Potential and challenges of drop-in biojet fuel in Malaysia

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Abstract: ***"Drop-in" biojet fuel is the term used for the renewable alternative jet fuel which requires no modification on the current aircraft engine and the existing infrastructures. Technically, biojet fuel is ready to be used as either mixed with petroleum-based jet fuel or potentially become a 100% replacement for conventional jet fuel. Although there have been some airline companies utilizing biojet fuel for their fleets, Malaysian airline companies have yet to implement it. Thus, the main objectives of this research are to investigate the potential of drop-in biojet fuel, to identify the challenges in implementing drop-in biojet fuel and to measure the potential and the challenges of drop-in biojet fuel to ensure a smooth transition in using the alternative jet fuel; all within Malaysia Airline Berhad (MAB) contexts and parameters. The quantitative data result shows that most of MAB's personnel in engineering and management department are aware and knowledgeable in biojet fuel. Most of them acknowledge the potential and challenges of drop-in biojet fuel. From the response from respondent, it is highly potential in Malaysia for the drop-in biojet fuel to be implemented. However, there are still challenges that need to be tacked to ensure the transition process from conventional to biojet fuel is smooth.***

Key Words: biojet fuel, Malaysia Airline Berha.

I. BACKGROUND

Biojet fuel also known as aviation biofuel is a biofuel used for an aircraft. It is considered by some to be the primary means by which the aviation industry can reduce its carbon footprint. Biofuels have made into land transportation like gasoline and diesel fuel supplies, but it is still in the early journey to enter the aviation industry especially in Malaysia.

The term of "Biojet" is to describe that the fuel is made from renewable, biologically-derived raw materials and it is suitable for use in an unmodified jet engine but must be blended with petroleum jet fuel. Meanwhile, the term of "Alternative jet fuel" is best to describe the general term for jet fuel blending components made from biogenic and fossil such as coal, natural gas, industrial waste gases or an even non-biogenic portion of municipal solid waste feedstock[1].

The "Drop-in" described that the biojet fuel is ready to drop into existing conventional jet fuel infrastructure and be handled in the same way as conventional jet fuel without requiring significant infrastructure adjustment[2].

This means the drop-in biojet fuel is combined with petroleum-based fuel either as a blend or potentially as a 100% replacement.

The increase in air travel comes to the cost of the environmental impacts such as noise and local air pollution. The main concern in the aviation industry is the contribution to the climate change by using the conventional jet fuels.

Currently, aviation industry contributes about 2% of total global Greenhouse Gas (GHG) emissions and about 12% of the Greenhouse Gas (GHG) emissions from all transportation sources and expected to grow around 3%-4% per year[3].

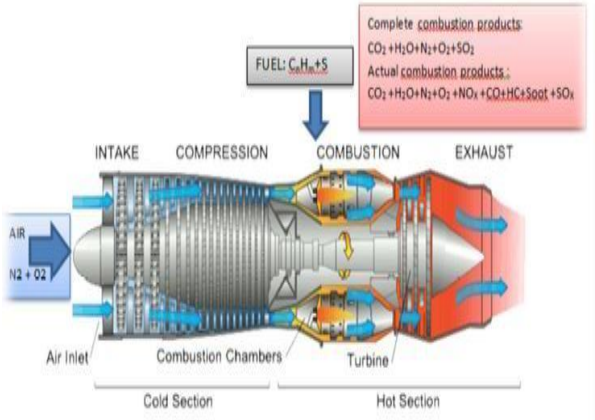

Fig. 1-1 Turbine Engine complete combustion products[4]

The gasses and particles that been released by the engine consist of carbon dioxide (CO_2), water vapor (H_2O), hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx or $NO+NO_2$), sulphur oxides (Sox) and non-volatile black carbon (BC or soot) particles (Figure 1-1) which contributed to the global warming[5]. Thus, reducing the Greenhouse Gas (GHG) is one of the advantages of the biojet fuels due to the amount GHG release is less than conventional jet fuel.

