UNIVERSITY OF TURKU

# ABSTRACT

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Abstract

Civil aviation is one of the busiest transport sectors which to this day has no competitors when it comes to speed and efficiency of transporting passengers and goods all around the world. Because of this the industry is constantly developing and trying to meet the huge demand for its services. The world economy directly depends on its main carrier, without which world trade would not be carried out in such large volumes and at such a fast pace. However, the function of civil aviation is totally dependable on various factors that directly or indirectly affect it. If we were only to look at the biggest pieces of the puzzle, such as the economy, politics and environmental changes, it could be easier to predict the future direction of civil aviation. However, we are left flustered when critical events, the so-called wild cards such as the COVID-19 pandemic, occur. Such events have already proved to us that they can in the worst case scenario completely suspend civil aviation operations and lead to the stagnation of global economy.

The purpose of this study is to go beyond the obvious and to identify some of the most important underlying factors which are likely to affect the future of aviation in the next twenty years. The aviation industry goes tightly together with the forefront of technology and is in the middle of search for innovations that can help achieve a more sustainable world where civil aviation still exists. Climate change is forcing the aviation industry, among many other fields, to look for solutions to drastically cut their carbon emissions while subsequently more and more consumers are choosing to minimize their carbon footprint and avoid air travel.

Moreover, climate change is not the only struggle aviation has to face in the future. The war in Ukraine has showed us how much of an inconvenience wars and military operations can be for civil aviation with plane routes being re-directed to avoid war-zones adding thousands of miles into their journey. Likewise the safety of civil aviation is always at risk when military actions including missiles are carried out, and even outside of war the industry still has not reached a 100% flight safety despite the extensive efforts of building safer and more reliable aircrafts. In addition, the industry which once was the crown jewel of human innovation is having to face the harsh reality that modern artificial intelligence might one day take over some of the key elements of aviation including piloting the planes.

These among other factors will most likely affect civil aviation in the next 20 years. The images of the future presented in this study and identified as critical are based directly on these scenarios and are backed up by information obtained from suitable sources on this topic.



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| Key words | civil aviation, images of the future, wild card, key factors |

TURUN YLIOPISTO

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| Avainsanat | civil aviation, images of the future, wild card, key factors |

UNIVERSITY OF TURKU
Turku School of Economics

# FUTURES OF CIVIL AVIATION OPERATIONS

## explored from the perspective of Finnair

Master's Thesis
in Futures Studies

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Turku

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# 1 INTRODUCTION

To date, civil aviation is still recovering from the unprecedented setback caused by the COVID-19 pandemic in the years 2020-2022. However, right before the coronavirus stagnated global travel nearly completely, the aviation industry was at its historical peak. Millions of passengers were boarding flights every hour of every day, using transportation via air for various needs such as tourism and business. The services of air carriers have developed and the range of services provided by airlines have significantly expanded to meet all the needs of consumers. In the 21st century air travel has connected all parts of the world providing the fastest way to travel from Finland to New Zealand in just over one day. Air travel is also the only current form of transportation to overcome geographical obstacles such as oceans, deserts and mountains, and that is not likely to change. However, in 2020 we saw that even a massive industry such as aviation can come to a halt due to an international catastrophe.

In December 2019, an outbreak of pneumonia was reported in Wuhan, China. The new respiratory syndrome, origin unknown, was called SARS-CoV-2 or COVID-19. (Ciotti et al. 2020.) As the virus started to spread globally, governments introduced lockdowns to prevent the disease from spreading any further. As a result, global travel was nearly completely suspended which heavily impacted civil aviation. The number of flights was decreased drastically leading to the liquidation and bankruptcy of several airlines and even airports. The new variations of coronavirus and the aggressive safety measures applied in almost every country made sure that air travel would not go back to what it was until this virus would be tackled.

Despite the fact that the aviation industry has gradually begun to get back on its feet in 2022, the full recovery from the economical damages will be slow and some airlines will never send an aircraft into the sky again. However, the summer of 2022 saw millions of passengers get onboard planes again for the first time since the beginning of the pandemic and the industry as a whole seems to have got past the lowest point. It is also worthy to make note that it is likely due to the global nature and connectivity of today´s air travel that the coronavirus was able to spread so rapidly and so uncontrollably to all parts of the world in the first place and this might be something aviation will have to pay a closer look to prevent any such catastrophes in the future.

