Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Sustainable Aviation Fuel (SAF) Procurement Challenges

Saketh Kumar Vishwakarma
Advance Supplier Management-Manufacturing Agent, Bombardier, Kansas, USA
Sakethkumarvishwakarma@gmail.com

ARTICLE INFO

Received: 21 Mar 2025

Revised: 30 Apr 2025

Accepted: 17 May 2025

ABSTRACT

Sustainable Aviation Fuel (SAF) has risen as a key saving grace for the airline industry to mitigate emissions and help achieve its sustainability goals. However, although SAF has several environmental values, the procurement of SAF on a large-scale encounter various challenge. Such challenges are high production costs, scarce feeder stock, technical matters, supply chain issues, and regulatory aspects. SAF production calls for a large amount of investment funds to be spent on infrastructure, technologies of research and development, and the cutting-edge refining technologies, which at the moment preclude the application of the product on a large scale and render the product prohibitively expensive if compared to the conventional jet fuel. Moreover, the fragmented environment of the regulatory landscape in different regions increases uncertainties in long-term procurement agreements and obstructs the regulatory Climate for SAF at the global level. Nevertheless, there are possible ways to meet these challenges. More synergies among governments, airlines, fuel manufacturers, and technology providers, coupled with rewards and policy advocates, can bring about this change. Also core to meeting these procurement challenges are improved production technologies, scaling up of SAF production facilities, and standardization of certification processes. With these challenges, the future of SAF procurement is looking bright, with possibilities of lower cost and greater availability as technology advances and regulations consider sustainable aviation practices more favorable. This paper identifies the key issues in SAF procurement, offers solutions to these barriers, and makes room for a sustainable and economically viable future for aviation fuel.

Keywords: Sustainable Aviation Fuel (SAF), Procurement Challenges, Aviation Sustainability, Carbon Emissions, Production Costs, Technological Barriers, Regulatory Hurdles, Supply Chain Complexity.

1. Introduction

Sustainable Aviation Fuel (SAF) is a biofuel used in aviation from renewable sources, including plant materials and leavings, waste oils, and other green feedstocks. Unlike conventional jet fuel, the use of SAF is less carbon-intensive across its life cycle, supporting efforts to reduce global greenhouse gas emissions and mitigate the effects of climate change. SAF is viewed as an important element of airline sustainability strategy according to global commitments, such as the Paris Agreement, to prevent global warming and minimize the transportation sector's impact on the environment. The fuel is designed to be compatible with current aircraft engines and infrastructure, making it a possible replacement for fossil-based aviation fuel without significant changes to existing technologies. The aviation industry is one of the most energy-intensive industries in the world, and a major contributor to carbon emissions all over the globe. Aviation contributes up to 2-3% of global CO_2 emissions, a percentage likely to rise with increased international air traffic (International Air Transport Association – IATA). This has made atheists' efforts to cut emissions related to aviation an impending necessity at the government, environmentalist bodies, and the aviation industry level. SAF has become an essential weapon for the aviation industry to achieve its decarbonization purposes and be instrumental in a more sustainable future. SAF appears to be an attractive way to lower the aviation sector's environmental footprint, as indicated by the promise to decrease lifecycle carbon emissions by up to 80% against the standard jet fuel. In addition, interests incorporated in the production of SAF are consistent with larger objectives that advocate for the use of renewable energy and improve dependence on fossil fuels.

The promise SAF has in solving aviation sustainability issues, the vast-scale adaptation is faced by various procurement barriers. There are many reasons why these challenges occur, some of the main reasons being that

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

production is costly and feedstocks are in short supply. Complex logistics are involved in incorporating SAF into the existing supply chain. The production of SAF demands enormous investment in infrastructure, technology, and research and development (R&D), and thus is less accessible to airlines than conventional jet fuel. Also, there are issues related to feedstock availability and competition with other industries like the biofuel industry (land use and agricultural resources). In addition, though SAF can mitigate carbon emissions, ramping up production to meet the world's requirements in terms of sustainable aviation fuel necessitates firm policy and regulatory measures. The procurement difficulty associated with SAF has been further complicated by uncertainties in pricing and long-term supply contracts, which necessitate international coordination. Once governments and industry players work together to establish a regulatory environment that will make the production and consumption of SAF viable, it will become a real and affordable solution for airlines worldwide. There are complexities surrounding the mass adoption of SAF, but these procurement complexities are fundamental to maximizing the SAF potential to achieve sustainability in aviation. This article will trace these challenges, including the various issues that constrain SAF procurement and, more importantly, examine their possible solutions.

2. Understanding Sustainable Aviation Fuel (SAF)

Sustainable Aviation Fuel (SAF) is one of the most critical elements of the aviation quest to reduce the carbon footprint and to go green. SAF is a biofuel product blended into renewable sources such as plants, algae, and waste to substitute for regular jet fuel in the immediate present. In contrast to the conventional counterpart, SAF produces a significantly smaller environmental impact, allowing the aviation industry to achieve its target of reducing carbon output. This section discusses composition and types of SAF, what makes it different from conventional jet fuel, environmental benefits, and the regulatory support that would encourage more adoption by the aviation industry.

2.1 What is SAF? Composition and Types

Under the conventional processes, SAF is more or less hydrocarbons produced from renewable feedstocks. These feedstocks have included biomass from vegetable oils and animal fats, agricultural residues, municipal solid waste, and even CO2 captured in industrial processes. SAF's most common production processes are Fischer-Tropsch synthesis, Hydroprocessed Esters and Fatty Acids (HEFA), and alcohol-to-jet (ATJ) technology. Such methods enable SAF to be chemically similar to ordinary jet fuel and thus to be compatible with current aircraft and airport infrastructure with a high level of compatibility (Goel & Bhramhabhatt, 2024). SAF is classified into various types based on the methodology used in production. For example, HEFA SAF is obtained from oils such as used cooking oil or algae, while ATJ SAF starts from alcohols such as Ethanol or Butanol. The aviation industry is also investigating other technologies, such as catalytic conversion and gasification, to diversify the nature of feedstocks while increasing the scalability of SAF production.