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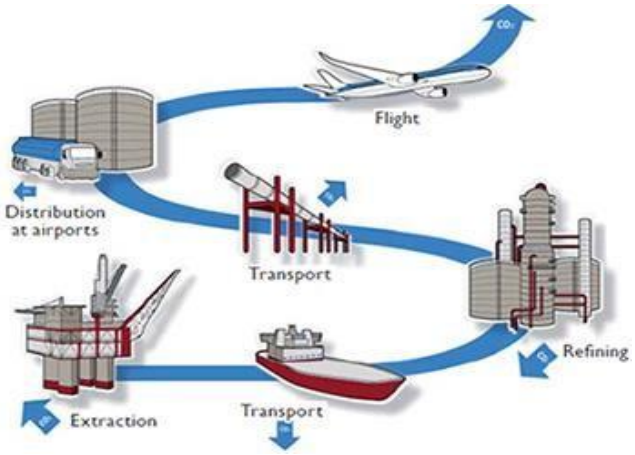


Fig. 1-2 Carbon lifecycle for fossil fuel (Source: Google Image)

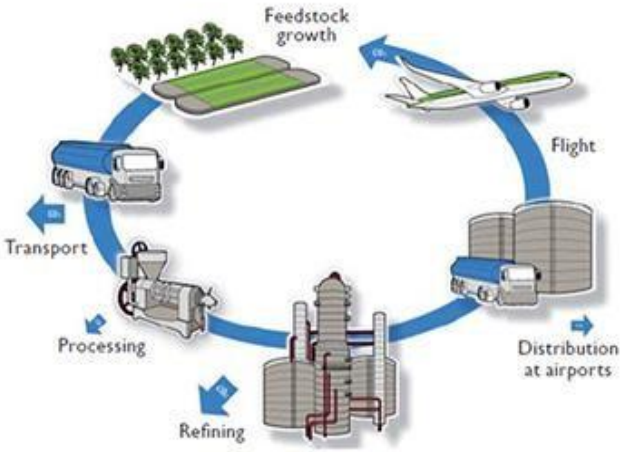


Fig. 1-3 Carbon lifecycle for biofuel (Source: Google Image)

II. METHODS

This section will be discussing the methodology of the research. The main purpose of the research is to find out the potential and the challenges that might and will occur when implementing the drop-in biojet fuel in Malaysia in the perspective of airline company especially Malaysia Airline Berhad (MAB). The data for the research will be collected through a quantitative method which is survey or questionnaire.

This research will be utilizing the quantitative research methodology. The instruments used to collect the data is a survey. A set of questionnaires expected to contain six questions will be divided into four sections. Different question-types, such as semantic differential scale, ranked order question, open-ended question, and the Likert question will be used in the questionnaires.

The different sections of the questionnaire will be: A) demographic information, B) general knowledge of biojet fuel, C) the potential of the drop-in biojet fuel in Malaysia and D) the possible challenges in implementing the dropinbiojet fuel in Malaysia. The questionnaire will be piloted to thirty peoples from technical and management staff in various departments on Malaysia Airline Berhad (MAB).

The respondent of the study will be the engineer, technician, and management personnel in Malaysia Airline Berhad (MAB) from the various department to gather the result from multiple perspectives in the companyresponse.

III. RESULTS

To analyze the data, a total number of three variable will be taken into consideration namely general knowledge of drop-in biojet fuel, the potential of the drop-in biojet fuel and the challenges of drop-in biojet fuel in Malaysia especially in Malaysia Airline Berhad (MAB) aircraft. After that, the data will be entered into the computer using Microsoft Excel software. The result of the study will be presented in a chart such as a bar chart and pie chart for the reader to understand easily of the findings.

When addressing the question in this section B, this section focuses on the general knowledge of respondent on the biojet fuel. The question that been asked is the type of feedstock used to produce the biojet fuel. From this question, it can be analyzed as the respondents are highly known for the biojet fuel and partially know and understand the biojet fuel technology.

Besides that, the question consists in this section also asked about the reason on why aviation industry needs to be introduced to biojet fuel and the rating question on reasons of what motivate the airlines in the world to implement the biojet fuel.