It is not to say the troubles for aviation are over, for the industry is and will be facing multiple other, possibly even much more severe obstacles than the coronavirus. Climate change, pollution, the political decisions made around them, global peace and technological advancements are all critical factors that will be affecting the future of aviation in the coming decades.

This study examines images of the future of international civil aviation. The Finnish national airline, Finnair, will be used as case study. Finnair specializes in connecting Europe and Asia via the short Northern route — a selling point which has separated Finnair from other European airlines but has now come to a pause because of the sanctions imposed against Russia during the war in Ukraine.

The airline is based in Helsinki, Finland and is founded in 1923, which makes it one of the oldest airlines in the world. One of the main goals of the company is sustainability, which is expressed by aiming for carbon neutrality. Finnair's operations include more than 100 destinations in Finland, Europe, Asia and North America. (Finnair 2020.) Until 2020 and the global pandemic, the company had actively been developing and growing by increasing its fleet and the number of employees thereby receiving significant increases in the number of passengers and profits alike. According to Finnair's website, the company's profit and passenger turnover fell by more than 90% when COVID-19 hit. (Finnair 2020.)

Finnair is an example of a large international airline that meets all international air transportation standards and embodies international civil aviation in general. In order to explore the futures of civil aviation operations, I used following futures studies methods like horizon scanning, 2X2 matrix (Scenario matrix), PEST analysis and Images of the future. Detailed information on the used methods can be found in section 2 "Overview of methods and data applied in the study". Images of the future are built on the basis of various factors and driving forces that might affect global aviation, thus Finnair. The results of this study were obtained by horizon scanning of the environment. For data collection for the study I have applied the horizon scanning method in a form of web-based data gathering which, according to Juho Ruotsalainen from the Finland Futures Research Centre, is one of the methods for horizon scanning (2018, 15). According to the Institute of Risk Management (Horizon Scanning: A Practitioner's Guide 2018), during horizon scanning attention should be paid to threats, opportunities, publications and professional websites, articles written by futurists, industry leaders, competitors, customers and technology and global perspectives. More on the horizon

scanning process and relevant sources can be found in section 2.1 “Horizon scanning”. Having collected the necessary information, which is depicted in detail in section 3, I compiled four different images of the future with a time horizon of 20 years, describing the possible development of Finnair as an active participant in civil aviation operations by 2042. The obtained Images of the future can be found in the section 7 “Images of the Future”. The importance of this type of knowledge lies in the study of factors and events that can directly or indirectly affect the aviation industry. In theory, this work might help the civil aviation industry to pay attention to the environment and expand the horizon of research to include a more vast perspective of the factors that might be affecting it soon. In practical terms, this study acts as a reminder of possible future consequences and therefore encourages actors to take action to help achieve or prevent a particular future.

### 1.1 Structure of the thesis

The thesis consists of 10 sections, as well as references section and list of figures and tables. The “Introduction” section provides information about the selected topic of the thesis. The “Research Questions” section presents the main research questions which I approach the topic with and to which answers should be found later in the research. The section “Overview of methods applied in the study” provides theoretical information on the methods of data collection and analysis used in the course of the study. The section “International civil aviation and factors influencing its development” provides data collected during horizon scanning, as well as identified key factors and driving forces that have an impact on civil aviation operations. The “Finnair as a case study” section provides information on the Finnair airline and its interaction with the macro environment. In the “Research material" section empirical material is provided, including complete information on the process of collecting and analyzing data for the formation of images of the future. This is followed by the section "Images of the Future", which presents four images of the future with different logic. The "Results", "Conclusion", "Discussion" and "References" sections complete the thesis.

## 1.2 Research questions

I am approaching this study by formulating three main research questions. My first question relates to how civil aviation operations interact with macro-environment phenomena such as politics, economy, society, technology and climate. Furthermore I am going to determine the most important and relevant key factors of these fore-mentioned phenomena which have either a direct or indirect influence on civil aviation. My first research question will help to understand how aviation affects many aspects of life and society. Information to further examine this research question will be collected from statistics, scientific literature and airline's official information channels.

*1. How does civil aviation interact with the macro-environment? What are the key factors and driving forces of the macro-environment that have a direct and/or indirect impact on civil aviation operations?*

My second research question takes a closer look at Finnair's involvement with the macro-environment of its home country Finland. I am also going to take a closer look on how the global key factors, determined by the research for my first question, affect Finnair as an individual airline. I have chosen Finnair as my case study in this research work so it is necessary to collect data abut the role of Finnair in its home country. I am also interested in how exactly Finnair interacts with the economy and social environment of Finland, how the company has developed itself over the past 20 years and what goals it sets for the future. Since Finnair is a major international airline it will be directly affected by global factors and driving forces that influence global aviation and it is bound to meet the same struggles as any airline in the future.