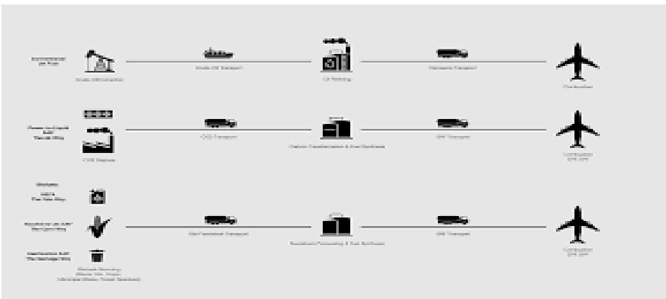

Figure 1: SAF: Guide to Sustainable Aviation Fuels

2.2 How SAF Differs from Conventional Jet Fuel

SAF varies from that of traditional jet fuel in its chemical composition, origin, and environmental impacts (Song et al, 2024). Unlike conventional jet fuel, which tends to come from crude oil, thereby containing carbon trapped for millions of years, the SAF is extracted from renewable sources that can be replenished and sustainably sustain a lifecycle. Energy-wise, SAF has the same energy density as fossil-based jet fuel, thus making aircraft performance unaltered by using SAF. The other significant difference is the carbon emissions related to SAF. Burnt conventional jet fuel produces considerable carbon emissions, leading to global warming and climate change. SAF has a high potential to decrease lifecycle carbon emissions by 80% compared to conventional jet fuel. This is possible because the carbons emitted from the combustion are balanced by the feedstock absorbing carbons while it is growing. Nevertheless, this emission reduction can differ depending on whether one uses a particular feedstock and production technology.

2.3 Environmental Benefits of SAF

There are several environmental gains of SAF, especially in terms of the reduction of greenhouse gas emissions. One significant benefit of SAF is that the fuel reduces carbon emissions throughout the entire lifecycle, from feedstock generation to combustion. As previously stated, SAF can minimize carbon emissions by up to 80%, depending on the method, and feedstock can be used for production. Besides, the ability of SAF to lower the concentration of particulate matter and nitrogen oxides, both of which aid in air pollution and urban health issues, exists. SAF also has other environmental advantages, such as reduction in fossil fuel dependence and stimulation of renewable energy emergence. Using waste materials and agricultural residues to produce feedstock, SAF can help diminish the amount going into landfills and promote circular economy activities (Emmanouilidou et al, 2023). Moreover, the manufacture of SAF could stimulate the development of the green industries and provide employment opportunities in the renewable energy and biofuel industries, thus supporting the move to a low-carbon-based economy.

2.4 SAF Adoption and Regulatory Support in the Aviation Sector

The uptake of SAF through the aviation industry has increased in the past few years due to increasing concern about the environment and regulatory pressure. Governments and international institutions have established lofty objectives for reducing carbon emissions that the aviation industry must achieve, using SAF as an important vehicle. For example, the "Fit for 55" initiative by the European Union will seek to reduce the carbon emissions of the EU by 55% by the year 2030, which will play a key role in SAF's realization of this goal. Besides regulatory support, several big airlines and aircraft manufacturers have promised to use the SAF in their fleets. For example, the US government has established goals for SAF production, and airlines like Delta and United Airlines have promised to make large deliveries of SAF (Korkut & Fowler, 2021). In addition, governments are providing financial rewards and subsidies to fuel producers, encouraging them to expand available SAF production, which is currently constrained by high production costs and insufficient supply. Though possibly hindered by regulatory momentum and industry interest, several hurdles exist in the acceptance of SAF by all. These are high production costs, limited availability of the feedstock, and the need for infrastructure investments for the distribution and storage of SAF. To date, however, the aviation industry's commitment to using SAF, which is supported by the public through regulation and increased investment, promises a bright future for sustainable aviation practices.

Figure 2: H2, sustainable fuels and new routes: Making aviation green

3. The Global Aviation Industry's Commitment to Sustainability

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

As part of the global aviation industry, air travel has always been a key cause of greenhouse gases, emitting approximately 2-3 % of global carbon dioxide (CO_2). To meet the rising urgency of climate change, the sector has been progressively making sustainability commitments through international goals, frameworks, and technological innovations. In these innovations, SAF has become a critical solution to minimize aviation carbon footprint. The will of the aviation industry to become sustainable is based on a variety of international goals, the key role of SAF, and increasing trends of fuel usage.

3.1 International Goals and Frameworks

An agency of the United Nations, a specialized agency, the International Civil Aviation Organization (ICAO) has been vital in coordinating global initiatives to reduce aviation's environmental impact. One of the key goals established by ICAO is its commitment to ensure the world achieves zero carbon emissions by 2050. This bold target corresponds to the broader global climate agendas, e.g., limiting global warming to well below 2°C compared to pre-industrial levels, as provided for in the Paris Agreement. CORSIA, the Carbon Offsetting and Reduction Scheme for International Aviation produced by ICAO, is yet another key structure aimed at keeping aviation emissions at 2020 levels and, in the long term, aims at achieving carbon-neutral growth through offsetting and emissions reduction measures. Besides the ICAO's initiatives, various national and regional governments have also introduced policies that will help them promote sustainability in aviation (Mayer & Ding, 2023). For example, the regulations implemented by the European Union are those that support the SAF use, such as blending mandates and tax breaks for those who produce SAF, just like the US, which has introduced a Sustainable Aviation Fuel Grand Challenge seeking to produce at least 3 billion gallons of SAF annually by 2030. These structures and platforms reflect the interest of aviation in sustainability and further reveal the relevance of SAF to achieve goals for carbon-neutral aviation.

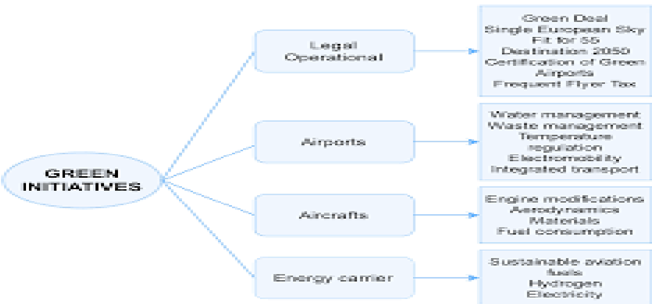

Figure 3: Passengers' Knowledge and Attitudes toward Green Initiatives in Aviation

3.2 Role of SAF in Meeting Carbon Neutral Aviation Goals

Sustainable Aviation Fuel (SAF) is the core in helping the aviation sector reach its net-zero emission target. SAF is a bio-based fuel, with a renewable source, such as agricultural waste, algae, or waste oils, that can power aircraft with a much lower carbon footprint than conventional jet fuel (Chavan, 2023). While traditional jet fuels only reduce lifecycle CO_2 emissions by approximately 80% based on feed and production processes, SAF has a zero-emissions rate. As a fuel that can be dropped in for existing fuel, SAF can easily be mixed into conventional jet fuels with changes to aircraft and related infrastructure not being necessary, thus making its integration smooth, easy, and scalable. SAF's capability to be integrated with the existing aviation infrastructure is key in speeding up its rates of adoption and its usefulness in facilitating airlines, achieving a sustainable future.

