Strategic Assessment of Sustainable Aviation Fuel Production Technologies Using WASPAS Method

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Abstract. *In the last 25 years, the amount of international passenger air traffic has tripled, and it is anticipated that this rapid growth will continue in the upcoming 25 years. Although it has significant economic advantages, the expansion of the aviation sector may also have more negative social and environmental effects. " Sustainable aviation policy" is created as a "balanced plan" to address this. While highlighting the financial advantages of the aviation industry, it seeks to address the significant environmental effects of its expansion. This definition of "sustainable aviation" is contested by other organisations, because there is little consensus among nongovernmental Organizations and the aviation sector. " Standard aviation policy" is therefore in dispute, and several parties attempt to change it to suit their own objectives. In order to build policies for sustainable aviation, competing environmental discourses were identified and examined through a classification exercise assisted by rhetorical, stylistic, and thematic analysis. One approach to making multi-attribute judgements that satisfies the consistency requirements of each reciprocal matrix is the analytical hierarchy process (AHP). The "Weighted Aggregates Sum Product Assessment System", or WASPAS for short, has just been described in the literature. It combines the weighted product sum and basic aggregate weighting approaches. Linguistic assessments are typically chosen as in decision-making matrix when there is uncertainty and ambiguity. There are numerous fuzzy variations of the AHP and WASPAS procedures, including Pythagorean Fuzzy Analytic hierarchy process, Intuitive Fuzzy AHP, and Intuitive Fuzzy WASPAS. There is, however, no paper that utilises spherical fuzzy sets to combine AHP and WASPAS approaches. As a result, the purpose of this study is to synthesise fuzzy sets AHP & WASPAS approaches and add to the literature. The challenge of outsourcing producer evaluation and selection is resolved using the suggested approach. Table 1 shows the Sustainable Aviation using MOORA method. The alternatives are HEFA_SO, HEFA_YG, VB_Stover, VB_Pine, ATJ_Stover, ATJ_Pine, DSHC_Stover, DSHC_Pine, FP_Stover, FP_Pine, GFT_Stover and GFT_Pine. The evaluation parameters are TCI (MM$), OPEX (MM$), MFSP, ($ L− 1) and MFSP ($ Mg− 1).*
Keywords: *international passenger air traffic, analytical hierarchy process (AHP), Sustainable Aviation, Life Cycle Analysis (LCA), Waspas.*

1. INTRODUCTION

Aviation fuel consumption and emissions trends that have an impact on the climate are reported by ICAO. These developments take into account the role played by aviation technology, better air traffic control, operational advancements, and SAF deployment. Regarding the production of sustainable aviation fuels (SAF), ICAO showed that 100% of demand could be met with sustainable aviation fuels (SAF) by 2050, corresponding to a 63% reduction in emissions. Only extremely significant financial investments in the infrastructure needed to produce "sustainable aviation fuels (SAF)" and strong political backing will allow for these levels of fuel production. However, it is unlikely that carbon-neutral growth will be achieved after 2020. Schilling et al. (2016) look at the advantages, difficulties, and emissions brought on by the use of novel technologies and fuels in fleets, including Fischer-Tropsch kerosene, composite wing bodies, all-electric aircraft, strut-braced wings with open rotors, and "non-liquid fuel (liquefied natural gas)". Although it is a relatively new method, the "Weighted Aggregate Product Assessment (WASPAS)" has been extensively used in the literature since its launch in 2012. Over the "Weighted Sum Model (WSM)" and the Weighted Product Model, WASPAS is preferable (WPM). enables more precise and detailed performance, resulting in a composite solution that is more dependable than the sum of its parts. Studies also frequently focus on WASPAS extensions that use fuzzy sets, such as human neutrosophic sets, interval-valued hesitant fuzzy fuzzy sets, and intervals type-2 fuzzy sets. To choose the weights of assessment criteria in MCDM approaches based on pairwise comparisons, the AHP method is a

well-known technique. On the other hand, because of its quantitative simplicity and capacity to deliver more accurate answers when compared to other straightforward MCDM methods, the "WASPAS method" is regarded as a beneficial decision-making tool. In order to get over WASPAS's lack of criterion weights, the AHP approach is integrated. To solve MCDM issues like location selection, researchers can use a hybrid powertrain of these two techniques to get outcomes that are rational and palatable.

