การวิเคราะห์แบบจำลองสมการโครงสร้างของการใช้น้ำมันแก๊สโซฮอล์ 95 ในรถจักรยานยนต์

Structural Equation Modeling of Motorcycle Gasohol 95 Consumption

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บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์เพื่อวิเคราะห์ปัจจัยที่ส่งผลต่อการใช้น้ำมันแก๊สโซฮอล์ 95 ในรถจักรยานยนต์ กลุ่มตัวอย่างที่ใช้คือ ผู้ขับขี่รถจักรยานยนต์ที่ใช้น้ำมันแก๊สโซฮอล์ 95 ในเขตอำเภอเมือง จังหวัดนครราชสีมา จำนวน 510 คน ทำการวิเคราะห์ข้อมูลด้วยเทคนิคการวิเคราะห์แบบจำลองสมการโครงสร้าง ผลการวิจัยพบว่า แบบจำลองสมการโครงสร้างสุดท้ายของการใช้น้ำมันแก๊สโซฮอล์ 95 ในรถจักรยานยนต์มีความสอดคล้องกลมกลืนกับข้อมูลเชิงประจักษ์ ปัจจัยที่ส่งผลต่อการใช้น้ำมันแก๊สโซฮอล์ 95 ในรถจักรยานยนต์ประกอบด้วย 7 ปัจจัย เรียงลำดับจากสูงสุดไปต่ำสุดได้ดังนี้ ปัจจัยด้านข้อมูลข่าวสาร ปัจจัยด้านสถานีบริการน้ำมัน ปัจจัยด้านความพึงพอใจ ปัจจัยด้านการประเมินผลทางเลือก ปัจจัยด้านการตัดสินใจซื้อ ปัจจัยด้านราคา และปัจจัยด้านการประชาสัมพันธ์ โดยปัจจัยทั้งเจ็ดส่งผลกระทบทางตรงเชิงบวกต่อการใช้น้ำมันแก๊สโซฮอล์ 95 ในรถจักรยานยนต์ และสามารถอธิบายความแปรปรวนของการใช้น้ำมันแก๊สโซฮอล์ 95 ในรถจักรยานยนต์ได้ร้อยละ 86.5

คำสำคัญ : การวิเคราะห์แบบจำลองสมการโครงสร้าง รถจักรยานยนต์ น้ำมันแก๊สโซฮอล์ 95

ABSTRACT

The purpose of this research was to analyze factors that affecting gasohol 95 consumption for motorcycles. The sample size consisted of 510 motorcyclists who used gasohol 95 in Muang District, Nakhon Ratchasima Province. The Structural Equation Modeling was used for analyzing data. The research results found that the final structural equation model of gasohol 95 consumption for the motorcycle was consistent with the empirical data. Factors affecting the consumption of gasohol 95 for motorcycles consisted of seven factors that could be sorted from highest to lowest as follows: first-information factor, second-gas station factor, third-satisfaction factor, fourth-alternative evaluation factor, fifth-purchase decision factor, sixth-price factor, and seventh-public relations factor. All factors had a positive direct effect on gasohol 95 consumption. Also, they could explain the variance in the consumption of gasohol 95 for motorcycles at 86.5 percent.

Keywords : Structural Equation Modeling, Motorcycle, Gasohol 95

1. Introduction

According to the final energy consumption situation in Thailand over the past 10 years, the tendency of the final energy consumption has increased continuously. In 2016, the final energy consumption increased from last year by 2.63 percent [1] as shown in Figure 1. The economic sector consuming the most of final energy is the transportation sector. The petroleum products are used in all economic sectors and also the highest proportion of consumption with 49.69 percent of total final energy consumption [2][3] as shown in Figure 2.

