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SUSTAINABLE AVIATION FUELS: SHOULD WE PAY MORE TO FLY?

The opinions of aeronautical professionals and academics in Portugal

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Dissertation for obtaining a master´s degree in Air Transport Operations

MARÇO de 2025

VERSÃO DEFINITIVA

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ISEC LISBOA - Escola de Aeronáutica | Aeronautical Sciences Scholl

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Acknowledgments

I would like to thank in a genuine and very simple way all those who have accompanied me along this journey of more than half a century, in which so many paths have crossed and so many laps in the sun we share in unique and simple moments. Thank you very much, from the bottom of my heart!

In this way, I would like to first thank my thesis advisors (and professors) Mr. Commander João Moutinho Barbosa and Mrs. Ana Cristina Freitas, who with all the diligence and patience led me to be able to carry out all my work in this master's thesis. These thanks are extended to all the teachers of ISEC Lisboa, by whom I had the privilege of being instructed and learning.

It was with family, friends, colleagues and teachers that I found the motivation and resilience to complete my master's degree and advance a little further in my training and acquired knowledge, namely in the aeronautical aspect, with the development of skills and cementing the perception, scope and idiosyncrasies of Air Transport Operations.

In personal and professional life, we have to deal with situations that make us want to know more and enlarge our curriculum in order to be updated in this competitive global market. This challenge was also embraced due to the COVID-19 pandemic, which allowed people to reflect on their skills and step out of their comfort zone in search of new challenges.

Knowing that in the walk of life many more obstacles will be encountered, being equipped with basic tools such as knowledge, training and education will be a guarantee of greater self-confidence and ease in solving these future challenges.

In the Azores (where I now reside), Algarve, Torres Vedras or in Lisbon (or anywhere else on the planet) work and knowledge should always be something to be developed with pleasure and serenity.

To conclude, I would like to quote the late former president of South Africa and Nobel Peace Prize winner in 1993, Nelson Mandela (Madiba): "UBUNTU" (I am, because you are...)

So be it…

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Agradecimentos

Gostaria de agradecer duma forma genuína e muito simples a todos os que me acompanharam ao longo desta caminhada de mais de meio século, em que tantos caminhos se cruzaram e tantas voltas ao sol partilhamos em momentos únicos e singelos. O meu muito obrigado, do fundo do coração!

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Na vida pessoal e profissional temos que lidar com situações que nos fazem querer saber mais e ampliar o nosso curriculum por forma a estarmos atualizados neste mercado global tão competitivo. Este desafio foi abraçado também devido à pandemia do COVID-19, que permitiu que as pessoas refletissem sobre as suas competências e saíssem da sua zona de conforto em busca de novos desafios.

Sabendo que na caminhada da vida muitos mais obstáculos se depararão, estar apetrechado de ferramentas basilares como o conhecimento, a formação e a educação serão uma garantia de uma maior autoconfiança e facilidade na resolução desses desafios futuros.

Nos Açores (onde agora resido), no Algarve, em Torres Vedras ou em Lisboa (ou ainda noutro qualquer lugar no planeta) o trabalho e o conhecimento deverão ser sempre coisas a desenvolver com agrado e serenidade.

Para concluir, gostaria de citar o falecido ex-presidente da Africa do Sul e premio nobel da paz em 1993, Nelson Mandela (Madiba): “UBUNTU” (Eu sou, porque vocês são…)

Que assim seja…

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Abstract

Framing (subject, context, motivation and problem)

Sustainable Aviation Fuels (SAF) are presented as a credible and necessary alternative, in the constant technological development that is felt in the aviation industry. Sustainability is a current issue that involves the scientific community, the fuel industry and the global economy as a whole (in addition to the concerns that a large part of humanity has with climate change and with the preservation of the planet, the environment and the ecosystems). This theme has had very specific technical approaches. In this project, we intend to explore these issues in the context of the technological development of the SAF, identifying and characterizing the opinions and representations that exist among professionals in the sector and the academic community in this specific area.

Resolution approach (case study and analyzed data)

Thus, we will try to understand the perceptions that various groups in society (of people connected to aviation) have about the use of SAF and if there is a different predisposition of the general public to pay more for air travel by this small part of the population because they have a little more information about these technologies. It is crucial to understand their perceptions, attitudes, social trust and risk and benefit analysis and how this changes their willingness to pay more for flights.

Finally, it is necessary to confront these perceptions coming from this different population and with a more specific and complete technical knowledge (?) with that which other studies allow to assess from the general public. Are they coincidental? Can we understand the reason for these similarities or differences?

In the search for a resolution after this type of approach, we analyzed the responses of a sample of 430 people professionally and academically related to aviation in the search for conclusive answers.

Most relevant conclusions

People related with aviation (professionally and academically) show some lack of knowledge about SAF that must have to be understanded and mitigated in a proper way.

This sample of people related with aviation show a predisposition to pay more for air travel if the perceived benefits are clear and the social trust are reinforced, and their attitude should be according to their knowledge (is not so big that we initially supposed to), so the willingness to pay should be a reality if all this indirect influence could be obtained. Risk perception also seems to be underestimated.

Keywords

Climate Change, Decarbonization, Public knowledge (about SAF), Public Perception, Sustainable aviation, Sustainable Aviation Fuels (SAF), Technological Development, Willingness to pay (for SAF).

Resumo

Enquadramento (assunto, contexto, motivação e problema)

Os Combustíveis de Aviação Sustentáveis (SAF) apresentam-se como uma alternativa credível e necessária, no constante desenvolvimento tecnológico que se faz sentir na indústria da aviação. A Sustentabilidade é um tema da atualidade que envolve a comunidade científica, a indústria dos combustíveis e a economia global como um todo (além das preocupações que uma grande parte da humanidade denota com as alterações climáticas e com a preservação do planeta, do ambiente e dos ecossistemas). Este tema tem tido abordagens técnicas muito específicas. No presente projeto, pretende-se explorar estes assuntos no contexto do desenvolvimento tecnológico dos SAF, identificando as opiniões existentes entre os profissionais do setor e a comunidade académica nessa área especifica, tentando perceber a sua predisposição existente para pagar mais pelo uso dos SAF nas viagens aéreas.

Abordagem resolutiva (estudo de caso e dados analisados)

Assim, iremos procurar compreender as perceções que diversos grupos da sociedade (de pessoas ligadas à aviação) têm sobre a utilização dos SAF e se existe uma predisposição diferente da generalidade do publico para pagar mais pelas viagens aéreas por esta pequena parte da população por terem um pouco mais de informação sobre estas tecnologias. Torna-se crucial compreender as suas perceções, atitudes, confiança social e analise dos riscos e benefícios e de que forma isso altera a sua vontade de pagar mais pelos voos.

Por fim, é preciso confrontar essas perceções advindas desta população diferente e com um conhecimento técnico mais específico e completo(?) com aquela que outros estudos permitem aferir do publico em geral. Serão coincidentes? Será que conseguimos perceber o porquê dessas similaridades ou diferenças?

Conclusões mais relevantes

As pessoas ligadas à aviação (profissional e academicamente) demonstram algum desconhecimento sobre a SAF que deve ser compreendido e mitigado à sua maneira.

Esta amostra de pessoas relacionadas com a aviação mostra uma predisposição para pagar mais (WTP) pelas viagens aéreas se os benefícios percebidos forem claros e a confiança social for reforçada, e a sua atitude deverá estar de acordo com o seu conhecimento (não é tão grande como inicialmente se supunha), pelo que a disponibilidade para pagar deveria ser uma realidade se toda esta influência indireta pudesse ser mantida. A perceção do risco também parece ser subestimada no estudo.

Palavras-chave

Alterações climáticas, Aviação sustentável, Combustíveis de Aviação Sustentáveis (*SAF*), Conhecimento do publico (sobre os SAF), Descarbonização, Desenvolvimento Tecnológico, Perceção do Público, Vontade de pagar (pelos SAF).

Table of Contents

List of Figures

List of Tables

Abreviations and Acronyms

ATAG – Air Transport Action Group

ATM – Air Traffic Management (Gestão de Tráfego Aéreo)

CO - Carbon monoxide

CO_2 – Carbon Dioxid (Dióxido de carbono)

CORSIA – Carbon Offsetting and Reduction Scheme for International Aviation

EASA – European Aviation Safety Agency

EUROCRONTROL - is a pan-European, civil-military organization dedicated to supporting European aviation.

G8 – Group of eight industrialized countries (Canada, France, Germany, Italy, Japan, United Kingdom, United States and Russia)

GHG - Greenhouse gas emissions

HC - Unburned hydrocarbons

ICAO - International Civil Aviation Organization

IATA - International Air Transport Association

ISEC – Instituto Superior de Educação e Ciências

KWS – Knowledge of Water Sustainability

LCJF – Low carbon Jet Fuels

NOx - Nitrogen oxides

SAF – Sustainable Aviation Fuel

SOx - Sulphur oxides

VCO – Voluntary Carbon Offset (programs)

Glossary

Aeronautical Sciences – Science that studies all aviation components in the scope of operation, design, production, maintenance, and training.

Circular Economy (CE) – The CE is a system where materials never become waste and nature is regenerated.

Composite Materials – materials used in the structure of the aircraft, consisting entirely of layers of glass fibers or layers of carbon fibers, can also be formed by mixing the two materials (hybrid parts). These materials replace the use of aluminum in the structure of the aircraft, which makes it significantly lighter, including other efficiency factors related to durability and maintenance.

Decarbonization – the process of limiting or eliminating the use of carbon-emitting energy sources in order to reduce the emission of Greenhouse Gases.

Electro fuels – use clean electricity to join water hydrogen with carbon dioxide carbon, which results in hydrocarbon fuel.

Green Rate – additional costs of clean energy.

Hubs – specific airports used by airlines as a transfer point for passengers to reach their final destination.

JET A1 – regular fuel for jet aircrafts

Kyoto Protocol – Signed in 1997, the Protocol should be ratified by at least 55 countries representing a minimum of 55% of Annex B emissions in 1990. This quorum was achieved in November of 2004 after the ratification of the Protocol by Russia which allowed its implementation in 2005.

Offsetting – offsetting carbon emissions**.**

Stakeholders – interested, concerned, keen, participants, participating, attendees, contestants.

Sustainable Fuels – are produced through biological sources, the term includes biofuel and all other fuels produced from other alternative sources, including non-biological sources. The production consists of mixing kerosene with renewable hydrocarbons.

1- Introduction

The present work focuses on Sustainable Aviation Fuels (SAF) and the willingness to pay (WTP) of Portuguese consumers, familiar with the topic, to support the use of this technology in air travels.

Debates about SAF denote some acquired knowledge and environmental concern (McLachlan et al., 2018), but is this enough to accept paying more for the use of this technology and is it a criterion to be taken into account when choosing the airlines to fly in the near future? Are these some of the reasons for the adoption of SAF in the aeronautical industry?

Motivation

The adoption of environmental policies and SAF technology is already a reality, including in Portugal (AeroDynamic Advisory, 2023; AirBP, 2025; Airbus, 2025; ATAG, 2025). The public's attitude and adherence, in general, to this new technology appears to be favorable (Chin et al., 2013; Sivashankar et al., 2016). Literature has sought to ascertain consumers' adherence to SAF, to what extent they are willing to pay (WTP) more for aviation travel using these new fuels (SAF) (Filimonau et al., 2018). Research findings suggest that individuals would even accept to support this pro-environmental initiative if they had more information about the topic. If so, the adherence could even be gradual and significant (Filimonau & Hogstrom, 2017).

The results of previous investigations do not reveal the opinion of those who, given the nature of their professional and/or academic activity in the aviation sector, have greater knowledge or familiarity with the SAF topic. Therefore, there is a gap in current knowledge regarding support for pro-environmental initiatives, such as the use of SAF in air travel, by more informed consumers. It is important to observe their ideas and perceptions since they are more operational-based, grounded on professional and academic experiences and, as so, more realistic or objective, when compared with general public opinions or perceptions.

Research questions

To address the gap in knowledge, we formulated the following research question:
What is the influence of knowledge about SAF on the willingness to pay more for a flight with the technology, in professionals and academics in the field of civil aviation in Portugal?

The literature has sought to identify predictors of passengers' WTP for SAF and attitude towards pro-environmental initiatives appears to be an important factor (Taylor et al., 2006; Tuck & Riley, 2017). On the other hand, more recent studies (Xu et al., 2022; Wendt et al., 2024; de Mello, 2024) highlight that knowledge about SAF is associated with perceptions about their benefits, risks and existing social trust in relation to the use of these fuels.

Derived from the general question, we formulated other more specific questions:

a) To what extent the willingness to pay (WTP) for SAF in air travels is influenced, directly and indirectly, by previous Knowledge or familiarity with the technology?
b) Does attitude towards the use of SAF plays a mediating role in the relationship between knowledge and WTP?
c) What factors influence the relationship between knowledge and attitude?

In order to answer the research questions and based on literature review, we formulated the following research hypotheses:

H1- Knowledge (familiarity with SAF technology) has a direct effect on the willingness to pay.

H2 - Attitude towards SAF predicts the (H2a) Willingness to pay and (H2b) plays a mediating role between Knowledge (familiarity with SAF technology) and Willingness to Pay.

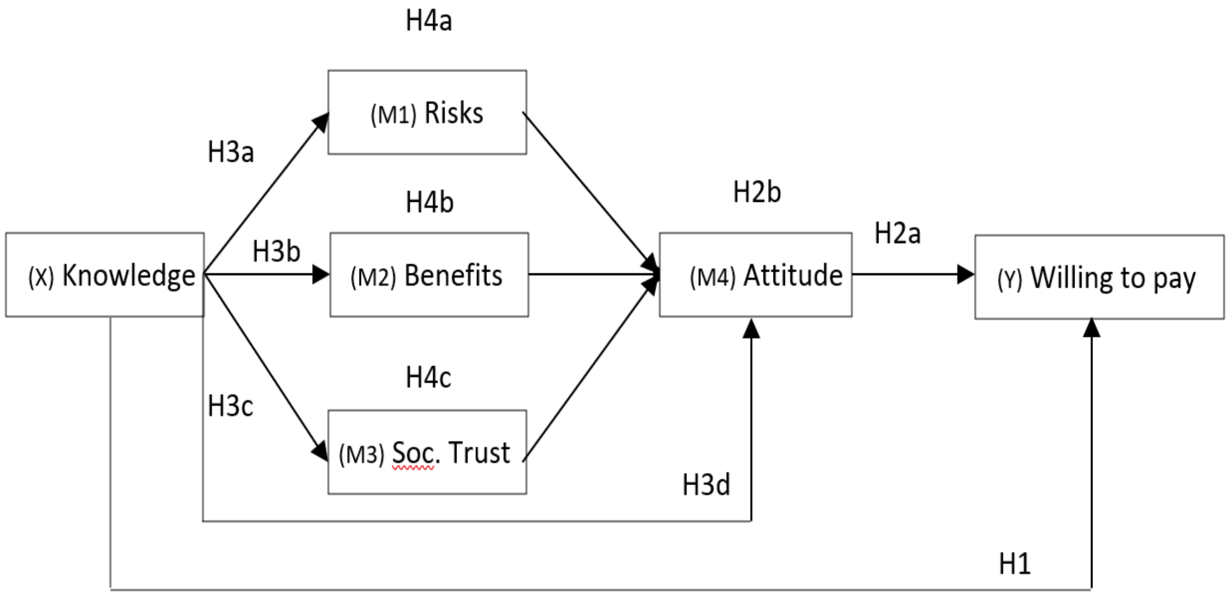
H3 – Knowledge (familiarity with SAF technology) is a predictor of the variables (H3a) Perceptions of Risks, (H3b) Benefits, (H3c) Social Trust and (H3d) Attitude towards SAF.

H4 – Perceptions of Risks (H4a), Benefits (H4b) and Social Trust (H4c) play an antecedent role of the variable Attitude in the relationship between Knowledge (familiarity with SAF technology) and Willingness to pay, mediated by Attitude.

Figure 1 represents graphically the conceptual scheme of study

Figure 1. Conceptual scheme of the study

Source: author (adapted from XU et al. study,2022)



Methodology

To fulfill the research objectives, we designed and implemented a cross-sectional study supported by an online survey. The 430 participants were selected through a non probabilistic sampling process, the "virtual snowball" (Baltar & Brunet, 2012) aimed at staff aviation groups in Facebook and WhatsApp. The final sample included as participants: aviation professionals that work in airlines, stakeholders (authority, military, airports, handling, ATC, Manufacturers, Air Cargo Air service and others) and people academically related to aviation (students, teachers, lecturers and others).

Work Structure

This dissertation is organized into seven chapters summarized as follows:

On Chapter 1, we made the introduction where we reveal some issues we want to study.
On chapter 2 we present the results of a literature review on Sustained Aviation Fuels (SAF) and the public opinion on its use, seeking to highlight aspects related to production and consumption of SAF in the world and related to public opinion on the technology.
On the third chapter, we developed the theme SAF, the relation between the public opinion and our study, and describe studies results on the construct 'willingness to pay' for air travels with sustainable fuels (Chin et al., 2013; Sivanshankar et al., 2016; Filimonau et al., 2018; Rice et al., 2020; Xu et al., 2022).
Chapter 4 intends to describe all the methodological decisions taken to fulfill the study goals and answer the research questions. The results of the analyzes are presented in Chapter 5 where we verify each of the hypotheses tested. Chapter 6 (Discussion) follows, where we seek to interpret the results of the study in light of our theoretical framework and analyze its contribution to answering the research questions. Finally, we finish our work with chapter 7 where we present the conclusions of the study and its contributions to the academic and professional communities. It is also here that we address the limitations of the study and present suggestions for future studies on the same issue.

2- Literature Review

Literature identifies benefits and procedures for pre-selection of Sustainable Aviation Fuels (SAF) candidates (Heyne et al., 2021). It also establishes which specific properties need to be identified so that early estimates of critical properties can be made for later measurement and recording in order to enhance fuel processing and development (Heyne et al, 2021). This specific technical knowledge is important to understand the different ways of obtaining SAF and the complexity of variables related to their production.

Singh and Sharma (2015) reviewed 277 articles (published between 1973 and 2014) on the topic. The authors concluded that the information was vast, dispersed, and increasing fast in recent years. It is necessary to identify and discuss the perspectives of different authors who have worked on the subject, understanding their respective orientations and recent development trends. It is also important to articulate the positions of the literature with current data (Liakakou et al., 2021; Patil et al., 2021; Yang et al., 2021). For example, a wide range of Airbuses is already flying on SAF including the cargo giant Beluga (flying on SAF since 2019), the Airbus A350 ECLIF and the A320 VOLCAN. In Portugal, reference companies such as TAP, Air Portugal and SATA Internacional (Azores Airlines) have already flown and have some experience (albeit very limited, as both have only made one flight using SAF) on the use of these fuels (Airbus, 2024).

Concepts and themes around SAF imply a necessary interaction with reality, for example, to the extent that the entire replenishment structure (storage and distribution), affecting our perception in different ways and determining changes in the positioning of companies, individuals and groups in the sector. We hope to contribute to current knowledge on the theme of sustainability by revealing the perspectives of the target population from this study and SAF.

Several studies use the SAF concept to justify many marketing options and investments (Whitmarsh, 2011; Camarero et al., 2014) but the idea of decarbonization by 2050 (and the difficulties around that) appears to be almost a utopic idea and we intend understand why. Perceptions of the academic, the public and all the authors is that global warming and climate change have been a subject of academic debate for over a century (Cameron et al., 2013). All the recent evidence has supported the relation between the increased global warming and all the human activities that have increased since the industrial revolution (Stocker et al., 2013). Climate change refers to all the alterations in global climate patterns resulting from Global Warming (Joos et al., 2001) and, therefore, the climate change has become (for the government policies) a significant driving force, such as the Kyoto Protocol, and has been a topic of discussion for policymakers in G8, at Rio de Janeiro and Copenhagen summits (Whitmarsh, 2011) and recently in the G7 annually (Since 2014 the Russia was expelled from G8 after Crimea annexation).

Signed in 1997 and implemented in 2005, The Kyoto Protocol is the only international framework aimed at combating climate change. All the countries that have signed the protocol within the United Nations Framework Convention on Climate Change have pledged to reduce the emission of carbon dioxide (and the five other gases that contribute to the greenhouse effect, too). Countries that were unable to achieve this commitment promised to increase their rights through carbon trading (Demir & Gozgor, 2018). To mitigate the effects of climate change, efforts should be made to reduce global warming. As the increase in greenhouse gases is the main cause of global warming, several countries (in Europe, especially) have set stringent carbon reduction targets to reduce greenhouse gas emissions (GHG), particularly carbon dioxide emissions, by 80% by 2050 compared to 1990 levels (Camarero et al., 2014).

Research has shown that passengers are generally willing to participate in carbon offset programs if they understand the environmental impacts of air travel and if the fees collected are used for meaningful environmental initiatives (Filimonau & Hogstrom, 2017; Filimonau et al., 2018; Rice at al., 2020; Xu et al., 2022). However, limited research has been conducted on passengers´ attitudes towards carbon offsetting in the aviation industry (McLachlan et al., 2018). Recently, de Mello (2024) study on Voluntary Carbon Offset (VCO), underscores the urgency for a balanced approach, marrying individuals’ initiatives and structural reforms to effectively manage VCO programs in aviation and yield significant emission reductions.

The global warming and climate change are significant factors driving the need for carbon offsetting in aviation sector (which is responsible for approximately 2% of global greenhouse gas emissions) primarily through the release of carbon dioxide, water vapor and nitric acid (IPCC, 2001). Many efforts have been made to reduce global warming and to mitigate climate change and have led governments to set carbon reduction targets (IPCC, 2001; Sulu, 2023). Carbon offsetting is seen as a tool to help the aviation industry to achieve these goals (Sulu, 2023).

The implementation of carbon offsetting schemes aims to achieve this, such as the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) by the International Civil Aviation Organization (ICAO). CORSIA requires that aircraft operators acquire emissions units to offset their emissions above a baseline. The calculation of emissions for offsetting purposes considers factors such as distance, passenger numbers, altitude, cargo loads and travel class. Further research is needed to understand passengers´ attitudes towards carbon offsetting and to identify ways to improve the success of such programs in the aviation industry and studies like de Mello (2024) about the voluntary carbon offset programs in aviation permits to highlight a systemic literature review of that.

The global aviation industry is facing its biggest transformation in decades (Gates, 2021). This transformation is quite complex and dependent on all the actors linked to the value chain. Key stakeholders will largely determine the speed of the ongoing transformation. Other business models, products, processes, skills and technologies will have to be needed to aim for success. Companies in the sector should establish concrete, measurable and easily understandable objectives. The Road to the Industry's Ultimate Goal climate neutrality by 2050 should be defined with equally clear milestones, and therefore that the manager's convenience does not win after the first initial successes. There is still little knowledge provided by research on the perceptions and opinions of aviation professionals and academics.

2.1. SAF related numbers

SAF has gained prominence in last ten years as a way to mitigate carbon emissions reductions in the airline sector, with several airline companies using SAF (Lufthansa, British Airways, Air France-KLM, United Airlines, Delta airlines, etc.). Brar et al. (2024) and Borodin et al. (2023) present updated statistical information that is relevant to understand the impact caused by SAF in the aeronautical sector.

The numbers presented on the table 1 highlight the advances related to the challenges of adopting SAF on a large scale and the search for a solution to the problems of decarbonization in the airline sector. We would like to highlight the 3 main SAF producing countries (group of countries), which have been expanding their capabilities in the last decade as global interest in mitigating actions aimed at decarbonizing the aviation sector advances (Sustainable Aviation, 2024).

Table 1 - SAF Numbers

Source: Author (Adapted from IATA annual review 2024)

	Past/Present	**Future**
Cost	**2 to 5** times more than Jet Fuel	**Expectations** → Production increases (price decreases)
Incentives and Investments	Governments offer incentives to accelerate production and use	**Estimate Investments** → **1,5 trillion** dollars (until 2050)
Airlines commitment	Several companies have already committed to using SAF (Lufthansa, British Airways, Air France-KLM, United Airlines)	Some companies have set specific goals for the future (***Delta Airlines***) **+10% SAF use** by 2030
Projected growth	IATA has established **10% SAF in total consumption** by 2030	**Estimate** → SAF production **grows 85 times** (until 2050)
Production and use	**Global SAF production** (2022) → **450 million** (liters) SAF = **0,1 %** Global Jet fuel consumption	**Estimate** (2050) → SAF annual production **5/6 Billion** (liters)
Emissions reduction	SAF → reduces GHG by **up to 80 %**	Depending on the material used in the production process **(from 50% up to 80%)**
Long-term goals	NET ZERO 2050 (IATA) → **65%** reduction of GHG using SAF	UE establish goal of **63% SAF use** by 2050

At the moment, global production is still quite small for the needs that lie ahead (compared to conventional fuels) but some countries are already standing out as leaders in this emerging industry:

- <u>**United States**</u>
  - 2022 (production) → +- **170 millions** of SAF litters
  - The world's largest producer of SAF, with government incentives and support for the development of biofuels.
  - Companies such as **NESTE** and **World Energy** are the main producers of SAF in the USA, as they invest in new technologies with production from agricultural and urban waste.