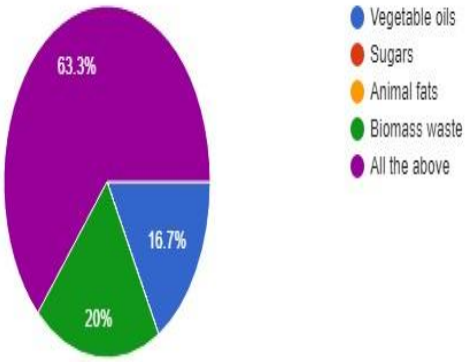


Fig. 4-1 Type of feedstock used to produce Biojet fuel

The first question in section B (B1) is asking for the type of feedstock that use to produce biojet fuel to identify the respondent's knowledge of the biojet fuel. As shown in figure 4-1, nineteen (63.3%) respondents are very knowledgeable on the biojet fuel because that the type of feedstock uses to produce biojet fuel is all listed on the answers. Meanwhile, six (20%) respondents which answered biomass waste and five (16.7%) respondents answered vegetable oils as the type of feedstock is indicated that they know what is biojet fuel is but not fully understand the technology.

The second question in section B (B2) is asking the respondents on what would be the reason that the aviation industry to introduce the biojet fuel. The result is as shown in figure 4-2(A) where twenty-three (76.7%) respondents choose environmental friendly to be the very highly reason on the introduction of biojet fuel to the industry followed by six (20%) respondents answered the environmental friendly high and one (3.3%) respondent answered low to the environmentally friendly.

Meanwhile, the next reasons on why the industry needs to introduce biojet fuel are to minimize the engine maintenance cost. This is because as the biojet fuel release less amount of emission compared to conventional fuel, it will reduce the residue of the carbon inside the engine after the combustion thus will reduce the maintenance hours for the engine and help reduce the

maintenance costs. From the findings as shown in figure 4-2(B), sixteen (53.3%) respondents answered high. Ten (33.3%) respondents answered it's in the moderate of the reason and two (6.7%) respondents answered very highly and another two (6.7%) respondents answered low.

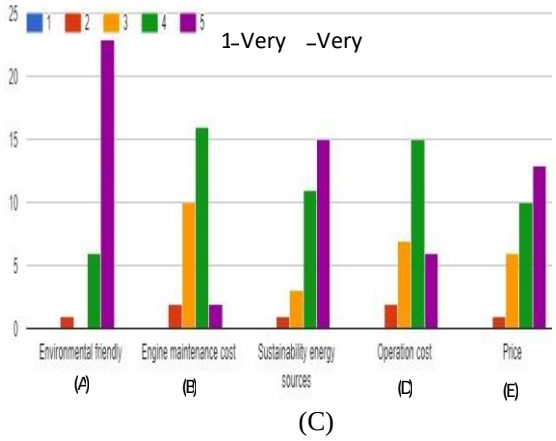


Fig. 4-2 Why industry need to introduce Biojet fuel?

Other reasons for why the industry needs to introduce the biojet fuel are sustainable energy sources. It is because as the crude oil on the world reserves oil is decreasing every year due to high demands on all type of transportation, aviation industry needs to come up with an alternative fuel for the upcoming years and reduce the dependency on a single energy source. As shown in figure 4-2(C), fifteen (50%) respondents answered very high, eleven (36.7%) respondents answered high, three (10%) respondents answered moderate, and one (3.3%) respondents answered low to the sustainable energy sources.

For the operation cost (figure 4-2(D)), fifteen (50%) respondents answered high as the reason that industry needs to introduce the biojet fuel along with seven (23.3%) respondents answered moderate and six (20%) respondents answered very highly. Lastly, two (6.7%) respondents answered low to the operating cost as the reason for industry need to introduce biojet fuel.

The last reason on the second question of section B (B2) is the price of the fuel. This question asked about the price will be the main factor of the transition from conventional jet fuel to the biojet fuel in the aviation industry. As shown in figure 4-2(E), thirteen (43.3%) respondents answered very high as the reason for the introduction of biojet fuel to the industry. Followed by ten (33.3%) respondents answered high, six (20%) respondents are on the moderate of the reason and one (3.3%) respondent answered low.