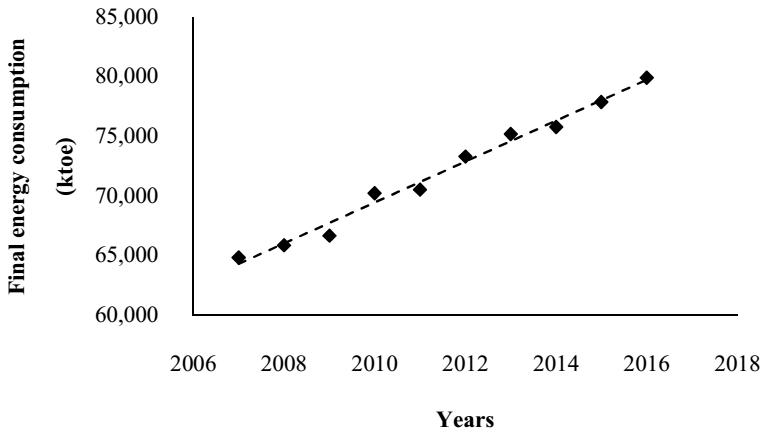

Figure 1: Final energy consumption in Thailand in 2007 – 2016 [1]

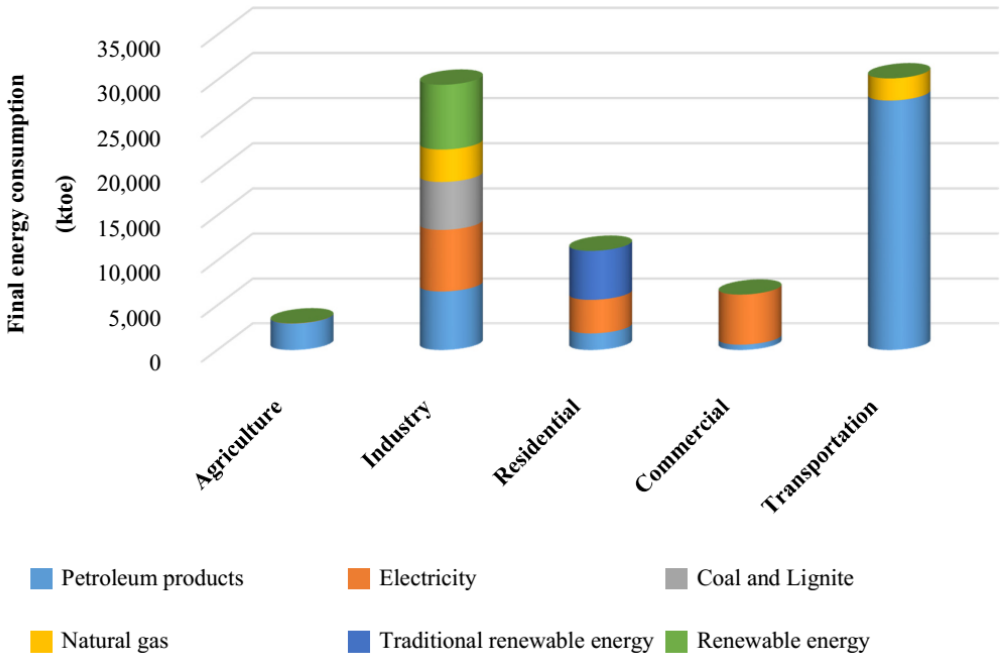

Figure 2: Final energy consumption by economic sectors in 2016 [2][3]

Petroleum products include liquefied petroleum gas, gasoline, jet fuel, kerosene, fuel oil, and diesel. Gasoline is a derivative product of crude oil. It is derived during the distillation process of crude oil. Also, it mixes the additives to suit the application such as mixing Methyl Tertiary Butyl Ether (MTBE) to increase octane. Because of Thailand cannot produce enough crude oil to demand, then it must be imported from abroad. Crude oil is the most energy imported as compared to other energy [4]. To reduce the import of crude oil as well as raise the level of agricultural crops in Thailand, King Bhumibol Adulyadej has initiated the Royal Chitralada Project on the production of gasohol since 1985 [5]. Gasohol is the combination of gasoline and ethanol. Ethanol is used to substitute methyl ether butyl ether that must be imported from abroad. Ethanol can be produced from agricultural crops such as sugarcane and cassava. In 2016, gasohol 91 and gasohol 95 were high consumed at 79.45 percent while gasohol E20 and gasohol E85 were low consumed at only 20.55 percent [6].

According to the number of the vehicle registered in Nakhon Ratchasima Province as of 28 February 2017, the motorcycles were the most registered number at 57.14 percent as shown in Figure 3. Also, they were the most registered number in the Northeastern region [7].