- **<u>European Union</u>**
    - 2022 (joint production) → +- **200 millions** of SAF litters
    - Europe (with Finland, France, Netherlands and Germany in the leadership) has produced a lot of SAF:
        - <u>Finland</u> - **NESTE** produced around **100 million SAF** liters (2022) and has expansion targets to **1.5 billion** liters by 2025.
        - <u>France and Netherlands</u> - Important for production, with refineries currently in operation (**Total Energies** and **SKYNRG**).

- **<u>Brasil</u>**
    - 2022 (production)→Still in the experimental phase with already significant volumes (confidential information).
    - Country with a lot of potential in the production of SAF given its history in the production of Ethanol (biofuels). The use of biomass (agricultural and forestry waste) will be an important point to be considered in the production of SAF.
    - The aviation company **EMBRAER** is actively involved in SAF research and development projects (taking advantage of the country's agricultural potential).

Other countries are also "participating in the race" for the production and development of SAF (the United Kingdom, China, Singapore, Australia, among others) with increasingly significant numbers, in rapid expansion, driven by incentive policies and the need to decarbonize the airline sector (Sustainable Aviation, 2024).

2.2. Public Opinion on SAF

In the recent past years, the media has been disseminating information about SAF (Youtube movie, Sustainable Aviation Fuel (SAF) - what it is, what it's made from and its many benefits, 2022). This information has attracted increasing interest from industry, regulators and public in general due to environmental concerns about our planet, particularly as SAFs have a very high potential to reduce carbon emissions in the aviation sector (EASA, EEA & EUROCONTROL, 2019). SAFs include a range of alternative fuels, such as vegetable oils and residues, biofuels derived from biomass and synthetic fuels produced from captured CO2 and renewable hydrogen (The Royal Society, 2019).

We cannot say that public opinion on SAF is solid and enlightened, nor that it is informed and consensual, largely due to the apparent lack of knowledge on the subject (Radics et al., 2015; Rains et al., 2017; McLachlan et al., 2018; Pavlenko et al., 2019; Gates, 2021). However, public opinion has become progressively favorable, as awareness of the need to reduce the climate impact of aviation increases (IPCC, 2001; Chin et al., 2013; Filimonau and Hogstrom, 2017; Filimonau et al., 2018). Nevertheless, concerns related to the economic viability and large-scale production of these fuels are still prevalent. Public confidence seems to be strongly linked to government support, the adoption of proven effective policies and the well-known visibility of the investments made by airlines and the entire aeronautical industry (Demir, 2018; Gates, 2021; Borodin et al., 2023).

According to The Royal Society (2019), SAF can reduce CO2 emissions by between 65% and 100% compared to conventional fossil fuels (Jet Fuel, Kerosene, 100LL, etc.), depending on the entire "technological route" followed throughout their production. These concrete figures reinforce the more optimistic public opinion that sustainable fuels are one of the ways and main solutions to achieve the (utopian?) goal of decarbonization in aviation (Wustenhagen et al., 2007). On the other hand, there are criticisms about the environmental and social impact of some sources of biofuels, namely competition with agricultural land and the possible impacts that may arise on biodiversity, which raises great concerns in the community (Markiewicz et al., 2020).

The study of Pavlenko et al. (2019), published by the International Council of Clean Transportation (ICCT) argues that all sustainable growth of SAF must be guided by rigorous sustainability criteria to avoid all these foreseeable adverse impacts. Despite the challenges, SAF are essential for reducing emissions in the aviation sector, especially in the short and medium term, while other emerging technologies (such as electric and hydrogen aircraft) are still in the early stages of development (Hacking et al., 2019; Gates, 2021). According to Camarero et al. (2013) and IATA (2021), the widespread adoption of SAF will be an essential and effective step towards achieving the long-term emissions reduction targets set out in the Paris Agreement.

Kousoulidou and Lonza (2016) highlight that the production costs of SAF are significantly higher than conventional fossil fuels, which raises several concerns about economic factors and the possibility of passing these costs to consumers. A consequence will be higher ticket prices for air travels. Therefore, the role that the public opinion plays in the use of SAF or any other technology in aviation cannot be ignored, since it may determine the market acceptance (Wegener & Kelly, 2008). As Berger et al. (2022) enhanced, such concern has guided research on the identification of the factors that influence consumers´ attitudes towards technology and, mainly, their willingness to pay for an airline ticket with SAF.

Overall, public opinion on aviation SAF tends to be positive, especially among groups concerned with climate change and those who support innovative solutions (Chin et al., 2013; Filimonau and Hogstrom, 2017; Filimonau et al., 2018). Research has tried to understand the consumers´ adherence to technological innovations, with environmental concerns, in the air transportation. However, economic and sustainability concerns persists and the widespread lack of awareness on the subject among the masses needs to be addressed if solutions as SAF are to be accepted and adopted in the near future (Rice et al., 2020). Several sectors of society still identify some benefits, challenges and risks in the use of SAF (ATAG, 2021). For example, McLachlan et al. (2018) surveyed 70 consumers to determine whether the environmental disclosure levels of six major UK airlines had an impact on their ticket purchasing decision. The findings suggested that the main criteria are cost and convenience, followed by destinations on offer and departure airports. Additionally, the ticket purchase decisions do not appear to be based on environmental (McLachlan et al., 2018). Rice et al. (2020) work examined the passengers´ willingness to pay (WTP) to reduce greenhouse gas emissions from commercial aircraft. The authors developed two studies involving 1192 participants who were presented with hypothetical scenarios about flying in a commercial airplane able to provide a 10-50% reduction (in 10% increments) in greenhouse gases. The subjects were then asked to signal to what extend they would pay an additional 5%, 10%, or 15% ticket price on short-haul domestic flights (first study) and on long-haul international flights (second study). Overall, the results suggested that more reductions in greenhouse gases increased the individuals´ willingness to pay the additional ticket price but limited in the 15% ticket price condition and for long-haul flights. The authors concluded that airlines can expect consumers to accept a small increase in ticket prices if they are convinced that the airplane flight emits fewer greenhouse gases.

Other studies explore the predictive influence of certain factors on the consumers´ WTP more from sustainable aviation fuel. Xu et al. (2022) analyzed the relationship between the WTP more for low carbon jet fuels (LCJF) and the consumers´ perception and general attitude towards the technology in a sample of 1008 UK citizens. The authors performed a logistic regression and confirmed the existence of three WTP predictors: social trust, perceived risks and attitude. Despite a positive perception regarding the use of the LCJF, in terms of benefits, the majority of respondents were not WTP more for carbon-neutral air travel.

Studies on consumers´ WTP for carbon offsetting related to flights have focused on travelers and the population in general (Berger et al., 2022), but leaving it unclear how familiar the topic is to the individuals and how such knowledge influences their motivation to support the use of the technology. It seems reasonable to expect that perceptions of the benefits of risks of using SAF in air travel, or even general attitudes toward the technology, will vary depending on consumers´ knowledge. This variable appears to play an important role in their attitude toward pro-environmental practices. For example, AlHaddid et al. (2024), investigated the influence of Knowledge of water sustainability (KWS) on the 3 attitudes (reduce, reuse and recycle) on sustainable water practices among women in Jordan. Using structural Equation Modelling, the results reveal that KWS plays a pivotal role in driving positive influence across the 3 attitudes of (water) sustainability. These insights offer valuable insights for policymakers to design context-specific educational programs and cross-sectional collaborations, ultimately fostering sustainable practices and contributing to the global effort to address water scarcity and environmental degradation.

Therefore, and considering the influence of knowledge on attitudes toward pro-environmental (technological) solutions, it is plausible that a great familiarity of individuals with the topic SAF due to, for example, professional experience, is associated with a more consistent opinion on the topic, influencing their WTP. The present research intends to complement the existing literature by analyzing the WTP for SAF in a sample of professionals and academics from the aviation industry and the predictive effect of knowledge

This study extends previous works on consumer WTP for sustainable fuels in aviation and the factors that influence it by focusing on the dispositions of a particular segment of consumers: professionals and academics in the field of civil aviation. Given their connection to the aviation industry, it is reasonable to expect that aviation professionals and academics have a higher awareness regarding the effectiveness of pro-environmental actions, such as the use of SAF, for emissions offsets and, to this extent, that they are more empowered as consumers. As enhanced by Manosuthi et al. (2020), the effectiveness of pro-environmental initiatives, like the use of SAF, is a fundamental factor for the consumers´ decision-making (for example, to pay more for an air travel with SAF).

3- Theme Development

3.1. SAF related numbers

Sustainable aviation fuel (SAF) is a very attractive option for decarbonization in civil aviation because does not require modification of aircraft, their type of engines, or existing refueling infrastructure. Nowadays, only small amounts of SAF are produced in appropriate facilities, at a significantly higher cost than the so-called normal fuel (Bauen et al., 2020). However, an initiative to promote SAF in the UK has led major industry stakeholders to predict that SAF will be an essential transition technology to lead to decarbonization of the challenging aviation sector until batteries become relevant to civil aviation (Sustainable Aviation, 2024). The use of SAF will require large government financial subsidies and will lead to the encouragement of companies and investors in developing SAF (Air BP, 2024). Supported by the right policies, the gradual introduction of SAF could reduce UK emissions by up to 32% (Sustainable Aviation, 2020). A model designed by Bauen et al. (2020) also points to the great potential of SAF. Their analysis estimates that SAF will contribute in the order of 4-8% of global jet fuel use by 2035, and almost a third of the UK's fuel needs by 2050.

There are authors who assume that both solid conversion technology and liquid waste, as well as the harnessing of waste gases from industry, will contribute to SAF by 2035, while from then on it should be carbon capture and algae technologies that will take over (Muldoon & Harvey, 2020). During this period at the International Air Transport Association(IATA) annual meeting, all major underwriting airlines have agreed on the target to achieve net-zero carbon emissions by 2050 (IATA, 2021).

About 300 airlines are part of this association, covering more than 94% of international air transport (IATA, 2024). This can already be considered a major milestone with great importance. On the other hand, Chinese airlines also discovered this situation and ambition and sought to push the target year into the following decade, to 2060 (Petchenik, 2021). It is anticipated that SAF are expected to fuel most of the global emissions mitigation by aviation by that date (IATA, 2021).

From 2025, the plan foresees that the SAF should represent almost 2% (8 billion liters) of the total fuel needs, and by 2050, the participation of the SAF will be of the order of 65% (450 billion liters). However, all the necessary transformation in the industry will require large investments and can only be successful through great collaborative action. In this way, governments need to strongly support the industry as it explores the most promising technology to achieve the goals of the Paris Climate Accords (Katz-Rosene & Ambe-Uva, 2023).

Going a little early in time (making an analepsis here), the relationship between the evolution of rising carbon emissions and global average temperature is a major concern for all scientists and people who have this perception and several actions will have to be taken to stop this notorious and worrying increase. By analyzing the values of carbon emissions, we can see a growing increase between 1850 and 2018, mainly due to industrial processes and the increase in the burning of fossil fuels. We can also see that the increase in CO_2 emissions is accompanied by an increase in the global average temperature.

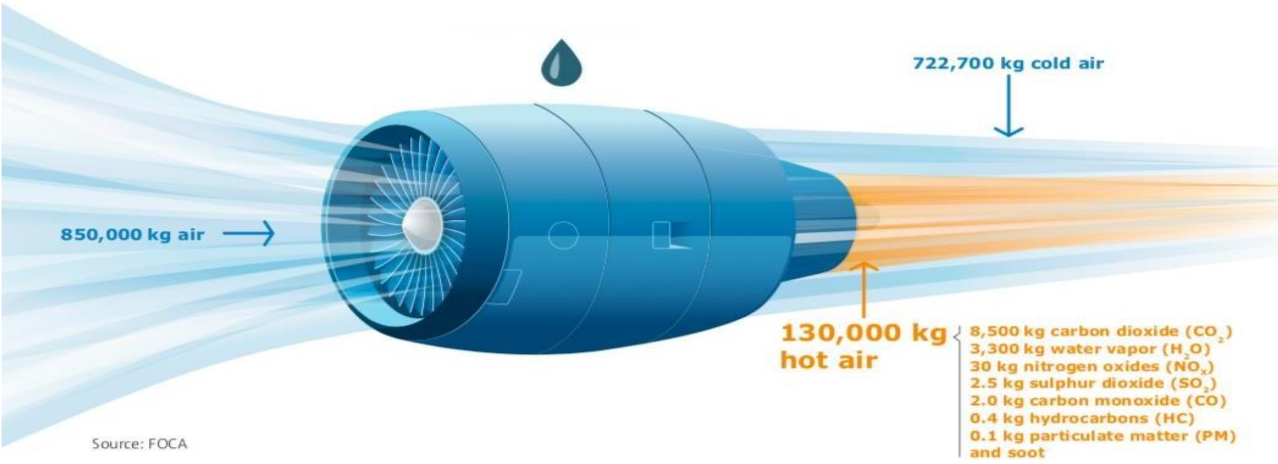
The possible scenarios of the evolution of world temperature depends on many things. It is necessary to take into account that emissions do not evolve in the same way in the various regions of the globe, with some evolving more rapidly and drastically in certain areas, compared to others showing a longer increase, derived from the way in which economic development (hence industry and aviation) is expanding in these areas.

After a more careful analysis of the real influence of pollutant emissions from the entire global industry, and their impact in environmental terms, it is necessary to address how commercial aviation interferes with these factors. The aeronautical sector drives economic growth, mobilizes people and goods at a very fast pace. The main air pollutants emitted by the continuous operation of aircraft engines are carbon dioxide (CO_2), water vapor, nitrogen oxides (NO_x), Sulphur oxides (SO_x), unburned hydrocarbons (HC), carbon monoxide (CO) and various other particles (EASA et al., 2019). Thus, in order to achieve neutrality in the air transport sector, it is essential that the industry works in synergy with the various governments in order to ensure that the correct and adequate investments are made and that all sustained regulations are complied with (EUROCONTROL, 2022).

We can analyze (next page, figure 2) the emissions from a twin-engine aircraft operating 1 hour flight with about 150 passengers and see all the components that are expelled to the air.

Figure 2 - Emissions from a twin-engine aircraft operating 1 hour flight with about 150 passengers.

Source: (European Aviation Safety Agency, 2019)



According to EUROCONTROL (2022), carbon neutrality can be achieved by eliminating 279 million tons of CO2 through:

- (17%) enhancing efficiency in conventional aircraft;
- (2%) use of hybrid and hydrogen aircraft;
- (8%) improvements in Air Traffic Management (ATM) and in the adequacy of air operations;
- (41%) use of sustainable aviation fuels;
- (32%) other type of measures.

Although SAF are the biggest contributor (41%) to the goal of achieving neutrality by 2050, the various market-based measures (32%) also play a key role. All these measures make it possible to correct the emissions that persist in existence after aviation has space to apply those measures to reduce carbon emissions that the various authorities impose.

All the progress made since 1990 to date, and the ways forward, taking into account the possible and desirable implementation of emission reduction measures, to reach the target by 2050. Making a quick analysis, we can mention that the large volume of emissions that has been possible to avoid since 1990 to date, is due various measures for sustainable development. It is also possible to establish a comparison of the evolution if today the same technologies were still used as in 1990.

It was in 2016 that ICAO presented the CORSIA program, which is based on the reduction and offset of carbon levels on international flights in order to minimize the notorious environmental impact of aviation. Offsetting is the process by which a company (or organization) offsets the amount of its carbon emissions by purchasing credit on the carbon market. These credits were created through projects that allow the reduction of carbon emissions in various parts of the world. Taking into account the notorious differences between the different countries, the CORSIA program has been designed so that the implementation is carried out in sequential phases. Framing so many studies and considerations (EUROCONTROL, 2022), it is time to move forward and frame the SAF in this operational desiderium, using some of the approach that the literature review allows.

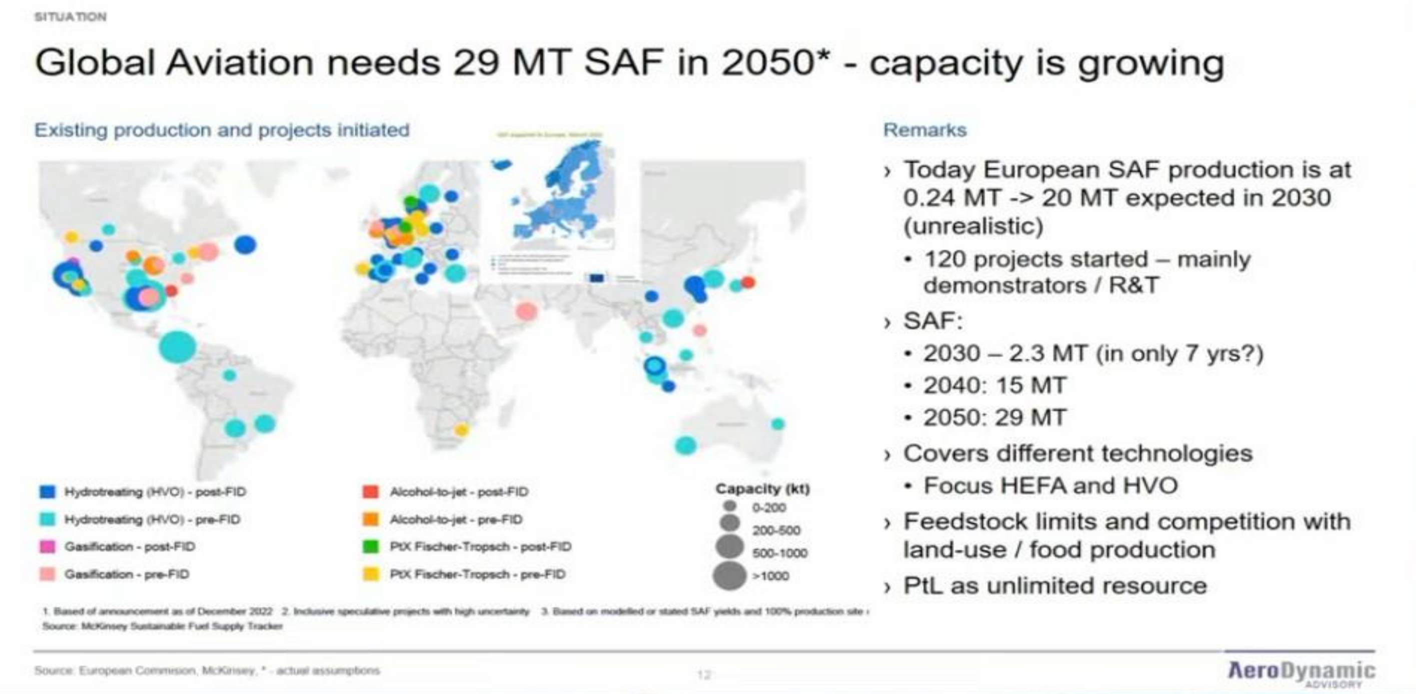
The effect of the COVID-19 pandemic during the year 2020 is notorious, with a noticeable drop in total emissions as air travel has come to a standstill. This is followed by a considerable recovery of the sector with the lifting of the safety measures of the pandemic.

According to ATAG (2021), SAF are necessary and essential to provide a clean energy source for all fleets of aircraft used in air and cargo transport worldwide, thus allowing to reduce all the environmental impact caused by the millions of passengers and cargo transported every year. SAF are produced through biological sources (materials from plants or animals). SAF terminology includes biofuel and all other fuels produced from various alternative sources, including non-biological sources. The production consists mainly of the mixture of kerosene with renewable hydrocarbons (Jet-A1). In this way, this alternative can be used in the whole range of aircraft without the need for technical modifications to them or to the various airport infrastructures.

Several development factors have been considered, and projections show that by 2050 aviation will need a fairly high number of about 450-500 million tons of SAF per year. We can say that the revised figures suggest that this situation may be achievable using strict sustainability criteria (ATAG, 2021). We could assess that the diffusion of SAF will be progressive, together with electrification and hydrogen, until the goal is reached by commercial aviation (but we would be leaving the scope of this thesis and we will not do so). Some visions (AeroDynamic Advisory, 2023) are a little bit more conservative and project the SAF needs by 2050 in a more realistic way as shown in figure 3 (next page).

Figure 3 - Global Vision 2050

Source: AeroDynamic advisory (AED days 2023 – Portugal)



The future growing necessity of SAF in the markets must have to be accomplished by the investment on the infrastructures and production in the present (AeroDynamic Advisory, 2023).

3.2. Public Opinion on SAF

In the business world knowing public opinion is essential to (Chong, D., & Druckman, J. N., 2007):

- Lead to consumer acceptance (shaping marketing and communication strategies).
- Promote innovation and development of strategic areas.
- Enhance and plan investments and partnerships.
- Influence government policies to exert some regulatory and political pressure.
- To help companies to position themselves with regard to their social responsibility.

Airlines are particularly vulnerable to public opinion (Hamelinck et al, 2013), and must be cautious in adopting large-scale innovations (Filimonau et al., 2018). SAF is a relatively recent technology, although rapidly developing, and the speed of its implementation and dissemination in the market will depend on the level of knowledge and confidence that the public has about it (Chin et al., 2013; McLachlan et al., 2018). Being aware of the public perception of SAF is an extremely important factor to align strategies, promote acceptance and drive positive changes in the aviation industry. The studies of Filimonau and Högström (2017), and Filimonau et al. (2018) investigated the social acceptance of the use of SAF. Both studies gathered data through a questionnaire and measured the participants Knowledge, Perceptions and Attitude towards SAF in aviation. Filimonau and Högström (2017) found in public (UK) understanding of sustainable liquid (bio)fuels in aviation. Similarly, Filimonau et al. (2018) echoed that there is limited understanding of sustainable aviation fuel technology, in addition to public (from Poland) safety concerns about its use. They also noted public distrust of institutions at national level (both) and, as a consequence, called for the development of awareness-raising campaigns to address this question. However, these two studies did not examine customers WTP for SAF use in commercial aviation. We can assess that being aware of the public perception of SAF is an extremely important factor to align strategies, promote acceptance and drive positive changes in the aviation industry.

3.2.1. Willingness to pay (WTP) more for an air travel with SAF

The willingness to pay more for air travel (WTP) refers to the extra value consumers are willing to bear for a product or service – in this case, air travel that uses SAF. This idea of WTP for environmental benefits was developed in the latest years of twenty century (1990s) by environmental economists using some contingent valuation methods trying to understand how much people would accept and pay for reducing air pollution, for cleaner air and to preserve the ecosystems (Knetsch, 1990; Hanemann, 1991). It reflects the real perceived value that has an impact on the environmental and sustainability benefits of air travel. The concept of WTP has its roots in economics, particularly in studies of consumer behavior and environmental economics. Researchers in broad fields such as environmental science, economics, and marketing have explored in different ways and with different approaches how consumers value sustainability and a large number of studies has been conducted in an effort to measure people´s willingness to offset flight-related carbon emissions (Berger et al., 2022).

Rice et al. (2019, p.1) enhanced the need for more research on consumer WTP for new sustainable aviation projects and in particular its relationship with sustainability benefits. The authors affirmed, “Airlines can expect consumers to accept a small increase in ticket prices if they are convicted that the airplane flight emits fewer greenhouse gases”.

Several studies have evaluated WTP for SAF (Sivashankar et al., 2016; Rice et al., 2020; Xu et al., 2022) using surveys choice experiments and contingent evaluation methods to collect data. Participants are asked how much extra they would be WTP for flights using SAF compared to conventional fuels. These studies (Sivashankar et al., 2016; Rice et al., 2020; Xu et al., 2022) results suggest that a significant portion of travelers is willing to pay more for sustainable options.

