation is significant (F=5.6512；R squared=0.4682；P-Value=0.000), at the significance level of 0.05. All the following ten variables reach the significance level: Types of air conditioners at home (HS), Brands of air conditioners at home (HB), the decision maker of buying air conditioners (BD), Priority brands of air conditioners (BB), environmentally-friendly factor(GF), health and safety factor,(HF)、quality and service factor (QSF), promotion factor, (SPF), space factor (SF), and annual family income(C_1、C_2、C_3).

Conclusion

Research conclusions: The inductive inference and the analysis according to the assumption established by the empirical consequence of our research are as follows:

Hypothesis one: The different shopping backgrounds of the consumers have influence on the consumers' buying behavior, and there is significant correlation between those two factors.

All that lies in consumers' memory about any brand imagery is "the association with brands in thinking," including product features, customers' profit, product purposes, the appearance of products, life styles, competitors, and nationalities. To confirm if the association is linked to the brands, we need to ponder how other marketing proposals would affect the consumers' brand experiences. The more deeply the consumers think about the product information and connect it with extant brand cognition, the stronger associations with certain brands the consumers will have. So the types of air conditioners at home(HS), the brands of air conditioners at home(HB), the decision maker of buying air conditioners(BD), and the top priority brands (BB) are the key factors to affecting the purchase of air conditioners.

Hypothesis two: Different purchase views of the consumers have influence on the consumers' buying behavior, and there is significant correlation between those two factors.

Furthermore, the characteristic that consumers were provided with subjective satisfaction and both visible and invisible needs (Grapentine, 1995).

Table 1. The analysis of descriptive statistics

Questions	Item Type	Times	Proportion (%)
Did you buy a HAWRIN air conditioner?	Yes	300	50%
	No	300	50%
How many air conditioners are there in your home right now?	1	67	11.2%
	2	146	24.3%
	3	182	30.3%
	4	205	34.2%
What types of air conditioners are those in your home?	Window	51	8.5%
	Wall split	267	44.5%
	Both window and wall split air conditioners	282	47.0%
What brands are those air conditioners in your home?	Hitachi	75	12.5%
	DAIKIN	56	9.3%
	Panasonic	54	9.2%
	TECO	38	6.3%
	SANYO	36	6.0%
	SAMPO	42	7.0%
	HAWRIN	300	50.0%
Who made the decision of purchasing air-conditioning products?	My own choice	181	30.2%
	The final decision after family discussion	301	50.2%
	The advice from the seller	118	19.7%
The considerations of purchasing air conditioning products	environmentally friendly	56	9.4%
	Energy efficient	184	30.7%
	Health and safety	19	3.2%
	Price	81	13.5%
	Functions and Appearances	71	11.8%
	Quality and service	99	16.5%
	Special promotion	90	15.0%
Top priority brands when buying air conditioning products	Hitachi	76	12.7%
	DAIKIN	58	9.7%
	Panasonic	49	8.3%
	TECO	38	6.3%
	SANYO	35	5.8%
	SAMPO	43	7.2%
	HAWRIN	300	50.0%

Table 2. The table of regression explanatory variables

Code	No. of Questions	Explanatory variables	Anticipated symbol	β	p-value
The consumers' point of view of purchasing air conditioners					
HA	A-2	How many air conditioners are at home	?	0.309	0.442
HS	A-3	What types of air conditioners are at home	?	-0.083	0.002**
HB	A-4	What brands of air conditioners are at home	?	0.008	0.000**
BD	A-5	Who made the decision of buying air conditioners	?	-0.428	0.000**
BF	A-6	The considerations of purchasing air conditioning products	?	0.005	0.884
BB	A-7	Top priority brands when buying air conditioning products	?	0.008	0.000**
A.Factors that influence consumers					
GF	B-1~B5	Environmentally-friendly factor	+	0.269	0.004**
HF	C-1~C5	Health and safety factor	+	0.304	0.039*
FOF	D-1~D8	Function and appearance factor	+	0.683	0.492
PF	E-1~E5	Price factor	+	-9.494	0.146
QSF	F-1~F7	Quality and service factor	+	8.788	0.001**
SPF	G-1~G5	Special promotion factor	+	0.943	0.049*
SF	H-1~H6	Space factor	+	5.421	0.000**
C.Personal information					
	I-1	Age	?	-0.158	0.752
	I-2	Residence	?	-0.607	0.964
	I-3	Annual family income	+	0.337	0.001**
R squared	0.4682	F	5.6512	P-Value	0.000**
Adj R squared	0.4233				

A product is consisted of a set of attributes like appearance, brand, function, and price. Product attributes can bring advantages to enterprises among other competitors. Different consumers have varied preference and priority level on product attributes. Product attributes can inspire consumers' need and hence differentiates their buying behaviors. More than this, the quality of service is also an important factor in a successful business.

It is eternally true that consumers look for good quality of service, especially when the price of products and their costs remain the same. Quality is an important element to satisfy consumers beneath the surface of service, *a fortiori* an important concept in service. Price, the extent of advertisements and brand image are three most frequently chosen as outside attributes by scholars. Therefore the environmentally-friendly factor (GF), health and safety factor

(HF), quality and service factor (QSF), special promotion (SPF) and space factor (SF) are key to the decision of buying air conditioners.

Hypothesis three: Different demographic variables have significant connection with consumers' buying behavior.

As for the annual family income, the consumption expenditure has the mathematical function relationship to the annual family income. *Ceteris paribus*, the more income, the more consumption whereas the less income, the less consumption. Thus, annual family income (C_1、C_2、C_3) is the key factor to buying air conditioners.

Research Recommendations: Based on the situations of the positive analysis, whether consumers purchase the air conditioner or not counts on its brand, functions, environmental issues, and designs, which are the key factors in their mind. Thus, in this research, the suggestions about the marketing strategy of HAWRIN are as follows:

(1) Suggestions about the managing strategy of the air conditioner manufacturers

Besides the scale restriction, the current situations of the air conditioner industry mostly result from the mechanic's and the industry's preference ofimported goods. Adopting home products, which were frequently designed without uniform standards, leads to the fact that the manufacturers are usually exhausted to deal with the cases of different type specifications, so the manufacturers cannot proactively research, develop and configure. For lack of the powerful support from the domestic market, the manufacturing industry cannot improve nor has international competitiveness. As a result, the propositions about the management of the air-conditioning industry are as follows:

1) Lift up the working value for the final user. Under the circumstances of the specific functions and qualities the customers ask for, be sure to cut down on the cost of energy and the emission of carbon dioxide, make

rational use of the material and resource, and consume the energy reasonably so as to obtain the support and approval from consumers and the society.

2) Producing and the study realms have to co-set the engineering design, the norms of equipment and instruments, and the principles of working, testing, operating, and maintaining, which the whole industry should follow, and based on the norms and principles, they ought to set a practicable standard and process to examine the equipment, to check out the construction, to check and accept the systematic functions, and to ensure the guarantee. In this way, they will have a common standard for designing; the manufacturers can do the research, develop, and do the producing, while the dealers can sell the products at high prices.

3) In the process of consumption, consumers show their care of the environment and they value the Green image of enterprises from which they buy products. With the rapid increase of income, the idea of pursuing healthy and safe Green products has become common. The consumers also seek better quality and higher safety of products. In order to win the sharp competition, manufactures have to research and develop Green products continuously.

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