2. SUSTAINABLE AVIATION

The use of "sustainable aviation fuels" is one of the most alluring ways to cut CO2 emissions in a reasonably short amount of time (SAF). For usage in current aircraft, they must match the quality and characteristics of conventional jet fuel. Because manufactures should not have to remodel aircraft or engines, and because fuel providers and airports will not have to create new fuel distribution systems, this factor is especially important. The aviation sector has some disadvantages from a technical standpoint for introducing drop-in fuels due to improved homogeneity in current aircraft, engines, and fuel standards. This is the other primary justification for employing these fuels. Using alternative fuels could be another way to lessen aviation's carbon footprint. A synthesis of different biofuels generated from plant-based resources, "sustainable aviation fuel (SAF)" is a fuel that is carbon-neutral. Due to their potential to lower greenhouse gas emissions, biofuels are a prospective replacement for petroleum fuels, which are currently utilised in commercial aircraft. Some SAFs made from fats, oils, agricultural waste, and improper waste management are legal in India. The effects of SAF manufacturing on the environment have been the subject of several research. In the most recent "Life Cycle Analysis (LCA)" study, reducing GHG emissions and improving energy efficiency were regarded as two crucial criteria. According to their findings, some SAF conversion processes need more energy than by using wastes and leftovers as a feedstock.

In a research conducted Staples et al. (2018), emission reductions through SAF production through non-food2 food goods were examined over all of the products' life cycles and several conversion methods. According to the research, it will take about $12 billion in investments annually to reduce GHG emissions to 50% or less by 2050. Other studies have looked at a constituent and process evaluation in addition to various feedstocks and conversion methods. Ganguli et al. (2018) conducted an LCA research on a lumber feed for SAF production. When compared to traditional jet fuel, it was discovered that the manufacture of SAF might reduce global warming effects by 78%. Similarly, Fortier et al. assessed the HTL of microalgae feedstock. There are two different manufacturing plants. According to their investigation, fuel generated in a traditional refinery has a higher concentration of GHGs than SAF manufactured in a sewerage system. Furthermore, Seber et al. (2014) performed LCA to assess Energy and greenhouse savings and manufacturing cost linked with HEFA jet form yellow yellow and fat. Comparing LCA of SAF made from yellow grease to petroleum-based jet fuel, the former produced reduced GHG emissions. Additionally, compared to SAF as a feedstock, SAF generated from yellow gasoline offers a lower "minimum selling price (MSP)". SAFs have the ability to diminish GHG emissions in aviation, according to LCA studies. However, due to the variability of the environment, the result of such research cannot be compared because each report makes its own unfounded assumptions system limits. Sgouridis et al. employed a continuous-time simulation approach, which was last from a primary standpoint. To examine the impact of brief policies and initiatives on eliminating CO2 emissions on global aviation. According to the report, utilising poor fuels and an emissions reductions mechanism together could help achieve the goal of lowering emissions.