There are studies (e.g. Sivashankar et al., 2016; Rice et al., 2020; Xu et al., 2022) reporting that consumers may be WTP between 5% and 20% more for flights using SAF, depending on demographic characteristics (nationality, age or level of education, for example) and contextual influences (gender or ticket price, for example). The difference under analysis is usually the difference between the WTP expressed by consumers and the actual market price of air travel with SAF. While studies report travelers´ WTP more, the actual adoption of SAF in the market is quite limited due to high production costs, infrastructure challenges, and widespread lack of availability (Chin et al., 2013; Filimonau et al., 2018). This discrepancy suggests the need to increase awareness, and potential subsidies or incentives to fill the gap. The study of Berger et al. (2022) presents as central finding that passengers are largely unwilling to offset their flights, in contrast to studies (e.g. Filimonau & Hogstrom, 2017; Wendt et al., 2024) that rely on hypothetical behavior.

The present study aims to analyze more deeply this perception of public opinion (unwilling to offset and pay) and assess the WTP in a group of individuals more familiarized with the topic “SAF in aviation”.

3.2.2. Predictors of WTP

Due to its recognized importance in the context of commercial aviation, research has sought to identify predictors of passengers´ WTP for SAF. One of the main theoretical backgrounds for predicting WTP is the theory of reasonable action (initially proposed by Martin Fishbein in early 1960 and 1970 and later on developed by Icek Ajzen), which is used to connect factors such as awareness and attitude toward the pro-environmental initiative (Taylor et al., 2006; Tuck & Riley, 2017). According to this theory, a person´s intention to perform a behavior is the best predictor of a behavior (especially if socially relevant as the support of emission offsets). In turn, intentions are influenced by the attitudes towards the behavior (i.e. evaluation or appraisals) and/or subjective norms (i.e. perceived expectations from others). In sum, individuals will have strong intentions to paying more for an air travel with SAF if they evaluate it positively (for example, with higher benefits and lower risks) and/or if they believe that others think they should do it. Research have already suggested that individuals´ beliefs and attitudes about environmental issues can predict their WTP to offset emissions from their air travel (Wendt et al., 2024). The meta-analysis of Wendt et al. (2024) analyzed and compared 31 published studies (from 2008 to 2022) looking for the factors that influence the consumers´ WTP for emission reduction in air travel. The authors found evidences on a set of variables such as environmental knowledge and attitude, among others. However, these findings came from samples that involved the general population, less knowledgeable on the specific characteristics of SAF than professionals and academics in the aviation area.

To the best of our knowledge, the influence on the WTP of factors as the knowledge on SAF, the perceived risks, benefits, social trust and the general attitude towards SAF hasn´t been mainly tested in individuals familiarized, from an academic and professional point of view, with the topic. Through the present study, we intend to fill the gap and verify to what extent (more) informed consumers on the topic SAF are willing to pay more for an air travel with this technology.

3.2.2.1. Knowledge

The knowledge about a new technological advancement and the advantages it provides influence the consumers´ purchasing decisions (e.g. Wegener & Kelly, 2008). Knowledge is a recognized predictor of WTP more for sustainable fuels in air travels (Lu & Shon, 2012). In our study, we use the knowledge or the familiarity of individuals with the subject as a predictor of perceived benefits and risks and social trust regarding the use of SAF in air travels. Individual perceptions about the performance of a product (for example, about the use of SAF in air travel), its effectiveness and credibility, influence the appreciation of it (Demirgüneş, 2015).

This seems to be especially true in the cases of environmental goods and consumers' involvement in pro-environmental actions (such as, for example, paying more for air travel with SAF) (Sharma et al., 2021). The familiarity with the technology (knowledge) is well explored as background to research on both studies, especially with considerable variation in reported WTP values (Sharma et al., 2021; Wendt et al., 2024).

AlHaddid et al. (2024) explored the role of knowledge in pro environmental actions in a study developed outside the air transportation area. The authors found that Knowledge of Water Sustainability (KWS) played a pivotal role in driving positive influence across the three attitudes toward water sustainability practices.

Environmental knowledge, defined as understanding facts, concepts, and relationships related to the natural environmental and its ecosystems, is a cornerstone for fostering sustainable water practices (Rausch and Koplin, 2022; AlHaddid et al., 2024). Several studies have enhanced the role of environmental knowledge in steering environmentally sustainable consumption behaviors and with individuals with a more profound comprehension of environmental issues. These individuals exhibit a heightened sense of responsibility towards the environment and sustainable development (Kumar et al., 2017; AlHaddid et al., 2024). Wendt et al. (2024) qualitative review found that WTP could be more than double for a credible offsetting scheme compared to one lacking credibility.

3.2.2.2. Social Trust

The social trust construct concerns the public confidence in relevant institutions as policymakers, scientific community, and LCJF producers, keys players that have the legitimacy and power to shape the public perspectives on SAFs (Xu et al., 2022). Similar patterns of social trust may be an alarming situation (Longstaff et al., 2015; Xu et al., 2022) because it suggests that most consumers felt left out in decisions on low carbon fuel. In Berger et al. (2022) study, the social trust on offsetting schemes shows that may be ineffective. Pro-environmental behavioral measures are high in Europe, but cost-benefit actions for the environment are very low in the sample and passengers are largely unwilling to offset their flights (Berger et al., 2022).

Social trust and acceptance are important in promoting the adoption of SAF in the aviation industry. Higher levels of trust can lead to a greater willingness of the consumer to pay extra for sustainable options and to support initiatives in the sector (de Mello, 2024). Building and maintaining social trust through transparency, effective communication and responsible practices is imperative for the successful implementation of SAF. Chin et al. (2013) and Xu et al. (2022) verified the role of social trust as a predictor of costumer's WTP. The first describes a reality in Malaysia that is different from previous studies, because alongside with implementing biofuel for domestic usage, the country is facing an acceptance issue since it is a biofuel producer country. A different reality is presented in Filimonau et al. (2018) and Xu et al. (2022) who analyzed the predictor role of social trust as did. Both studies found a low level of trust in government decision related with SAF.

3.2.2.3. Perceived Risks

The public's perception of the risks associated with SAF in aviation seems to be influenced by a combination of awareness, misinformation and individual values (Xu et al., 2022). On Xu et al. (2022) study, the consumers showed an apprehensive state about the SAF use because they believed it will protect the environment but its production may harm the environment (in terms of soil and water pollution) by the increased competition for agricultural land. It is necessary to understand the several risks relating to availability, production and safety of SAF. The biggest of such concerns was the lack of SAF availability (Xu et al., 2022). On Filimonau et al. (2018) study they investigated the SAF safety issue from a non-technical perspective, but it seems unnecessary because all SAF must be internationally certified before they can be used in aviation (Xu et al., 2022).

3.2.2.4. Perceived benefits

The public recognition of perceived benefits of using SAF is increasing due to a growing awareness of environmental issues and the desire for sustainable travel options (Xu et al., 2022; de Mello, 2024; Wendt et al., 2024). On road transport studies (Longstaff et al., 2015) and other aviation studies (Gegg et al., 2015; Xu et al., 2022), the perceived benefits construct has already been explored. These benefits include emissions reduction potential, fuel diversification, and supply security in addition to enhanced regional/rural development (Xu et al., 2022). However, the authors identified a lack of understanding and awareness of the SAF characteristics that would achieve emission reduction, and this further strengthens the notion that SAF use in aviation needs promotion (Xu et al., 2022).

3.2.2.5. Attitude toward SAF

It regards the usefulness attributed to sustainable fuels (Filimonau & Högström, 2017; Kantenbacher et al., 2018). The attitude towards SAF is influenced by the knowledge about the technology and interacts with a number of other factors, such as price, personal values, social influences, and economic conditions (Chin et al., 2013). We intend to identify if attitude towards SAF performs a mediating role between the familiarity with SAFs and the WTP more for an air travel with the technology in a group of professionals and academics of the aviation sector, more familiarized with the topic than the general public. Wendt et al. (2024) meta-analysis identified studies that establish a link between attitudes and the consumers' WTP for emission reduction in air travel. The literature review suggests that public attitudes to biofuels and their use in aviation should be better understood (Filimonau & Hogstrom, 2017).

Rice et al. (2020) suggest that airlines can expect consumers to accept a small increase in ticket prices if they are convicted that the airplane flight emits fewer greenhouse gases. Berger et al. (2022) central finding is that passengers are largely unwilling to offset their flights, in contrast with studies that rely on hypothetical behavior. In a recent study, Wendt et al. (2024) found that individuals´ beliefs and attitudes about environmental issues can predict their WTP to offset their air travel emissions.
On our study we intend to analyze that (based on literature review) to answer our research question:

What is the influence of knowledge about SAF on the willingness to pay more for a flight with the technology, in professionals and academics in the field of civil aviation in Portugal?

Derived from this general question, other more specific questions were formulated:

- To what extent the willingness to pay (WTP) for SAF in air travels is influenced, directly and indirectly, by previous Knowledge or familiarity with the technology?
- Does attitude towards the use of SAF plays a mediating role in the relationship between knowledge and WTP?
- What factors influence the relationship between knowledge and attitude?

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4- Methodology

To test our research hypothesis and the conceptual model, we designed and implemented a quantitative descriptive-correlational study with a cross-sectional design supported by a survey with an online questionnaire.

4.1. Research approach and study design

The descriptive-correlational quantitative method is a common option in studies that analyze consumers and industry perceptions of SAF. For example: studies on energy efficiency and reduction of environmental impacts (De Mello, 2024); analysis of acceptance and commercial viability of SAF (Berger et al., 2022); economic costs and operational efficiency of SAF (McLachlan et al., 2018); and studies aimed to analyze of the impact of SAF on reducing carbon emissions (Xu et al., 2022). There are reasons for the popularity of the descriptive-correlational quantitative methods. They provide broad and detailed descriptions and practical usefulness, a basis for possible subsequent studies, and for forecasting models. If their relationships are sufficiently strong and consistent, they can be used to predict trends or behaviors in similar populations (Wendt et al., 2024).

The cross-sectional design is a type of observational research "design" that collects data at a given point in time providing an immediate "portrait" of a certain situation (Sivashankar et al., 2016; Berger et al., 2022). It appeared to be the most appropriate to the present study due to its characteristics, namely its practicality and speed, its feasibility in limited resources (it is efficient), and its suitability for determining the prevalence of conditions or behaviors in a given population (de Mello, 2024; Wendt et al., 2024).

4.2. Participants

The target population of the present study were the professionals and academics of the aviation area living in Portugal. Other criteria were defined for participation in the study, such as being over 18 years old, being familiar with the SAF topic and completing the questionnaire until the end. To verify compliance with the criteria, we incorporated selection items in the questionnaire, in the sociodemographic variables section (annex 1).

The initial sample had 711 responses: 667 individuals (93,8%) professionally and/or academically related with aviation. The remaining 44 (6,2%) respondents were not related to aviation, so they were excluded from the survey. Then, we also excluded the respondents who did not complete the questionnaire, those who never heard about SAF and those who lived outside Portugal. Therefore, we obtained a viable and convenience sample of 430 participants.

The main context of participants relationship with aviation was 375 (73%) that work at airlines, and the professional area of 322 (75,3%) were the Operational sector. Almost half of the participants, 229 (53,3%) said that are not academically related to aviation (only professionally), so we have a huge participation of people academically related with aviation. The number of males that participate were 362 (84,4%) and the females were 68 (14,8%) and there were 4 non-responses in the socio demographic section. Most of the participants (n=291, 67,9%) had a higher educational degree (post-graduation, bachelor or Master degree of education).

4.3. Data collection

To collect the data, we built a questionnaire using the app Google Forms. According to Silverman and Patterson (2014), the best way to obtain data within an already specialized industry niche is to question experts which can be done through interviews or targeted questionnaires.

4.3.1. Measures

- As previous studies on the consumers´ Willingness to pay (WTP) (e.g. Sivashankar et al., 2016; Rice et al., 2020; Xu et al., 2022; Berger et al., 2022; Wendt et al., 2024), we used perception as a construct to understand the influences on the participants' disposition to support SAF. To measure the constructs under study, with the exception of 'participant's knowledge or familiarity with the topic SAF' we followed Xu et al. (2022) and used the same 5 points (1 – totally disagree, 5 – totally agree) Lickert-type scales which are widely used and recommended in exploratory studies (Filimonau et al., 2018):
- About 'Willingness to Pay' (WTP), in the present study, we assumed Rains et al (2017) definition of WTP which is "the additional cost consumers are willing to bear for tickets on flights powered by SAF, reflecting their valuation of the environmental and sustainability benefits". To measure the WTP variable, we used a scale with 3 items. An item sample is 'I would be willing to pay a higher ticket price for my flights using SAF'. The scale had a reliability (alpha of Cronbach) of .88 in Xu et al. (2022).

- To measure 'Perceived Risks' (PR), 'Perceived Benefits' (PV), 'Attitude'(At), and 'Social Trust' (ST) (respectively, α=.75, α=.88, α=.77 and α=.72 in Xu et al. (2022) study), we used scales with 5 items. Sample items are, respectively: 'SAF poses a safety concern'; 'Investments in SAF will benefit both the economy and the society', 'I believe is a good idea to use SAF for flights'; 'The scientific community is doing a good job for the society by developing SAF'.
- 'Social trust' or the confidence in institutions (e.g., academic, government, and industry) (Filimonau et al., 2018; McLachlan et al., 2018) was measured with 3 items (α=.72). A sample item is 'The scientific community is doing a good job for the society by developing SAF'.
- Participants' familiarity with the subject SAF was first identified by a filter item: 'Have you ever heard about SAF?' Only an affirmative (yes) answer would allow the individuals to proceed in the questionnaire. To measure the variable 'Knowledge or familiarity with SAF' and based in IATA (2024) survey, we built a scale with four items, one with reversed score (INV):

  1) The most strategic topic to the airlines management is sustainability,

  2) Economic efficiency and sustainability are contradictory in terms (INV),

  3) Carbon neutrality is a realistic issue in aviation,

  4) SAF is a bridging technology until hydrogen and electric aircraft become more viable.

- The variable "Attitude", or the public's opinion regarding the usefulness of SAF, was measured by 5 items (α= .77). A sample is "I believe it is a good idea to use SAF for flights".

4.3.2. Procedures

To distribute the questionnaire and collect the data, we adopted the "virtual snowball sampling", a non-probabilistic sampling method especially useful to gather research subjects from hard-to-reach populations (Baltar and Brunet, 2012): in a digital environment, one subject gives to researcher the contact of another subject, which in turn provides the name of a third, and so on.

We started to contact the researchers´connections in social networks (Linkedin, Whatsapp and Facebook) dedicated to aviation and invited them to participate in the study by answering the questionnaire and send it to their own contacts. To facilitate the dissemination of the questionnaire and the adherence of individuals, we wrote the questionnaire in English, commonly spoken in the aviation industry.

4.4. Data analysis

All the analysis were performed with IBM-SPSS Statistics (v.27). The hypotheses and research questions were tested with the macro “PROCESS”, a modelling tool particularly useful to estimate direct and indirect pathways through which an antecedent variable X is related to a consequent variable y.

We performed a preliminary examination of the database to identify missing data, outliners and to assess the presence of normality in the variables distribution. For that purpose, we produced histograms, plots, and a descriptive analysis (Annexes 3, 4 and 5). Additionally, to a univariate profiling, we also examined the relationship between variables and examined group differences.

To analyze the variables internal consistency, we calculate alpha of Cronbach. The item of the Attitude scale “I dislike the idea of using SAF for flights” was removed from all analyzes as it was found that its elimination considerably increased the alpha of Cronbach.

Since the present study involves a single measure, we decided to access the presence of the common method variance (CMV) bias. CMV occurs when responses vary in systematically way due the use of a common scaling approach on measures, which derives from a single data source. The bias happens when the so-called method causes large distortions and divergences between true and observed relationships, for example, by deflating or inflating correlations leading researchers to believe that relationships exist (error type I) (Fuller et al., 2016). To obtain a basic assessment of the common method bias, we conducted the Harmans´ One-Factor test and performed an exploratory factor analysis and found a total variance extracted by one factor of 29,67% (table 4), which less is than the recommended threshold of 50% (Fuller et al., 2016) suggesting that common method bias is not a problem in our study.

To test the hypothesis in PROCESS macro, we customized a one serial-parallel multiple mediator model. The dependent variable (WTP) was regressed on the independent variable (Knowledge) and the mediators (Perceived Risks, Perceived Benefits, Social Trust and Attitude). The analyses were run with 5000 bootstrap samples.

The summary statistics are presented in table 4 (next chapter). The regression coefficients reported both in figure 4 and table 4 are unstandardized (see results in next chapter).

5- Results

In this section we present the results of the performed analyzes. After the descriptive results, and to facilitate reading and interpretation, we organized the presentation of results by research hypotheses.

5.1. Descriptives

Table 2 presents the descriptive measures of each variable. All the variables, with the exception of perceived risks, have significant (*p*<.01) and positive correlations with each other. The reliability scores were quite acceptable, as they ranged between .72 and .88 (Cronbach's alpha), with the exception of the 'Perceived Risks' scale (α = .64).

Table 2 - Means, standard-deviations, correlations and reliability

Source: Author (see annex 3, 4 and 5)

Variables	Mean	SD	KN	PR	PB	AT	WP	ST
(KN) Knowledge	3.33	1.11	*(.72)*					
(PR) Perceived risks	2.83	.48	.168**	*(.64)*				
(PB) Perceived benefits	3.79	.67	.536**	.040	*(.80)*			
(AT) Attitude	3.80	.67	.494**	.065	.580**	*(.81)*		
(WP) Willingness to pay	2.66	.97	.367**	.049	.432**	.532**	*(.88)*	
(ST) Social trust	3.31	.64	.414**	.042	.569**	.505**	.382**	*(.74)*

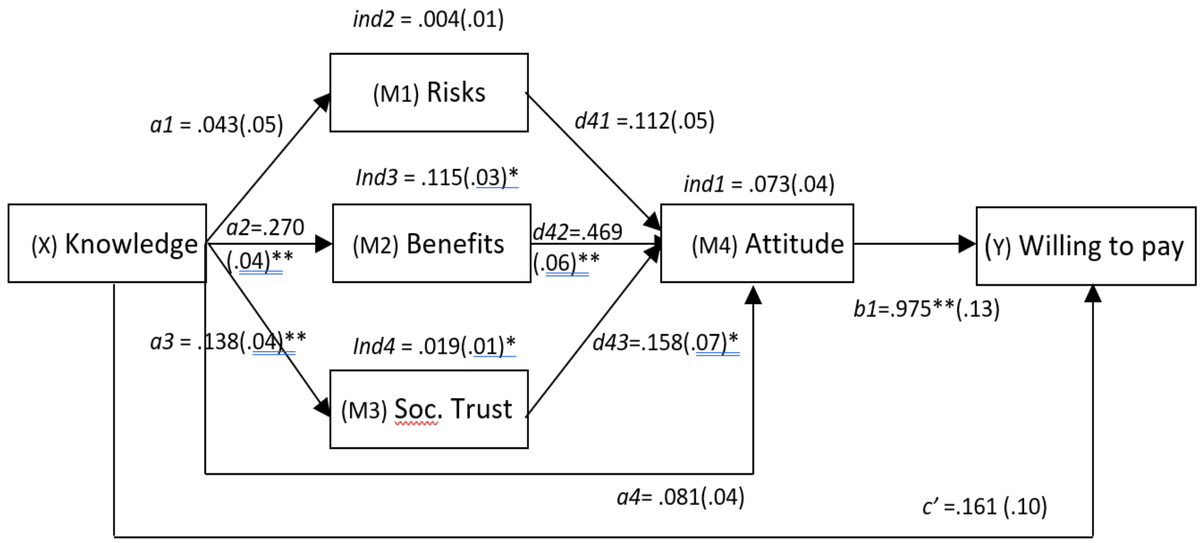
Note: ***p* < .01 (2 tailed); *(in italic)* alpha Cronbach, reliability

5.2. Hypothesis testing results

Figure 4 (next page) presents the study statistical diagram with the results of the hypothesis testing.

Figure 4 - Statistical diagram of the serial multiple mediators models the knowledge influence on the willingness to pay

Source: author 2024



Note. * *p* <.05; ** *p* < .001; ( ) = standard error; direct effects of X and M's: a1, a2, a3, a4, d41, d42, d43, b1, c'; indirect effects X->Y trough M1, M2, M3, M4: ind1, ind2, ind3, ind4.

The table 3 (below) shows the direct and indirect effects of Knowledge on Willingness to pay, a resume of the table 4 and the annexes 3, 4 and 5 with the standard error, the lower level, upper level and confidence interval.

Table 3 – Direct and indirect effects of Knowledge on Willingness to pay

Source: author 2024

Variables	*b*	*SE*	*t*	*p*
Direct effects				
Knowledge -> WTP	.161	.104	1.537	.126
Knowledge -> Perceived benefits	.269	.042	6.367	< .001
Knowledge -> Perceived risks	.043	.054	.786	.433
Knowledge -> Social trust	.138	.040	3.439	< .001
Knowledge -> Attitude	.081	.042	1.870	.060
Indirect effects	*b*	*SE*	*LL CI*	*UL CI*
Knowledge-> Attitude -> WTP [ind1]	.073	.040	-.004	.158
Knowledge-> Risks -> Attitude -> WTP [ind2]	.004	.006	-.007	.019
Knowledge-> Benefits -> Attitude -> WTP [ind. 3]	.115	.031	.062	.183
Knowledge-> Social Trust -> Attitude -> WTP [ind.4]	.019	.011	.002	.045
Total indirect effects	.210	.053	.114	.321

Note. SE: standard error; *LL*: lower level; *UL*: upper level; *CI*: confidence interval

5.2.1. The direct influences of Knowledge on SAF

According to our conceptual model, Knowledge on SAF exerts a direct effect on the variables 'Perceptions of Risks', 'Perception of Benefits', 'Social Trust', 'Attitude' and 'Willingness to pay'. The results found support for the hypothesized relationships between (H3c) Knowledge and Perceptions of Benefits (*b*=.269, *SE*=.042, *t*=6.367, p<.001) and Knowledge (H3d) and Social trust (*b*=.138, *SE*=.040, *t*=3.439, *p*<.001). However, the direct effects of Knowledge on the variables 'Perceptions of Risks' (b=.043, SE=.054, t=.786, p=.433) and 'Willingness to pay' (*b*=.908, *SE*=.139, *t*=6.521, *p*<.001) for SAF were not statistical significant. The influence of Knowledge on the 'Attitude' is not significant (*b*=.081, *SE*=.042, *t*=1.87, *p*=.060). Therefore, the results support the hypotheses H3b and H3c, but not hypotheses H3a, H3d and H1. By itself, Knowledge explains 14,4% of the Perceived benefits variance ($F_{(1,242)}$ = 40,54, *p*<.001) and 5% of Social Trust variance ($F_{(1,242)}$ = 11,83, p<.001).
Next, we show a few figures (Figure 5,6,7,8,9 and 10) that support or study and could be more deeply analyzed on annexes 3,4 and 5.