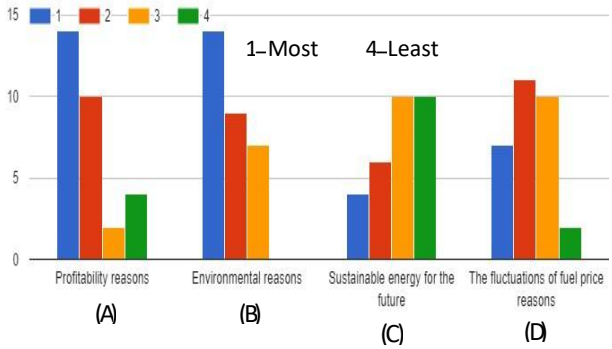


Fig. 4-3 Reasons on which motivate airliner in the world to implement the drop-in Biojet fuel

The third question on section B (B3) is asked the respondent on reasons on which motivate airliner in the world to use the drop-in biojet fuel. This question is based on the airline that has implemented the use of drop-in Biojet fuel in the world such as KLM, Singapore Airline and so on to identify what would be the reason that motivates them to use the biojet fuel to their aircraft. The results for B3 is shown in figure 4-8. As shown in figure 4-3(A), one of the reasons that motivate the airliner is due to the profitability. Fourteen (46.7%) respondents answered it is the most important reason followed by ten (33.3%) respondents answered it as important reasons. Meanwhile, four (13.3%) respondents answered it least important and two (6.7%) respondents answer less important.

Figure 4-3(B) illustrate the results of next reason which motivate airliner to use drop-in biojet fuel which is environmental. Fourteen (46.7%) respondents answered it as most important reasons, nine (30%) respondents answered is as important and seven (23.3%) respondents answered that environmental is less important that motivate an airliner in the world.

Other than that, figure 4-3(C) shows the finding of the reason that motivates an airliner to use drop-in biojet fuel which is sustainable energy for the future. From the figure, ten (33.3%) respondents answered is the least important that motivate airliner along with another ten (33.3%) respondents answered it as less important. However, six (20%) respondents find that it is an important reason that motivates airliners followed by four (13.3%) respondents answered it most important reasons.

Lastly, for the question B3, the last reason that motivates an airliner is due to the fluctuation of fuel prices in the world. As illustrated in figure 4-3(D), eleven (36.7%) respondents answered it as important reasons and seven (23.3%) respondents find it the most important reasons. However, ten (33.3%) respondents find it less important and two (6.7%) respondents find it the least

important reason on which motivate airliner to implement the drop-in biojet fuel in the world.

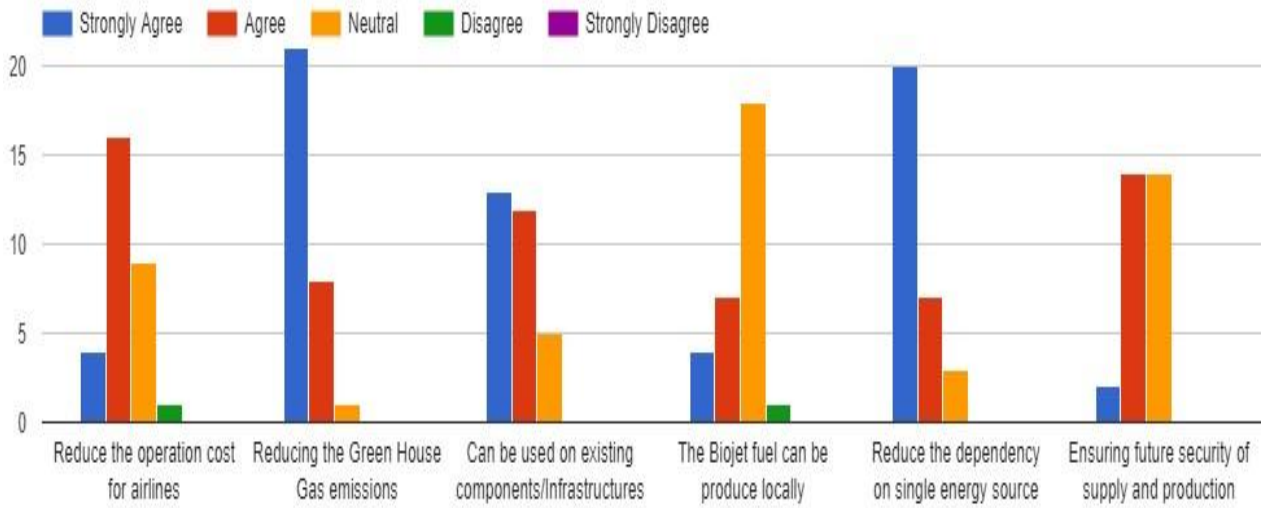
In summary of the findings in section B, more than 50% of respondents are very conscious of the biojet fuel which indicates their awareness and readiness of the biojet fuel in Malaysia. Most of the respondents are aware the benefit of biojet fuel which more environmentally friendly, sustainable energy sources and the price of the fuel that which more secure. However, some of the respondents are still unsure on the ability of biojet fuel able to reduce the operation cost and reduce the maintenance cost of the engine but they believe the biojet fuel will be better than conventional jet fuel.