3.3 Current SAF Usage Statistics and Projections for Growth

Even though the Potential of SAF is promising, its current usage is not widespread. By 2023, SAF will have a share of air fuel consumption globally, which amounts to only 0.1%. However, with tremendous optimism about its future growth, there is much confidence in it. According to projections, compressive SAF output could hit 30 billion liters/year by 2030, amounting to about 5% of the global needs for aviation fuel (Air Transport Action Group 2022). This SAF growth will be generated by refinements in production technology, increased feedstock availability, and regulations. The aviation industry's environmental footprint is set to be reshaped by virtue of its steadfast commitment to sustainability, backed by an international framework and the critical nature of SAF. Through scalable

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

SAF production and adoption, the aviation sector will be able to drastically minimize carbon emissions and help achieve global climate targets to make airlines safer in the future.

4. Challenges in SAF Procurement

Sustainable Aviation Fuel (SAF) has proved to be a promising alternative to traditional jet fuels, reducing the delivery of carbon emissions and making it easier to transition the aviation industry toward an environmentally friendly energy source. However, procurement and universal uptake of SAF experience several challenges that hinder its scalable and commercial feasibility. Such challenges can be grouped into supply chain, technology, regulatory policies, and other challenges.

4.1 Supply Chain Issues

The lack of production capacity is among the most significant obstacles in the procurement of SAF. The manufacturing of SAFs is at an early stage of development compared to conventional jet fuel, and current world production is not enough to supply the fast-growing demand from the aviation industry. The 2020 global SAF production at just 1.4 million liters is relatively poor compared to the industry's roughly 300 billion liters annually of jet fuel (International Air Transport Association [IATA], 2021). This small production capacity causes a severe supply shortage, making SAF scarce and costly. Moreover, differences in SAF production at the regional level intensify supply chain issues. Although certain regions (the United States and Europe) have advanced work on developing SAF production facilities, other regions, especially the ones in Asia and Africa, are more behind on the issue. Offsetting the uneven geographical distribution of SAF production facilities and infrastructure requires efforts to ensure that the world requires it. International airlines may discover sourcing SAF inconvenient/not possible in areas where SAF production is in short supply/unavailable, respectively.

This geographic imbalance also results in high transportation costs, compounding the price of SAF and making the product unsustainable for most airlines economically. Another critical supply chain barrier for SAF procurement appears in feedstock sourcing. SAF is produced from diverse stocks such as biomass, agricultural residues, and waste oils. Feedstocks' sustainability and availability may differ significantly by region. For instance, the agricultural waste that constitutes a large part of the SAF feedstock may not be available in adequate volumes in all regions. Apart from this, the dependency on biomass leads to concerns regarding land use and competition with food production, which has an unwanted environmental impact. Finding reliable and predictable amounts of sustainable and cheap feedstocks is still a significant challenge in the SAF supply chain (Meerstadt et al, 2021).

4.2 Technological Barriers

Another key problem in the purchase of SAF results from technological barriers. One of the top technological challenges is the absence of high-sophistication refining technologies that would enable SAF production at large volumes. Currently, technology in production processes involved in the manufacture of SAF is cumbersome and entails huge capital outlays in state-of-the-art refineries. While these technologies, including the Fischer-Tropsch synthesis, hydro processing, and alcohol-to-jet, have been scaled and tested at pilot and commercial scale, scaling them to produce SAF in large volumes is still an unresolved issue. Many refineries are not equipped with the required infrastructure and know-how to convert into SAF producers, which has depressed the industry growth. The high cost of production is directly linked to technological limitations (Frenkel, 2003). However, SAF production is being conducted at an order of magnitude higher price than conventional jet fuel, primarily because of the very high costs of the refining process and the need to utilize advanced technologies.

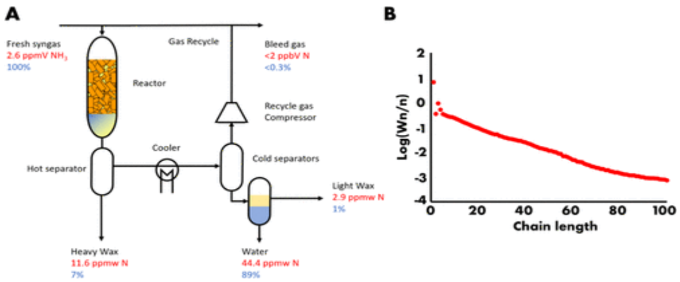

Figure 4: Fischer–Tropsch Synthesis for the Production of Sustainable Aviation Fuel

The cost of producing SAF is four times the price of conventional jet fuel, rendering SAF undesirable to airlines and other players in the aviation supply chain (Chavan, 2021). This price gap has created a resistance from airlines, most of which are averse to using SAF unless there are government incentives or a massive reduction in production cost. The excessive price of SAF still poses a significant obstacle in the procurement and application of SAF throughout the aviation industry. Scalability worries are also a feature of the technological barriers to SAF procurement. Apart from pilot projects showing that SAF can replace traditional jet fuel, scaling up SAF production to serve the needs of the global aviation industry presents significant challenges. The aviation industry uses massive quantities of fuel, and present-day SAF manufacture cannot cope with that consumption. As long as technologies that allow SAF to be produced in large quantities at smaller prices are not discovered, scalability will be a key challenge in SAF procurement.

4.3 Regulatory and Policy Challenges

Regulations and policies are also important factors that influence the purchase of SAF. The primary problem is the necessity for SAF regulatory approvals and certifications (Chiaramonti & Goumas, 2019). The aviation industry is highly regulated. Because of that, any new fuel entering the market must undergo rigorous safety and performance tests to be allowed for flight in commercial use. Getting the required certifications of SAF (which involves demonstrating that it is safe, performs, and is compatible with existing aircraft engines) takes years and is expensive. The certification process is lengthy and country-specific, causing a delay in the dispersion of SAF. Another challenge in the regulatory landscape is policy uncertainty. Even though many countries are now developing policies and incentives to support the production and adoption of SAF, there is still no coherent global policy.

The aviation industry is international, where fragmentation in SAF policy can lead to confusion and inefficiency in policy implementation. Many airlines and fuel producers need explicit and stable policies to engage in long-term investments in SAF. Without regular policy frameworks, future demand may not be met with required investments in SAF infrastructure. Environmental standards that compete further compound the regulatory scenario. Different regulatory environments in different countries and regions can result in inconsistencies in how SAF is produced and consumed (Mandel, 2003). For instance, in the case of Finland, that has set an ambitious target for production and consumption of SAF while the rest of the world continues pursuing SAF initiatives, such as the United States, may have other regulatory regimes/regulations as regards SAF implementation; this is given different regulatory frameworks in different regions. Such differences in environmental standards may act as a barrier to the widespread implementation of the SAF and lead to confusion and delays in the procurement process.

