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An Exploratory Factor Analysis of Market Survey Instruments for Automobile Industry: A study on Malaysian Motor Vehicle Industry

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Abstract

Industrial and manufacturing sectors in Malaysia quite often perform market survey research to evaluate their customer's behavior, trust, and loyalty through the marketing activities approach which henceforth boosts up their organizational profit. However, there is a lack of good and potential instruments that could effectively measure marketing activities for the motor vehicle industry in Malaysia. Thus, in this paper, a new instrument were designed based on literatures and opinion from experts for measuring the targeted constructs in this industry. As to accessing these validity indicators, exploratory factor analysis (EFA), reliability and correlation analysis were used. The results of the analysis based on 151 local made car owners indicated that all extracted factors as having good values of factor loadings and communalities (i.e. above 0.55) and acceptable level of reliability value (i.e. Cronbach's alpha above 0.70). These extracted factors also have good discriminant and nomological validity, since the correlation analysis proof that, the directions of relationships among the extracted factors follow the expected theory (i.e. positive direction) and the strength of the correlation is moderately strength. Therefore, the designed instruments were valid and reliable for accessing the targeted variables in the context of motor vehicle industry in Malaysia.

Keywords: Automotive sector, statistical analysis, questionnaire, validity, reliability.

1. Introduction

Competition among the carmakers is getting more intense around the world with the impact of new technologies in Industrial Revolution 4.0 (i.e. IR 4.0). The Malaysian motor vehicle industry has not been excluded from this situation as several well-known foreign carmakers have established a variety of car models in Malaysia (Pauzi et al. 2014, Mashahadi and Mohayidin 2015). However, due to the escalating price of foreign made cars, many Malaysians from the moderate-income group would turn to the local made cars, which is lower in price and economical (Saidin et al. 2015, Zolkifly 2013). Hence, this has generated a big competition between the two local Malaysian carmakers which is Perusahaan Automobil Nasional Berhad (Proton) and Perusahaan Automobil Kedua (Perodua). Based

on this scenario, both local carmakers should have a good marketing strategy for attracting customers to buy their products (Leow and Husin 2015, Khamis and Abdullah 2014, Ghazali et al. 2008). Although, they may have a good marketing strategy for making sales, it is the loyalty and trust of the customers that they must upkeep (Javed et al. 2015, Anantha and Huam 2014, Nawi et al. 2013, Nezakati et al. 2011).

According to Kandampully et al. (2015), Javed et al. (2015) and Mansour et al. (2014), good levels of brand trust and loyalty will lead to high intention of customers buying the products. Therefore, it is very crucial to measure the impact of marketing activities toward brand trust, brand loyalty, and response behavior of the customers among the customers that using the Malaysian brand cars. It is because in the Malaysian motor vehicle industry, there is no standard instruments that could effectively measure marketing activities for the motor vehicle industry in Malaysia (Wad and Govindaraju 2011, MIDA 2009, MITI 2009). With the development of the instruments, this paper will examine the construct reliability and validity of the indicators that will effectively measure marketing activities, brand trust, brand loyalty, and response behavior conceptual variables among the local made car owners, since these selected variables are the important variables for capturing the response behavior of the respondents (Zemack-Rugar et al. 2019, Zaw and Sirion 2014, Wang et al. 2014, Yee et al. 2011, Churchill 1979).

2. Design and Methodology

2.1. Study design

This study applied a survey cross-sectional design with the applications of quantitative methods. Part of the method involved validating and exploring the relationships between the conceptual and operationally defined variables namely, marketing activities, brand trust, brand loyalty and response behavior. In this study, target population are people who are related to a Malaysian local car. Specifically, the target population shall consist of people who currently owned a local car and wanted to purchase a second local car, namely repeat customer. Judgmental sampling technique is used and deemed suitable since there is no sampling frame criteria for choosing the targeted respondent (Lohr 2010).