The respondents believe that motivate an airliner in the world to implement the usage of biojet fuel is due to the profitability and environmental reason as the airline needs to increase their profit to be able to provide services to the customer and compete with other airliners and at the same time they aware that the nature must be
preserved for as long as possible. It also due to unstable fuel prices made the airliner to use the biojet fuel and to have an alternative sustainable energy source in the future to reduce the dependency on the single energy source.

In section C, the questions are more focuses on the lists of the potential of drop-in biojet fuel in Malaysia. The questions are a scale from strongly agree to strongly disagree with the listed potential of drop-in biojet fuel. The first potential of drop-in biojet fuel is to reduce the operation cost for airlines in Malaysia. The result for this potential is shown in figure 4-4(A).

As illustrated in figure 4-4(A), sixteen (53.3%) respondents are agreed that there is the potential of drop-in biojet fuel to reduce the operation cost and four (13.3%) respondents strongly agree that biojet fuel is potential to reduce the operation cost. However, nine (30%) respondents are neutral the potential of biojet fuel in term of reducing the operation cost and one (3.3%) respondent disagrees that it will be the potential in Malaysia.

The second potential of drop-in biojet fuel is to reduce the Green House Gas emissions in Malaysia. The result is shown in figure 4-4(B). Twenty-one (70%) respondents are strongly agreed followed by eight (26.7%) respondents agreed. However, there is one (3.3%) respondent is neutral with the potential of drop-in biojet fuel able to reduce the GHG emission.



(A) (B) (C) (D) (E) (F)

Fig. 4-4 Potential of Drop-in Biojet fuel in Malaysia

The third potential of drop-in biojet fuel is that it can be used on existing components or infrastructure in Malaysia which mean no alteration and modification required to the existing ground facilities such as storage tanks. It will save the airline's capital cost to implements the usage of drop-in biojet fuel. The result of this potential is displayed in figure 4-4(C). Thirteen (43.3%) respondents strongly agree that it is the potential of drop-in biojet fuel along with twelve (40%) respondents agreed with it. Meanwhile, five (16.6%) respondents are neutral whether it will be the potential of biojet fuel in Malaysia.

The fourth potential of drop-in biojet fuel in Malaysia is that it can be produced locally by a local fuel producer. In this case, it will help the price of biojet fuel much less compare to import. Besides that, the feedstock that use to produce the biojet fuel can be planted and obtained locally in Malaysia. The results of this potential are as shown in figure 4-4(D). Four (13.3%) respondents strongly agreed that the potential of drop-in biojet fuel can be produced locally along with seven (23.3%) find it agreed. However, eighteen (60%) respondents are neutral of the potential and followed by one (3.3%) respondent to disagree with the potential.

The fifth potential of drop-in biojet fuel in Malaysia is reducing the dependency on a single energy source such as conventional jet fuel. The result of potential is shown in figure 4-4(E).

Twenty (66.7%) respondents strongly agree with the potential along with seven (23.3%) respondents agree. However, three (10%) respondents are neutral whether it can be the potential of drop-in biojet fuel.

The sixth potential of drop-in biojet fuel is ensuring the future security of supply and production of biojet fuel in Malaysia. This question is to identify that the future supply and production of biojet fuel is continuous and maintain as the production and supply of conventional jet fuel. The findings are displayed in figure 4-4(F). Two (6.7%) respondents find it strongly agrees that it will be the potential meanwhile fourteen (46.7%) respondents agree. However, another fourteen (46.7%) respondents are neutral that this will be the potential due to uncertainties of the supply and productions.