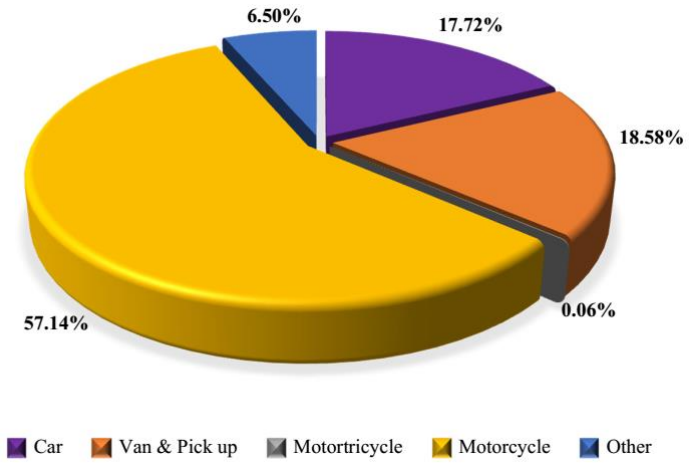

Figure 3: Number of vehicle registered in Nakhon Ratchasima Province as of 28 February 2017 [7]

In 2015, the situation of ethanol consumption was only 3.50 million litres a day or 652 thousand tons of crude oil equivalent (ktoe). For the oil management plan in 2015 – 2036, the target of ethanol consumption in 2036 rises to 11.30 million litres a day or 2,104 ktoe [8].

To raise the ethanol consumption in Thailand and to achieve the set target in 2036 must be getting the cooperated all gasohol users as well as must be created acceptance and reduced opposition to use gasohol in the future. Therefore, the study about factors that affecting gasohol consumption for the motorcycle is the need. In this research concentrates on gasohol 95 because it is high consumption in Nakhon Ratchasima Province and Thailand. The research results help to acknowledge the factors that affect the decision to consume gasohol 95 for the motorcycle as well as can further expand the research on risk analysis and risk management. Also, government or Ministry of Energy or the private agencies can use the research results in planning and

promotion increasing gasohol consumption and achieving the target in 2036.

2. Objective

The objective of this research is to analyze factors that affect to gasohol 95 consumption for motorcycles.

3. Hypothesis

From the previous research results about factor analysis of using biofuels for motorcycle [9] found that F1: information, F2: price, F3: gas station, F4: public relations, F5: alternative evaluation, F6: purchase decision, and F7: satisfaction were factors involved the use of biofuels for motorcycle. All factors could be measured by the observed variables as X1-X15, X17-X23, and X25-X45 that the details of each variable display in Appendix A. The initial structural equation model of research is presented in Figure 4 when variable Y is gasohol 95 consumption in litres. Thus the hypotheses of this research are defined as follows:

H1: F1 influences gasohol 95 consumption (Y)

H2: F2 influences gasohol 95 consumption (Y)

H3: F3 influences gasohol 95 consumption (Y)

H4: F4 influences gasohol 95 consumption (Y)

H5: F5 influences gasohol 95 consumption (Y)

H6: F6 influences gasohol 95 consumption (Y)

H7: F7 influences gasohol 95 consumption (Y)