Figure 5 – Reliability Knowledge (see Annex 3 with IBM-SPSS information)

Source: author 2024

Confiabilidade

Escala: Reliability - Knowledge

Resumo de processamento de casos

		N	%
Casos	Válido	429	99,8
	Excluídos[a]	1	,2
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,725	5

Figure 6 – Graphic Q-Q Normal of Perceived Risks (See Anexx 3 with IBM-SPSS information)

Source: author 2024

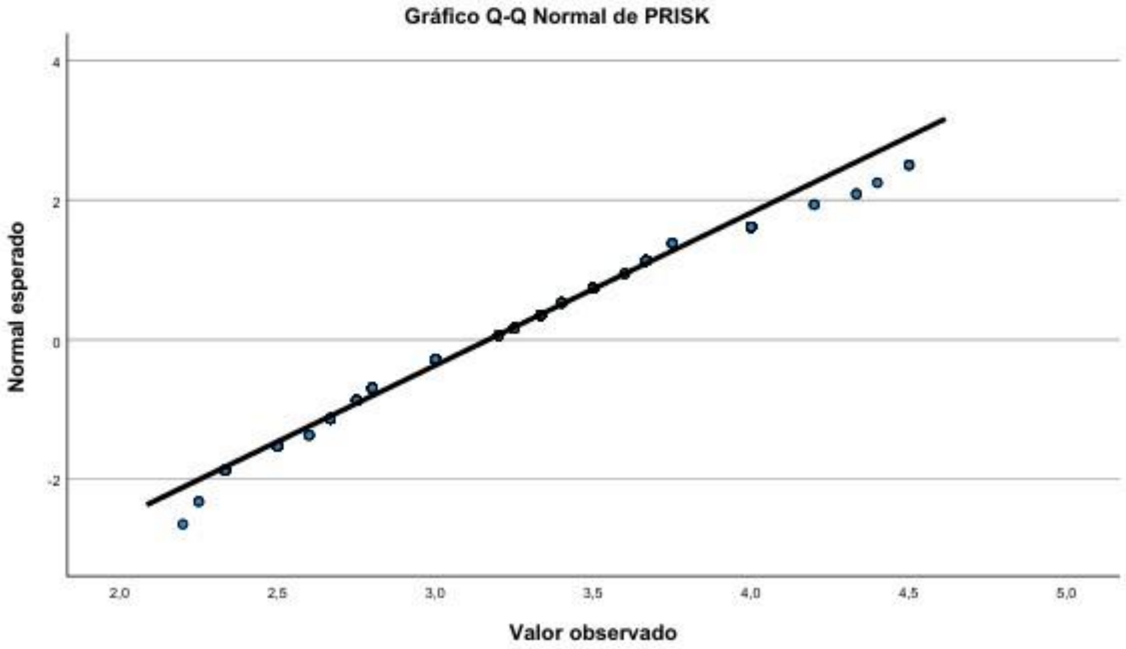


Figure 7 – Graphic Q-Q Normal of Perceived Benefits (See Anexx 3 with IBM-SPSS information)

Source: author 2024

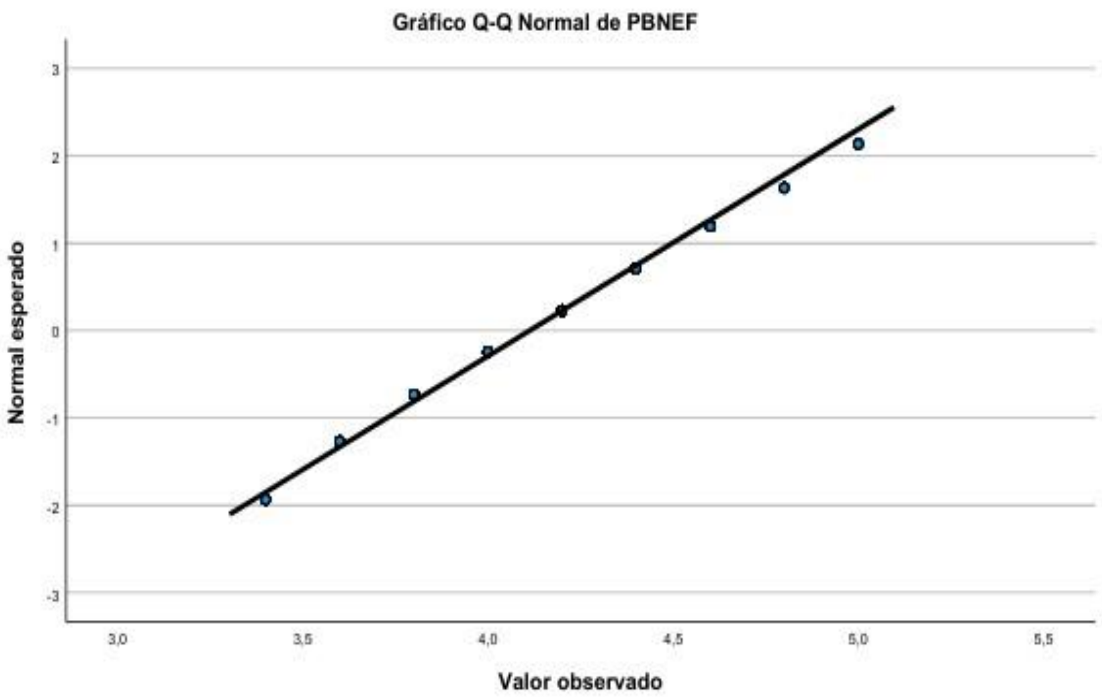


Figure 8 – Graphic Q-Q Normal Social Trust (See Anexx 3 with IBM-SPSS information)

Source: author 2024

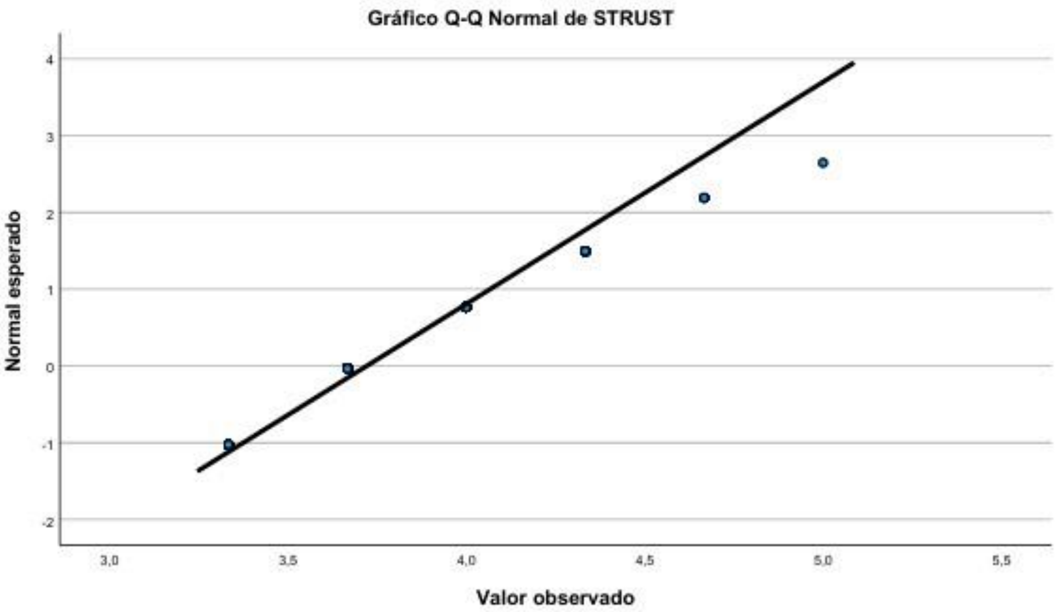


Figure 9 – Graphic Q-Q Normal Attitude (See Anexx 3 with IBM-SPSS information)

Source: author 2024

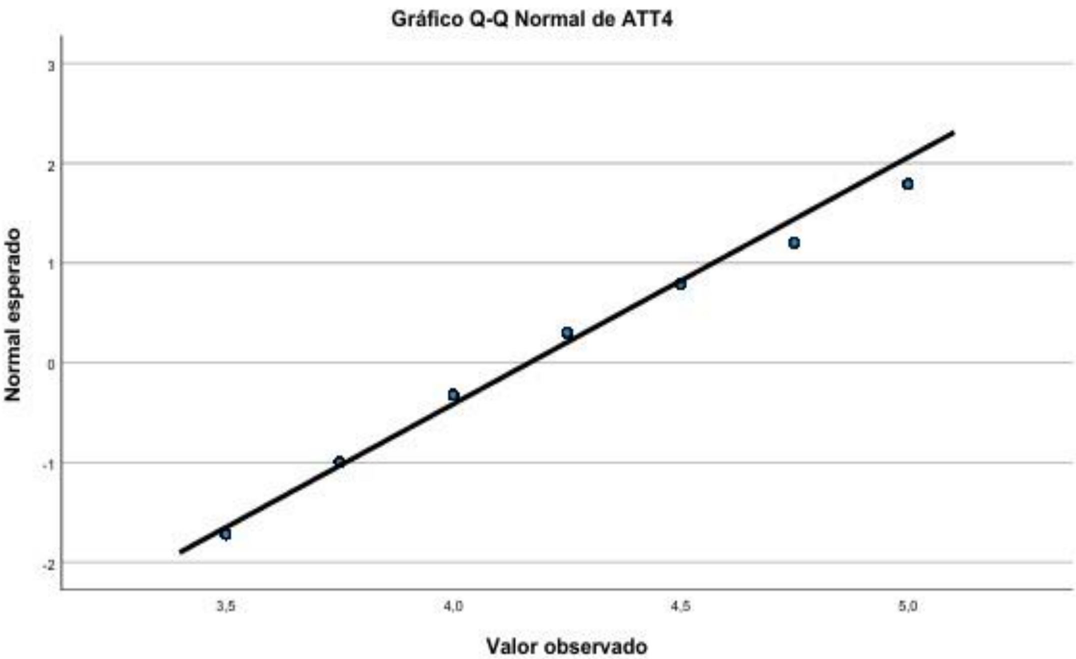


Figure 10 – Reliability Willingness to pay (see Annex 3 with IBM-SPSS information)

Source: author 2024

Confiabilidade

Escala: Reliability - Willing to pay

Resumo de processamento de casos

		N	%
Casos	Válido	430	100,0
	Excluídos[a]	0	,0
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

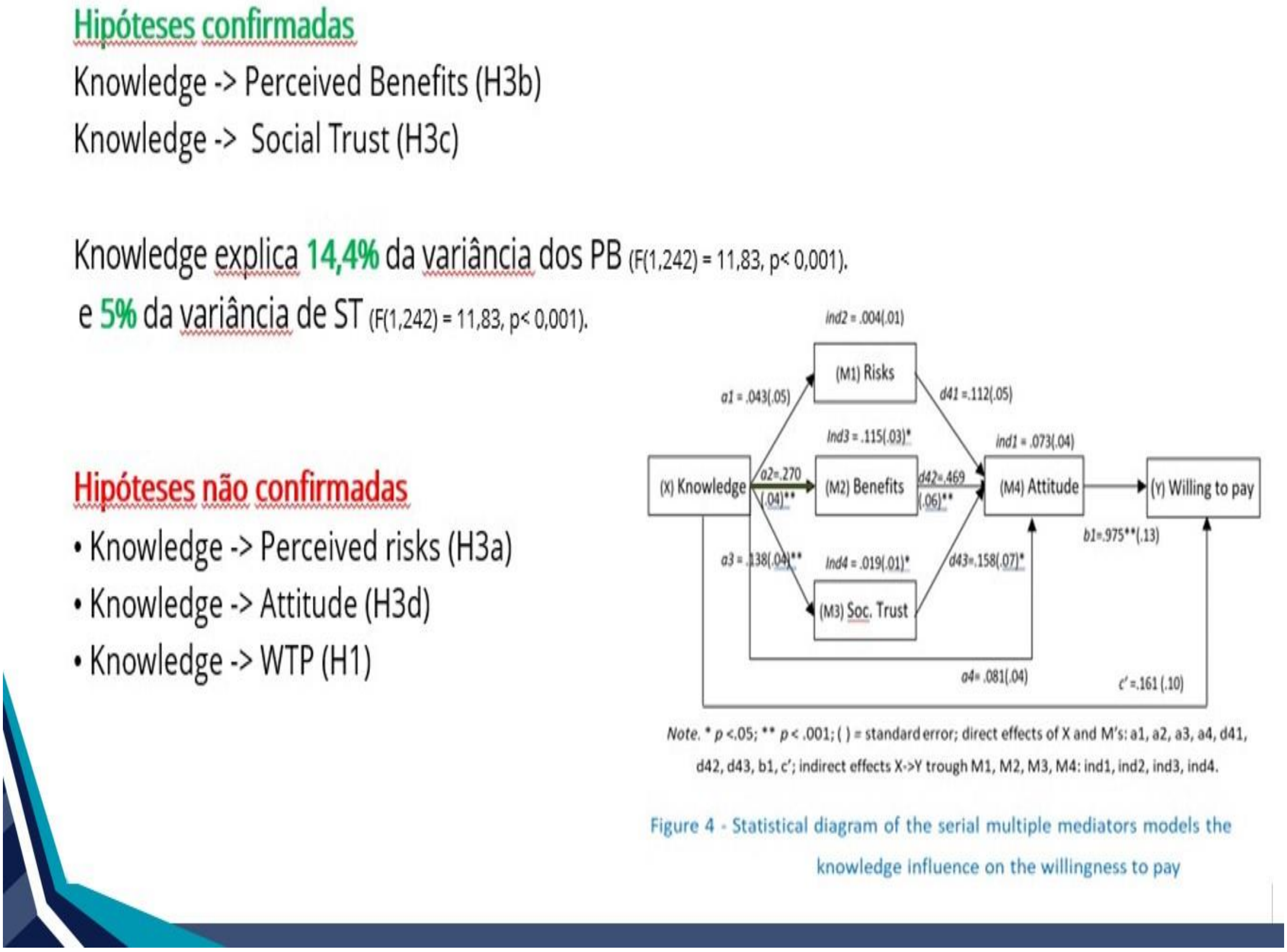
Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,876	3

To better understand all this technical information about the direct influences of Knowledge on SAF Willingness to pay we show figure 11 (next page) that are a resume of all this information (Power Point Presentation summary of the study presentation).

Figure 11 – Direct influences of Knowledge on SAF Willingness to pay (Power Point presentation)

Source: author 2024



5.2.2. The mediating influence of Attitude towards SAF in the relationship between Knowledge and Willingness to pay.

In our tested model, Knowledge, Perceived Risks, Perceived Benefits and Social Trust directly influence Attitude towards SAF. These assumptions were partially supported by the results since only the last two were found to have significant relationships with Attitude, respectively, *b*=.469, *SE*=.065, *t*=7.191, *p*<.001 and *b*=.1510, *SE*=.069, *t*=2.191, *p*<.05.

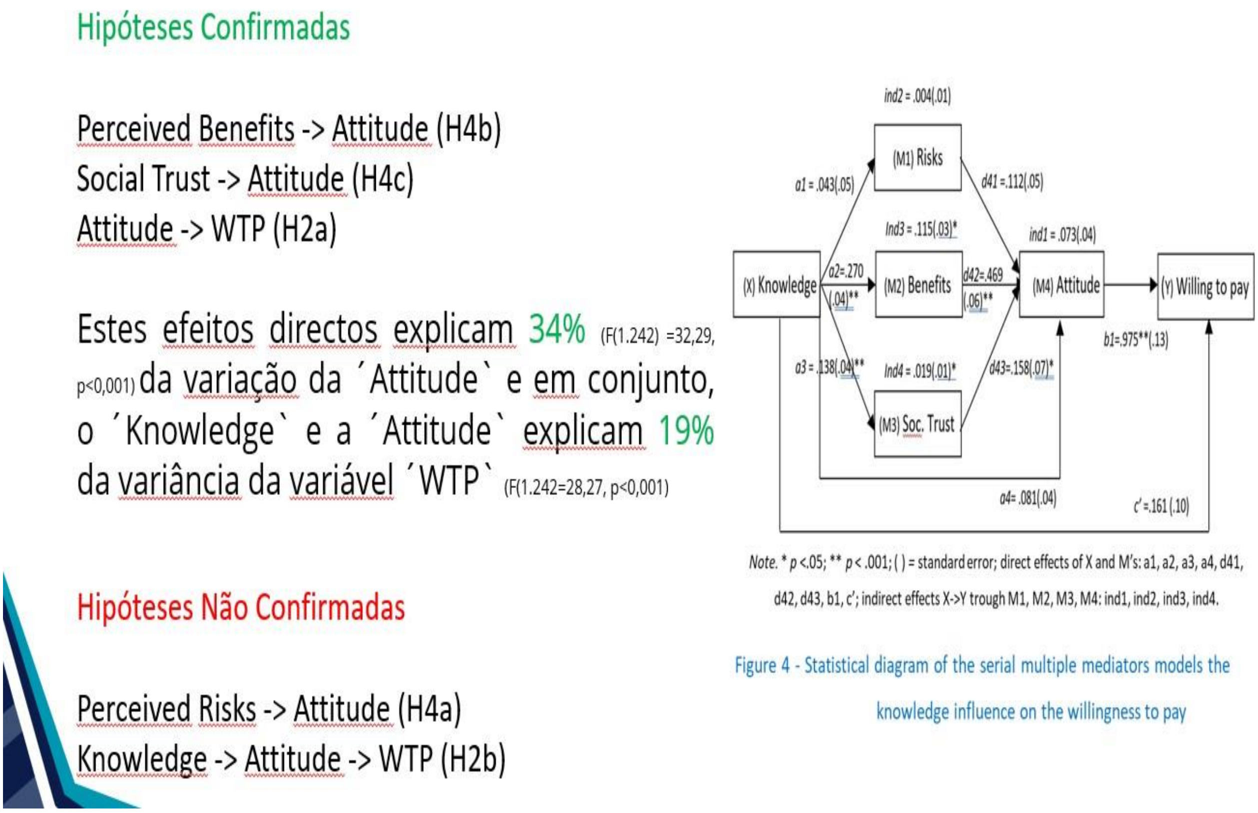
Overall, these direct effects explain 34% ($F_{(1,242)}$ =32.29, *p*<.001*)* of the Attitude variance (table 5). In sum, we found support for H4b and H4c, but not for H4a.

We hypothesized (H2a) that Attitude has a predictive influence on Willingness to pay (WTP) and plays a mediating role in the relationship (H2b) between Knowledge and WTP. Again, our results partially support these assumptions since the influence of Attitude on the variable WTP was found to be significant (*b*=.908, *SE*=.139, *t*=6.521, *p*<.001) but the mediating effect of Attitude was not confirmed (*b*=073, *SE*=.041, 95% Boot CI [-.000, .158]). Therefore, the results support H2a but not H2b. Together, Knowledge and Attitude explains 19% of the variable WTP variance ($F_{(1,242}$=28.27, *p*<.001).

To better understand all this technical information about the mediating influence of attitude towards SAF in the relationship between Knowledge and WTP we show figure 12 (next page) that are a resume of all this information (Power Point Presentation summary of the study presentation).

Figure 12 – The mediating influence of attitude towards SAF in the relationship between Knowledge and WTP (Power Point presentation)

Source: author 2024



5.2.3. The indirect influence of Knowledge on Willingness to pay.

The total indirect effect of Knowledge on SAF on the Willingness to pay (WTP) was found to be statistically significant (*b*=.210, *SE*=.053, 95% BootCI[-.115, -.322]). We predicted that Knowledge would influence the subjects' Attitude, motivating them to pay more for air travelling with SAF. In our results, we found evidence for the indirect effects of Knowledge through the Perception of benefits (*b*=.032, *SE*=.023, 95% BootCI[-.038, .104]) and Social trust (*b*=.003, *SE*=.004*)* 95% BootCI[-.000, .026]), but not through Perception of Risks (*b*=.003, *SE*=.004, 95% BootCI[-.004, .011]), and Attitude (as presented above). Therefore, the results support H4b and H4c, but not H4a.

To access the difference between specific indirect effects, we test the hypothesis that the two significant indirect effects were equal in size. For that purpose, all possible pairwise comparisons were calculated through contrast option of PROCESS. The results showed three paths statistically different:

C1 (ind1-ind2), *b*=.040, *SE*=.022, 95% BootCI[-.000, .088]

C4 (ind2-ind3), *b*=.065, *SE*=.017, 95% BootCI[-.101, .033]

C6 (ind3-ind4), *b*=.056, *SE*=.018, 95% BootCI[-.024, .096]

We can measure it through the analysis of table 3 and 4.

The table 4 (next page) shows the regression coefficients, Standard errors, and model summary information for the Knowledge influence parallel-serial multiple mediator model, and is made from all the information that the IBM-SPSS provide (see Anexx 3, 4 and 5 for specific information related).

Table 4 - Regression coefficients, Standard errors, and model summary information for the Knowledge influence parallel-serial multiple mediator model depicted in figure 4

Source: author 2024

	Consequent																			
		(M1) Risks				(M2) Benefits				(M3) Soc. trust				(M4) Attitude				(Y) Willing to pay		
Antecedent		Coeff	*SE*	*p*		Coeff	*SE*	*p*		Coeff	*SE*	*p*		Coeff	*SE*	*p*		Coeff	*SE*	*p*
(X) Knowledge	*a1*	.043	.054	.433	*a2*	.270	.042	<.001	*a3*	.138	.040	<.001	*a4*	.081	.042	.060	*c′*	.161	.104	.126
(M1) Risks		-	-	-		-	-	-		-	-	-	*d41*	.112	.047	.017		-	-	-
(M2) Benefits		-	-	-		-	-	-		-	-	-	*d42*	.509	.062	<.001		-	-	-
(M3) Soc. trust		-	-	-		-	-	-		-	-	-	*d43*	.158	.069	.024		-	-	-
(M4) Attitude		-	-	-		-	-	-		-	-	-		-	-	-	*b1*	.975	.132	<.001
Constant	*iM1*	3.014	.198	<.001	*iM2*	3.141	.154	<.001	*iM3*	3.223	.146	<.001	*iM4*	1.133	.299	<.001	*iy*	-1.076	.556	.054
		$R^{2\prime}$= .003				$R^{2\prime}$= .144				$R^{2\prime}$=.047				$R^{2\prime}$= .344				$R^{2\prime}$= .190		
		$F_{(1,não\ 242)}$ = .62, *p* = .432				$F_{(1,242)}$ = 40.54, *p* =<.001				$F_{(1,242)}$ = 11.83, *p* = <.001				$F_{(1,242)}$ = 32.29, *p* = <.001				$F_{(1,242)}$ = 28,27, *p* = <.001		

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6- Discussion

The present study intendeds to understand, in a sample of individuals familiarized with the topic SAF, to what extent their knowledge influenced their willingness to support the technology through the mediating influences of perceived risks, benefits, social support and attitude toward the use of SAF.

We tested the hypothesis that the individuals' knowledge had a direct influence on their willingness to pay (WTP) as well as on the mediating variables. We started from this assumption because we wanted to test in the present sample (aviation academics and professionals in Portugal) this particularity that had not been contemplated in previous studies carried out, namely in the studies by McLachlan et al. (2018), by Xu et al. (2022) and by Wendt et al. (2024). However, the results did not meet our expectations, as familiarity with the technology did not show a direct influence on WTP.

It seems that knowledge per se has no motivational effect on individuals to pay more for an air travel with SAF. These results are similar (in part) in the study by Wendt et al. (2024) regarding negative WTP results from European Union studies indicate that a carbon offset program needs additional desirable attributes before respondents are willing to pay even the lowest price available.

On the other hand, the results are different from those presented in the study by McLachlan et al. (2018) where the knowledge about the impact on the environment was considered the least important factor and one of the main justifications for passengers not wanting to pay any extra (WTP) for air travel (study carried out in the United Kingdom).

We could find the similarities from this study results with Xu et al. (2022) study about UK market (they said that their results can be taken as reflective of countries having similar socio-economic characteristics) and we could test that if it is real with this Portuguese sample that we use in our study.

In our sample, the familiarity with the topic SAF functioned as a predictor of Perceived Benefits, and Social Trust, but not as a predictor of Perceived Risks. These results are different from all the other studies before made, in part because we analyzed deeply the indirect relationship and influences of the constructs among them, and the attitude change that could arise from these relationships. This was notorious, even compared to the study by Xu et al. (2022) which we can consider the most similar to ours carried out so far.

Additionally, the set of items used to measure the variable Perceived Risks showed a low reliability, which may explain the differences between our findings and the McLachlan et al. (2018), the Xu et al. (2022) and the Wendt et al. (2024) studies results.

We also foreseen a significant direct relationship between knowledge and attitude towards the use of SAF, and an indirect relationship through the mediating influences of perceived benefits, social trust and perceived risks. The findings did not support the direct hypothesis, meaning the familiarity with the topic was not enough for subject to form an attitude. The influence of Knowledge on the Attitude towards the use of SAF appears to depend of the perceptions regarding the Benefits and the Social trust associated with the technology in relation to its use. We find support for mediating role of the first two variables but not for the later.

These results are different from the others studies made before and the mediating attitude that knowledge could built based in the right perception of benefits and social trust, and that about the perceived risks (which in a way seems to be overlooked in our sample of participants) seems to be the right answer about the awareness and motivation of WTP.