2. *How Finnair´s operations affect the macro-environment of Finland? How do global key factors and driving forces affect Finnair?*

My third and final research question is to form images of the future based on the critical factors determined in my research and to look at a timeline of twenty years from present day to see what kind of phenomena and factors civil aviation might have to face. This

part of the research will help to form an extensive picture of the future of aviation through the example of Finnair.

3. *Based on the critical factors determined in the research, what are the key images of the future for Finnair?*

# 2 OVERVIEW OF METHODS AND DATA APPLIED IN THE STUDY

This section is devoted exclusively to the theory of the methods that are used in this study for data collection and analysis. How exactly the methods are used is explained in the Research Material section.

To collect and analyze information on the topic of futures of aviation, I will use several methods widely applied in futures studies. I will use horizon scanning to determine weak signals and significant for the aviation factors by collecting statistical information and information from scientific sources that support statistical data. Horizon scanning is a widespread method of exploring the future, identifying weak signals and driving forces that may develop into global trends. Also, horizon scanning allows to search for information individually in the web space. That is why I chose this method to start my research with. From the collected through horizon scanning data I will identify the key factors and driving forces significant for the field of aviation.

To analyze the received data I will apply the 2x2 or "high impact high uncertainty" matrix tool. This method of distributing the received data was most often used in the practical futures studies teamworks during the education on the Master's program of Futures Studies, and it proved simplicity in application and giving structure to any number of various data obtained. In this matrix, I will distribute by impact and uncertainty the key factors and driving forces identified during the horizon scanning.

For the layout and presentation of data in an accessible form I will use PESTE table and then create Images of the Future. The PESTE table is also widely used in the futures studies program, serving as a framework for the distribution of key elements by political, economic, social, technological and environmental characteristics. Due to the ease of use and the creation of a basis for creating scenarios and images of the future, I will use this table to distribute data coming out from the 2x2 matrix. Further, in order to make the obtained data more clear and accessible, I will present it in the form of short narratives representing images of the future and containing all the elements obtained during the research.

I will try to summarize the whole process briefly. I use horizon scanning to gather information. Next, I analyze the collected data using a 2x2 matrix and right from it I transport the analyzed data to the PESTE table for better clarity. The data in the PESTE

table is presented as ready-made columns, containing the key data elements and serving as templates for building images of the future based on them.

Below is a description of each of the methods used.

### 2.1 Horizon scanning

Starting preparations for the study of possible futures, it should be understood that it is first necessary to collect a large amount of diverse information. Scanning the operating environment for signs of changes is the main component of foresight, as with the help of this process, the persons involved will be able to gain deeper knowledge about the driving forces and gain an in-depth understanding of the interaction of these forces. This process of scanning the environment is called horizon scanning. (Ruotsalainen 2018, 15.)

Horizon scanning plays an important part in analyzing the future and pushes to look into it, to look forward. It helps to explore the future and its every signal and emerging problems, and analyze the importance of events that may occur. (Cuhls 2019, 4.)

Horizon scanning approaches mainly serve to increase the sustainability of the policy-making process, to meet the needs and concerns of policy makers regarding new challenges, to identify business opportunities by predicting the needs of consumers and society, or to prepare society for less expected or rapid changes. (Cuhls 2019, 4.)

The definition of Horizon Scanning used by the European Commission in the project on Horizon Scanning is the following: "*Horizon Scanning is the systematic outlook to detect early signs of potentially important developments. These can be weak (or early) signals, trends, wild cards or other developments, persistent problems, risks and threats, including matters at the margins of current thinking that challenge past assumptions. Horizon Scanning can be completely explorative and open or be a limited search for information in a specific field based on the objectives of the respective projects or tasks. It seeks to determine what is constant, what may change, and what is constantly changing in the time horizon under analysis. A set of criteria is used in the searching and/or filtering process. The time horizon can be short-, medium- or long-term."* (Cuhls et al. 2015, 8.)

There are several signals to look for while applying a horizon scanning (Rubin, 2006, 16): Megatrends (strong), trends (medium), weak signals (weak), wild cards/ black swans (sudden and impactful).

Weak signals are the one to look for, because they can lead to a possible trend or a megatrend (Rubin, 2006, 16). Unnoticed weak signals can lead to a wild card, a good example of which is the COVID-19 pandemic.