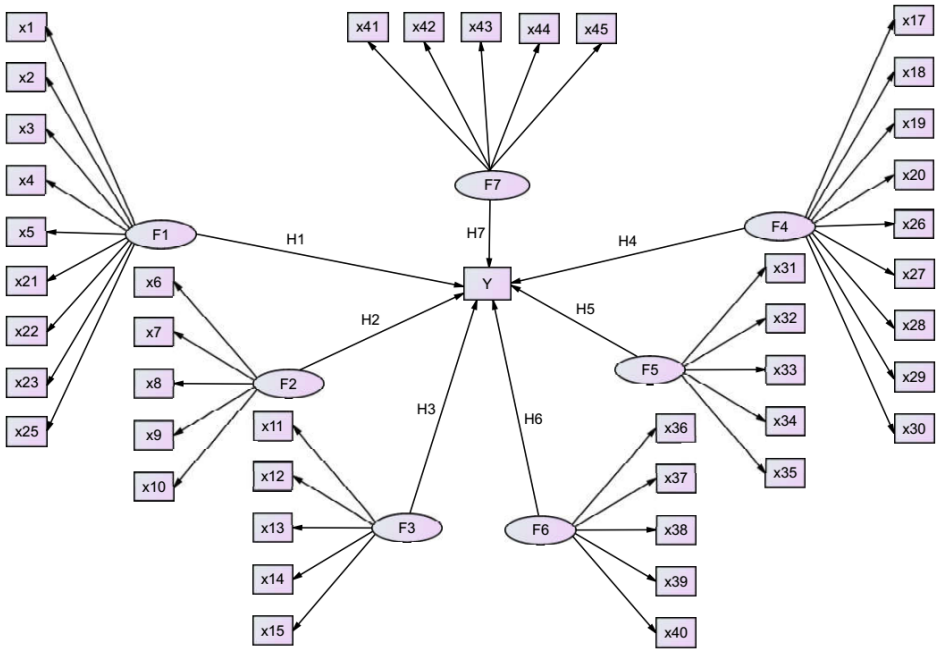

Figure 4: Initial structural equation model

4. Research Methodology

The population of this research was motorcyclists who use gasohol 95 in Muang District, Nakhon Ratchasima Province. The analysis by using Structural Equation Modeling (SEM) should have the sample size of at least 100–200 [10][11][12] or at least 5 to 10 times of the number of variables [13][14][15][11][16][17]. This research had the number of observed variables as 44 variables: X1-X15, X17-X23, X25-X45, and Y. For protecting error and increasing reliability, so the sample size of this research was 510 motorcyclists. The purposive sampling was used to select top six areas in

Muang District, Nakhon Ratchasima Province where have the most people for collecting data (25 percent of the administrative district) as follows: Nai Muang Sub-district, Cho Ho Sub-district, Pho Klang Sub-district, Hua Thale Sub-district, Nong Bua Sala Sub-district, and Khok Kruat Sub-district. Furthermore, the convenience sampling was used collecting data as 85 samples for each of Sub-district.

The measurement instrument of this research was the questionnaire which based on the previous research about factor analysis of using biofuels for motorcycle [9]. The items of the questionnaire reviewed from theories and researches relating marketing mix, i.e., product, price, place, and promotion, consumer behavior, and consumer buying decision process, i.e., problem recognition, information search, evaluation of alternatives, purchase decision, and post-purchase behavior. These are very important to the decision buying from consumers [18-25]. A five-point Likert scale (5=most influencing, 4=much influencing, 3=moderate influencing, 2=less influencing, and 1=least influencing) was applied to answer each item. The items of the questionnaire are presented in Appendix A. The measurement instrument was assessed for their content validity by three experts in their respective fields upon the Item - Objective Congruence (IOC) index. The IOC indices of each item were between 0.67-1.00 (higher than 0.50 was acceptable [22]). In order to assess the reliability of the questionnaire, the questionnaire was tried out with 40 motorcyclists who are not the sample. The reliability of questionnaire estimated by Cronbach's alpha coefficient. The Cronbach's alpha coefficient was 0.96 (higher than 0.70 was acceptable [26]).

This research used SEM to inquire factors affecting gasohol 95 consumption on motorcycles. SEM is a multivariate statistical tool that is used to analyze the relationships between constructs. It composes of two models as measurement model and structural model that can analyze at the same time. Also, it is the combination of Multiple Regression Analysis (MRA) and Factor Analysis (FA). The measurement model is an analysis of relations between observed variables and latent variables using Confirmatory Factor Analysis (CFA). The structural model is an analysis of the causal relations between latent variables among themselves using Multiple Regression Analysis. A measurement model and structural model can be analyzed in a single model [27]. The initial structural equation model as in Figure 4 was analyzed using AMOS. Maximum Likelihood (ML) was used to estimate model parameters. Also, the several indices used to evaluate overall model consistency such as relative chi-square (CMIN/DF) [28][11][29], Incremental Fit Index (IFI) [30][26], Comparative Fit Index (CFI) [30][26], Tucker-Lewis Index (TLI) [30][17][26], and Root Mean Square Error of Approximation (RMSEA) [17]. The acceptable values of each index represent in Table 1. These mean that the model is consistent with the empirical data. Moreover, HOELTER Index uses to decide the reasonable sample size that should greater than 200 [26].