3. WASPAS METHOD

Using the MCDM framework, we presented and verified a set of high - level parameters for assessing compressed aerial photographs. In order to estimate lossy compression techniques that are controlled by suitable quality parameters for data compression and graphically acceptable lossy compression, we have created a new MCDM issue. Additionally, we ranked lossy compression methods with various compression ratios according to how well they worked with various aerial image resolutions. We choose the Direct Weighted Determination and "Weighted Aggregate Product Assessment (WASPAS)" procedures in the neutrosopic environment to guarantee the stability of the MCDM ranking outcomes. When used to address diverse real-world issues, these approaches demonstrate excellent stability. We have created a novel multi-criteria decision-making process for choosing the best lossy compression for aerial photos, which also includes approaches for resolving other subtasks like adjusting weights or feature sets. There are five parts to the article. gives a summary of studies that have been published on evaluating the quality of compressed aerial images. specifies the direct weights and MCDM pythagorean fuzzy WASPAS methodologies for data processing, as well as the overall structure of the strategy, a set of alternatives, and conditions for the non - linear and non-task of evaluation criteria of loss decompression of aerial photographs. A selection of aerial photos is offered together with a quality evaluation, a ranking of the collection's summary results through using Neutrosopic WASPAS-SVNS method, or a presentation of the study. There are conclusions and recommendations for the future. The purpose of the current study is to suggest a strategy that combines the enhanced accuracy of non - linear and non-decision making with the resilience of interval-valued fuzzy numbers in handling uncertainty. In light of this, a proposed extension of the recently created "Weighted

Aggregate Product Assessment (WASPAS)" is made. To obtain the best estimation accuracy, WASPAS employs a suggested strategy to optimise the weighted aggregate function. By choosing an appropriate location, it has been effectively applied to the sustainable and environment evaluation of modernising multiple residential homes. It is demonstrated in a case study how to rank the facades of public and commercial buildings, and the method's reliability is confirmed. crisp in order to improve rankings accuracy in a crucial situation, WASPAS was used to choose the optimum occupational safety approach during construction work.

This approach, known as WASPAS-IVIF in the current study, is expanded with intermission intuitionistic fuzzy numbers. A general version of fuzzy sets that takes into account both the ordinal membership degree and the non-membership degree of the fuzzy numbers are interval-valued intuitionistic fuzzy numbers. The experts were given a questionnaire to complete in order to determine the weight efficiency indices. SWARA-WASPAS was established in response to their input. With regard to SWARA evaluation, weighting criteria, and key supplier selection, WASPAS is utilised to assess various options. Since the "SWARA method" is correlated with the ability of trying to assess the conclusions or special interests about the great significance of qualities in the taken into account when designing (Kersuliene et al.., 2010), Aghdaie et al. (2013) asserted that the rationalisation there next to using this approach is to use the expertise and insights of experts. The first parameter in the ranking is thought to be the most significant, and the final parameter in the ranking is thought to be the least significant, according to experts who apply their own instincts. The SWARA approach is more appealing and effective for researchers due to the fact that it requires fewer comparison than other MCDM techniques, according to Stanujkic et al (2015).'s comparison of Contact with different with other MCDM methods like AHP, ANP, etc. The WASPAS method was proposed by Javadskas et al. (2012), who also showed in their analysis that WASPAS' accuracy is superior to both its robustness and other approaches. The "weighted sum method (WSM)" and the "weighted product method", two well-known MCDM techniques, are combined in this method (WPM). In their study, showed that utilising both WSM and WPM together produces results that are more accurate than using either system alone. Despite being relatively new tools, SWARA and WASPAS are developing a name for themselves in modern research.

4. RESULT AND DISCUSSION

TABLE 1. Sustainable Aviation

	TCI, MM$	OPEX, MM$	MFSP, $ L− 1	MFSP, $ Mg− 1
HEFA_SO	77.00000	54.00000	1.12000	1446.00000
HEFA_YG	69.00000	46.00000	0.88000	1190.00000
VB_Stover	398.00000	89.00000	2.32000	2610.00000
VB_Pine	425.00000	99.00000	2.54000	2796.00000
ATJ_Stover	417.00000	86.00000	2.31000	2793.00000
ATJ_Pine	435.00000	90.00000	2.42000	2862.00000
DSHC_Stover	654.00000	136.00000	3.61000	4689.00000
DSHC_Pine	677.00000	146.00000	3.86000	4967.00000
FP_Stover	257.00000	74.00000	1.78000	1963.00000
FP_Pine	249.00000	69.00000	1.68000	1751.00000
GFT_Stover	342.00000	73.00000	1.94000	2146.00000
GFT_Pine	254.00000	108.00000	2.79000	2968.00000