Weak signals and wild cards are significant phenomena for the topic of my research hence I want to elaborate on them further.

A **weak signal** is an indication of possible emerging trend. It is the first expression of a change or a specific impact which critically changes the course of events to a different direction. Its connection to the future situation cannot necessarily be based on a statistically valid continuity such as a historical time series. (Rubin, 2006, 17) The most supported weak future signal is an early warning of a change. This signal becomes stronger in combination with other signals. The importance of a weak future signal is determined by its recipient, and it is possible to determine this signal by systematic search. A weak future signal requires support, critical mass, a growing area of influence and dedicated actors. This is necessary in order for the signal to become strong, or to prevent the signal from becoming negative. A weak signal of the future is usually noticed by pioneers or special groups rather than by experts in the field. (Hiltunen 2008, 251.)

The **wild card** can be explained as "a future event, the probability of which is very small, but the impact on the environment is as great as possible." (Smith & Dubois 2010, 847). When checking the possibility of responding to a questionable wild card, regardless of how great its impact is, it should not be disastrous. It can be noted that if the Wild Card cannot be avoided, the organization takes some responsibility for how the Wild Card affects it. Therefore, the organization should be prepared and adaptive to mitigate the possible effect. (Smith & Dubois 2010, 847.)

The size of the Wild Card can be as wide as human imagination allows. The main characteristics of a Wild Card are that they are improbable (but not completely impossible) and come with potentially wide-ranging impacts. (Smith & Dubois 2010, 847). Wild Cards can completely redirect the evolution of current trends or a social system. Wild Cards have a direct impact on the state of humanity, and their effect is so large-scale and fast that the whole system does not have time to adjust and recover from the shock. For this reason, the study and calculation of Wild Cards is an important process, since timely preparedness for this phenomenon can help avoid severe consequences. (Mendonça et al. 2004, 203.)

Despite the fact that Wild Cards are by definition a surprise, it cannot be said that they are impossible to imagine. Especially weak signals preceding Wild Cards are

analysed, then realistic measurements of the impact of Wild Cards on a particular area can be done. Analyzing Wild Cards increases the possibility that some of the possible consequences of the future can be reduced, as well as positive actions can be applied in the direction of avoiding serious consequences. The consequences of not taking Wild Cards into account from the beginning of the management process will be the loss of time and the unpreparedness of crisis management when they appear. (Mendonça et al. 2004, 203.)

From the theory it can be concluded that when researching the future in a particular area, it is necessary to catch weak signals before they turn into wild cards. This is exactly what the horizon scanning method is used for.

There are two main methods of horizon scanning. The first is face-to-face meetings, such as interviews or workshops. The second method is based on collecting information in the web space (Ruotsalainen 2018, 15). After narrowing my research questions I conducted web-based data gathering by utilising key words related to my research questions such as “civil aviation”, “civil aviation operations”, “airline”, “airplane” and “future of aviation” and familiarised myself with the results. I focused on the data that was provided by a confirmed source and which was recently published or updated. I also selected sources that had an objective approach to the matter preferably backed by statistics. One of my criteria for data collection was also that it should be provided by well-known expert bodies of the field of aviation who have produced the data in question as part of their field of expertise.

In this thesis, I will use the second horizon scanning method, namely web-based data gathering. Juho Ruotsalainen in his article “Scanning the shape of journalism – Emerging trends, changing culture?” (Ruotsalainen 2018) uses both methods of scanning the horizon, focusing on the fact that when searching for web information, he turns to the acknowledged web pages.

As a rule, horizon scanning is based on desk research, which should help expand the horizons of research and see the big picture behind ordinary issues. Successful horizon scanning can serve as a foundation for future development research and thereby gain time before it is too late to act. Horizon scanning can also serve as a tool for determining and pre-evaluating assumptions about the future, and thus be the basis for constructing scenarios. (Cuhls 2019, 5)

Horizon scanning is a systematic method for spotting potential causes of uncertainty, ensuring adequate preparation, exploiting opportunities and surviving threats. It is not a

tool for predicting the future. Horizon scanning supports the process of building organisational resilience and is one part of a suite of tools which can help practitioners understand and prepare for future risks. Other tool for horizon scanning, which I use in the research, is a driver mapping, which means using an analytical tool such as STEEPLE (societal, technological, economic, environmental, political, legal, ethical) or PESTLE (political, economic, societal, technological and legal) to consider a wide range of potential sources of future risk. An important element of horizon scanning that distinguishes it from conventional risk analysis is the emphasis on finding information in sources located outside the company, rather than in sources within the company (data sources and internal management). (Horizon Scanning: A Practitioner's Guide 2018, 7-14.)