To establish the strengths of the final SEM, then reliability and validity assessment of constructs were needed. The reliability assessment with Cronbach's alpha coefficient performed by using SPSS. The acceptable Cronbach's alpha coefficient should greater than 0.70 [31][32]. Convergent validity assessed from the standardized loadings of the measurement models in the final SEM analysis. The acceptable standardized loadings should be not less than 0.50 but a threshold of 0.70 widely used as an acceptable level [16][31][32]. The observed variables with low standardized loadings should consider eliminating. Furthermore, discriminant

validity assessed by cross-loadings analysis using SPSS. For cross-loadings analysis, the factor loading indicators on the assigned construct must be higher than all loading of other constructs [31][32][33].

The acceptable hypothesis considered from the significance level (p-value) less than 0.05 and the Critical Ratio (C.R.) greater than 1.96 [34].

5. Results

The collecting data of the sample indicated that the mean of each item that involved to factors of using biofuels for motorcycles ranged from 3.394 to 4.094, and the standard deviation ranged from 0.584 to 1.055. The mean of gasohol 95 consumption was 22.434 litres and the standard deviation was 9.465 litres. In addition, the normality test of variables was done using SPSS. The absolute values of Skewness Index (SI) were between 0.003 and 0.770 that less than 2 [35] and the absolute values of Kurtosis Index (KI) were between 0.051 and 0.780 that less than 7 [35]. Thus, the distribution of variables was the normality and appropriate to use ML estimator in SEM analysis.

The results of the initial SEM analysis and model refinements showed that the observed variables X7: Each of biofuels price is not the same resulting you choose the cheapest biofuels, X23: Biofuels help to achieve the target for the oil management plan in 2015-2036, X35: There is an evaluation of worthiness in tuning up an engine or mounting additional equipment when it does not work with biofuels, and X37: There is a decision to use biofuels because it supports the policy of the government were eliminated because of their standardized loadings lower than 0.50. The final SEM of the factors affected gasohol 95 consumption presented in Figure 5. The findings showed that the final SEM was consistent with the empirical data with CMIN/DF = 2.142, IFI = 0.973, TLI = 0.971, CFI = 0.973, RMSEA = 0.049, and HOELTER = 244 as shown in Table 1.