In summary for section C, most respondents find that the main potential of drop-in biojet fuel in Malaysia would be the reducing of Green House Gas (GHG) emissions which highly contribute to reducing the environmental issues in Malaysia and globally. The respondents also agree the potential of drop-in biojet fuel will be a reduction of operating cost for the airliners due to the price of biojet fuel is more stable and secure.

Other than that, most of the respondents agree the potential of drop-in biojet fuel in Malaysia is to reduce the dependency on single energy sources. This is because the supply of crude oil is not infinite, and supplies will eventually start to run down, and the price of the crude oil will increase even further. However, most of the respondents neutral on the potential of biojet fuel can be produced locally and ensure the future supply and production of biojet fuel in Malaysia. Since there is less initiative from the public and private sectors that wanted to produce and commercialize the biojet fuel. Lastly, there is a high potential of drop-in biojet fuel in Malaysia as some of the respondents are aware of the benefit of biojet fuel offered and ready for the implementation the all commercial aircraft in the airline (MAB).

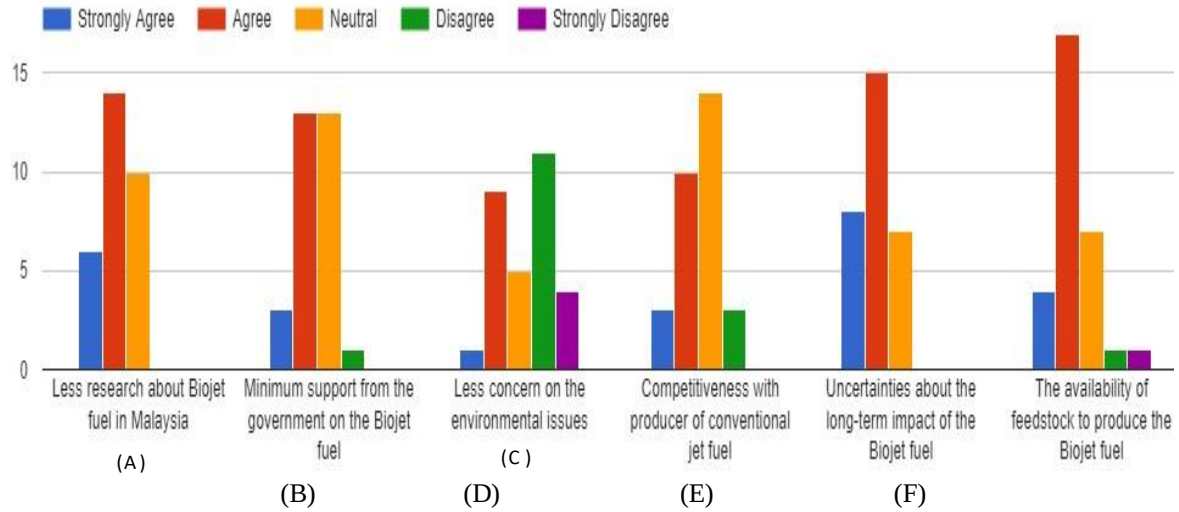


Fig. 4-5 Challenges of Drop-in Biojet fuel in Malaysia

In section D, the first questions (D1) asked the respondents are more focusing towards the challenges of drop-in biojet fuel in Malaysia. The respondents answered by choosing the scale answer from strongly agree to strongly disagree. The first challenges of drop-in biojet fuel in Malaysia are less research about biojet fuel in Malaysia. The results of this challenge are illustrated in figure 4-5(A). Six (20%) respondents are strongly agreeing that it is the challenge in Malaysia followed by fourteen (46.7%) respondents agree. However, ten (33.3%) respondents are neutral that less research could be the challenge.

In the second challenges of drop-in biojet fuel in Malaysia is minimum support from the government. The results are shown in figure 4-5(B). Three (10%) respondents strongly agree that this is the challenge faces. Meanwhile, thirteen (43.3%) respondents are agreeing to the minimum support from the government is the challenge that needs to overcome. However, thirteen (43.4%) respondents are neutral that this is the challenge followed by one (3.3%) respondent disagree.

The third challenges of drop-in biojet fuel in Malaysia are because of less concern on the environmental issues. The finding is illustrated in figure 45(C). One (3.3%) respondent is strongly agreed that this could be the challenge followed by nine (30%) respondents agrees. Five (16.7%) respondents are neutral that this could be the challenge.