The search for information outside the organization is very important, as it can give an understanding that the organization is moving in the opposite direction to the direction of the business area in which it is located. In such cases, in order to stay afloat, it is necessary to change the direction of the business. In all cases different aspects should be considered (Horizon Scanning: A Practitioner's Guide 2018, 14).

Below I will elaborate on the needed sources to be considered.

- Threats:
  What is coming over the horizon which could adversely affect future commercial or other success? (Horizon Scanning: A Practitioner's Guide 2018, 14.)
- Opportunities:
  How can the information collected help in choosing the future direction of the company and what advantages can it give in the future? (Horizon Scanning: A Practitioner's Guide 2018, 14.)
- Publications and professional websites:
  This applies to publications and websites that are important and related to the industry, and also includes the general press. It is important to look for expert articles in given area of business. (Horizon Scanning: A Practitioner's Guide 2018, 14.)

- Articles written by futurists should be considered, as it is very important to think out of the box and monitor the development of innovations, as new developments in all areas can have an impact on given business. (Horizon Scanning: A Practitioner's Guide 2018, 14). For the topic of the thesis as professional websites are considered the websites of ICAO (International Civil Aviation Association), IATA (International Air Transport Association) and Finnair.
- Industry leaders:

  At the core of any given business, industry leaders who have their own opinion about the industry are likely to be involved, so it is important to divide the business into separate parts and follow innovation leaders on individual elements. (Horizon Scanning: A Practitioner's Guide 2018, 15.)

  Innovations in other business sectors can have an impact on the future success of the given business, and if managers and stakeholders do not react quickly, the given business will lag behind in the global market. (Horizon Scanning: A Practitioner's Guide 2018, 15). For this research the industry leaders Airbus and Boeing will be considered as the main manufacturers and innovators in the field of aviation.
- Competitors:

  Every business should be aware of what competitors are doing and how they are changing. (Horizon Scanning: A Practitioner's Guide 2018, 15.)
- Customers:

  It is necessary to find out the needs of customers in order to understand whether the business is moving in the right direction. All customer groups should be taken into account. (Horizon Scanning: A Practitioner's Guide 2018, 15.)
- Technology and global perspectives:

  The connectedness of the world today requires constant monitoring, e.g. technology such as AI, digitalization, big data, high performance computing (HPC), political and economic changes, and changes to resources.

  It should be taken into account how these changes will affect the business and how to adapt to them. (Horizon Scanning: A Practitioner's Guide 2018, 16.)

For such a process of collecting a large amount of diverse information, a large amount of raw information is typical, from which only the most interesting and suitable should be subsequently identified (Ruotsalainen 2018, 15).

- Importance of data and process:
  All the information found should be provided clearly and accessible. All data must be reliable and indisputable, and data analysis and demonstration tools will help to present the result. (Horizon Scanning: A Practitioner's Guide 2018, 18.)
  It is important to present trend data in the form of risks and opportunities. It is necessary to understand that when using trends to represent possible futures, there is a chance to miss innovations because they do not follow trends. (Horizon Scanning: A Practitioner's Guide 2018, 18.)

The methods of risk visualization have advanced in recent years. The main methods which consist of visual data such as pie chart, the bulls eye and risk radar, probability, scenarios, PESTLE, SWOT and top 5 emerging risks (Horizon Scanning: A Practitioner's Guide 2018, 18.)

In the process of horizon scanning I will pay attention to threats and opportunities for civil aviation operations. I will look for data and statistics provided by IATA (International Air Transport Association) and ICAO (International Civil Aviation Organization) as well as Finnair's official sources of information. I will also collect data provided by the leaders of the aviation industry the Boeing Company and the Airbus SE. All the listed sites contain statistical reports that are primary data, and serve as a guarantee of the reliability of the information provided. Also, in order to gain a greater understanding of the topic of this study, I will pay attention to the publications of futurists on the topic of civil aviation and its future. This will help me understand how other researchers see the aviation of the future and what points they focus their attention on. This information will also help me avoid duplicating an existing research and stick to the factor of novelty.

As a result visualization tool in this thesis I will use PESTE table and Images of the Future.