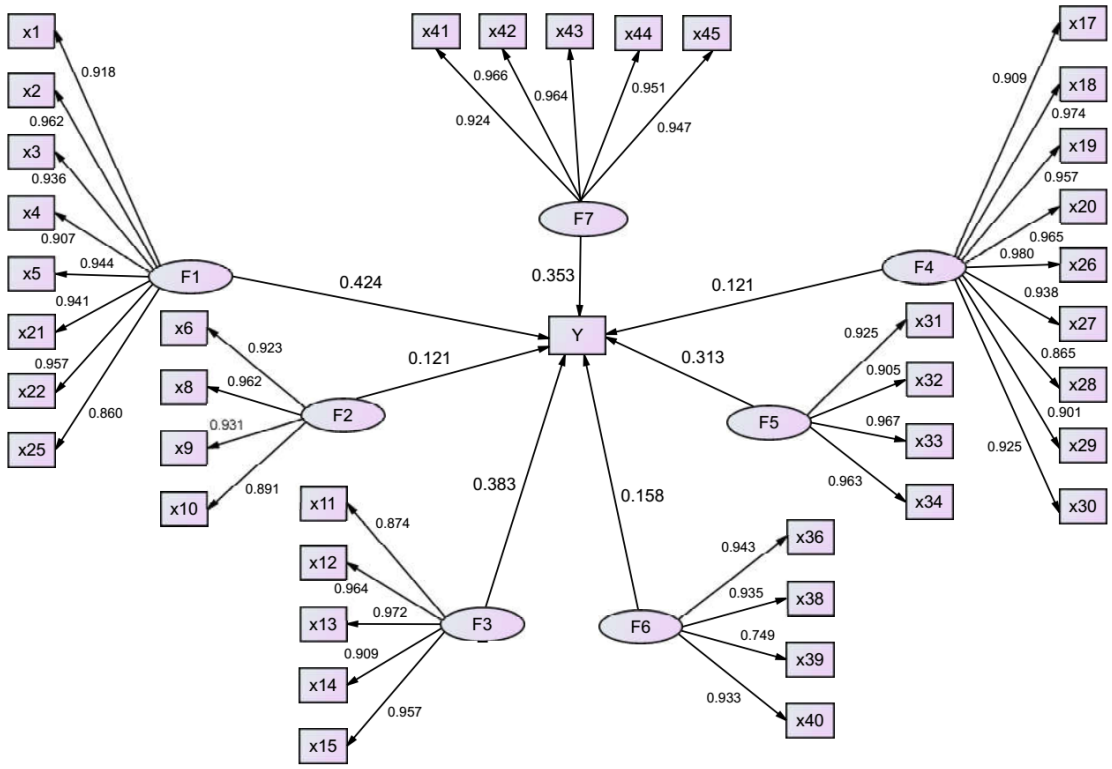

Figure 5: Final SEM of the factors affected gasohol 95 consumption

Table 1 Goodness of fit indices for the final SEM on gasohol 95 consumption

Goodness of fit index	Recommended level	Final SEM
CMIN/DF	≤ 3.00	2.142
IFI	≥ 0.90	0.973
TLI	≥ 0.90	0.971
CFI	≥ 0.90	0.973
RMSEA	≤ 0.05	0.049
HOELTER .05	> 200	244

From reliability testing of the final SEM found that Cronbach's alpha coefficients were greater than 0.70. For convergent validity assessment found that all standardized loadings of the measurement models were above 0.50 as shown in the final SEM as in Figure 5. Moreover, discriminant validity assessment by checking the cross-loadings found that factor loadings were high on their respective constructs. Overall, the final SEM in this research were reliable and valid.

The standardized path coefficients of the relationship between the constructs were all significant as shown in Table 2. All hypotheses supported at the acceptable significance level (p-value) less than 0.05 and C.R. greater than 1.96. Therefore the factors that significantly affected gasohol 95 consumption as follows: information, price, gas station, public relations, alternative evaluation, purchase decision, and satisfaction. As seen in Table 2, information (path coefficient 0.424) as a factor that has the greatest influence on gasohol 95 consumption, followed by gas station (path coefficient 0.383), satisfaction (path coefficient 0.353), alternative evaluation (path coefficient 0.313), purchase decision (path coefficient 0.158), price (path coefficient 0.121), and public relations (path coefficient 0.121) at a significance of 0.05. Also, those factors could predict gasohol 95 consumption for motorcycles at 86.5 percent ($R^2 = 0.865$).

Table 2 The standardized path coefficients of the final SEM on gasohol 95 consumption

Hypothesis	Relationship between constructs	Standardized path coefficient	C.R.	P-value
H1	Y <--- F1	0.424	19.932	***
H2	Y <--- F2	0.121	5.624	***
H3	Y <--- F3	0.383	16.443	***
H4	Y <--- F4	0.121	6.185	***
H5	Y <--- F5	0.313	15.864	***
H6	Y <--- F6	0.158	8.098	***
H7	Y <--- F7	0.353	17.620	***

Note: *** indicates P-value less than 0.001

6. Conclusion and Discussion

From SEM analysis found that the final structural equation model on the consumption of gasohol 95 for motorcycles was fit with the empirical data with CMIN/DF = 2.142, IFI = 0.973, TLI = 0.971, CFI = 0.973, RMSEA = 0.049 and HOELTER = 244. Factors that affected gasohol 95 consumption for motorcycles prioritized from highest to lowest as follows: information, gas station, satisfaction, alternative evaluation, purchase decision, price, and public relations. The seven factors had positive direct effects on gasohol 95 consumption. Moreover, those factors could predict gasohol 95 consumption for motorcycles at 86.5 percent ($R^2 = 0.865$).

Based on the analysis of factors affecting the consumption of gasohol 95 for motorcycles, F1: information factor was the most important. Variable X2: Biofuels result efficient engine comparable to gasoline had the highest standardized loading. Accordingly, the quality of biofuels influences consumption of gasohol 95 for motorcycles. The result was similar to the studies to Lertharn [20], Putsom [21], Kuwatanavanit [23], Wachirakomen [24], and Lilarungrot [25] that found that the marketing mix in product influences decision buying consumer. Maybe due to gasohol 95 has distributed in Thailand for a long time causing assure in quality of gasohol 95 that safety to user and motorcycle, environment-friendly, don't negatively affect the engine, and efficiency comparable to gasoline. These reasons take to high gasohol 95 consumption in Thailand. To increase the consumption of biofuels should make confidence with the consumers on safety to use and efficiency of biofuels compared to gasoline.