Table 1 shows the Sustainable Aviation using MOORA method. The alternatives are HEFA_SO, HEFA_YG, VB_Stover, VB_Pine, ATJ_Stover, ATJ_Pine, DSHC_Stover, DSHC_Pine, FP_Stover, FP_Pine, GFT_Stover and GFT_Pine. The evaluation parameters are TCI (MM$), OPEX (MM$), MFSP, ($ L− 1) and MFSP ($ Mg− 1) to calculate the final value.
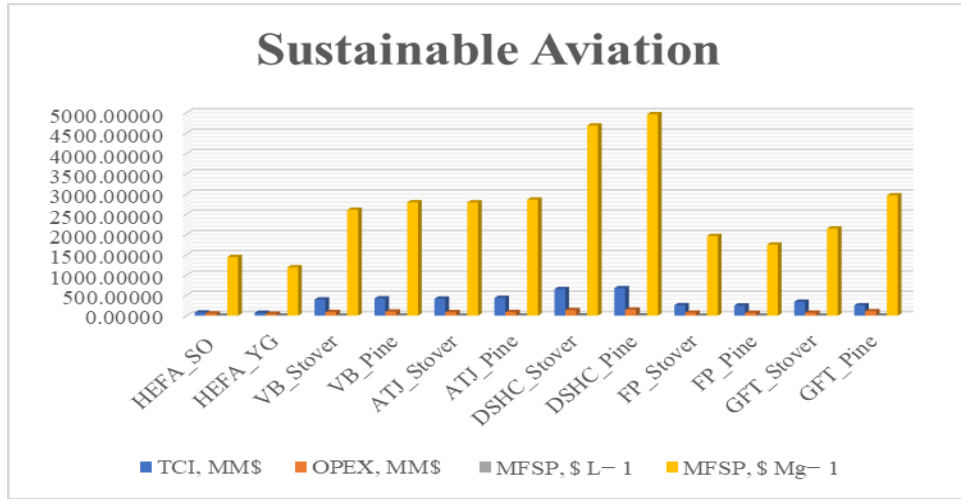
FIGURE 1. Sustainable Aviation

Shows the figure 1 Sustainable Aviation using MOORA method. The alternatives are HEFA_SO, HEFA_YG, VB_Stover, VB_Pine, ATJ_Stover, ATJ_Pine, DSHC_Stover, DSHC_Pine, FP_Stover, FP_Pine, GFT_Stover and GFT_Pine. The evaluation parameters are TCI (MM$), OPEX (MM$), MFSP, ($ L− 1) and MFSP ($ Mg− 1) to calculate the final value.

TABLE 2. Performance value

	Performance value		
HEFA_SO	0.11374	0.36986	0.78571	0.82296
HEFA_YG	0.10192	0.31507	1.00000	1.00000
VB_Stover	0.58789	0.60959	0.37931	0.45594
VB_Pine	0.62777	0.67808	0.34646	0.42561
ATJ_Stover	0.61595	0.58904	0.38095	0.42607
ATJ_Pine	0.64254	0.61644	0.36364	0.41579
DSHC_Stover	0.96603	0.93151	0.24377	0.25379
DSHC_Pine	1.00000	1.00000	0.22798	0.23958
FP_Stover	0.37962	0.50685	0.49438	0.60621
FP_Pine	0.36780	0.47260	0.52381	0.67961
GFT_Stover	0.50517	0.50000	0.45361	0.55452
GFT_Pine	0.37518	0.73973	0.31541	0.40094