### 2.2 2x2 matrix (scenario matrix)

The 2x2 matrix method helps to generate up to 4 contrasting scenarios or images of the future related to a particular area of interest by placing two factors that influence the future of the problem on two axes that intersect and form four quadrants (Figure 1). (Scenario Building: The 2x2 Matrix Technique, 2017, 3.)

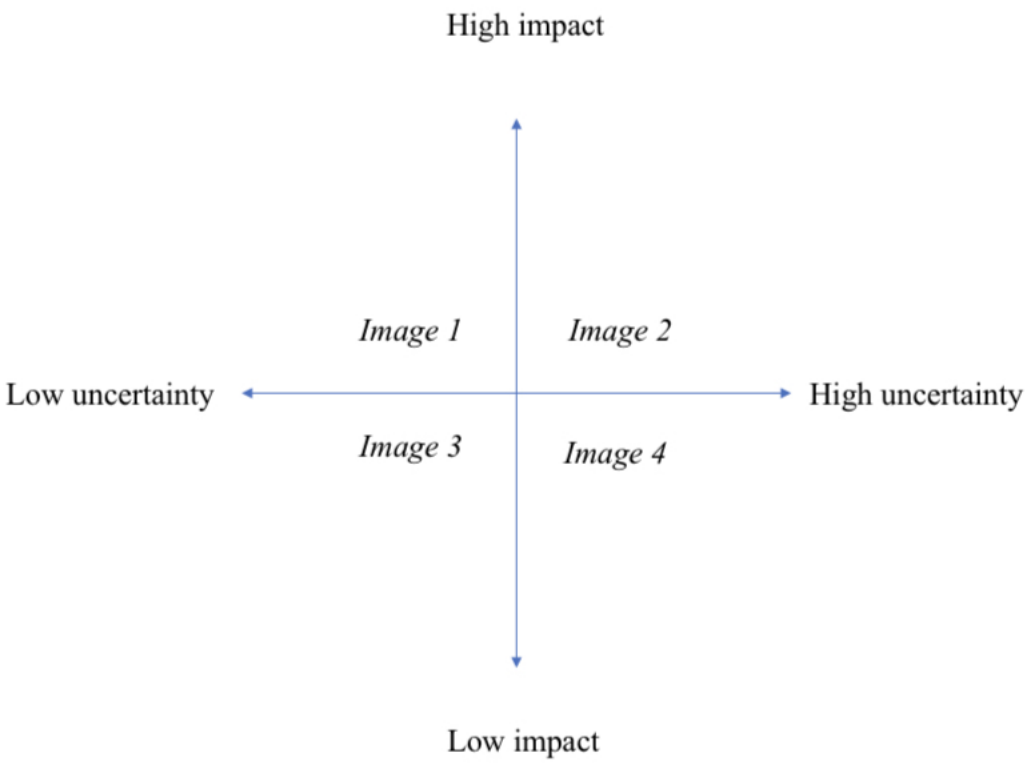


**Figure 1. 2x2 Matrix**

The factors selected for axes should be “high-impact, high-uncertainty". This choice ensures that the four images in different quadrants will be completely different. Further, from the elements located in these quadrants, it is possible to develop scenarios or images of the future. (Scenario Building: The 2x2 Matrix Technique, 2017, 3.)

The advantage of the 2x2 matrix is the ease of communication of the structure, which allows to compare the produced scenario storylines. Quadrants provide a clear framework for separating and locating scenarios in relation to each other. The matrix is also a useful starting point for the formation of each scenario in the set. Scenarios constructed using a

2x2 matrix differ significantly from each other and do not overlap one another. (Ramirez and Wilkinson 2014, 255.)

Using this method, I will distribute the key factors and driving forces obtained during horizon scanning, according to the principle “high impact high uncertainty”. After that I will transfer the ready four groups of elements into the PESTE table. The description of the PESTE table is provided below.

### 2.3 PEST analysis

Images of the future and scenarios are the main tools for planning or for further research. The PEST table or Futures table clarifies key variables with their alternative states of values, and thus is a popular tool for creating scenarios or images of the future. (Kuhmonen & Kuhmonen 2015, 369.)

PEST analysis is widely used as an analytical tool to consider a wide range of potential sources of future risk (Horizon Scanning: A Practitioner’s Guide 2018, 7).

PEST stands for four sources of change: political, economic, social and technological. This tool is widely used to understand strategic risks and identify changes and impacts of the external macro environment on the competitive position of the business and the company in particular. (Sammut-Bonnici & Galea, 2014, 1.) In this tool, it is also possible to take into account another sources of changes, such as the environmental, which happens to be in key role for the purpose of my research. For this reason, the research tool I am using in my work is PESTE.