5. The Role of Government and Industry Stakeholders

The move to Sustainable Aviation Fuel accounts for a lot of the decarbonization process in the aviation industry and the attainment of the industry's sustainability agenda. Nevertheless, the transition into the new paradigm is accompanied by complex challenges that call for the participation of industry and government stakeholders. Working together is important to surmount procurement barriers and reap the full extent of SAF implementation.

5.1 Government Support and Incentives for SAF Production

The government also plays a fundamental role in assisting the SAF market to grow. They can create funding, tax incentives, and subsidies for SAF producers to reduce the costs of SAF production. These incentives are critical to investment in SAF technology and infrastructure. For instance, governments can provide grants and loans to companies developing FAT production infrastructure or those investing in research and development to improve the technologies of FAT production. Such support helps balance the high production costs of SAF, which continue to be a significant problem in large-scale adoption. Government initiatives that seek to lower barriers limiting the uptake by industry of emerging technologies like SAF are pivotal in catalyzing the industry into broader adoption of sustainable practices (Singh, 2022). Additionally, government support can go beyond monetary incentives to include policy measures that will make favorable conditions for the adoption of SAF possible. Regulations that require a specific percentage of SAF in the fuel mix or transparent medium—to—long—term decarbonization goals will send a clear market signal to SAF producers. These policies help eliminate uncertainty and promote long-term investments in SAF infrastructure. A propitious regulatory climate and the inducement of government make SAF a viable alternative to jet fuel.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/ **Research Article**

5.2 Industry Partnerships and Collaborations

Critical success in implementing SAF is the relationship and partnerships developed with industry stakeholders, such as airlines, fuel producers, and technology providers. Industry players now understand that sharing resources and expertise is the secret to addressing procurement problems. For instance, airlines are key players in establishing hope for SAF, as their interest in sustainable aviation practices could be a significant factor in SAF's rollout (Nilson & Tuvlind, 2020). Shared ventures between airline-fuel manufacturers integrate investments toward SAF production facilities and infrastructure development. Such alliances will help develop economies of scale, and they might reduce the price of SAF, making the SAF more competitive with traditional jet fuel. Moreover, the willingness of aviation enterprises and research institutions to cooperate enables the development of more sophisticated technologies of SAF (Sustainable Aviation Fuels). Industry partnerships based on the involvement of individuals and the entire public and private sectors have also proved helpful in accessing financing and regulatory support. Such partnerships are critical because they ensure that barriers in the form of logistics and technology that may be critical in stagnating growth in the SAF market do not obstruct the market from developing.

5.3 Importance of Government Policies in SAF Marketing Expansion

Government policies adequately contribute to the successful extension of the SAF market. Clear, thought-through long-term policies make the ground for all the stakeholders' stability and certainty, as well as investment and innovations in the SAF production. Carbon pricing or emissions cut mandates, as the incentive policies from the government, drive a robust business case for airlines to adopt SAF. Besides, government policy that conforms to international sustainability standards and frameworks can facilitate global partnership in the SAF market. The convergence of the world aviation industry's attitude towards reducing emissions requires collective action from government policies to promote the production of SAF as a part of the solution. On the last note, government support and industry collaboration are necessary to solve the problem of SAF procurement. Governments must develop incentives and supporting frameworks to enable SAF production, and industry individuals must work together to develop a sustainable and scalable SAF Supply Chain (Collier et al, 2017). This collaborative effort will be instrumental in the mass adoption of SAF, bringing the aviation industry to its sustainability targets.

Figure 5: How airlines can chart a path to zero-carbon flying

6. Alternative Solutions and Innovations against SAF Procurement Challenges

The carbon footprint of air transport has evolved into Sustainable Aviation Fuel (SAF) as the key measure for addressing this problem. Notwithstanding, SAF procurement restraints, such as cost, scalability, and supply chain complexity, eliminate its global use. Different alternative methods and innovations are being developed to fix these issues, such as advances in the technologies related to the production of SAF, strategic partnerships, supporting fuels, etc., and the efforts of large airlines.

6.1 Advancements in SAF Production Technologies

One of the most important steps in overcoming the problems of SAF procurement is the continued design of SAF production technologies. A promising approach is the Power-to-Liquid (PtL) technology that converts renewable electricity into liquid fuel by capturing carbon dioxide from the atmosphere and using it with the hydrogen obtained through water electrolysis (Karwa, 2023). This process enables the development of SAF independently of traditional fossil fuels. PtL is especially advantageous because it incorporates renewable energy sources that may help make up for SAF's current feedstock (biomass or waste oils) limitations. Another important achievement is algae-based SAF. Since algae are fast-growing organisms, they can produce large amounts of usable lipids for conversion to biofuels.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

The production of algae-based SAF has the advantage of using non-arable land and atmospheric carbon dioxide, meaning it will be very sustainable. The technology is still developing, but there is hope to create a scalable, cost-effective, and friendly environment, SAF. Investment in these technologies and continued exploration will facilitate the necessity to face the issues relating to cost and availability of SAF.

6.2 Strategic Partnerships for Sustainable Fuel Innovation

Besides technological innovations, strategic partnerships are instrumental in meeting SAF procurement challenges. Collaboration of governments, airlines, fuel producers, and research institutions is of the essence for scaling up SAF production and integration into the global aviation supply chain. For example, an alliance between airlines and fuel producers can assure a continuous supply of SAF with the help of collaboration with technology companies that can be used to improve production methods. One such collaboration is between British Airways and Velocys, which is working on a waste-to-fuel plant in the UK, hoping to produce sustainable jet fuel from household and commercial wastes. Airlines are also signing long-term supply agreements with SAF producers, helping to guarantee the fuel's availability and determining financial investments in SAF's infrastructure. These collaborations must not only make up for the excess supply but also help cut down production costs, thereby making SAF affordable and accessible. Such strategic partnerships can enable the aviation industry to transcend the shackles associated with SAF procurement, supply chain, and cost barriers that currently prevent the everyday use of SAF (Edwards et al, 2014).