Meanwhile, eleven (36.7%) respondents disagree that this could be the challenge along with four (13.3%) respondents are strongly disagreeing.

The fourth challenges of drop-in biojet fuel in Malaysia are the competitiveness with the producer of the conventional jet fuel. The results are shown in figure 4-5(D).

Three (10%) respondents answered

strongly agrees that this will be the challenge followed by ten (33.3%) respondents answered agrees. However, fourteen (46.7%) respondents find it to be neutral and three (10%) respondents answered disagree.

The fifth challenges of drop-in biojet fuel in Malaysia are the uncertainties about the long-term impact of the biojet fuel. The results are represented in figure 4-5(E). Eight (26.7%) respondents strongly agreed that this the challenge that needs to face along with fifteen (50%) respondents agrees. Meanwhile, seven (23.3%) respondents are neutral that this could be the challenge.

The sixth challenges of biojet fuel in Malaysia are the availability of feedstock to produce biojet fuel. The results are presented in figure 4-5(F). Four (13.3%) respondents are strongly agrees followed by seventeen (56.7%) respondents are agreed that this is the challenge of drop-in biojet fuel in Malaysia. Besides that, seven (23.3%) respondents are neutral. Meanwhile, one (3.3%) respondents disagree along with one (3.3%) strongly disagree that this will be the challenges.

In summary for this section D1, most of the respondents believe the challenge that interferes of implementing the drop-in biojet fuel in Malaysia is the availability of feedstock that use to produce the biojet fuel as they don't know how much feedstock needed to produce a gallon of biojet fuel. Besides that, the uncertainties of the long-term impact of biojet fuel are still questionable will be the challenge as the biojet fuel is new technology and in the early stage of adopting the new energy source. However, less concern about environmental issues is not a challenge in Malaysia since most the respondents aware of conserving the nature.

Other than that, less research on the biojet fuel is the challenge that respondents believe need to encounter. More research required for the airline in Malaysia especially MAB to adapt to the usage of biojet fuel in short period of time. Most of the respondent also agree that minimum support from the government on the initiative of biojet fuel in Malaysia is one of the main challenges that need to face and encountered. All these challenges need to overcome as soon as possible so that the drop-in biojet fuel can be implemented in all commercial aircraft from every airline especially MAB soon.

In section D of the questionnaire, the last question (D2) is asked the respondents to give their opinion on the possibility of drop-in biojet fuel replacing the conventional jet fuel in upcoming 10-15 years in Malaysia.

Seven (28%) respondents said yes with the reason for the price. Most the respondents answered that with the price of the biojet fuel, it will help the airlines to gain more profit due to less operation cost compare to using conventional jet fuel. As in the price of biojet fuel more constant, secure and less than the conventional jet fuel. However, two (8%) respondents said no due to the price uncertainties in Malaysia since they need to be acquired from the foreign companies.

Besides that, four (16%) respondents said yes with the reason of environment and zero (0%) said no. This is because all four respondents' states that with the usage of biojet fuel, it will reduce the GHG emissions which help to preserve the environment and reduce contributing the air pollution. Other than that, the respondents that said yes to the question giving the reasons for research. Two (8%) of respondents said that it is possible that in 10-15 years, all airline in Malaysia will using the drop-inbiojet fuel due to the more research have been done related to the biojet fuel. Throughout the years, more research related to the biojet fuel has been conducted by the various institution to bring the awareness to the Malaysian Industry especially aviation. Some of the research is more focusing on the production of the biojet fuel where it can be produced in Malaysia and the nurturing of the feedstock so that it can lower the production cost of biojet fuel.

However, three (12%) respondents answered no and said Malaysian are still lack of biojet expertise that needs to consult with. That is why there is no local producer able to produce and commercialize the biojet fuel in Malaysia. For that reasons, the respondents said the level of performance and the biojet fuel price still questionable. Meanwhile, five (20%) respondents said no and provide the reason that there is not possible for drop-in biojet fuel to replacing the conventional jet fuel in 10-15 years is due to the time. All the respondents said that is not enough time for the airline in Malaysia to shift from conventional jet fuel to the biojet fuel. Airlines in Malaysia required more time to adapt the technology and implement it.