The external environment consists of components that are beyond the control of any indiviual or a company, such as an airline. These components require careful study and analysis to determine the future direction of the company. Companies operate in a large ecosystem and they are influenced by volatile factors that can greatly affect their competitiveness. The purpose of strategic analysis is to understand external factors and find ways to adapt to them. (Sammut-Bonnici & Galea, 2014, 1.)

PEST analysis and its variations form part of the evaluation stage in the strategic management process. The process begins by identifying current and future factors in the external political, economic, social and technological environment. This is followed by an analysis of the possible impact of each of the factors on the competitiveness of the company. After that, the factors should be divided into opportunities and threats to the company. Further, the results obtained need to be distributed according to the level of

priority. As a rule, the distribution is based on the extent and period of impact on the company. This is followed by the development of strategic actions aimed at correcting negative effects and building positive effects. PEST analysis aims to provide strategists with a framework by which they will increase the awareness of the external environment. However, this analysis is not a panacea, and various factors may contradict each other. Researchers are warned to focus only on factors that are important for a particular industry and that are possible to change in the foreseeable future. This will enable the company to focus only on the changing factors that are important for the competitiveness of the company. (Sammut-Bonnici & Galea, 2014, 7.)

With the help of the PESTE table, I will achieve greater clarity of the four groups of elements formed in a 2x2 matrix. In the PESTE table, the elements will be in the correct fields, depending on their involvement in politics, economics, society, technology or the environment. Based on the four groups of elements located in the PESTE table, images of the future will be constructed.

### 2.4 Images of the future

In his work "Images of the Future of Privacy", Matti Minkkinen (2013, 23) describes the image of the future as a description of one possible future. They differ from scenarios primarily because of their focus on a single point in the future, since scenarios describe the path traveled from the present to the future. On the other hand, their common feature is that they both distinguish the plurality of the future, since there may be many different images of the future and many possible scenarios about the future. Images of the future can differ from each other in many directions, such as time horizon, complexity, desire, awareness. The importance of images of the future lies in the fact that individuals need to create images to get a clearer picture of the future, as well as because images of the future affect human actions in the present, consciously and unconsciously. (Minkkinen 2013, 23.)

Basically, images of the future represent probable, possible or preferable futures based on individual opinions, faith, expectations, hopes, values and fears, and take into account development and change. Images of the future work well as indicators of alternative futures, distanced from the present and call to bring the future closer. Since they contain more creative elements than scenarios, they are easier to resolve sustainability issues and proposed actions, and they are also useful for determining a long-

term strategy. Also, images of the future can be used to determine the desired future. (Jokinen et al., 2022, 2-3.)

Images of the future are of great importance to futures researchers, as they have a great influence on what exactly the future will be. They have a very strong influence on human motivation, since by their decisions and actions people are able to move towards the desired future, or avoid an undesirable future. As a result, images of the future can affect people's lives and faith. Images of the future are developed with the help of individuals or groups of people, respectively, by a wide variety of actors at any social level. When the future itself, having become a reality, will contain elements of past expectations, it can be seen as a materialization of the consequences of human actions and choices. (Rubin 2013, 40.)

As a working definition of images of the future, Bell and Mau (1971, 22) propose: “An image of the future is an expectation about the state of things to come at some future time. We may think most usefully of such expectations as a range of differentially probable possibilities rather than as a single point on a continuum.” There can be a wide variety of images of the future: they can be tied to reality and also be relevant at the level of abstraction. They can describe a certain area or humanity as a whole. They can also differ in time, describing the near or far future, and they can also differ in location. Bell and Mau propose a pair of additional aspects of images of the future, the first of which is the pessimism and optimism, where the image of the future is evaluated as better or worse than the present, and the second aspect is the assumption of whether the factors in the image are subject to a person or they are beyond his influence. With different images, large differences are noticed in human behavior, depending on the pessimistic or optimistic content of the image and on whether the person is able to influence it or not. (Bell & Mau 1971, 22.)

In the work of Bell and Mau, a separate chapter is devoted to the question "does the author present an image of the future?". They focus on this issue because in many scientific works the images of the future are vague, inconsistent and contradictory. Despite this, the images of the future are still potentially important and should be presented clearly, as much as possible. To do this, Bell and Mau offer a checklist of questions that will help the author to correctly construct images of the future. These questions help to focus on such important details as the content of the images of the future, the location of the described, the relationship with the institution (family, economy, army,

etc.), the relationship with religion, the concentration on material and technological aspects or human norms and values, cultural and social elements. The author's assessment of his image of the future is also an essential question - whether it is negative or positive, utopia or anti-utopia, what are the goals depicted in the future, what goals should be achieved to achieve utopia, and so on. (Bell & Mau 1971, 45.)