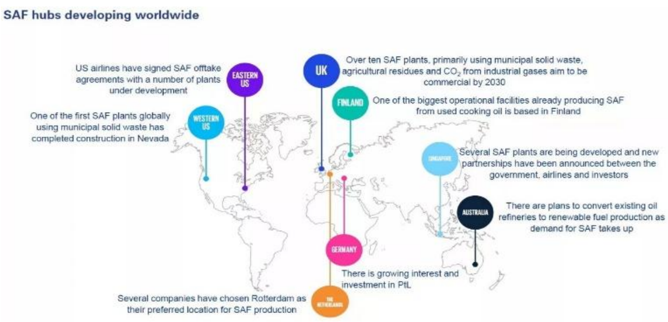

Figure 6: Sustainable Aviation Fuel Market

6.3 The Potential Green Hydrogen and Biofuels in Complementing SAF

Another alternative solution is using green hydrogen and biofuels to complement SAF. Green hydrogen, which can be derived from electricity by electrolysis, may be used in fuel cells or mixed with CO2 to make synthetic fuels. Although hydrogen-driven planes are in the experimental stage, green hydrogen can play an added fuel for aviation in the long run to mate with conventional SAF while offering additional scalability to address future demand. Biofuels, including those obtained from waste oils or agricultural residues, can also supplement SAF by increasing the overall availability of renewable aviation fuels. Biofuels can be mixed with conventional fuel or used directly in current engines, thus making them flexible and practical (Demirbas, 2007). These fuels, in particular, are helpful in areas where SAF production from algae or PtL technologies may still not be practical on a large scale.

6.4 Initiatives from Major Airlines and Aviation Companies

Major airlines and aviation corporations are also considering making arrangements to handle matters related to SAF procurement. For example, United Airlines committed to purchasing 1.5 billion gallons of SAF in the next two decades, perhaps the largest SAF deal in the industry. Likewise, the attempts at Lufthansa to push the SAF development have been numerous, as well as engagement with the local governments and environmental organizations to develop policies supportive of the SAF use (Ydersbond et al., 2020). Besides, airlines are also investing in infrastructure designed to make SAF accessible to the population. This involves building SAF refueling stations at pertinent airports, and we develop logistics systems capable of managing SAF tracking and distribution. Such cautions are necessary for overcoming logistical barriers to SAF purchases and airline access under competitive terms.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

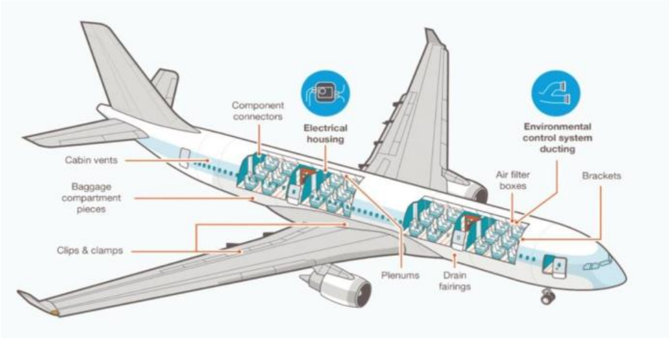

Figure 7: Top Technology Trends in Aviation Industry

7. Methodology

This research approaches this research problem analytically by exploring the challenge of accessing sustainable aviation fuel (SAF). To delineate the significant obstacles and prospects of the procurement process, this study attempts to integrate the qualitative and quantitative approaches about cost issues, scalability, and policy effectiveness. The methodology is designed to provide an integrated view of the SAF procurement factors acting upon and the possible answers to confronting these challenges.

7.1 Research Design

The research design is analytical, according to the difficulties of the stakeholders involved in the procurement of SAF. This approach enables a profound analysis of key problems such as production costs, supply-side limitations, and policy influences on procurement strategies. Primary and secondary data sources inform the research design, and hence the research can achieve holistic and accessible results based on real-life experience in the explored industry (Jensen & Laurie, 2016).

7.2 Data Sources

Most of the primary data for this study is based on expert interviews and industry reports. Experts in various aviator-industry fields, including fuel manufacturers, air carriers, and government agencies, share valuable insight regarding challenges and opportunities to pursue the acquisition of SAF. These semi-structured interviews give the freedom to solve the given topics with a focus on important issues. In addition, secondary data taken from governmental publications and industry reports are analyzed to address a broader perspective on the procurement of SAF (Hsieh et al., 2004). These documents have valuable information regarding drugs' prescriptions, regulatory infrastructure, market tendencies, and the technological state required to get one's head around the general ambit in which SAF procurement takes place.

7.3 Evaluation Metrics

The study measures SAF procurement challenges with multiple metrics. The first metric is cost analysis; it is research on the financial effect of SAF procurement, including different production, distribution costs, and price volatility. This metric enables analysis of the economic practicability of the SAF application, particularly in the context of financial restraints applied to the aviation companies. The second metric, production scalability, assesses the capability of SAF production to meet the aviation industry's continuously increasing demand (Chiaramonti & Goumas, 2019). Such an assessment should consider the availability of the raw materials, the state of technological improvements in production processes, and the facilities' capacity. Finally, policy effectiveness is assessed by examining the role of governmental and international policies in dictating SAF procurement. This metric questions the effects of policies, like subsidies, carbon taxes, and emissions regulations, on the dynamics within the market and procurement of airlines and fuel producers.

7.4 Limitations of the Study

Although it is an interesting instrument that provides some insights into the challenges associated with procuring SAF, it also has several limitations. Geographic scope is one limitation in that it largely centers on regions where SAF adoption is the most advanced, i.e., Europe and North America. Consequently, the findings may not capture the challenges of the less developed SAF markets. Another limitation is that some companies may be unwilling to share sensitive financial or operational information, and the data availability from private industry

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

stakeholders may also be a limitation in reflecting the depth of the cost analysis. Also, the research heavily draws its findings from expert opinion. Thus, it may be subject to assumptions favoring the given argument. Finally, policy changes during the research may influence the relevancy of the findings since the government regulations and the market dynamics change fast in response to environmental and economic pressures (Sardana, 2022).

Figure 8: Geographical scope with l classifications for the modelling analysis

8. Impact of SA F Procurement Challenges on the Aviation Industry

The aviation industry has always contributed to global carbon emissions, making switching to sustainable aviation fuel (SAF) to achieve zero emissions critical. Nevertheless, the procurement of SAF has created several problems, both on the financial terrain and with long-term industry viability. The issues of supply chain, regulatory, and production constraints have enormous implications for airlines, airports, and the overall aviation landscape. This section discusses the financial implications, the impact on net-zero emissions targets, and sustainability concerns regarding SAF procurement challenges.

8.1 Financial Implications for Airlines and Airports

The procurement issues related to SAF directly impact the financial soundness of air carriers and airports, which are prominent value chain actors. The high cost of SAF is the primary barrier one has to face as it continues to be much more costly than conventional jet fuel. Since the production of SAF is still in its infancy, the economies of scale have not yet been reaped, and the cost of SAF is prohibitive to many airlines, especially those on tight margins. SAF can be up to 3 times more expensive than traditional jet fuel, which is a considerable cost burden on airlines seeking to diversify their fuels using SAF. The scarcity of SAF further increases the financial pressure because the existing production capabilities do not serve world demand (Hanjra & Qureshi, 2010). This scarcity pushes airlines to use less SAF, thus increasing the prices. Airlines might have to languish or scale down their sustainability efforts for some time as they pick affordable but less environmentally friendly conventional fuels. Airports also have problems in this aspect as they need to upgrade infrastructure to support the distribution of SAF, which is an additional expense.