Yet, some of the respondents said that 10-15 years is not enough time to changeover from conventional jet to biojet, but it can be used together whereby to blend the biojet fuel and conventional jet fuel for the flight operation. Lastly, one (4%) respondent said yes with the reason of the sustainable natural resource of the feedstock where it can be nurturing and reproduceanytime and anywhere. Another one (4%) respondent said no and give the reason for the availability of feedstock whether the feedstock is enough to accommodate the demand in Malaysia.

In summary for this possibility, most of the respondent realize that the biojet fuel will give more benefit to the environment and the airline operation cost with the benefit offered by the fuel. It also indicates that they are aware and readiness level are high for the airline (MAB) to implement the usage of the biojet fuel. However, there are some of the respondents are still unconcerned with the benefits that biojet fuel offered. They readiness level need to increase as the implementation of biojet fuel sooner or later will be applied as part of an initiative of ICAO that by 2050 all the commercial aircraft will operate by biojet fuel to reduce the Green House Gas (GHG) Emission for a better environment.

The differential between potential and challenges of drop-in biojet fuel need to be measured in favor of to ensure a smooth transition in the airline from conventional jet fuel to biojet fuel. The process to analyze the data is by categorizing the scales into positive,

neutral and negative to acquire accurate data. For

positive, the scale of strongly agree and agree is used, and as for negative is obtain from disagree and strongly disagree. However, to measure the data, only positive responses will be considered to get the most potential and challenges listed on the questionnaire. The number of responses will be divided to get an average for each category and the average of more than ten responses will be taken.

The high potential of drop-in biojet fuel in Malaysia is consists of four out of six potentials listed as in red colour which is ten positive responses (66.7%) on reducing the operating costs for airlines, fourteen point five positive responses (96.7%) on reducing the GHG emissions, twelve point five (83.3%) on the biojet fuel that can be used on existing components or infrastructures without modification and alteration required, and thirteen point five (90%) on reducing the dependency on single energy source.

The highly challenges of Drop-in Biojet fuel in Malaysia is consists of three out of six challenges listed in red colour which is ten responses (66.7%) on less research about biojet in Malaysia, eleven point five responses (76.7%) on the uncertainties about the long term impact of the biojet fuel and ten point five responses (70%) on the availability of feedstock to produce the biojet fuel, whether it is enough to accommodate the demand in Malaysia.

The number of potentials is four (66.7%) and the number of challenges is three (50%) indicates that the drop-in biojet fuel is highly potential to be implemented in the airline (MAB). The data also indicate that most of the personnel in the engineering and management departments are aware on the potential of the biojet fuel can provide to the aircraft, the airlines economy and to the environment, and ready for the airlines to adopt the implementation of biojet fuel to their aircraft.

Thus, all local public and private sectors that associated with the oil and gas should take the initiative to start the process and produce the biojet fuel so that it can be used on every airline in Malaysia especially MAB to reduce the operation costs and engine maintenance costs which greatly contribute in increasing the company profits.

IV. CONCLUSIONS

To overcome the most challenges of drop-in biojet fuel, there are few solutions that can be done. One of them is that government intervention is needed to create sustainable markets for low-carbon technologies, help to fill in R&D funding for the biojet fuel research, create an infrastructure that enables the research to conduct an experiment and encouraging international collaboration which by means of inviting the countries where their airlines already implement the usage of biojet fuel. Other than that, private sector which mainly oil & gas businesses should have invested in the nurturing and producing of biojet fuel.

Lastly, more researchers are needed in Malaysia to come out with a different type of research study or experimental study to support the idea of biojet fuel that will greatly contribute to the economy and to the environment. With more researchers been done to prove the benefit and the advantages of the biojet fuel, it will give enough proofs to support and drive the airline's industry to use biojet fuel as their primary energy source[6-24].

In summary for this research study, the potential of drop-in biojet fuel in Malaysia is greater than challenges, thus, the biojet fuel will be able to be applied to the airline in Malaysia especially MAB. From the results and finding, indicates maintenance and management personnel of MAB are ready to adopt the implementation as their aware of the biojet fuel and understand the benefit of it. Lastly, the projection time will be determined based on the public and private sector that involves in this technology to nurturing and produce the biojet fuel, so it can be used as alternative jet fuel in MAB as soon as possible.

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