A total of 151 respondents who are owners of the local brand cars in the Klang Valley have participated in this study. This sample size is considered adequate, as the minimum sample size required to cover a 95% confidence interval with 15% effect size power is 90 respondents. This is based on the calculation of the G-Power (Hair et al. 2017). Data was collected using a combination of two communication methods namely, face-to-face interview and self-administered internet survey via Google form. This is to ensure a moderate to high response rates are achieved.

2.2. Survey instruments

In measuring marketing activities, brand trust, brand loyalty and response behavior, 29 indicators were constructed based on literature and expert opinions. These 29 indicators were assigned a 7-point Likert scale where 1 refers to strongly disagree and 7 refers to strongly agree and were randomly located in the instruments. In measuring marketing activities, three dimensions were constructed based on Kim and Ko (2012), which are trendiness, interaction and entertainment. Trendiness can be defined as the characteristics of the product styles that meet the customer needs (Huyen and Costello 2017), whereas interaction is the process of interaction between any sales medium and customers about the product (Evert and Cristina 2010). Entertainment is the positive medium of after sales marketing activities such as services after sales and social media platform between customers and carmakers (Taylor et al. 2011). For each dimension, four indicators operationally measure each dimension.

As for Brand Trust, it can be defined as the willingness of customer to rely on the stated function of the product brand (Lu et al. 2010, Kim and Hyun 2011) and the ability and willingness to fulfil customer's needs and welfares (Sahin et al. 2011). Brand Loyalty is the faithfulness feeling of customers to the same brand (Flavian et al. 2006, Lau and Lee 1999). According to Kandampully et al. (2015), brand loyalty can also be considered as psychological commitment that a customer makes in purchase without necessarily considering that actual recurrence purchase into account. Four indicators were used to operationally measure the variables. Finally, three dimensions, namely positive word-of-mouth (i.e. PWOM), purchase intention and recommendation represent response behavior.

In PWOM, customers will spread positive story about the product based on their experience using the product (Sweeney et al. 2010, Kim and Ko 2012). Purchase intention relates to feelings and behavior towards buying something while recommendation is a suggestion from the current customers to the new customers about their experience using the product (Curty and Zhang 2013, Park et al. 2007). According Hajli et al. (2014), social media can be used as a platform for the recommendation process. Three indicators were constructed to operationally measure each dimension. Table 1 shows the 29 indicators that represents the respective dimensions in this study.

2.3. Statistical analysis

The processes of data entry and data analysis were conducted using the IBM SPSS Statistics for Windows, Version 21 (IBM Corp 2012). Since the primary interest in this study is to examine the construct reliability and validity of the instrument, therefore exploratory factor analysis (i.e. EFA) and correlation analysis were used. This analysis allows the researcher to validate and refine the indicators used in this study (Ong and Puteh 2017, Hair et al. 2010). Two regimes of EFA analysis were compared in order to obtain a valid structure for the instruments. The first regime is about a combination of principal axis factoring (i.e. PAF) extraction method with direct oblimin rotation (Hair et al. 2010, William et al. 2010) while the second regime of EFA analysis used the combination of principal component (i.e. PC) extraction method with a varimax rotation analysis (Pallant 2010, William et al. 2010).

In ensuring that the covariance matrix among the items are sufficient and not an identity matrix, Kaiser-Meyer-Olkin (i.e. KMO) index should be greater than 0.60 (Field 2009, Tabachnick and Fidell 2007) and also the Bartlett's Test of Sphericity should be significant (Pallant 2010), hence the EFA analysis can be proceeded. Thompson and Daniel (1996) suggested to use multiple criteria approached for determine the number of factors or variables that should be extracted in order to confirming and validating the number of variables extracted from the analysis. In this analysis procedure, only factors with eigenvalue greater than 1.00 are retained (Hair et al. 2010, Tabachnick and Fidell 2007) and the percentage of the variance that is more than 60% can be used to determine the number of factors or variables that should be extracted (Hair et al. 2010, Thompson and Daniel 1996). As for measuring the validity of the items, factor loading and communalities values should be more than 0.55 (Hair et. al. 2010) for a considerable sample size (n = 151). This is to ensure a highly confident and adequate level of factors extracted is distinct, meaningful and valid. Finally, internal test of consistency items grouped from the EFA were analyzed using Cronbach's alpha reliability test. Nunnally and Bernstein (1994) suggested that, the cutoff 0.70 and above can be used to indicate the grouped items were reliable.