7. Recommendation

The research results indicated that information was the most affected factors on the consumption of gasohol 95 for motorcycles. Therefore, the consumers who use the motorcycle select to fill up biofuels on the consideration of the products information basis such as quality or qualification of biofuels and efficiency of using biofuels. In order to achieve the target of biofuels consumption in 2036, government, or Ministry of Energy, or the private agencies should consider the factor on the biofuels information basis in the first priority. The suggestions are as follows: quality of biofuels should improve better and efficiency of using biofuels well.

The future studies maybe analyze the structural equation model of the consumption of gasohol 91, gasohol E20, and gasohol E85 for motorcycles. Also, risk analysis and risk management of factors that affected biofuels consumption should be done. Risk factors should consider factors which have standardized path coefficient greater than 0.30 [36][37]. For this research, the factors as follows: information, gas station, satisfaction, and alternative evaluation have the standardized path coefficient above 0.30. Therefore four factors should be considered as risk factors for risk analysis in the future.

8. Acknowledgements

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10. Appendix

Appendix A: The group of observed variables by constructs

Observed variable	Detail
F1: Information	
X1	Biofuels are safe to use.
X2	Biofuels result efficient engine comparable to gasoline.
X3	Biofuels can be mixed with gasoline left in the tank. No need to wait for gasoline to empty before.
X4	Biofuels make the combustion complete so the engine is clean.
X5	Biofuels do not negatively affect the engine.
X21	Biofuels help to save the budget for importing Methyl Tertiary Butyl Ether (MTBE) from abroad.
X22	Biofuels help to raise the prices of agricultural crops as well as increase income for farmers.
X23	Biofuels help to achieve the target for the oil management plan in 2015-2036.
X25	Biofuels help to reduce air pollution.
F2: Price	
X6	The biofuels price is lower than gasoline.
X7	Each of biofuels price is not the same resulting you choose the cheapest biofuels.
X8	The volatility of gasoline prices results in your turned to biofuel.
X9	Biofuels are worthiness for short-term use.
X10	Biofuels are worthiness for long-term use.
F3: Gas station	
X11	The number of gas stations is numerous and sufficient to demand.
X12	Gas stations sell several types of biofuels.
X13	Gas stations have enough biofuel feeders resulting fast service.
X14	Gas stations have landscaped beautifully, seats for rest, clean bathroom, and convenience store.
X15	Gas stations are close to home or close to work or on regular traveling routes.
F4: Public relations	
X17	The biofuel producers advertise to demonstrate the performance of engines using biofuel.
X18	Motorcycle manufacturers have the quality assurance to ensure in using biofuel.
X19	The government has partnered with motorcycle manufacturers and gas stations to build confidence among consumers by promoting and advertising the use of biofuels.
X20	Government agencies promote and campaign to motivate and build confidence in using biofuels.
X26	Information about biofuels gets from close people.
X27	Information about biofuels receives from public relations through media such as television, posters, newspapers or social media such as Line or Facebook.
X28	Information about biofuels gets from government agencies or private organizations involved.

Appendix A: (Continued)

Observed variable	Detail
X29	Information on the use of biofuels has been obtained from reliable institutions such as educational institutions.
X30	Information about biofuels gets from their own experience.
F5: Alternative evaluation	
X31	There is an evaluation of price lower than gasoline.
X32	There is an evaluation of efficiency that equivalent to the use of gasoline.
X33	There is an evaluation of after-sales service or motorcycle repair shop on adequate quality and standard.
X34	There is an evaluation of the participation in decision making of family or close person.
X35	There is an evaluation of worthiness in tuning up an engine or mounting additional equipment when it does not work with biofuels.
F6: Purchase decision	
X36	There is a decision to use biofuels because it reduces air pollution.
X37	There is a decision to use biofuels because it supports the policy of the government.
X38	There is a decision to use biofuels because it used to feel comfortable to help farmers.
X39	There is a decision to use biofuels because it reduces travel costs.
X40	There is a decision to use biofuels because it is safe to use.
F7: Satisfaction	
X41	There is a recommendation for the close person or acquaintance in using the same type of biofuel you use.
X42	There is the use of the same type of biofuel repeated.
X43	There is overall satisfaction with the use of biofuels compared to expectations.
X44	There is a switch to other types of biofuels that are expected to be better.
X45	There is a recommendation for the close person or acquaintance in using better biofuel.