8.2 Impact on Achieving Net-Zero Emissions in Aviation

Aviation contributes roughly 2 3% of global carbon emissions, and switching to SAF is one of the most promising ways out of the carbon footprint of air travel (Dhanagari, 2024). Nonetheless, the procurement difficulties of SAF severely obstruct the attainment of net-zero emissions in the aviation industry. Although SAF fuel has been acknowledged as a lower-carbon fuel substitute for conventional jet fuel, its advantages can only accrue if SAF is produced and consumed on a large scale. The existing production rate of SAF, combined with procurement issues, makes it impossible for airlines to incorporate enough SAF into their operations to have a meaningful effect on emissions. Furthermore, the adoption of the fuel is also greatly hindered by the absence of regulatory frameworks and incentives to promote SAF procurement. Regulators should put in place policies that will make it easier to produce, distribute, and consume SAF, which will compel airlines and airports to switch from fossil fuels. Moreover, without adequate regulatory support, the industry risks not meeting its long-term emissions reduction targets, undermining the overall goal to decarbonize aviation to net-zero emissions.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

8.3 Short-term and Long-term Industry Sustainability Concerns

Over the short term, issues related to SAF purchasing are detrimental to the aviation industry's efforts to meet its sustainability objectives. Airlines are squeezed between the necessity to minimize carbon emissions and the economic truth of costly SAF purchasing. This paradox is that airlines will be encouraged to select the cheaper, usually conventional jet fuel, barring them from operating in a sustainable environment. In the long term, the challenges surrounding SAF procurement threaten the industry's sustainability. If the production of SAF is constrained and costly, the aviation industry might have difficulties coping with the increasing demand for greener travel modes. This may cause those airlines that fail to cater to the growing consumer demand for sustainability to face reputational damage. Moreover, the long-term financial viability of airlines may be in jeopardy if they fail to offset their cost of operations by switching to cheaper, more sustainable fuel options. As the world adopts stricter environmental policy measures, airlines are likely to be penalized either through the imposition of charges or increased operational costs, thus worsening such airlines' financial situation (Borenstein & Rose, 2014).

9. Case Studies of SAF Procurement Challenges

Sustainable Aviation Fuel (SAF) has received much attention as a key step towards reducing aviation's carbon footprint. However, airlines and governments have encountered many difficulties when acquiring SAF, such as technological, financial, and legal problems. The following case studies describe real procurement hurdles, lessons learned, and implemented strategies to overcome these hurdles.

9.1 Delta and the High Costs of SAF

The largest carrier of the US, Delta Air Lines, had to go through much trouble to get SAF because the production costs were high. In 2021, the airline adopted a landmark pledge to become carbon neutral by 2030, including procuring SAF. However, SAF production is currently more expensive than traditional jet fuel by approximately twice, up to four times the price (Singh, 2024). With a challenge of limited demand in the entire world, high demand from other airlines and industries made the procurement challenge faced by Delta more complex.

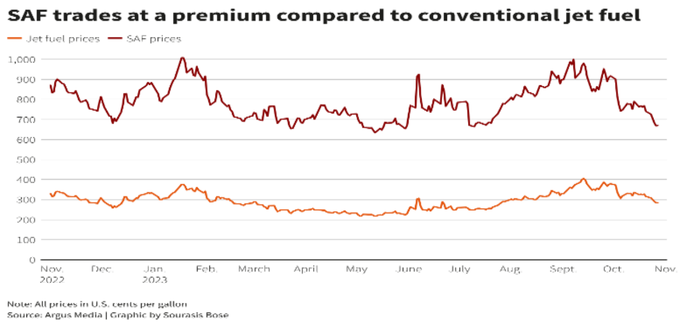

Figure 9: U.S. sustainable aviation fuel production target faces cost, margin challenges

Lessons Learned:

The case of Delta demonstrates the necessity of scaling up capabilities for SAF production capacity and the role of the government in absorbing the high cost until they are produced at scale. Those airlines that are serious about SAF integration must enter into long-term agreements with SAF producers to ensure supply and stabilize prices.

Successful Strategies:

Delta has partnered with governments and SAF producers to reduce SAF costs. The airline has also lined up joint ventures with fuel producers to enhance supply and contain production prices (Mortensen et al, 2019). In addition, Delta joined efforts like the "Clean Bills for Tomorrow" coalition, which lobbies for policy frameworks and incentives to drive SAF adoption. These initiatives have enabled the airline to win a SAF contract at attractive prices.

9.2 Singapore Airlines and Government Incentives

The difficulty for procurement posed by SIA in acquiring SAF was subject to the nascent state of SAF production in Asia. The carrier struggled to achieve its sustainability targets due to the low availability of SAF and high cost. However, in 2022, Singapore Airlines achieved SAF supply thanks to cooperation with the Singaporean

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

government and SAF producers. The government encouraged the local fuel producers to increase SAF production to cover the initial drains on the airline financially.

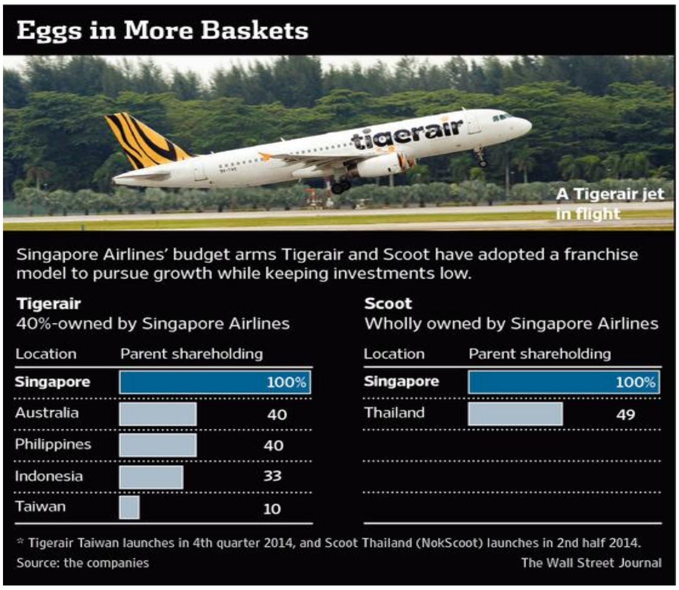

Figure 10: Singapore Airlines Extends Low-Cost Push Despite Challenges

Lessons Learned:

This case illustrates how critical government incentives can play a role in addressing the procurement challenges. Cooperation of airlines with governments to drive SAF development is helpful for both parties by lowering fuel costs and being an eco-friendly alternative. It shows that it is possible to streamline supply chains by cooperating with local producers and ensuring a safer SAF supply.