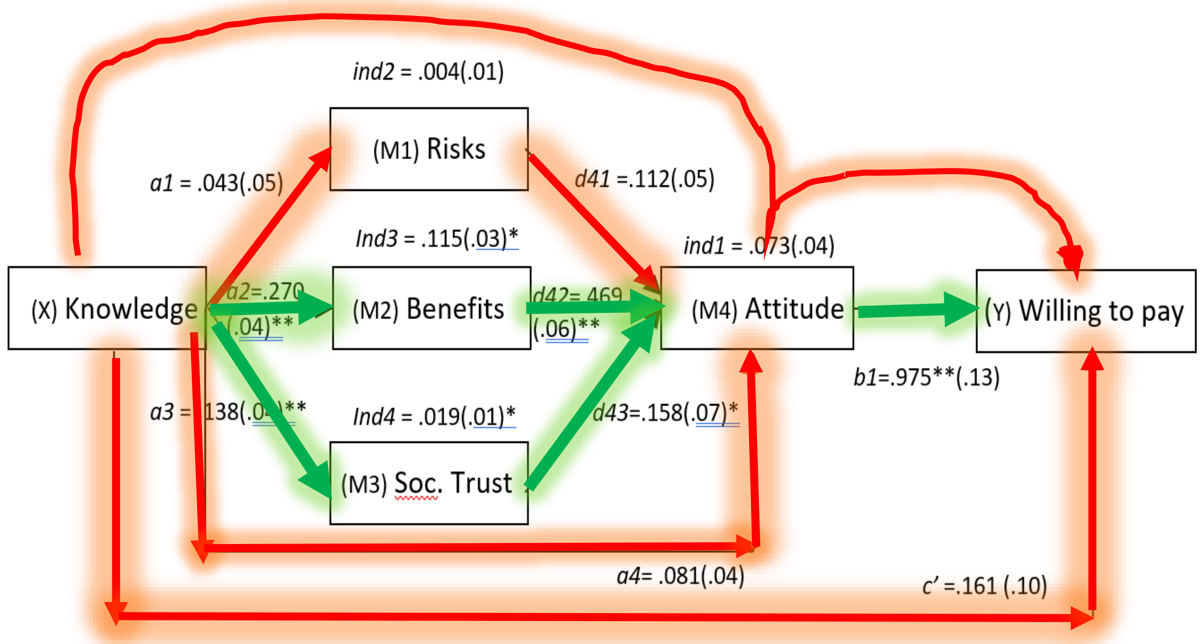
7- Conclusions

The present work has as its theme the SAF and the opinion of consumers in the aviation area in Portugal. It is sought to ascertain to what extent familiarity with this technology influences the willingness of individuals to pay (WTP) more for air travel using SAF.

The study was developed with the intention of unveiling the influence of Knowledge in the WTP through the mediating effects of the perceived benefits, risks, social trust and attitude towards the use of the technology. To achieve this purpose, we surveyed a sample of 430 professional and academics in the aviation sector in Portugal.

Figure 13 – The direct and mediating influence of attitude towards SAF in the relationship between Knowledge and WTP (Power Point presentation)

Source: author 2024



The results suggest that knowledge (or the familiarity with the topic SAF) has no direct effect on the attitude towards the use of the technology, but only through perceptions of the benefits and social trust associated with it, together explaining 34% of the attitude variance.

Attitude was found to be a significant predictor of WTP, explaining 19% of its variance, a result consistent with previous studies (Xu et al., 2022; Wendt et al., 2024). In Xu et al. study (2022) a significant proportion of participants not only showed a keen interest in learning more about SAF (64%) but they also believe it was a good idea to use it for flights (53%). We also expecting to find a direct relationship between knowledge and the participants´ willingness to support a pro-environmental initiative as the use of SAF in air travels, as suggested by previous research (Xu et al., 2022; de Mello, 2024). However, we did not find the hypothesized direct influence, but rather an indirect one, through the mediating effects of perceived benefits and social trust.

Studies on the public´s opinion on SAF have suggested that they may have a more limited knowledge about SAF and all its environmental implications. Awareness of the importance of SAF can vary widely, but we assumed that the present study relies on an informed sample.

There is a slow growing interest in more sustainable types of travel among consumers, but this interest can often be influenced by factors such as communication and marketing. In general, the public is very sensitive to the cost of airline tickets. The WTP more for SAF is often limited, especially if there is no clear and immediate perception of the benefits or effective communication about environmental impacts.

Consumers may be more WTP an increased price for SAF if there is a clear understanding of the environmental benefits and this additional cost is reasonable and justifiable. However, if there is a lack of transparency and communication, this provision can be greatly limited.

According to our results, the willingness to pay more for SAF may be more dependent on factors such as perceived value and understanding of environmental benefits. Education and communication play a crucial role in shaping these opinions.

Main contributions of the study

This study contributes to management strategic decisions (eg. Marketing, pricing, fuel hedging) regarding the use of SAF, as to anticipate the behavior of a particular segment of consumers. It also contributes to academic knowledge in the aviation area by providing an overview of the use of biofuels in the aviation industry and the beneficial effects for the environment as the reduction of greenhouse gases permits.

This study also contributes to have the perception that people related with aviation (professionally and academically) show some lack of knowledge about SAF that must have to be understanded and mitigated in a proper way.

Study limitations

Like all studies, ours also has its limitations. We used a cross-sectional design, with a single source of data and a convenience sample. These opinions limit the generalizability of our results. However, all the methodology and research carried out, as well as the theoretical information obtained in the vast review of the existing literature, allowed us to consider that the present study adds material to consider in the development of the theme. And the sample (due to its size) had the desirable variety to obtain a solid portrait of the phenomenon under analysis, which allowed us to consider that the objectives were achieved.

This sample of people related with aviation show a predisposition to pay more for air travel if the perceived benefits are clear and the social trust are reinforced, and their attitude should be according to their knowledge (is not so big that we initially supposed to), so the willingness to pay should be a reality if all this indirect influence could be obtained. Risk perception also seems to be underestimated.

Suggestions for future research

Increase the scope of the research, trying to obtain information and opinions on the topic of SAF from a more international sample.

The recent Resolution of the Council of Ministers of Portugal (see annex 8) from 28 of October of 2024 shown that in our country (Portugal) this theme about SAF use and the structural and regulatory measures (that are necessary to establish an environmental, economic and continuity policy for the aviation sector) are actual and important, confirming this theme as relevant to frame and motivate dialogue and awareness of all stakeholders (from the various sectors responsible for change) and optimization of resources.

Despite the recognition by the Portuguese government of the several benefits associated with the SAF use, the general public may have a more limited understanding and be more resistant to paying extra to fly SAF, unless there is an investment in communication strategies to enhance benefits and importance of SAF. This could represent a fruitful research avenue.

The future research should use a type of approach similar with that we used on our study, reinforcing the perception of risks, and giving some additional information to the public before the questionary are submitted (a more extensive, comprehensive and complete answers could be obtained).

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Annexes

Annex 1. Plano de questionário (Questionnaire Plan) e Parecer da comissão de Ética

Renato Sérgio da Cruz Rodrigues MOTA20210598

Plano de questionário

Variáveis	Questão	Possibilidades de resposta	Validação noutros trabalhos
Socio-Demographic Variables (SDV)	SDV1- Are you academically or professionally related with aviation?	1 - 1-Yes (continue the questionary) / 2- No (thank you for your time! Questionary finished)	
	SDV2- How are you professionally or academically related with aviation?	13 – 1 – Airports / 2- Airlines/ 3- Handling / 4-ATC / 5- Catering / 6- Authority / 7- Constructors / 8- Manufacturers / 9- Air Cargo / 10- Air service / 11- Military / 12- Aviation schools / 13 other (specify)	
	SDV3- Please specify your professional sector:	7 – 1- Operational / 2-Administration / 3- Maintenance / 4- Management / 5- Research / 6- Commercial / 7- other (specify)	
	SDV4- If you are academically related to aviation, explain how?	4 - 1-Student / 2-teacher / 3-lecturer / 4-other (specify)	
	SDV5- Gender	4 – 1 Male/2-Female/3-No binary/4- I don´t want to give that information	
	SDV6 - Country	1 specify	
	SDV7 – How old are you?	1 specify	
	SDV8 – what are your level of education?	5 – 1 -primary education or less / 2- secondary education/ 3- post-secondary education/ 4- bachelor´s degree/5-Master´s degree or higher	

Perceiving knowledge (PK)	PK1- Do you think that the increasing use of SAF can make a difference in reducing the CO2 quantity that is constantly released into the atmosphere by planes?	3 – 1 yes/ 2 no / 3 don´t no	
	PK2 – On a scale from 1-5 (very confident- not confident), how confident do you feel about large-scale implementation of SAF?	(likert scale) 5 – 1 very confident / 2 rather confident / 3- neutral / 4 rather not confident /5 not confident	Yes *
Perceiving Benefits (PB)	PB1 - Investments in SAF will benefit both the economy and the society.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PB2 - SAF use can greatly help in protecting the environment.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PB3- using SAF will reduce the dependence on foreign oil.	likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PB4- SAF can reduce conventional jet fuel dependence.	likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PB5 – The benefits of using SAF exceed other GHG emissions reduction measures in aviation.	likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
Perceiving Risks (PR)	PR1 -SAF pose a safety concern.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PR2 – A higher production of SAF would lead to an increased competition for agricultural land.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree /	Yes*

		5 Strongly Agree	
	PR3 - SAF production would harm the ecosystem.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PR4- Saf take more energy to make than it worth.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	PR5 -There is not enough SAF to meet the demand.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
Social Trust (ST)	ST1 - The scientific community is doing a good job for the society by developing SAF.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	ST2 - SAF producers are helping the society	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	ST3- Government/Policymakers have done a good job so far in regulating SAF	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
Attitude (AT)	AT1- I believe it is a good idea to use SAF for flights.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	AT2 - I dislike the idea of using SAF for flights.	(likert scale) 5 – 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	AT3 – I would prefer flying with airlines using SAF.	(likert scale) 5 – 1 Strongly Disagree/ 2 Disagree /	Yes*

		3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	
	AT4- I would encourage others to fly on flights using SAF.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	AT5- I would like to know more about SAF.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
Willingness to pay (WP)	WP1 - I would be willing to pay a higher ticket price for my flights using SAF.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	WP2 - I would be willing to pay a higher ticket price for using SAF even if a cheaper flight using regular jet fuel is available.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*
	WP3 – I would be willing to choose a flight that uses saf regardless of the flight ticket price.	(likert scale) 5 - 1 Strongly Disagree/ 2 Disagree / 3 Neither Agree Nor Disagree /4 Agree / 5 Strongly Agree	Yes*

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*(Based on Sebastian Britzke Thesis - 2022) – "The Introduction of Carbon Neutral Propulsion Systems and Sustainable Air Fuels in Aviation" - Sebastian Paul Britzke - Thesis written under the supervision of Peter V. Rajsingh PhD

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DIREÇÃO GERAL PARA A INVESTIGAÇÃO E DESENVOLVIMENTO

COMISSÃO DE ÉTICA

PARECER

Caro investigador Renato Rodrigues:

O questionário intitulado ""Sustainable Aviation Fuels"" enquadra-se num trabalho final do Mestrado em Operações de Transporte Aéreo, no ISEC Lisboa, e tem como objetivo sondar a comunidade aeronáutica de forma direta, compressiva e pertinente. Para atingir o seu objetivo, o estudo centra-se sobretudo no contexto nacional português e envolverá profissionais da aviação de várias empresas do setor aeronáutico, comunidade universitária e várias pessoas dos mais diversos setores da sociedade (relacionados com a aviação) que queiram contribuir com a sua opinião sobre o tema. O Inquérito foi considerado correto pela Comissão de Ética e ficou registado com o código 2023/07/12, na situação:

APROVADO

Data: 12/07/2023

A Presidente da Comissão de Ética

Annex 2. Codification Table for Sociodemographic analysis in IBM- SPSS System

SD2 The main contest of your relationship with aviation is…	1- Airlines
	2- Authority + Military + Other
	3- Airports + Handling + ATC + Manufacturers + Air Cargo + Air Service + Aviation schools
SD3 Your professional area is…	1 - Administration + Management
	2 – Commercial + Research
	3 - Operational
	4 – Maintenance + Other
SD4 Is you are academically related to aviation, please explain on what role:	1- Student
	2 - teacher
	3 – lecturer
	4- other
	5 – Not academically related to aviation
	6 – (no answer)
SD5 Gender	1- Male
	2 – Female
	3 – Prefer not to say
SD6 Country of residence	1- Portugal
	2- North America (USA+Canadá)
	3- Brasil
	4- **Other 1** (All European countries except Portugal)
	5 - ***Other 2*** (Africa + middle east + Asia)
SD8 Level of education	1 – primary education or less + high school education + high school professional course
	2 – Post Graduation education + Bachelor´s degree + Master´s degree or higher

Annex 3. IBM-SPSS output - descriptive measures, normality tests, reliability and Pearson correlations

```
EXAMINE VARIABLES=ATT4 KNOL PRISK PBNEF WTP STRUST
  /PLOT BOXPLOT NPPLOT
  /COMPARE GROUPS
  /STATISTICS DESCRIPTIVES EXTREME
  /CINTERVAL 95
  /MISSING LISTWISE
  /NOTOTAL.
```

Explorar

Resumo de processamento de casos

	Casos					
	Válido		Omisso		Total	
	N	Porcentagem	N	Porcentagem	N	Porcentagem
ATT4	244	56,7%	186	43,3%	430	100,0%
KNOL	244	56,7%	186	43,3%	430	100,0%
PRISK	244	56,7%	186	43,3%	430	100,0%
PBNEF	244	56,7%	186	43,3%	430	100,0%
WTP	244	56,7%	186	43,3%	430	100,0%
STRUST	244	56,7%	186	43,3%	430	100,0%

Descritivas

			Estatística	Estatística do teste Padrão
ATT4	Média		4,1680	,02589
	95% de Intervalo de Confiança para Média	Limite inferior	4,1170	
		Limite superior	4,2190	
	5% da média aparada		4,1589	
	Mediana		4,0000	
	Variância		,164	
	Erro Padrão		,40438	
	Mínimo		3,50	
	Máximo		5,00	
	Amplitude		1,50	
	Amplitude interquartil		,50	
	Assimetria		,378	,156
	Curtose		-,502	,310
KNOL	Média		3,6119	,03468
	95% de Intervalo de Confiança para Média	Limite inferior	3,5436	
		Limite superior	3,6802	
	5% da média aparada		3,6260	
	Mediana		3,6000	
	Variância		,293	

Descritivas

			Estatística	Estatística do teste Padrão
	Erro Padrão		,54170	
	Mínimo		2,00	
	Máximo		5,00	
	Amplitude		3,00	
	Amplitude interquartil		,79	
	Assimetria		-,391	,156
	Curtose		,468	,310
PRISK	Média		3,1680	,02928
	95% de Intervalo de Confiança para Média	Limite inferior	3,1103	
		Limite superior	3,2256	
	5% da média aparada		3,1573	
	Mediana		3,0000	
	Variância		,209	
	Erro Padrão		,45737	
	Mínimo		2,20	
	Máximo		4,50	
	Amplitude		2,30	
	Amplitude interquartil		,70	
	Assimetria		,370	,156
	Curtose		,025	,310
PBNEF	Média		4,1131	,02464
	95% de Intervalo de Confiança para Média	Limite inferior	4,0646	
		Limite superior	4,1617	
	5% da média aparada		4,1080	
	Mediana		4,2000	
	Variância		,148	
	Erro Padrão		,38489	
	Mínimo		3,40	
	Máximo		5,00	
	Amplitude		1,60	
	Amplitude interquartil		,60	
	Assimetria		,189	,156
	Curtose		-,486	,310
WTP	Média		2,9863	,05913
	95% de Intervalo de Confiança para Média	Limite inferior	2,8699	
		Limite superior	3,1028	
	5% da média aparada		3,0033	
	Mediana		3,0000	

Descritivas

			Estatística	Estatística do teste Padrão
	Variância		,853	
	Erro Padrão		,92360	
	Mínimo		1,00	
	Máximo		5,00	
	Amplitude		4,00	
	Amplitude interquartil		1,33	
	Assimetria		-,263	,156
	Curtose		-,596	,310
STRUST	Média		3,7213	,02213
	95% de Intervalo de Confiança para Média	Limite inferior	3,6777	
		Limite superior	3,7649	
	5% da média aparada		3,6998	
	Mediana		3,6667	
	Variância		,120	
	Erro Padrão		,34575	
	Mínimo		3,33	
	Máximo		5,00	
	Amplitude		1,67	
	Amplitude interquartil		,67	
	Assimetria		,737	,156
	Curtose		,197	,310

Valores Extremos

			Número do caso	Valor
ATT4	Mais alto	1	37	5,00
		2	140	5,00
		3	149	5,00
		4	334	5,00
		5	339	5,00[a]
	Mais baixo	1	360	3,50
		2	329	3,50
		3	327	3,50
		4	272	3,50
		5	260	3,50[b]
KNOL	Mais alto	1	425	5,00
		2	83	4,75
		3	365	4,75
		4	419	4,75
		5	125	4,60[c]
	Mais baixo	1	351	2,00
		2	287	2,00
		3	259	2,00
		4	266	2,20
		5	221	2,20
PRISK	Mais alto	1	132	4,50
		2	324	4,50
		3	232	4,40
		4	140	4,33
		5	396	4,33
	Mais baixo	1	407	2,20
		2	336	2,25
		3	28	2,25
		4	326	2,33
		5	325	2,33[d]
PBNEF	Mais alto	1	37	5,00
		2	52	5,00
		3	408	5,00
		4	413	5,00
		5	420	5,00[a]
	Mais baixo	1	347	3,40
		2	346	3,40

Valores Extremos

			Número do caso	Valor
		3	345	3,40
		4	320	3,40
		5	230	3,40[e]
WTP	Mais alto	1	428	5,00
		2	429	5,00
		3	430	5,00
		4	423	4,67
		5	424	4,67[f]
	Mais baixo	1	38	1,00
		2	37	1,00
		3	36	1,00
		4	35	1,00
		5	34	1,00[g]
STRUST	Mais alto	1	422	5,00
		2	83	4,67
		3	368	4,67
		4	413	4,67
		5	421	4,67
	Mais baixo	1	428	3,33
		2	415	3,33
		3	380	3,33
		4	379	3,33
		5	378	3,33[h]

a. Apenas uma lista parcial de casos com o valor 5,00 é mostrada na tabela de extremos superiores.

b. Apenas uma lista parcial de casos com o valor 3,50 é mostrada na tabela de extremos inferiores.

c. Apenas uma lista parcial de casos com o valor 4,60 é mostrada na tabela de extremos superiores.

d. Apenas uma lista parcial de casos com o valor 2,33 é mostrada na tabela de extremos inferiores.

e. Apenas uma lista parcial de casos com o valor 3,40 é mostrada na tabela de extremos inferiores.

f. Apenas uma lista parcial de casos com o valor 4,67 é mostrada na tabela de extremos superiores.

g. Apenas uma lista parcial de casos com o valor 1,00 é mostrada na tabela de extremos inferiores.

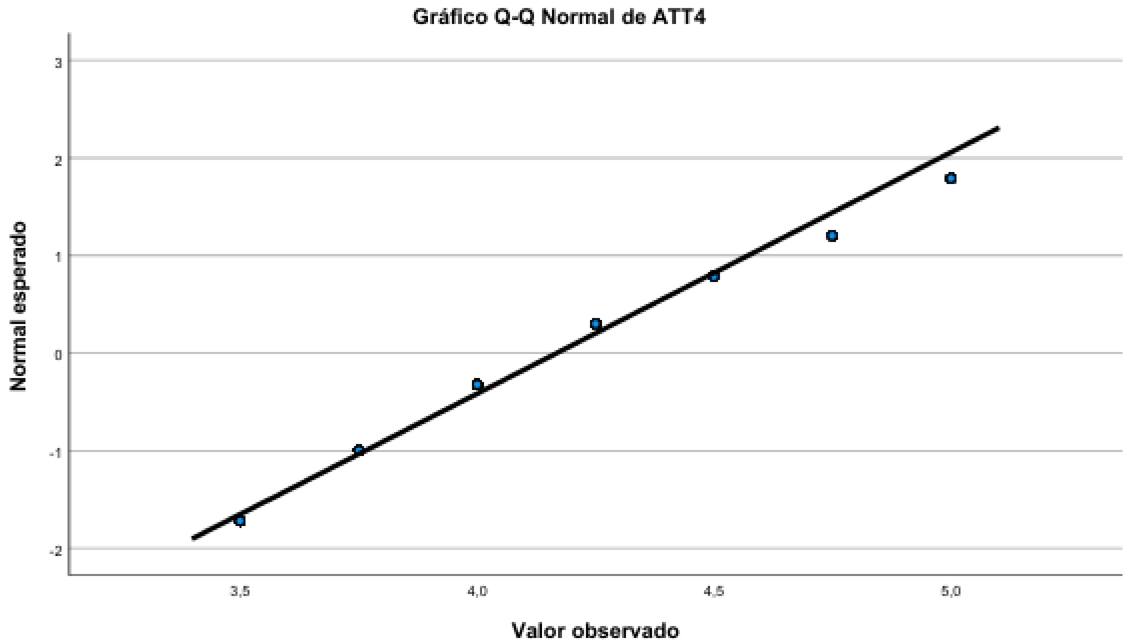
h. Apenas uma lista parcial de casos com o valor 3,33 é mostrada na tabela de extremos inferiores.

Testes de Normalidade

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Estatística	gl	Sig.	Estatística	gl	Sig.
ATT4	,173	244	,000	,937	244	,000
KNOL	,102	244	,000	,978	244	,001
PRISK	,151	244	,000	,974	244	,000
PBNEF	,111	244	,000	,965	244	,000
WTP	,125	244	,000	,964	244	,000
STRUST	,231	244	,000	,866	244	,000

a. Correlação de Significância de Lilliefors

ATT4



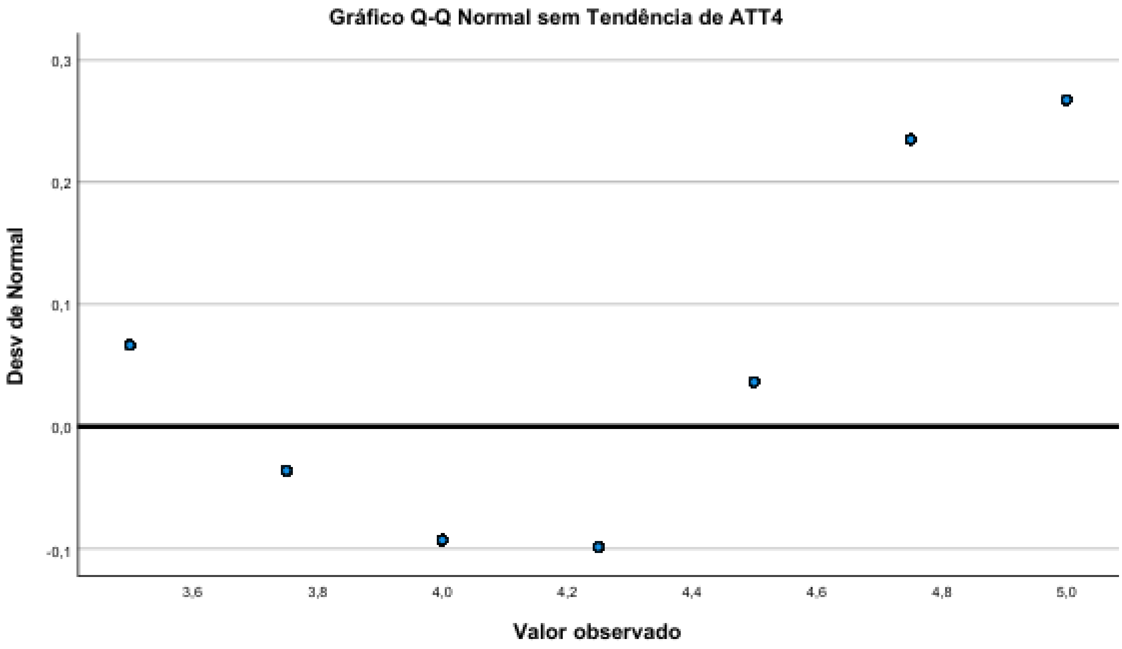
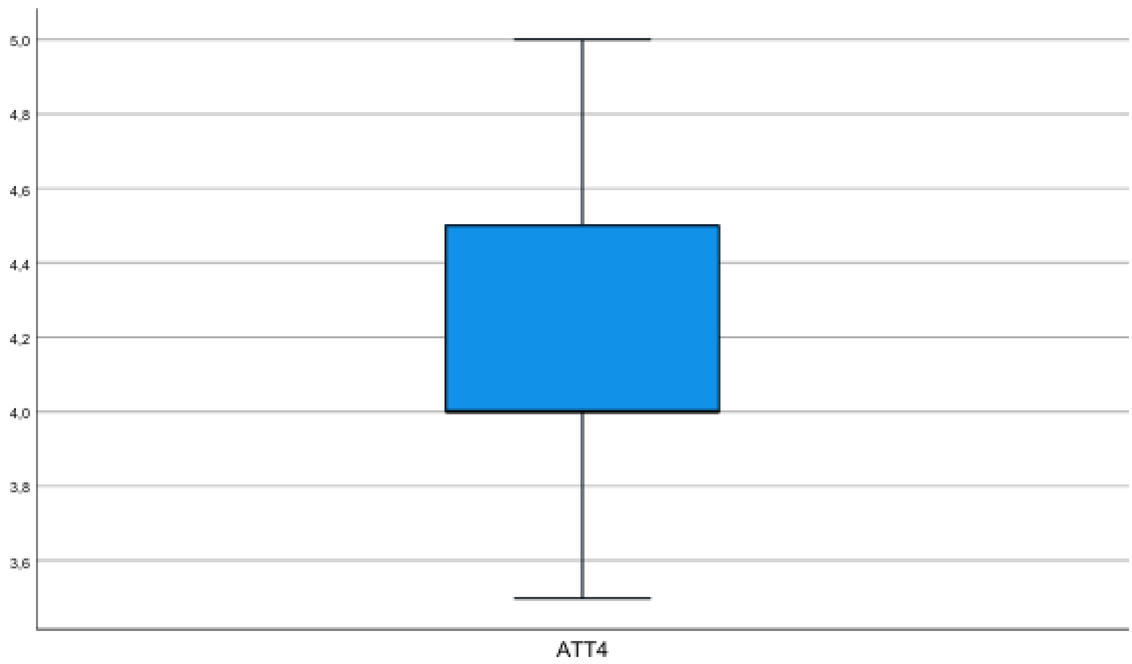