To further access the validity of the extracted factors from the EFA analysis, discriminant and nomological validity was performed. Nomological validity is a logical and relevance relationship exists among the variables that follows the expected relationship direction, which is either it is a positive or negative relationship (Creswell 2014, Hair et al. 2010, Saunders et al. 2009, Kaptein 2008).

In this nomological validity process, correlation analysis was used since this analysis permit the researchers to measure the direction of the relationship among the extracted variables (Creswell 2014; Field 2009). On the other hand, discriminant validity is about to testing the degree to which the measures of different variables are distinct (Hair et al. 2010, Kaptein 2008). Hence, from the correlation analysis, this discriminant validity can be access by measuring the strength of the relationship. According to Hair et al. (2010), there is exist a discriminant validity when the correlation coefficient is less than 0.70, which below than moderate strength.

Table 1 Variables and indicators description

Variable	Code	Indicator Description
Trendiness	TRE1	Using this local made car make me follow the latest trend about car
	TRE2	Using this local made car support my lifestyle trending
	TRE3	This local made car reflect my lifestyle trending
	TRE4	This local made car complete my lifestyle trending
Interaction	INT1	This local made car social media enable information-sharing with others
	INT2	Conversation or opinion exchange with others is possible through this local made car social media
	INT3	It is easy to deliver my opinion through this local made car social media
	INT4	Local made car party provide social media platform interaction that is easy to access
Entertainment	ENT1	Using this local made car social media platform is fun
	ENT2	Using this local made car social media platform makes me happy
	ENT3	Using this local made car social media platform is entertaining
	ENT4	Using this local made car social media platform make my life completed
Brand Trust	TRU1	I have trust in this brand
	TRU2	This brand is reliable
	TRU3	This is a true brand
	TRU4	This brand meet my expectations
Brand Loyalty	LOY1	I regularly monitor the popularity of this brand
	LOY2	I would buy a same brand car even though it is in the average value
	LOY3	This brand would always be my first choice
	LOY4	If I like a brand, I rarely switch to buy new brand
Positive Word-of-Mouth	WOM1	I would like to pass information on this local made car to my friends
	WOM2	I would like to upload content of this local made car on my blog or micro blog
	WOM3	I'll talk about the strengths of this local made car with people I know
Purchase Intention	PUR1	Although another brand has the same features as this local made car, I would prefer to purchase from this local made car
	PUR2	If another brand does not differ from this local made car, it seems smarter to purchase from this local made car
	PUR3	Although there is another brand as good as this local made car, I prefer to buy from this local made car
Recommendation	REC1	I would like to recommend this local made car to other customers
	REC2	I would to recommend this local made car to my friends and relatives
	REC3	If you ask me about local made car, I will definitely recommend it

3. Analysis and Results

3.1. Exploratory factor analysis

Referring to the Table 2, it shows the summary of multiple criterions used to determine the number of factors that could be extracted. The analysis shows that, the EFA analysis for both methods could extract seven components from a group of 29 indicators since the first seven eigenvalues under the Kaiser's criteria (i.e. between 13.193 and 1.057) exceeded the value of 1.00. The extracted factors are 78.71%, which exceed 60% of the cumulative percentage of variance explained. Hence, this confirms the extraction of seven components or factors from the 29 indicators. The KMO index for both analysis was 0.937 and the Bartlett's test for sphericity for the indicators in both regimes were largely significant ($\chi^2 = 6630.17$, p-value < 0.01). Therefore, it can be concluded that, the covariance matrices for these 29 indicators were not identity matrices and the items can be used for EFA analysis.