Successful Strategies:

Such an alliance with the Singaporean government and the SAF producers has proved effective in ensuring a continuous supply of SAF for the airline. Government financial incentives, also known as tax relief and subsidies, discouraged firms from purchasing biodiesel blends, lowered the cost of SAF, and made SAF more competitive to conventional jet fuel (Avagyan & Singh, 2019). In addition, the airline took a collaborative approach (complying with government policies on sustainability) to support the production of SAF.

9.3 The European Union and Barriers in Policies

The European Union has been keen to drive SAF adoption to meet its ambitious climate goals, but the policy process entails many procurement challenges. One of the main barriers is the lack of a unified regulatory structure among EU member states. The inconsistent policies and safety regulations observed among nations have developed uncertainty among SAF producers and airlines, which has impeded procurement activities.

Lessons Learned:

The EU's experiences point to the necessity of aligning with regulations and clarifying policy frameworks to make the adoption of SAF achievable within the aviation industry (Bruce & Spinardi, 2018). Harmonized standards and regulations among the member states would simplify the process and enhance industry confidence in SAF.

Successful Strategies:

To circumvent these policy obstacles, the EU has begun harmonizing regulations and initiating financial incentive measures for producing and using SAF. One example of the EU's resolution of these procurement challenges is the "Fit for 55," which contains a proposal for increased use of SAF in aviation. By establishing a more predictable regulatory environment, the EU has moved towards ensuring that SAF procurement achieves long-term sustainability.

9.4 United Airlines, the SAF Supply Chain is Facing Challenges

United Airlines' procurement of SAF was problematic because of constraints in global SAF production capacity (Vicente, 1999). Notwithstanding being one of the pioneering airlines that endorsed using SAF, United had

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

difficulty obtaining a regular and dependable source. The airline's procurements were delayed due to a lack of infrastructure for the production of SAF and the time needed to scale up production facilities globally.

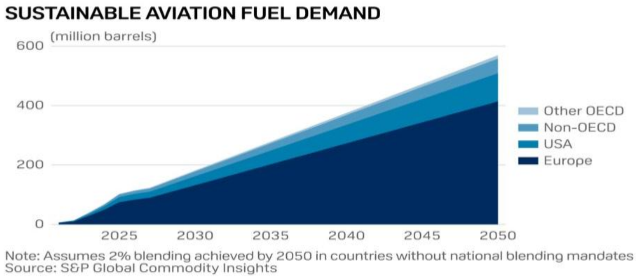

Figure 11: Long-term demand for SAF could run into supply constraints

Lessons Learned:

United's case shows the need to develop global infrastructure and the production of SAF. The supply chain shortage provides a rationale for bringing the industry together to develop a sustainable and expandable SAF production system.

Successful Strategies:

United Airlines addressed these challenges by investing in companies that produce SAF and concluding long-term deals with fuel producers. United became a more dependable and stable SAF supplier by owning an equity stake in these companies. Besides, the airline has consulted with aviation stakeholders to support increasing SAF production infrastructure worldwide (Mousavi & Bossink, 2017).

10. Conclusion

Sustainable Aviation Fuel (SAF) is one of the leading solutions for the carbon footprint in the aircraft industry. However, so many challenges come with the extensive purchase of SAF that must be solved to tap the full potential. This paper will examine some of the significant problems in the procurement of SAF, including high production costs, low availabilities, technological barriers, policy/regulatory barriers, and logistic issues. These have been significant impediments to the commercialization of the SAFs and the attainment of the sustainability goals and the carbon reduction targets of the aviation industry. One of the key issues pointed out in the SAF procurement process is the high production cost. SAF is much more expensive to produce than traditional jet fuel, mainly due to the relatively low level of its current production and demand for high technology, which is given to its production.

Additionally, the availability of required feed stubs would continue to be a constraint; this adds to the difficulty people have experienced in increasing production levels to suit the rising demand. The market experiences reallocation, which results from an inadequate supply of SAF. Consequently, the price volatility and instability are experienced, hence long-term procurement agreement engagements by airlines and fuel providers are a nightmare.

The same is true for the limiting measure of the SAF procurement, which has technological barriers playing an important role. Even with multiple pathways for SAF, most of these technologies are in the early stages and not ready for large-scale commercialization. This lowers the limits for meeting the growing demand for SAF without sacrificing cost competitiveness against conventional jet fuel. In addition, airports and refineries' current infrastructure may not be compatible with SAF production and delivery; SAF logistics may be complicated. Policy and regulatory issues are other important agents of concern for SAF procurement. An imprecise, heterogeneous, standardized policy world relating to the production, certification, and carbon offsetting of SAFs sets an ambiguous regulatory framework for aviation industry stakeholders. Such inconsistencies discourage investment in SAF technology and the infrastructure that confines airlines from using SAF more fully. In addition, with a lack of firm encouragement and subsidies from the government, airlines and fuel producers may not be keen on SAF due to the high capital outlay necessary. Despite such challenges, it is possible to manipulate solutions to make the procurement of SAF easy. First, the aviation industry, jointly with governments, should work on developing and scaling SAF production technologies. Increased R&D investments are necessary to enhance production efficiency and costs.

Governments may be instrumental if they offer financial motivators, such as tax incentives and subsidies on producing and adopting SAFs. Further international coordination and unified regulations on SAF certification and offsetting of carbon will make this regulatory process more predictable. In addition, agreements between airlines, fuel suppliers, and airport operators help improve the logistics of SAF distribution. Infrastructure scalability is required to address logistical constraints on SAF storage and refueling. Private partnerships allow investment in such infrastructure developments, making SAF acquisition and distribution more effective. The future of SAF procurement in the aviation industry seems promising, but is beset with challenges. Despite the fact that the cost of SAF will be decreased and the product can be used by all airlines worldwide because of gradually developing technologies and economies of scale and positive policy trends, the cost of the product debut will be as high as $300 per gallon. Further initiatives towards sustainability in the aviation industry and further collaboration in overcoming these barriers will likely culminate in a more sustainable and economically feasible SAF market. The necessary factors for SAF procurement to be successful are technology, policy, and industry cooperation to ensure a low-carbon sustainable future in aviation.