Shows the table 2 Performance value is divided by the maximum of the given value

TABLE 3. Weight

	Weight		
HEFA_SO	0.25	0.25	0.25	0.25
HEFA_YG	0.25	0.25	0.25	0.25
VB_Stover	0.25	0.25	0.25	0.25
VB_Pine	0.25	0.25	0.25	0.25
ATJ_Stover	0.25	0.25	0.25	0.25
ATJ_Pine	0.25	0.25	0.25	0.25
DSHC_Stover	0.25	0.25	0.25	0.25
DSHC_Pine	0.25	0.25	0.25	0.25
FP_Stover	0.25	0.25	0.25	0.25
FP_Pine	0.25	0.25	0.25	0.25
GFT_Stover	0.25	0.25	0.25	0.25
GFT_Pine	0.25	0.25	0.25	0.25

Table 3 shows the weight of the Sustainable Aviation the weight is equal for all the value in the set of data in the table 1. The weight is multiplied with the previous table to get the next value.

Table 4. Weighted normalized decision matrix (WSM) and Preference Score

	Weighted normalized decision matrix				Preference Score
HEFA_SO	0.02843	0.09247	0.19643	0.20574	0.52307
HEFA_YG	0.02548	0.07877	0.25000	0.25000	0.60425
VB_Stover	0.14697	0.15240	0.09483	0.11398	0.50818
VB_Pine	0.15694	0.16952	0.08661	0.10640	0.51948
ATJ_Stover	0.15399	0.14726	0.09524	0.10652	0.50300
ATJ_Pine	0.16064	0.15411	0.09091	0.10395	0.50960
DSHC_Stover	0.24151	0.23288	0.06094	0.06345	0.59877
DSHC_Pine	0.25000	0.25000	0.05699	0.05990	0.61689
FP_Stover	0.09490	0.12671	0.12360	0.15155	0.49677
FP_Pine	0.09195	0.11815	0.13095	0.16990	0.51096
GFT_Stover	0.12629	0.12500	0.11340	0.13863	0.50332
GFT_Pine	0.09380	0.18493	0.07885	0.10024	0.45782

Table 4 shows the weighted normalization decision matrix using weighted sum method it is calculated by multiplying the weight and performance value in table 2 and table 3. the preference score of WSM Weighted Sum Model it is calculated by the sum of the value on the row of weighted normalized decision matrix.

TABLE 6. Weighted normalized decision matrix (WPM) and Preference Score

	Weighted normalized decision matrix				Preference Score
HEFA_SO	0.58073	0.77985	0.94149	0.95246	0.40611
HEFA_YG	0.56502	0.74921	1.00000	1.00000	0.42332
VB_Stover	0.87564	0.88361	0.78478	0.82173	0.49895
VB_Pine	0.89012	0.90745	0.76721	0.80770	0.50054
ATJ_Stover	0.88590	0.87607	0.78563	0.80792	0.49262
ATJ_Pine	0.89531	0.88608	0.77655	0.80301	0.49469
DSHC_Stover	0.99140	0.98242	0.70266	0.70977	0.48574
DSHC_Pine	1.00000	1.00000	0.69099	0.69962	0.48343
FP_Stover	0.78494	0.84376	0.83852	0.88238	0.49004
FP_Pine	0.77876	0.82913	0.85073	0.90796	0.49875
GFT_Stover	0.84306	0.84090	0.82067	0.86294	0.50206
GFT_Pine	0.78264	0.92740	0.74941	0.79574	0.43283