Table 2 Multiple criterion for factors to be extracted

Component Number	Initial Eigenvalue	Cumulative % Variance Explained	Decision
1	13.193	48.94	Accept to Extract
2	2.312	56.92	Accept to Extract
3	1.891	63.44	Accept to Extract
4	1.884	68.05	Accept to Extract
5	1.337	72.02	Accept to Extract
6	1.152	75.66	Accept to Extract
7	1.057	78.71	Accept to Extract
8	0.884	-	Reject to Extract

Note: Only the first 8 out of 29 components were reported

Table 3 shows the loading and communalities values for each indicator based on two methods of EFA analysis. For the first EFA method (i.e. PC + Varimax), all loadings (i.e. range 0.552 to 0.847) and communalities (i.e. range 0.607 to 0.905) values were above the minimum cut-off point value of 0.55. Similarly for the second EFA method (i.e. PAF + Oblimin), all 29 indicators also have a loading (i.e. range 0.553 to 0.910) and communalities (range 0.514 to 0.906) values more than 0.55. Therefore, it can be concluded that, all 29 indicators were valid and can be used as indicators for measuring the targeted variables in this study.

Based on the pattern of indicators grouping, both analysis methods show a similar pattern. Entertainment, interaction and trendiness, which are sub-dimensions of marketing activities, were treated as three components. In both analyses, brand trust and brand loyalty have maintained their variable structure. For response behavior, both analyses indicate that positive word-of-mouth and recommendation should be combined into one dimension, whereas purchase intention should maintain its component structure. Therefore, a combination of positive word-of-mouth and recommendation components were renamed as the positive recommendation dimension, since both methods of EFA analysis shows that all the six indicators collapse in one dimension structure. Besides that, by looking at the items description from WOM1 until REC3, all items can be categorized as a positive linguistic activity. In terms of reliability of the grouped indicators, Cronbach's alpha reliability analysis, which is 0.772, indicates that all the seven grouped indicators meet the minimum cut-off value of 0.70. Hence, it can be concluded that, all grouped indicators were valid and consistently measuring the variables.

Table 3 Comparative results of two methods of EFA analysis

Components and Items Included	PC + Varimax		PAF + Oblimin	
	Loading	Communalities	Loading	Communalities
Variable: Entertainment				
ENT1	0.767	0.850	−0.810	0.802
ENT2	0.799	0.899	−0.910	0.906
ENT3	0.773	0.850	−0.825	0.801
ENT4	0.631	0.723	−0.559	0.619
Eigenvalue = 1.152, % variance explained = 3.64%. Cronbach's alpha = 0.904				
Variable: Interaction				
INT1	0.806	0.766	0.800	0.660
INT2	0.847	0.816	0.909	0.768
INT3	0.783	0.752	0.748	0.673
INT4	0.682	0.647	0.582	0.514
Eigenvalue = 1.337, % variance explained = 3.97%. Cronbach's alpha = 0.844				
Variable: Trendiness				
TRE1	0.699	0.737	0.581	0.657
TRE2	0.732	0.813	0.629	0.758
TRE3	0.704	0.734	0.553	0.621
TRE4	0.788	0.882	0.807	0.914
Eigenvalue = 2.312, % variance explained = 7.98%. Cronbach's alpha = 0.879				
Variable: Brand Trust				
TRU1	0.807	0.872	0.814	0.838
TRU2	0.828	0.905	0.882	0.906
TRU3	0.819	0.890	0.839	0.864
TRU4	0.658	0.779	0.584	0.724
Eigenvalue = 13.193, % variance explained = 48.94%. Cronbach's alpha = 0.929				
Variable: Brand Loyalty				
LOY1	0.634	0.684	0.562	0.557
LOY2	0.676	0.711	0.794	0.725
LOY3	0.576	0.716	0.574	0.657
LOY4	0.744	0.607	0.585	0.525
Eigenvalue = 1.057, % variance explained = 3.05%. Cronbach's alpha = 0.772				
Variable: Purchase Intention				
PUR1	0.792	0.852	0.801	0.839
PUR2	0.788	0.792	0.775	0.720
PUR3	0.752	0.796	0.706	0.733
Eigenvalue = 1.891, % variance explained = 6.52%. Cronbach's alpha = 0.901				
Variable: Positive Spreads				
WOM1	0.710	0.784	−0.611	0.709
WOM2	0.552	0.676	−0.562	0.590
WOM3	0.792	0.834	−0.728	0.765
REC1	0.586	0.809	−0.588	0.783
REC2	0.611	0.827	−0.570	0.807
REC3	0.595	0.821	−0.598	0.803
Eigenvalue = 1.884, % variance explained = 4.61%. Cronbach's alpha = 0.910				