References;

[1] Air Transport Action Group. (2022). *Aviation's contribution to climate action*. https://www.atag.org

[2] Avagyan, A. B., & Singh, B. (2019). Biodiesel: feedstocks, technologies, economics and barriers. *Assessment of Environmental Impact in Producing and Using Chains*.

[3] Borenstein, S., & Rose, N. L. (2014). How airline markets work… or do they? Regulatory reform in the airline industry. In *Economic regulation and its reform: What have we learned?* (pp. 63-135). University of Chicago Press.

[4] Bruce, A., & Spinardi, G. (2018). On a wing and hot air: Eco-modernisation, epistemic lock-in, and the barriers to greening aviation and ruminant farming. *Energy research & social science*, *40*, 36-44.

[5] Chavan, A. (2021). Eventual consistency vs. strong consistency: Making the right choice in microservices. *International Journal of Software and Applications, 14(3), 45-56*. https://ijsra.net/content/eventual-consistency-vs-strong-consistency-making-right-choice-microservices

[6] Chavan, A. (2023). Managing scalability and cost in microservices architecture: Balancing infinite scalability with financial constraints. *Journal of Artificial Intelligence & Cloud Computing, 2, E264*. http://doi.org/10.47363/JAICC/2023(2)E264

[7] Chiaramonti, D., & Goumas, T. (2019). Impacts on industrial-scale market deployment of advanced biofuels and recycled carbon fuels from the EU Renewable Energy Directive II. *Applied Energy*, *251*, 113351.

[8] Chiaramonti, D., & Goumas, T. (2019). Impacts on industrial-scale market deployment of advanced biofuels and recycled carbon fuels from the EU Renewable Energy Directive II. *Applied Energy*, *251*, 113351.

[9] Collier, Z. A., Connelly, E. B., Polmateer, T. L., & Lambert, J. H. (2017). Value chain for next-generation biofuels: Resilience and sustainability of the product life cycle. *Environment Systems and Decisions*, *37*, 22-33.

[10] Demirbas, A. (2007). Progress and recent trends in biofuels. *Progress in energy and combustion science*, *33*(1), 1-18.

[11] Dhanagari, M. R. (2024). Scaling with MongoDB: Solutions for handling big data in real-time. *Journal of Computer Science and Technology Studies, 6*(5), 246-264. https://doi.org/10.32996/jcsts.2024.6.5.20

[12] Edwards, J., Ketchen, D., Short, J., & Try, D. (2014). *Mastering Strategic Management-1st Canadian Edition Mastering Strategic Management-1st Canadian Edition*.

[13] Emmanouilidou, E., Mitkidou, S., Agapiou, A., & Kokkinos, N. C. (2023). Solid waste biomass as a potential feedstock for producing sustainable aviation fuel: a systematic review. *Renewable Energy*, *206*, 897-907.

[14] Frenkel, A. (2003). Barriers and Limitations in the Development of Industrial Innovation in the Region. *European planning studies*, *11*(2), 115-137.

[15] Goel, G., & Bhramhabhatt, R. (2024). Dual sourcing strategies. *International Journal of Science and Research Archive, 13(2), 2155*. https://doi.org/10.30574/ijsra.2024.13.2.2155

[16] Hanjra, M. A., & Qureshi, M. E. (2010). Global water crisis and future food security in an era of climate change. *Food policy*, *35*(5), 365-377.

Journal of Information Systems Engineering and Management
2025, 10(47s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

[17] Hsieh, M. H., Pan, S. L., & Setiono, R. (2004). Product-, corporate-, and country-image dimensions and purchase behavior: A multicountry analysis. *Journal of the Academy of marketing Science*, *32*(3), 251-270.

[18] International Air Transport Association (IATA). (2021). *Sustainable Aviation Fuel: The Way Forward*. https://www.iata.org

[19] Jensen, E., & Laurie, C. (2016). Doing real research: A practical guide to social research.

[20] Karwa, K. (2023). AI-powered career coaching: Evaluating feedback tools for design students. *Indian Journal of Economics & Business*. https://www.ashwinanokha.com/ijeb-v22-4-2023.php

[21] Korkut, E., & Fowler, L. B. (2021). Regulatory and policy analysis of production, development and use of sustainable aviation fuels in the United States. *Frontiers in Energy Research*, *9*, 750514.

[22] Mandel, G. N. (2003). Gaps, inexperience, inconsistencies, and overlaps: crisis in the regulation of genetically modified plants and animals. *Wm. & Mary L. Rev.*, *45*, 2167.

[23] Mayer, B., & Ding, Z. (2023). Climate change mitigation in the aviation sector: a critical overview of national and international initiatives. *Transnational Environmental Law*, *12*(1), 14-41.

[24] Meerstadt, C. J., Peerlings, B., van der Sman, E. S., & Tojal Castro, M. (2021). Feedstocks for sustainable aviation fuels in the Netherlands: A review of feedstock sustainability and availability and identification of knowledge gaps for policy making.

[25] Mortensen, A. W., Wenzel, H., Rasmussen, K. D., Justesen, S. S., Wormslev, E., & Porsgaard, M. (2019). Nordic GTL: A pre-feasibility study on sustainable aviation fuel from biogas, hydrogen and CO2.

[26] Mousavi, S., & Bossink, B. A. (2017). Firms' capabilities for sustainable innovation: The case of biofuel for aviation. *Journal of Cleaner Production*, *167*, 1263-1275.

[27] Nilson, K., & Tuvlind, A. (2020). Carbon offsetting and sustainable aviation: a study of contemporary and future sustainable aviation via carbon offsetting.

[28] Sardana, J. (2022). Scalable systems for healthcare communication: A design perspective. *International Journal of Science and Research Archive*. https://doi.org/10.30574/ijsra.2022.7.2.0253

[29] Singh, V. (2022). Explainable AI in healthcare diagnostics: Making AI models more transparent to gain trust in medical decision-making processes. *International Journal of Research in Information Technology and Computing, 4(2)*. https://romanpub.com/ijaetv4-2-2022.php

[30] Singh, V. (2024). Ethical considerations in deploying AI systems in public domains: Addressing the ethical challenges of using AI in areas like surveillance and healthcare. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*. https://turcomat.org/index.php/turkbilmat/article/view/14959

[31] Song, Z., Li, Z., & Liu, Z. (2024). Comparison of Emission Properties of Sustainable Aviation Fuels and Conventional Aviation Fuels: A Review. *Applied Sciences*, *14*(13), 5484.

[32] Vicente, K. J. (1999). *Cognitive work analysis: Toward safe, productive, and healthy computer-based work*. CRC press.

[33] Ydersbond, I. M., Buus Kristensen, N., & Thune-Larsen, H. (2020). *Nordic sustainable aviation*. Nordic Council of Ministers.