Table 4 shows the weighted normalization decision matrix using weighted Product method it is calculated by multiplying the weight and performance value in table 2 and table 3. the preference score of WPM Weighted Product Model it is calculated by the product of the value on the row on weighted normalized decision matrix.
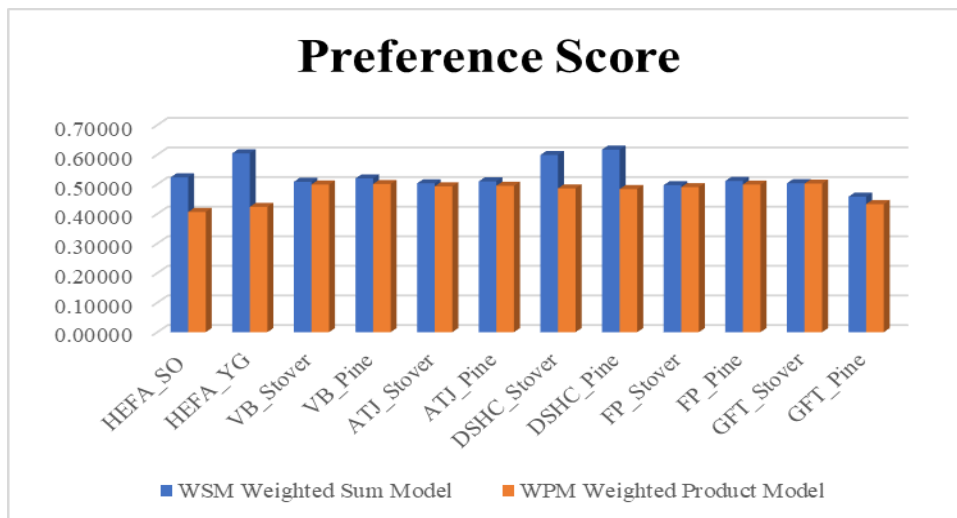

FIGURE 2. Preference Score

Shows the figure 2 preference score of WSM Weighted Sum Model it is calculated by the sum of the value on the row on weighted normalized decision matrix. HEFA_YG to plan (WSM) (WPM) is the highest and the value the calculation of the WPM Weighted Product Model and WSM Weighted Sum Model.

TABLE 7. WASPAS coefficient and Rank

	lambda	WASPAS Coefficient	Rank
HEFA_SO		0.46459	11
HEFA_YG		0.51378	3
VB_Stover		0.50357	6
VB_Pine		0.51001	4
ATJ_Stover		0.49781	9
ATJ_Pine		0.50215	8
DSHC_Stover		0.54226	2
DSHC_Pine		0.55016	1
FP_Stover		0.49340	10
FP_Pine		0.50485	5
GFT_Stover		0.50269	7
GFT_Pine	0.5	0.44532	12

Table 7 shows the WASPAS Coefficient value lambda 0.5 and sustainable aviation ranking values.the WASPAS coefficient value DSHC_Pine the highest value and GFT_Pine is lowest value. DSHC_Pine is got first rank and GFT_Pine is got lowest rank
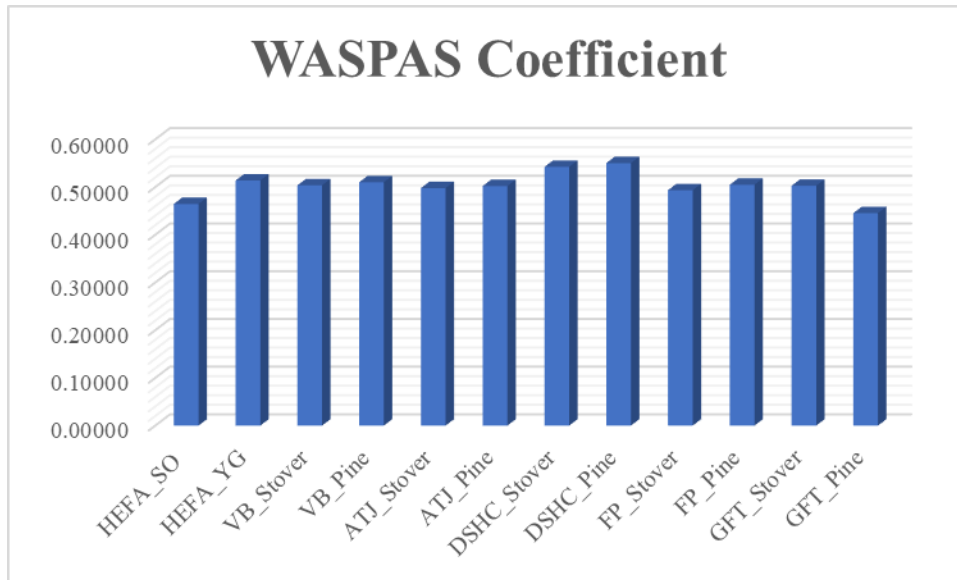