Gráfico Q-Q Normal sem Tendência de ATT4
Desv de Normal
0,3
0,2
0,1
0,0
-0,1
3,6
3,8
4,0
4,2
4,4
4,6
4,8
5,0
Valor observado


5,0
4,8
4,6
4,4
4,2
4,0
3,8
3,6
ATT4

KNOL

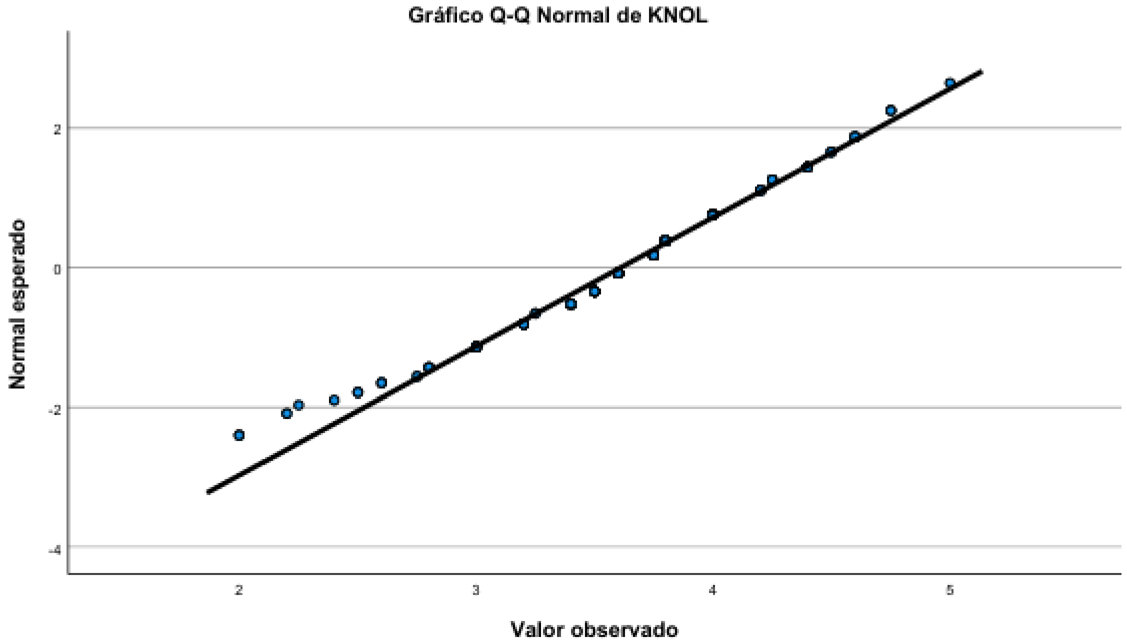


Gráfico Q-Q Normal de KNOL
Normal esperado
Valor observado
2
0
-2
-4
2
3
4
5

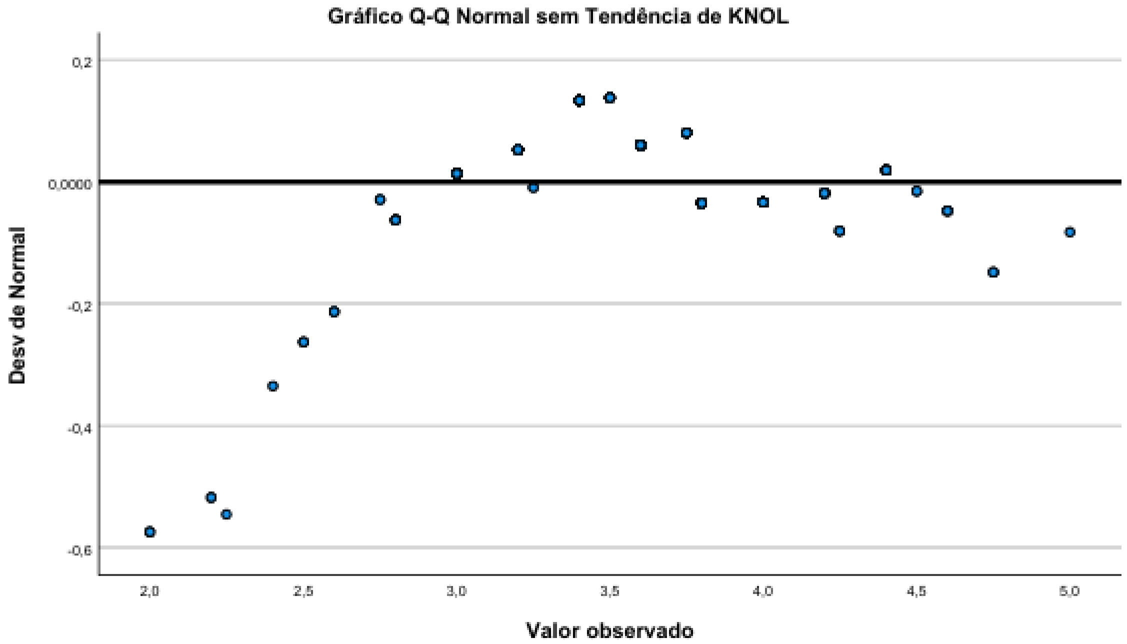
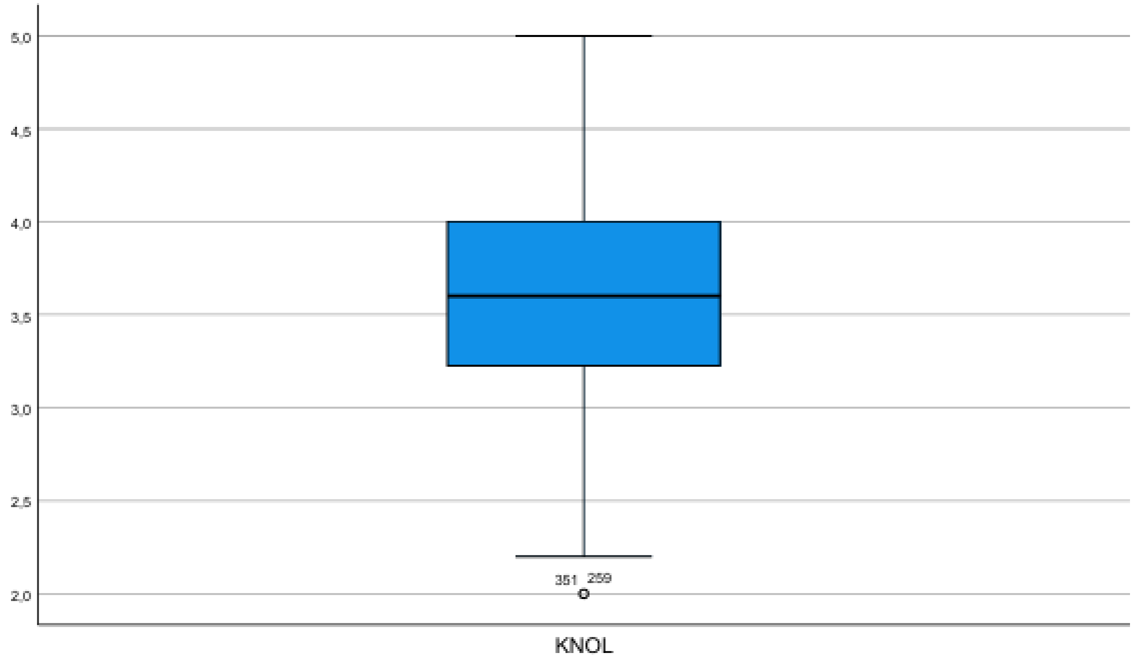


Gráfico Q-Q Normal sem Tendência de KNOL
Desv de Normal
Valor observado
0,2
0,0000
-0,2
-0,4
-0,6
2,0
2,5
3,0
3,5
4,0
4,5
5,0


5,0
4,5
4,0
3,5
3,0
2,5
2,0
351
259
KNOL

PRISK

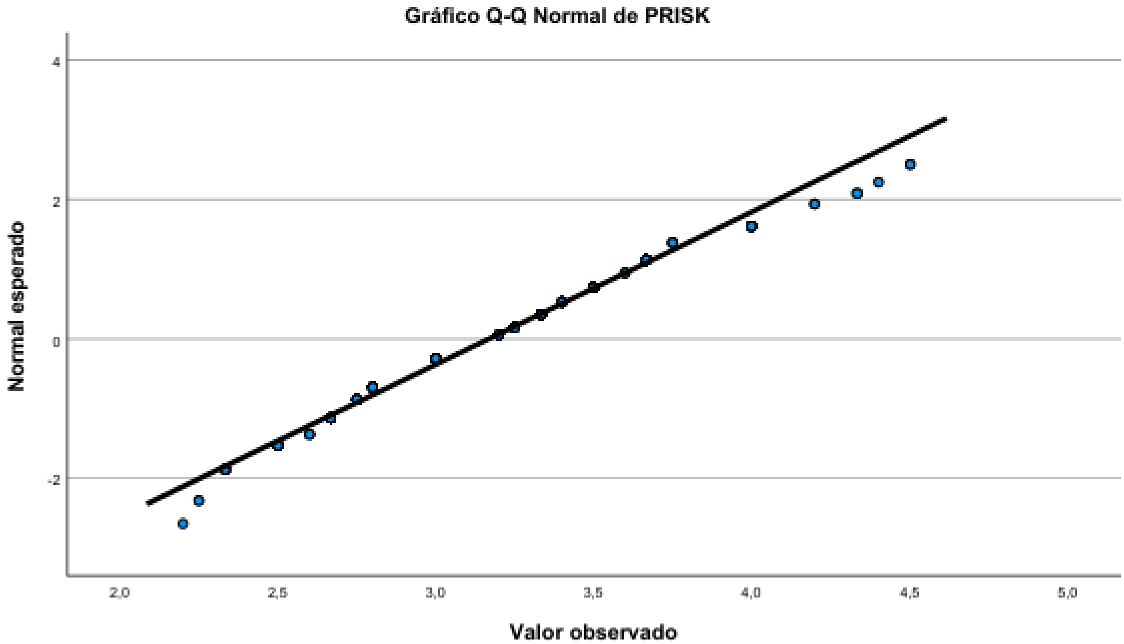


Gráfico Q-Q Normal de PRISK
Normal esperado
4
2
0
-2
2,0
2,5
3,0
3,5
4,0
4,5
5,0
Valor observado

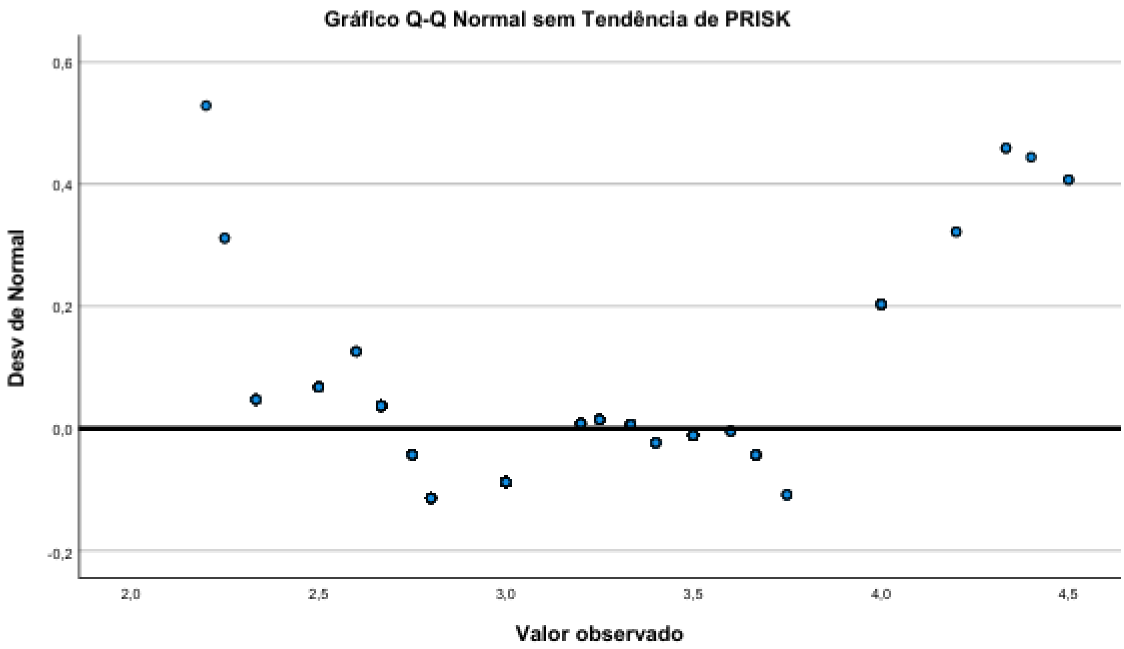
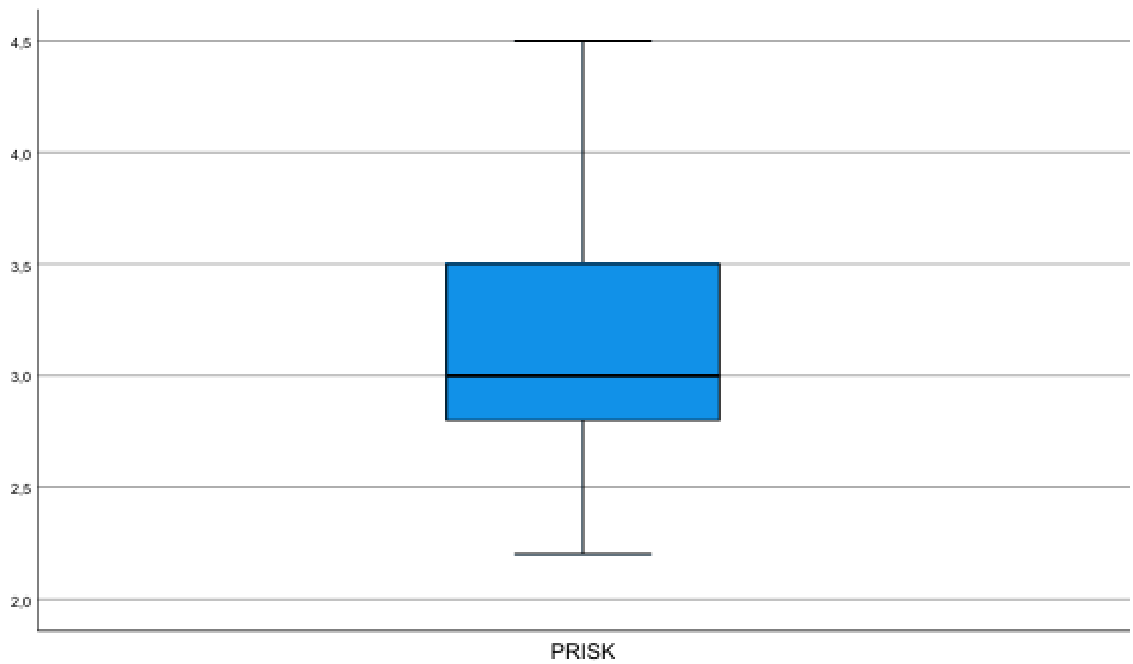


Gráfico Q-Q Normal sem Tendência de PRISK
Desv de Normal
0,6
0,4
0,2
0,0
-0,2
2,0
2,5
3,0
3,5
4,0
4,5
Valor observado


4,5
4,0
3,5
3,0
2,5
2,0
PRISK

PBNEF

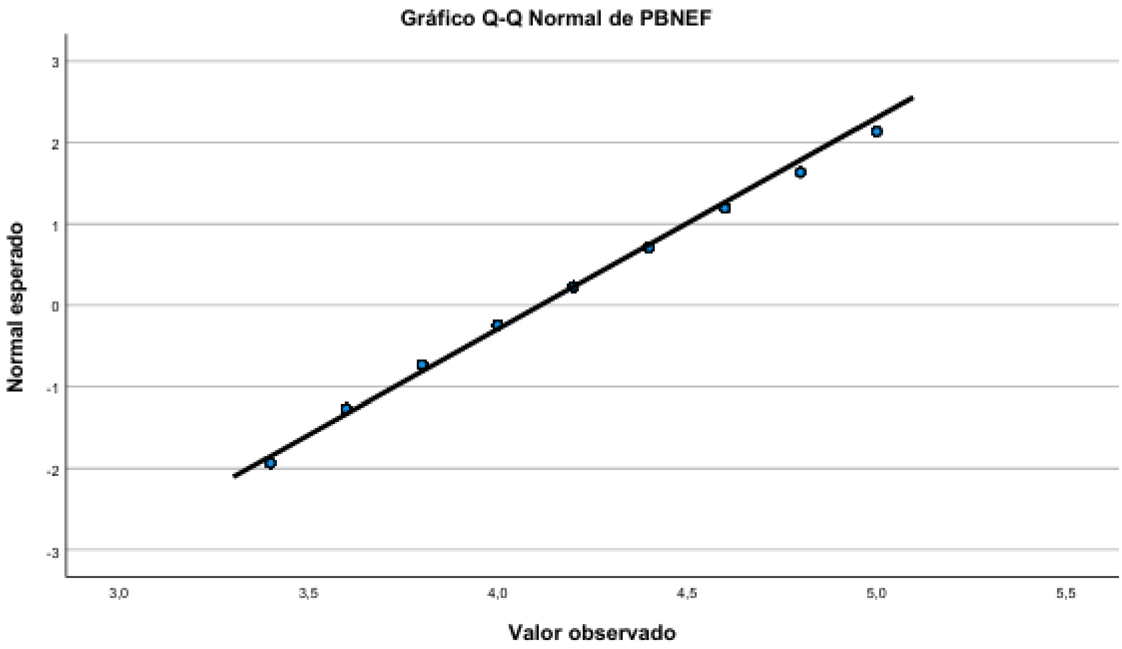


Gráfico Q-Q Normal de PBNEF
Normal esperado
3
2
1
0
-1
-2
-3
3,0
3,5
4,0
4,5
5,0
5,5
Valor observado

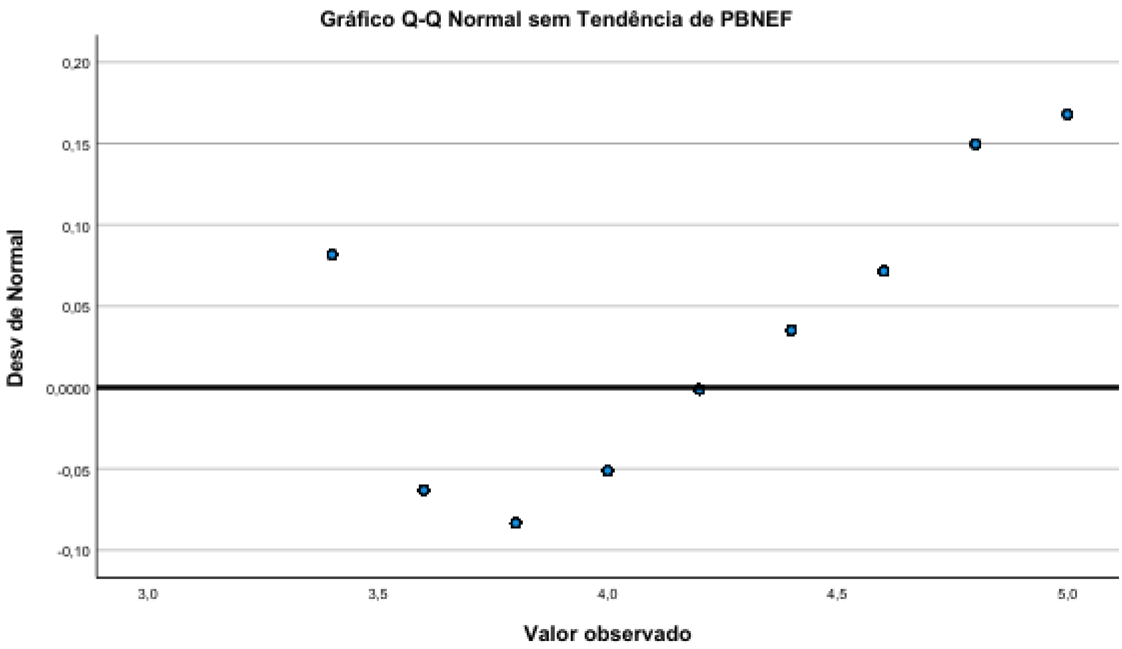
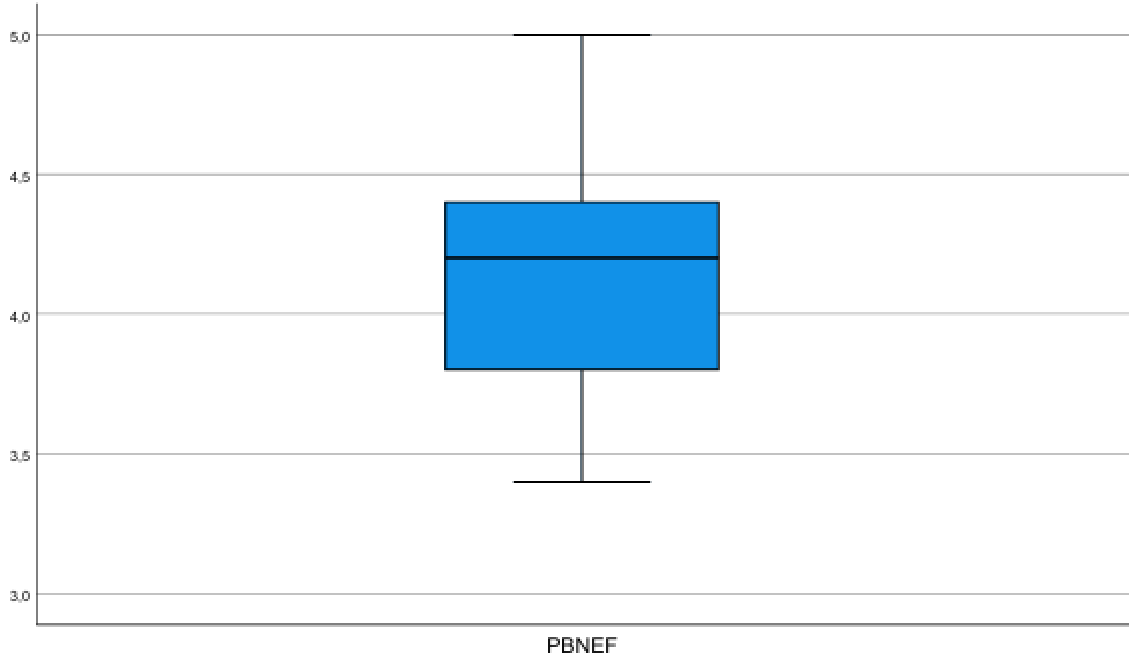


Gráfico Q-Q Normal sem Tendência de PBNEF
Desv de Normal
0,20
0,15
0,10
0,05
0,0000
-0,05
-0,10
3,0
3,5
4,0
4,5
5,0
Valor observado