Note: The negative signs in the loading values indicate that, these indicators were located at the negative axis of the rotation method; Both EFA analysis regimes produces the same value of eigenvalues, hence produce the same of variance explained from the extracted components which is 78.71%; PC = principal component; PAF = principal axis factoring; Refer to Table 1 for coded indicators definition.

3.2. Discriminant and nomological validity

Table 4 shows the results of the correlation analysis that examine the nomological validity of the variables. The correlation analysis indicates that, all the bivariate relationship among the components were positively significant at 95% confidence level (i.e. all p-values < 0.05). Therefore, it can be concluded the components have a good nomological validity since all bivariate relationships among the components have a positive relationship. On the other hand, the correlation analysis also confirm that, discriminant validity were met since all the correlation coefficient are less than 0.70 (range 0.274 to 0.699). Hence, the extracted groups of items that measuring variables can be considered sufficiently discriminate the variables extracted since the strength of the relationship can be considered below than moderate strength.

Table 4 Correlation analysis among extracted components from EFA analysis

Component	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1)	1.000						
(2)	0.481*	1.000					
(3)	0.546*	0.445*	1.000				
(4)	0.562*	0.351*	0.519*	1.000			
(5)	0.397*	0.299*	0.549*	0.461*	1.000		
(6)	0.604*	0.392*	0.699*	0.620*	0.630*	1.000	
(7)	0.402*	0.274*	0.364*	0.468*	0.476*	0.561*	1.000

Note: (1) = Entertainment; (2) = Interaction; (3) = Trendiness; (4) = Brand Trust; (5) = Brand Loyalty; (6) = Positive Spreads; (7) = Purchase Intention; n = 151; *p-value < 0.05.

4. Discussion

This paper has demonstrated the process of developing the survey instruments based on two methods of EFA and correlation analysis for the Malaysian automobile industry as for to examining the instrument validity and reliability. Based on the two EFA methods, the selected indicators for measuring the variables showed a valid and acceptable result. This is emphasized either through the first or second method of extraction and rotation techniques where a similar pattern of indicators grouping was identified. Furthermore, each indicator has also met the minimum requirement loading and communalities of more than 0.55. In addition, the internal consistency reliability test based on Cronbach's alpha value also proved that for each group of indicators, it has an acceptable and satisfactory internal consistency, since the minimum value of Cronbach's alpha was 0.772. Pearson's correlation analysis also confirmed that all bivariate relationship among the variables were positive and statistically significant (i.e. p-value < 0.05) and the strength of the relationship can be categorized as below than moderate strength (i.e. r < 0.70). This indicates that, all extracted variables from the EFA analysis have good nomological and discriminant validities.

5. Conclusions

Based on this findings, the develop instrument can be described as a valid and fit instrument to measures the targeted variables based on EFA and correlation analysis. This research work is very importance since it can be an alternative useful tool for measuring overall customer perceptions toward the Malaysian local car services from the perspective of after sale services. In addition, this develop instrument can be as a stepping stone work for redesigning and creating a good instrument for measuring this interesting phenomena that meet the Industrial Revelation 4.0 era. On the other hand, this research work also emphasized the useful of EFA analysis for the initial development stage of instrument validation procedure. Hence, this study has demonstrated that all indicators in this

instrument were valid and reliable for assessing the market survey variables in the Malaysian automobile industry. Following this analysis, this study has also embarked on a causal analysis for further examine the global fits indexes such using the RASCH analysis, confirmatory factor analysis (i.e. CFA) or partial least square consistency (i.e. PLSc) for further testing the validity of the instrument. In addition, this instrument can be used outside from the automotive industry such as electrical consumer industry and also heavy machinery industry, provided that it has a marketing activity based on IR 4.0 platform as for achieving the overall global fit indexes for this instrument.

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