FIGURE 3. WASPAS Coefficient

Table 7 shows the WASPAS Coefficient value lambda 0.5. The WASPAS coefficient value DSHC_Pine = 0.55016, the highest value and GFT_Pine = 0.44532 is lowest value.
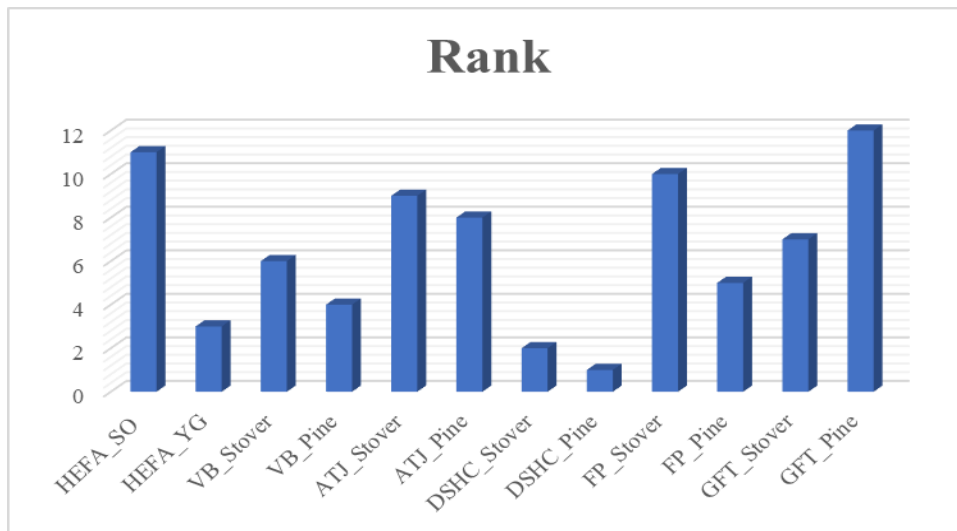
FIGURE 4. sustainable aviation rank

Shows the figure 4 sustainable aviation rank using WASPAS method. DSHC_Pine is got first rank and GFT_Pine is got lowest rank

5. CONCLUSION

This article discusses a number of intricate conclusions that came from a discourse of sustainable aviation policymaking. The procurement technology and managerial solutions, which carry far more weight than geographical factors, dominate ecological modernization in the hotly contentious sustainable aviation policy, which is a tumultuous mashup of competing discourses. the social facets of sustainability, for instance. While the focus of this essay, with some minor differences, is on sustainable alternative architecture in India, ecological modernization seems to be the major theme in other nations and locations. The methodology created in this study combines the course WASPAS and rough AHP approaches, with the latter being used to rank and evaluate vendors and the former to determine the weight values of criteria. The model was verified by choosing vendors within the business to make PVC furnishings depending on nine criteria. The fifth possibility is the best choice in both the sensitivity analysis areas of modifying the coefficient's value and solving the ensemble method using various methods recently created, according to the findings obtained using the approximation WASPAS methodology. The approximate WASPAS technique has a perfect connection with the ratings of the other approaches, according to analysis of the data from the determination of Spearman's correlation coefficient. sustainable aviation rank using WASPAS method. DSHC_Pine is got first rank and GFT_ Pine is got lowest rank

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