5,0
4,5
4,0
3,5
3,0
PBNEF

WTP

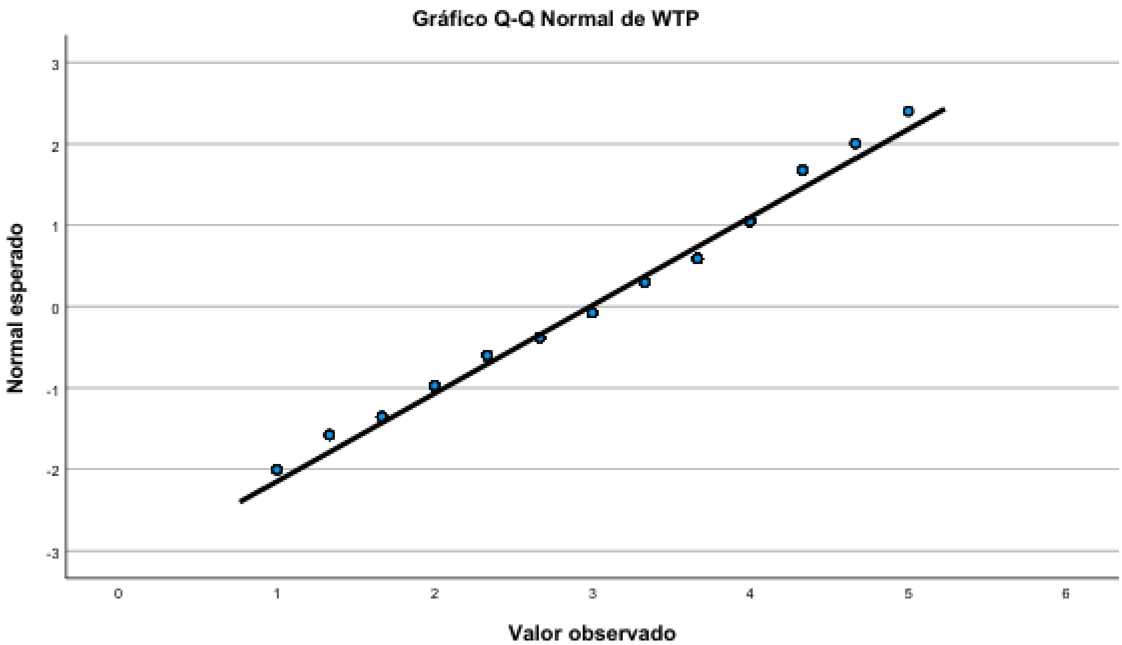


Gráfico Q-Q Normal de WTP
Normal esperado
Valor observado
3
2
1
0
-1
-2
-3
0
1
2
3
4
5
6

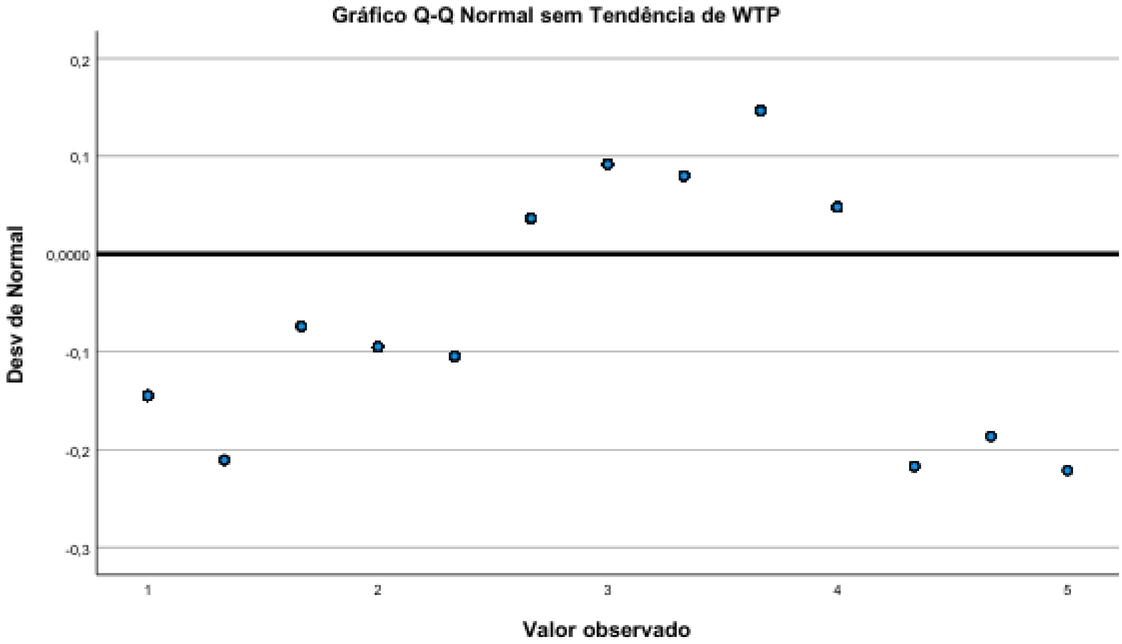
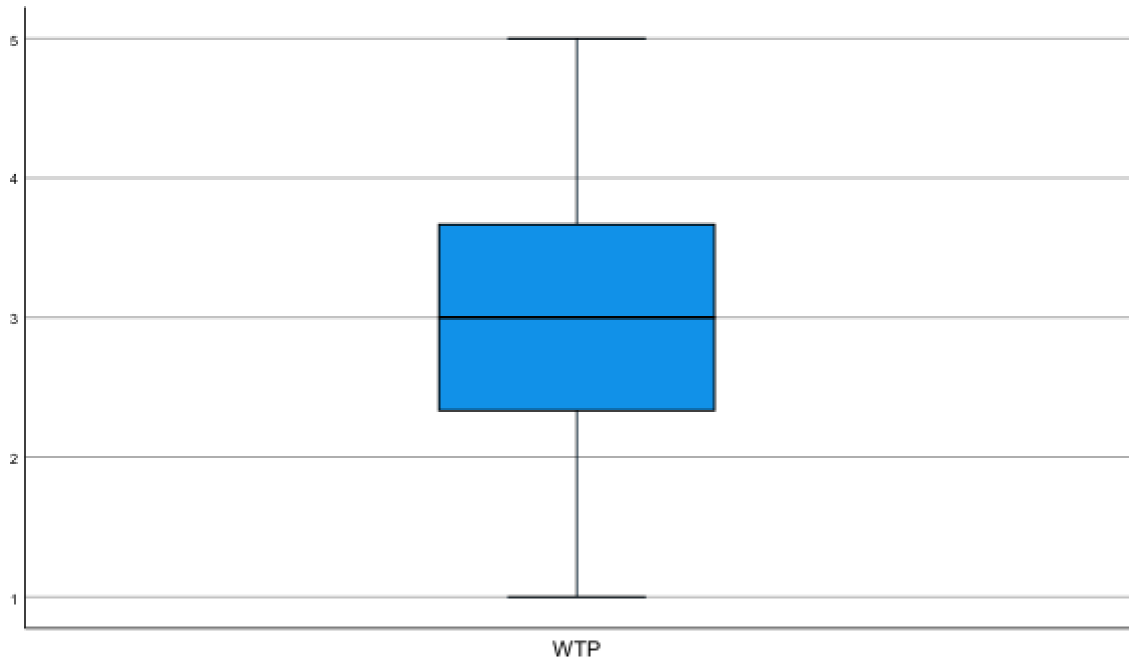


Gráfico Q-Q Normal sem Tendência de WTP
Desv de Normal
0,2
0,1
0,0000
-0,1
-0,2
-0,3
1
2
3
4
5
Valor observado


5
4
3
2
1
WTP

STRUST

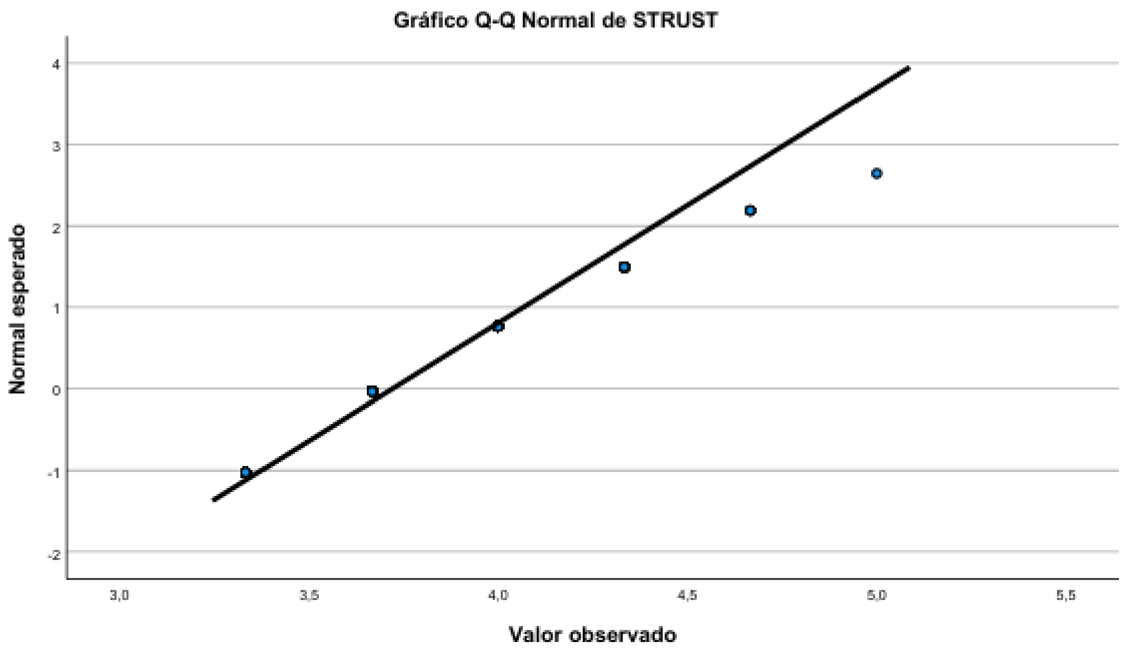


Gráfico Q-Q Normal de STRUST
Normal esperado
Valor observado
4
3
2
1
0
-1
-2
3,0
3,5
4,0
4,5
5,0
5,5

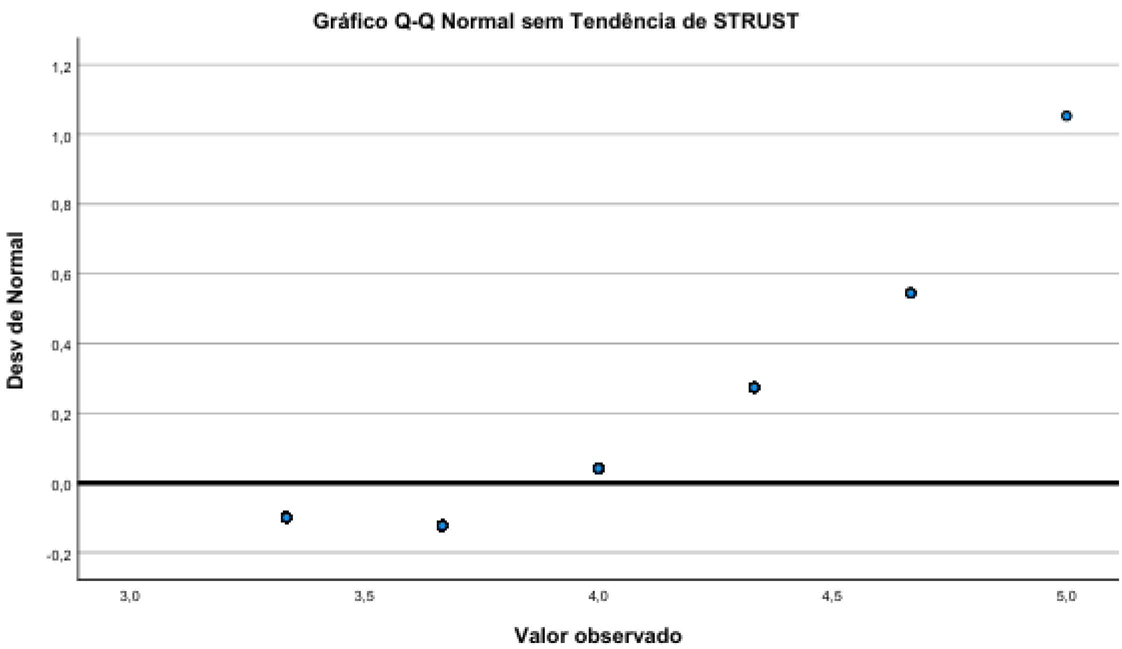
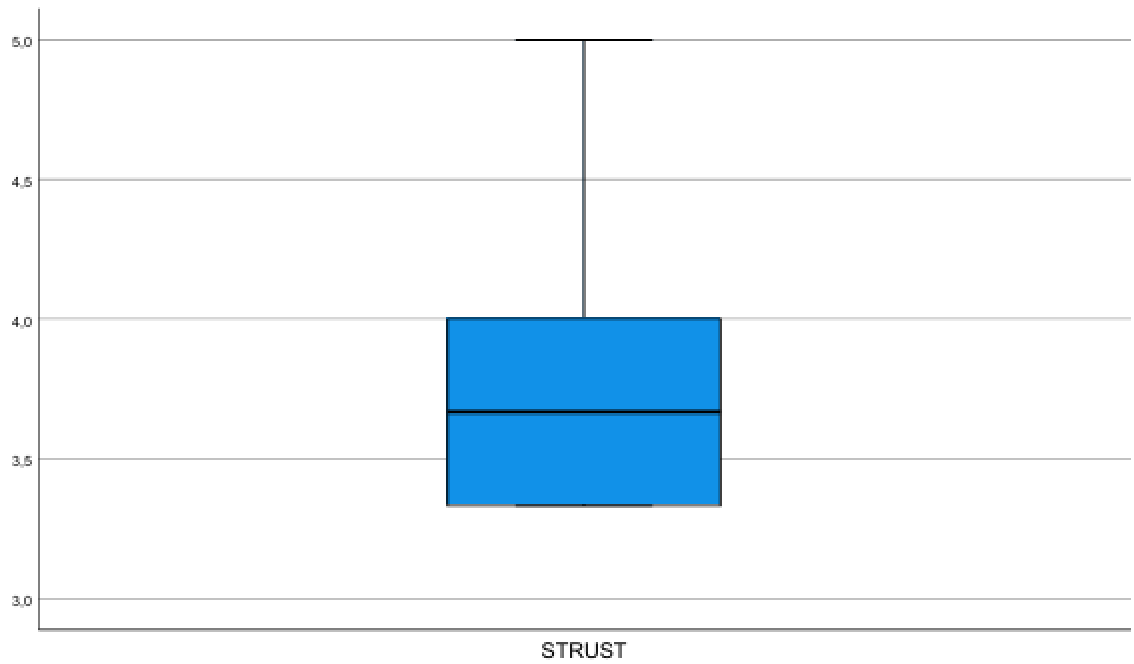


Gráfico Q-Q Normal sem Tendência de STRUST
Desv de Normal
Valor observado
1,2
1,0
0,8
0,6
0,4
0,2
0,0
-0,2
3,0
3,5
4,0
4,5
5,0




```
DESCRIPTIVES VARIABLES=KNOL
  /SAVE
  /STATISTICS=MEAN STDDEV MIN MAX KURTOSIS SKEWNESS.
```

Descritivas

Estatísticas Descritivas

	N	Mínimo	Máximo	Média	Desvio padrão	Assimetria
	Estatística	Estatística	Estatística	Estatística	Estatística	Estatística
KNOL	430	1,75	5,00	3,4202	,61380	-,262
N válido (de lista)	430					

Estatísticas Descritivas

	Assimetria	Curtose	
	Erro Padrão	Estatística	Erro Padrão
KNOL	,118	-,276	,235
N válido (de lista)			

```
SORT CASES BY ZKNOL (A).
RELIABILITY
  /VARIABLES=PR1 PR5 PR2inv PR3inv PR4inv
  /SCALE('Reliability - Perceived Risks') ALL
  /MODEL=ALPHA
  /STATISTICS=SCALE
  /SUMMARY=TOTAL.
```

Confiabilidade

Escala: Reliability - Perceived Risks

Resumo de processamento de casos

		N	%
Casos	Válido	430	100,0
	Excluídos[a]	0	,0
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,742	5

Estatísticas de item-total

	Média de escala se o item for excluído	Variância de escala se o item for excluído	Correlação de item total corrigida	Alfa de Cronbach se o item for excluído
SAF pose a safety concern	13,03	4,631	,049	,628
There is nott enought SAF to meet the demand	12,13	4,143	,214	,600
PR2 A higher production of SAF would lead to an increased competition for agricultural land	12,32	4,288	,276	,659
PR3 SAF production would harm the ecosystem	13,21	3,849	,319	,618
PR4 SAF take more energy to make that it worth	12,83	4,124	,351	,611

Estatísticas de escala

Média	Variância	Desvio Padrão	N de itens
15,88	5,768	2,402	5

```
RELIABILITY
  /VARIABLES=PK2 PK3 PK4inv PK5 PK6
  /SCALE('Reliability - Knowledge') ALL
  /MODEL=ALPHA
```

```
/STATISTICS=SCALE
/SUMMARY=TOTAL.
```

Confiabilidade

Escala: Reliability - Knowledge

Resumo de processamento de casos

		N	%
Casos	Válido	429	99,8
	Excluídos[a]	1	,2
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,725	5

Estatísticas de item-total

	Média de escala se o item for excluído	Variância de escala se o item for excluído	Correlação de item total corrigida	Alfa de Cronbach se o item for excluído
The most strategic topic to the Airlines 1 is sustainability.	12,96	6,669	,327	,646
How confident do you fell about large-scale implementation of SAF	12,95	7,586	,206	,617
PK4 Eco2mic efficiency and sustainability are contradictory in terms.	13,67	7,898	,088	,694
Carbon neutrality is a realistic issue in aviation	13,00	5,958	,456	,654
SAF is a bridging tech2logy until hydrogen and electric aircraft become more viable	12,80	6,599	,423	,691

Estatísticas de escala

Média	Variância	Desvio Padrão	N de itens
16,35	9,695	3,114	5

```
RELIABILITY
  /VARIABLES=PB1 PB2 PB3 PB4 PB5
  /SCALE('Reliability - Perceived benefits') ALL
  /MODEL=ALPHA
  /STATISTICS=SCALE
  /SUMMARY=TOTAL.
```

Confiabilidade

Escala: Reliability - Perceived benefits

Resumo de processamento de casos

		N	%
Casos	Válido	430	100,0
	Excluídos[a]	0	,0
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,796	5

Estatísticas de item-total

	Média de escala se o item for excluído	Variância de escala se o item for excluído	Correlação de item total corrigida	Alfa de Cronbach se o item for excluído
PB1	14,80	7,163	,626	,740
PB2	14,88	6,949	,666	,727
PB3	15,27	7,254	,568	,760
PB4	15,10	7,282	,616	,744
PB5	15,71	8,629	,408	,804

Estatísticas de escala

Média	Variância	Desvio Padrão	N de itens
18,94	11,083	3,329	5

```
RELIABILITY
  /VARIABLES=A1 A3 A4 A5
  /SCALE('Reliability - Attitude') ALL
  /MODEL=ALPHA
  /STATISTICS=SCALE
  /SUMMARY=TOTAL.
```

Confiabilidade

Escala: Reliability - Attitude

Resumo de processamento de casos

		N	%
Casos	Válido	430	100,0
	Excluídos[a]	0	,0
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,805	4

Estatísticas de item-total

	Média de escala se o item for excluído	Variância de escala se o item for excluído	Correlação de item total corrigida	Alfa de Cronbach se o item for excluído
I believe it is a good idea to use SAF for flights	11,04	5,644	,567	,780
I would prefer flying with airlines using SAF	11,75	4,783	,687	,721
I would encourage others to fly on flights using SAF	11,65	5,062	,676	,727
I would like to know more about SAF	11,19	5,737	,554	,785

Estatísticas de escala

Média	Variância	Desvio Padrão	N de itens
15,21	8,857	2,976	4

```
RELIABILITY
  /VARIABLES=WP1 WP2 WP3
  /SCALE('Reliability - Attitude') ALL
  /MODEL=ALPHA
  /STATISTICS=SCALE
  /SUMMARY=TOTAL.
```

Confiabilidade

Escala: Reliability - Willing to pay

Resumo de processamento de casos

		N	%
Casos	Válido	430	100,0
	Excluídos[a]	0	,0
	Total	430	100,0

a. Exclusão de lista com base em todas as variáveis do procedimento.

Estatísticas de confiabilidade

Alfa de Cronbach	N de itens
,876	3

Estatísticas de item-total

	Média de escala se o item for excluído	Variância de escala se o item for excluído	Correlação de item total corrigida	Alfa de Cronbach se o item for excluído
WP1	5,24	3,990	,749	,835
WP2	5,35	3,724	,823	,767
WP3	5,38	4,063	,714	,867

Estatísticas de escala

Média	Variância	Desvio Padrão	N de itens
7,98	8,317	2,884	3

```
CORRELATIONS
  /VARIABLES=PRISK PBNEF WTP STRUST ATT4 KNOL
  /PRINT=TWOTAIL NOSIG LOWER
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.
```

Correlações

Estatísticas Descritivas

	Média	Desvio Padrão	N
PRISK	3,1145	,48993	430
PBNEF	4,0238	,39815	353
WTP	2,6605	,96129	430
STRUST	3,6896	,34212	276
ATT4	4,1250	,42251	328
KNOL	3,4202	,61380	430

Correlações

		PRISK	PBNEF	WTP	STRUST	ATT4
PRISK	Correlação de Pearson	--				
	N	430				
PBNEF	Correlação de Pearson	,061	--			
	Sig. (2 extremidades)	,255				
	N	353	353			
WTP	Correlação de Pearson	,183**	,313**	--		
	Sig. (2 extremidades)	,000	,000			
	N	430	353	430		
STRUST	Correlação de Pearson	,095	,480**	,238**	--	
	Sig. (2 extremidades)	,114	,000	,000		
	N	276	265	276	276	
ATT4	Correlação de Pearson	,085	,562**	,401**	,374**	--
	Sig. (2 extremidades)	,123	,000	,000	,000	
	N	328	306	328	251	328
KNOL	Correlação de Pearson	,133**	,368**	,371**	,232**	,285**
	Sig. (2 extremidades)	,006	,000	,000	,000	,000
	N	430	353	430	276	328

Correlações

		KNOL
PRISK	Correlação de Pearson	
	N	
PBNEF	Correlação de Pearson	
	Sig. (2 extremidades)	
	N	
WTP	Correlação de Pearson	
	Sig. (2 extremidades)	
	N	
STRUST	Correlação de Pearson	
	Sig. (2 extremidades)	
	N	
ATT4	Correlação de Pearson	
	Sig. (2 extremidades)	
	N	
KNOL	Correlação de Pearson	--
	Sig. (2 extremidades)	
	N	430

**. A correlação é significativa no nível 0,01 (2 extremidades).

Annex 4. IBM-SPSS output - factorial analysis

Análise de Fatores

Matriz de componente[a]

	Componente
	1
The most strategic topic to the Airlines 1 is sustainability.	,419
How confident do you fell about large-scale implementation of SAF	,479
PK4 Eco2mic efficiency and sustainability are contradictory in terms.	,040
Carbon neutrality is a realistic issue in aviation	,512
SAF pose a safety concern	,039
PR2 A higher production of SAF would lead to an increased competition for agricultural land	,028
PR3 SAF production would harm the ecosystem	-,458
PR4 SAF take more energy to make that it worth	-,025
There is nott enought SAF to meet the demand	,070
I believe it is a good idea to use SAF for flights	,757
A2 I dislike the idea of using SAF for flights	-,520
I would prefer flying with airlines using SAF	,755
I would encourage others to fly on flights using SAF	,778
I would like to know more about SAF	,567
PB1	,739
PB2	,773
PB3	,619
PB4	,682
PB5	,521
ST1	,644
ST2	,698

Matriz de componente[a]

	Componente
	1
ST3	,243
WP1	,538
WP2	,597
WP3	,614
SAF is a bridging tech2logy until hydrogen and electric aircraft become more viable	,490

Método de Extração: análise de Componente Principal.

a. 1 componentes extraídos.

Comunalidades

	Extração
The most strategic topic to the Airlines 1 is sustainability.	,175
How confident do you fell about large-scale implementation of SAF	,230
PK4 Eco2mic efficiency and sustainability are contradictory in terms.	,002
Carbon neutrality is a realistic issue in aviation	,262
SAF pose a safety concern	,002
PR2 A higher production of SAF would lead to an increased competition for agricultural land	,001
PR3 SAF production would harm the ecosystem	,210
PR4 SAF take more energy to make that it worth	,001
There is nott enought SAF to meet the demand	,005
I believe it is a good idea to use SAF for flights	,573

Comunalidades

	Extração
A2 I dislike the idea of using SAF for flights	,271
I would prefer flying with airlines using SAF	,571
I would encourage others to fly on flights using SAF	,605
I would like to know more about SAF	,322
PB1	,546
PB2	,598
PB3	,383
PB4	,465
PB5	,272
ST1	,414
ST2	,487
ST3	,059
WP1	,289
WP2	,357
WP3	,377
SAF is a bridging tech2logy until hydrogen and electric aircraft become more viable	,240

Método de Extração: análise de Componente Principal.

Variância total explicada

	Somas de extração de carregamentos ao quadrado		
Componente	Total	% de variância	% cumulativa
1	7,715	29,674	29,674

Método de Extração: análise de Componente Principal.

Annex 5. IBM-SPSS - serial-parallel multiple mediator model.

```
* Encoding: UTF-8.
preserve.
set printback=off.
```

Matriz - com o social trust como variável mediadora

```
Run MATRIX procedure:

***************** PROCESS Procedure for SPSS Version 4.2 *****************

          Written by Andrew F. Hayes, Ph.D.       www.afhayes.com
    Documentation available in Hayes (2022). www.guilford.com/p/hayes3

**************************************************************************
Model  : 80
    Y  : ATT4
    X  : KNOL
   M1  : PRISK
   M2  : PBNEF
   M3  : STRUST

Sample
Size:  244

**************************************************************************
OUTCOME VARIABLE:
 PRISK

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      ,0504      ,0025      ,2095      ,6171     1,0000   242,0000      ,4329

Model
              coeff         se          t          p       LLCI       ULCI
constant     3,0142      ,1980    15,2257      ,0000     2,6242     3,4041
KNOL          ,0426      ,0542      ,7855      ,4329     -,0642      ,1494

Standardized coefficients
          coeff
KNOL      ,0504

**************************************************************************
OUTCOME VARIABLE:
 PBNEF

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      ,3788      ,1435      ,1274    40,5436     1,0000   242,0000      ,0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     3,1410      ,1544    20,3463      ,0000     2,8369     3,4451
```

```
KNOL          ,2692      ,0423     6,3674      ,0000      ,1859      ,3524

Standardized coefficients
          coeff
KNOL      ,3788

**************************************************************************
OUTCOME VARIABLE:
 STRUST

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      ,4587      ,2104      ,0956    21,3159     3,0000   240,0000      ,0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     1,8697      ,2551     7,3293      ,0000     1,3671     2,3722
KNOL          ,0315      ,0396      ,7946      ,4276     -,0465      ,1095
PRISK         ,0450      ,0434     1,0356      ,3014     -,0406      ,1305
PBNEF         ,3879      ,0557     6,9672      ,0000      ,2782      ,4976

Standardized coefficients
           coeff
KNOL       ,0493
PRISK      ,0595
PBNEF      ,4318

Test(s) of X by M interaction:
             F        df1        df2          p
M1*X      ,1603     1,0000   239,0000      ,6893
M2*X      ,8358     1,0000   239,0000      ,3615

**************************************************************************
OUTCOME VARIABLE:
 ATT4

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      ,5863      ,3437      ,1091    31,2936     4,0000   239,0000      ,0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     1,0444      ,3015     3,4638      ,0006      ,4504     1,6384
KNOL          ,0799      ,0424     1,8865      ,0604     -,0035      ,1634
PRISK         ,1086      ,0465     2,3352      ,0204      ,0170      ,2002
PBNEF         ,4690      ,0652     7,1896      ,0000      ,3405      ,5975
STRUST        ,1510      ,0690     2,1896      ,0295      ,0151      ,2869

Standardized coefficients
            coeff
KNOL        ,1071
PRISK       ,1228
PBNEF       ,4464
```

```
STRUST      ,1291

Test(s) of X by M interaction:
              F        df1        df2          p
M1*X      ,1556     1,0000   238,0000      ,6936
M2*X     3,8269     1,0000   238,0000      ,0516
M3*X      ,7122     1,0000   238,0000      ,3996

************************** TOTAL EFFECT MODEL ****************************
OUTCOME VARIABLE:
 ATT4

Model Summary
          R       R-sq        MSE          F        df1        df2          p
      ,3102      ,0962      ,1484    25,7687     1,0000   242,0000      ,0000

Model
              coeff         se          t          p       LLCI       ULCI
constant     3,3316      ,1666    19,9968      ,0000     3,0034     3,6598
KNOL          ,2316      ,0456     5,0763      ,0000      ,1417      ,3214

Standardized coefficients
          coeff
KNOL      ,3102


************** TOTAL, DIRECT, AND INDIRECT EFFECTS OF X ON Y **************

Total effect of X on Y
     Effect         se          t          p       LLCI       ULCI       c_cs
      ,2316      ,0456     5,0763      ,0000      ,1417      ,3214      ,3102

Direct effect of X on Y
     Effect         se          t          p       LLCI       ULCI      c'_cs
      ,0799      ,0424     1,8865      ,0604     -,0035      ,1634      ,1071

Indirect effect(s) of X on Y:
          Effect     BootSE   BootLLCI   BootULCI
TOTAL      ,1517      ,0300      ,0961      ,2150
Ind1       ,0046      ,0066     -,0080      ,0198
Ind2       ,1262      ,0278      ,0779      ,1888
Ind3       ,0048      ,0071     -,0080      ,0210
Ind4       ,0003      ,0007     -,0005      ,0022
Ind5       ,0158      ,0080      ,0014      ,0328
(C1)      -,1216      ,0288     -,1846     -,0705
(C2)      -,0001      ,0092     -,0187      ,0182
(C3)       ,0043      ,0063     -,0078      ,0190
(C4)      -,0111      ,0101     -,0314      ,0094
(C5)       ,1215      ,0296      ,0688      ,1856
(C6)       ,1259      ,0279      ,0778      ,1889
(C7)       ,1105      ,0293      ,0604      ,1758
(C8)       ,0045      ,0070     -,0082      ,0204
(C9)      -,0110      ,0097     -,0338      ,0035
```

```
(C10)     -,0155      ,0078     -,0322     -,0013

Completely standardized indirect effect(s) of X on Y:
          Effect     BootSE   BootLLCI   BootULCI
TOTAL      ,2032      ,0381      ,1316      ,2828
Ind1       ,0062      ,0087     -,0108      ,0257
Ind2       ,1691      ,0358      ,1058      ,2476
Ind3       ,0064      ,0095     -,0106      ,0286
Ind4       ,0004      ,0009     -,0007      ,0030
Ind5       ,0211      ,0105      ,0018      ,0432
(C1)      -,1629      ,0373     -,2437     -,0961
(C2)      -,0002      ,0122     -,0253      ,0243
(C3)       ,0058      ,0084     -,0103      ,0245
(C4)      -,0149      ,0134     -,0415      ,0124
(C5)       ,1627      ,0382      ,0927      ,2452
(C6)       ,1687      ,0359      ,1055      ,2470
(C7)       ,1480      ,0382      ,0810      ,2311
(C8)       ,0060      ,0093     -,0109      ,0275
(C9)      -,0148      ,0128     -,0452      ,0047
(C10)     -,0207      ,0103     -,0425     -,0018

Specific indirect effect contrast definition(s):
(C1)           Ind1      minus   Ind2
(C2)           Ind1      minus   Ind3
(C3)           Ind1      minus   Ind4
(C4)           Ind1      minus   Ind5
(C5)           Ind2      minus   Ind3
(C6)           Ind2      minus   Ind4
(C7)           Ind2      minus   Ind5
(C8)           Ind3      minus   Ind4
(C9)           Ind3      minus   Ind5
(C10)          Ind4      minus   Ind5

Indirect effect key:
Ind1  KNOL        ->    PRISK       ->    ATT4
Ind2  KNOL        ->    PBNEF       ->    ATT4
Ind3  KNOL        ->    STRUST      ->    ATT4
Ind4  KNOL        ->    PRISK       ->    STRUST      ->    ATT4
Ind5  KNOL        ->    PBNEF       ->    STRUST      ->    ATT4

*********** BOOTSTRAP RESULTS FOR REGRESSION MODEL PARAMETERS ************

OUTCOME VARIABLE:
 PRISK

             Coeff   BootMean     BootSE   BootLLCI   BootULCI
constant    3,0142     3,0135      ,1947     2,6324     3,3994
KNOL         ,0426      ,0428      ,0536     -,0636      ,1482

----------

OUTCOME VARIABLE:
 PBNEF
```

	Coeff	BootMean	BootSE	BootLLCI	BootULCI
constant	3,1410	3,1376	,1536	2,8340	3,4380
KNOL	,2692	,2699	,0421	,1858	,3527

OUTCOME VARIABLE:
STRUST

	Coeff	BootMean	BootSE	BootLLCI	BootULCI
constant	1,8697	1,8659	,2833	1,3245	2,4258
KNOL	,0315	,0303	,0399	-,0504	,1082
PRISK	,0450	,0454	,0421	-,0367	,1293
PBNEF	,3879	,3895	,0632	,2644	,5169

OUTCOME VARIABLE:
ATT4

	Coeff	BootMean	BootSE	BootLLCI	BootULCI
constant	1,0444	1,0453	,2933	,4916	1,6152
KNOL	,0799	,0799	,0423	-,0037	,1639
PRISK	,1086	,1072	,0507	,0031	,2053
PBNEF	,4690	,4696	,0661	,3432	,6015
STRUST	,1510	,1512	,0693	,0129	,2850

*********************** ANALYSIS NOTES AND ERRORS ************************

Level of confidence for all confidence intervals in output:
95,0000

Number of bootstrap samples for percentile bootstrap confidence intervals:
5000

------ END MATRIX -----

Annex 6. Resolução do Conselho de Ministros nº 147/2024 de 28 de outubro

DIÁRIO
DA REPÚBLICA

Resolução do Conselho de Ministros n. º 147/2024, de 28 de outubro

Publicação: Diário da República n.º 209/2024, Série I de 2024-10-28
Emissor: Presidência do Conselho de Ministros

Data de Publicação: 2024-10-28

SUMÁRIO

Estabelece o Roteiro Nacional para a Descarbonização da Aviação e determina que se proceda à criação de apoios à produção de combustíveis de aviação sustentáveis.

TEXTO

Resolução do Conselho de Ministros n. º 147/2024

O XXIV Governo está comprometido com a sustentabilidade ambiental e a necessidade urgente de combater as alterações climáticas, conforme estabelecido no Roteiro Nacional para a Neutralidade Carbónica 2050 e conforme os objetivos definidos no Acordo de Paris, que visam manter o aumento da temperatura média global abaixo dos TC em relação aos níveis pré-industriais e prosseguir todos os esforços para limitar o aumento da temperatura global a 1,5 º C.

O setor da aviação é responsável por aproximadamente 2 % das emissões globais de dióxido de carbono (C02) e, sem intervenções significativas, estas emissões podem triplicar até 2050, conforme relatado pela Organização Internacional da Aviação Civil (ICAO).

A descarbonização do transporte aéreo é uma prioridade absoluta para assegurar o desenvolvimento da indústria e o acesso à mobilidade dos cidadãos com níveis de sustentabilidade crescentes, considerando ainda mais a relevância económica e social do setor em Portugal, que contribui para o turismo, o comércio e a conectividade internacional. Para cumprir as metas de descarbonização acordadas ao nível internacional e também regional, é necessário um forte empenho do setor da aviação a nível nacional.

A nível comunitário importa realçar que o setor da aviação integra, desde 2012, o regime do comércio europeu de licenças de emissão, estabelecido pela Diretiva 2003/87/CE, passando a partir de 2025 a incluir, para além das emissões de dióxido de carbono (CO), a monitorização, comunicação e verificação dos efeitos da aviação não relacionados com o C02.

A cobrança da taxa de carbono no âmbito do transporte aéreo de passageiros - prevista no artigo 390. º da Lei n. º 75-B/2020, de 31 de dezembro, regulamentada pela Portaria n. º 38/2021, de 1 6 de fevereiro, e alargada nos termos do artigo 184. º da Lei n. º 24-D/2022, de 30 de dezembro, que se mantém em vigor por força dos artigos 49. º-Q e 49. º-R aditados à Lei n. º 82-D/2014, de 31 de dezembro, pela Lei n.º 82/2023, de 29 de dezembro -, suportada pelos utilizadores do transporte aéreo para a sustentabilidade ambiental, consubstancia uma das faces do empenho do setor a nível nacional, constituindo uma contrapartida pela emissão de gases poluentes. Esta taxa constitui receita própria do Fundo Ambiental (FA), nos termos da alínea l) do n. º 1 do artigo 4. º do Decreto-Lei n. º 42-A/2016, desejando-se uma aplicação mais proporcional no desenvolvimento sustentável do setor da aviação. Urge garantir que o montante cobrado é utilizado em prol de ações ou atividades de descarbonização no setor da aviação civil.

A consecução de um roteiro nacional para a descarbonização do setor da aviação deve promover, nomeadamente, a disponibilização e utilização de combustíveis de aviação sustentáveis (SAF) como parte integrante das estratégias de descarbonização e transição energética, em conformidade com as iniciativas europeias como o Renewable Energy Directive (RED III) e ReFuelEU Aviação (REFUEL EU Aviation), podendo para tal contemplar a utilização de receitas do Fundo Ambiental respeitantes ao setor. Mais ainda, este roteiro deve promover a inovação e adoção de tecnologias verdes, nomeadamente sistemas de propulsão mais eficientes ou alternativos, visando reduzir as emissões e o ruído das aeronaves, fomentando os processos de renovação de frota e acolhendo, quando aplicável, processos de retrofitting e melhoria das aeronaves existentes. Melhorias operacionais (por exemplo, no âmbito do controlo de tráfego aéreo, em linha com o Single European Sky, ou da descarbonização da atividade aeroportuária) serão também determinantes à maior eficiência dos recursos e das operações.

O montante máximo previsto de 40 milhões de euros de apoios às empresas para estimular a produção nacional de combustíveis de aviação sustentáveis (SAF) e eletrocombustíveis de aviação sustentáveis (eSAF), a atribuir no âmbito do RONDA, em 2026, encontra correspondência nas receitas obtidas pelo Fundo Ambiental por via do Comércio de Licenças de Emissão (CELE) aviação e pela taxa de carbono, devendo contribuir para a descarbonização do setor.

No seu todo, estas medidas deverão complementar o efeito de incentivo inerente às medidas de mercado em presença, nomeadamente o regime de CELE e o regime de compensação e de redução do carbono para a aviação internacional (CORSIA) da Organização Internacional da Aviação Civil (ICAO).

Assim:

Nos termos da alínea g) do artigo 199. º da Constituição, o Conselho de Ministros resolve:

1 - Aprovar o Roteiro Nacional para a Descarbonização da Aviação (RONDA) e da Aliança para a Sustentabilidade na Aviação (ASA), cuja primeira versão de manifesto e lista de entidades participantes consta do anexo à presente resolução, da qual faz parte integrante.

2 - Delegar na Ministra do Ambiente e Energia e no Ministro das Infraestruturas e Habitação, com faculdade de subdelegação, a cocoordenação do RONDA, e ASA incluindo a aprovação e convite a novas entidades, e as atualizações necessárias ao manifesto e plano de atividades.

3 - Determinar que o acompanhamento e gestão do RONDA e ASA competem à Autoridade Nacional de Aviação Civil (ANAC) e à Agência Portuguesa do Ambiente, I. P (APA, I. P.), devendo garantir-se os recursos necessários à execução adequada do mandato, designadamente no tocante ao financiamento e à capacitação técnica e especializada das entidades.

4 - Estabelecer que, em alinhamento com os objetivos do Roteiro para a Neutralidade Carbónica (RNC 2050), do Plano Nacional Energia Clima (PNEC 2030) e do plano setorial de mitigação às alterações climáticas do setor dos transportes previsto no artigo 22. º da Lei n. º 98/2021, de 31 de dezembro, é apresentado, no prazo de seis meses, um plano e cronograma do RONDA detalhados de ações e metas específicas para curto, médio e longo prazo, desenvolvido pela ANAC em articulação com a APA, I. P., e aprovado pelos membros do Governo das áreas governativas referidas no n. º 2.

5 - Estabelecer que o plano a que se refere o número anterior deve incluir um mecanismo de monitorização e avaliação contínua, sendo remetidos ao Governo relatórios anuais sobre o progresso alcançado, desafios identificados e medidas corretivas propostas.

6 - Estabelecer que o RONDA é revisto, no máximo, com periodicidade quinquenal, a contar da data da sua aprovação.

7 - Determinar que se proceda à criação de apoios às empresas para 'Estímulos à produção nacional de combustíveis de aviação sustentáveis e eletrocombustíveis de aviação sustentáveis '', estabelecido por portaria do membro do Governo da área do ambiente e energia, a ser operacionalizado através do Fundo Ambiental em 2026, com o apoio da ANAC, da Direção-Geral de Energia e Geologia da APA, I. P., com um orçamento de até 40 milhões de euros, correspondendo a receitas obtidas neste setor da aviação no âmbito do CELE e da taxa de carbono.

8 - Determinar que a presente resolução produz efeitos à data da sua aprovação.

Presidência do Conselho de Ministros, 4 de outubro de 2024. - O Primeiro-Ministro, Luís Montenegro.

ANEXO

(a que se refere o n.º 1)

Aliança para a Sustentabilidade na Aviação

A medida que o tráfego aéreo nos aeroportos nacionais continua a crescer, torna-se imperativo repensar este setor vital para a economia nacional. A aviação é um pilar estratégico para o desenvolvimento do País, tanto pela criação direta de empregos como pelo desenvolvimento do turismo em Portugal, com um impacto significativo na economia portuguesa, como também pelo papel determinante na conectividade.

No entanto, também apresenta desafios ambientais substanciais, especialmente em relação às emissões de gases de efeito estufa, poluentes atmosféricos e poluição sonora. Encontrar um equilíbrio entre esses fatores é essencial para garantir que os benefícios da aviação possam ser desfrutados sem comprometer a saúde do nosso planeta e o bem-estar das futuras gerações.

Para alcançar esse equilíbrio, é necessário adotar uma abordagem multifacetada que inclua inovação tecnológica, estruturas regulatórias e medidas baseadas no mercado. Como tal, acreditamos que a criação de uma coligação dedicada à promoção de uma aviação sustentável é crucial para enfrentar os desafios das alterações climáticas e garantir que o setor prospere de forma responsável, equilibrada e sustentada.

No âmbito do Roteiro Nacional para a Descarbonização da Aviação (RONDA) e num princípio de cooperação entre as diferentes partes interessadas do sistema da aviação civil em Portugal é criada a Aliança para a Sustentabilidade na Aviação (ASA).

A ASA deverá reunir as diversas partes interessadas, não só do setor da aviação, mas também associações, grupos de interesse, representantes de instituições e da academia e empresas que operam em diferentes capacidades na cadeia de abastecimento e no setor dos transportes e logística em geral, estimulando um debate rigoroso que integre as diferentes dimensões da sustentabilidade (social, económica e ambiental) e os contributos dos vários intervenientes envolvidos.

Manifesto

A Aliança para a Sustentabilidade na Aviação (ASA) visa construir uma discussão sistémica e fundada para traçar medidas e ações economicamente viáveis e cientificamente estruturadas, construindo os mecanismos de ação capazes de liderar os agentes económicos no cumprimento do objetivo necessário da descarbonização do transporte aéreo.

A descarbonização do transporte aéreo é uma prioridade absoluta para garantir o desenvolvimento de todo o setor e o acesso dos cidadãos à mobilidade. Atualmente, a aviação é responsável por cerca de 10 % das emissões do setor dos transportes, cerca de 2 % das emissões globais. No entanto, todo o ecossistema da aviação é reconhecido também por apostar fortemente em mecanismos de eficiência e sustentabilidade para reduzir de forma sistémica e sistemática as suas emissões e demais impactes ambientais.

A luz do objetivo do Acordo de Paris de manter o aumento da temperatura média global bem abaixo dos 2 º C em relação aos níveis pré-industriais e prosseguir os esforços para limitar o aumento da temperatura a 1 ,5º C, reconhece-se que o compromisso global europeu de se atingir a neutralidade climática, pelo menos, até 2050, antecipado a nível nacional para 2045, maximizará esta possibilidade, alinhando os esforços internacionais para reduzir as emissões do setor da aviação de forma coerente como uma via para atingir este limite de temperatura

Por isso, e em articulação com o previsto no Roteiro de Neutralidade Carbónica (RNC2050) e no Plano Nacional Energia Clima (PNEC 2030), considera-se indispensável aprofundar o conhecimento, identificando um caminho prático e exequível para garantir o contributo do setor para a neutralidade climática, com base numa abordagem rigorosa e científica que avalie os impactos das possíveis ações não só do ponto de vista ambiental, mas também económico, social e de Governança

A coligação reúne uma vasta gama de intervenientes, incluindo companhias aéreas, organizações governamentais e organizações não governamentais de ambiente, com o objetivo comum de reduzir as emissões de gases com efeito de estufa (GEE) da aviação. Reconhecendo que o aumento do tráfego aéreo, previsto para as próximas décadas, representa uma oportunidade para inovar e liderar a transição para práticas mais verdes, através da colaboração e partilha de conhecimentos, será possível desenvolver soluções tecnológicas avançadas que reduzam significativamente as emissões de GEE e promovam uma maior eficiência energética.

A ASA alinhará o seu compromisso no seguinte conjunto de princípios diretores.

Trabalhar em conjunto, tanto através da ICAO e de outras iniciativas de cooperação complementares como através do regime do CELE aplicável à aviação, para avançar com ações ambiciosas de redução das emissões de GEE da aviação, em conformidade com o objetivo da aviação internacional de emissões líquidas nulas de carbono até 2050, em linha com os objetivos do Acordo de Paris;

Apoiar a aplicação de todos os elementos do cabaz de medidas da ICAO para atingir a neutralidade climática até 2050, reconhecendo que o maior impacto potencial na redução das emissões de GEE da aviação virá das medidas relacionadas com os combustíveis sustentáveis para a aviação,

Promover a definição partilhada de uma metodologia orgânica para avaliar a sustentabilidade dos vários segmentos de produtos do setor da aviação e para identificar, de forma racional e transparente, os pontos fortes a explorar e os pontos fracos a colmatar;

Fomentar a adoção de políticas que permitam a necessária expansão e desenvolvimento do transporte aéreo e da atividade aeroportuária através de novos processos tecnológicos, com a definição de regras e objetivos claros e vinculativos, concretamente alcançáveis através de metas intermédias, para atingir os objetivos de neutralidade climática;

Enquadrar ao nível do ordenamento nacional as ações e medidas prospetivadas.

Sob o patrocínio do Ministério do Ambiente e Energia, do Ministério das Infraestruturas e da Habitação, da Autoridade Nacional da Aviação Civil e da Agência Portuguesa do Ambiente, a ASA compromete-se a criar um Steering Committee com representantes das organizações signatárias e a contribuir com propostas concretas, através da colaboração de todas as partes interessadas, para a implementação de uma estratégia de ação a curto, médio e longo prazo.

Este Steering Committee, tendo em conta os resultados dos trabalhos que realizará nas suas reuniões periódicas, compromete-se a organizar uma reunião anual aberta ao público para analisar os progressos alcançados.

Em conclusão, este manifesto é um apelo à ação conjunta e coordenada para assegurar que o crescimento do tráfego aéreo é compatível com os objetivos globais de combate às alterações climáticas. Acredita-se que, com esforço coletivo, será possível transformar a aviação num modelo de sustentabilidade, garantindo que futuras gerações possam beneficiar dos avanços no transporte aéreo sem comprometer o planeta.

Steering Committee:

Ministra do Ambiente e Energia e Ministro das Infraestruturas e Habitação, com faculdade de subdelegação, Autoridade Nacional de Aviação Civil e Agência Portuguesa do Ambiente, I. P., e representantes das organizações signatárias.

Intervenientes:

Associações de transportadoras aéreas no âmbito nacional;

Transportadoras em âmbito na ReFuel EU Aviation e CELE Aviação/CORSIA;

Aeroportos e aeródromos;

NAV Portugal;

Operadores de handling nas categorias restritas (3, 4 e 5);

LNEG - Laboratório Nacional de Energia e Geologia;

DGEG - Direção-Geral de Energia e Geologia;

Academia;

Organizações não governamentais de ambiente;

Fornecedores de combustível para a aviação;

Contribuidores para a cadeira de valor de SAF e eSAF;

Representantes da indústria aeronáutica,

ANI - Agência Nacional de Inovação.

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