Images of the future do not give guarantees about the future and that it will turn out exactly as they show, because there are a great many unexpected phenomena that are beyond human control. But images of the future can influence the creation of a desired future, guiding people's mood in the necessary direction to achieve the desired future. (Bell 1997, 83.)

The ultimate goal of my research is to construct images of the future of Finnair. These images of the future will describe the macro environment how it will be in the potential future and present some of the challenges and phenomena that Finnair will be faced with. As a result, the created images of the future will clarify the threats and opportunities for Finnair and serve as a ground for reflection, as well as an incentive to move towards the desired future and avoid the undesirable.

Next, in sections 3, 4 and 5 the results of horizon scanning will be presented in particular of the fields of politics, economics, technology, society and the environment. In the next section, the publications of other futurists will be taken into consideration and an analysis of Finnair as an airline will be conducted. After collecting the data, I will independently, using all the knowledge I have gathered throughout my research, identify the most important key factors, elements and driving forces for the future of aviation and in particular, Finnair. How the methods were applied to my selected sources will be presented in Section 6 "Research material".

### 2.5 Overview of data used in this thesis

My main sources of data used are publications by the industry leaders as well as futurists publications.

In this section I will unfold the information on the primary statistical data sources. Information on the futurists publications can be found in section 4 “Futures of aviation from the perspective of futures researchers publications”.

To search for data which could be related to political and economical factors affecting aviation, it was necessary to turn to the main political regulatory body

responsible for civil aviation operations; the International Civil Aviation Organization (ICAO). ICAO is supported by 193 member States and is a body working under the United Nations and it is responsible for the implementation of all norms of domestic and international flights. The official site of ICAO is providing information on air traffic regulations as well as civil aviation statistics in a form of reports. ICAO's Aviation Benefits Report (Aviation Benefits Report 2019) was used to gain information on world economic growth versus air traffic growth, evolution of average price of airtravel and aviation's global employment and GDP impact.

Another source to get information on the relationship between aviation and the economy are the reports by the International Air Traffic Association (IATA). IATA reports consist of statistical information for the past 20 years and demonstrate the connection between aviation and the economy. On the IATA official web page the information is also provided in a form of report called World Air Transport Statistics (World Air Transport Statistics 2021). It includes important statistical information such as RKP versus GDP growth, industry-wide passenger and cargo load factors and air tourist spending and the value of trade by air.

For statistical data on how aviation affects the environment I have turned to the industry leaders in airplane manufacturing - Boeing and Airbus. In their environmental reports they provide information on energy, emissions and waste.

For information about the case study – Finnair – I have turned to Finnair's official site. Finnair provides a fully transparent information in a form of reports. Information on Finnair's policies, economy benefits and environmental care can be found in sustainability report and material management report.

Instead of collecting primary data through questionnaires, interviews and workshops, I chose statistical data as my primary data because it reflects as accurately as possible all the parameters of civil aviation operations. I found organisational statistics as a more suitable data source for this broad topic due to its high accuracy and trustworthiness. The biggest and most important advantage of statistics for my research is that they provide a reliable data. Compared to statistics, questionnaires have disadvantages which can lead to collection of irrelevant or incorrect data. These disadvantages range from incorrect feedback, reluctance towards sensitive topics, ignorance of questions, neglecting emotions, different interpretations, survey fatigue, lack of accessibility, superficial responses, inaccuracy in analysing open-ended questions, use of complicated language to getting too impersonal or too personal with the survey (Pro Profs Survey Maker 2022).

All these nuances can lead to receiving incorrect or unreliable answers from the participants of the questionnaire.

Collecting relevant data through a workshop also can have many disadvantages. Participants can have a very different skills and knowledge, especially on such a topic as civil aviation, which requires inside information and professional opinion. It also can lead to organisational problems such as setting a suitable for all the participants place, date and time of the workshop. Participants social skills and positions also should be taken into account. It can happen that more dominant participants, or participants in hierarchy superior roles, will not let others to express their opinions in the best way. Workshops can be very time consuming which can be a problem for some of the participants. (British Council 2019). Also COVID-19 was the biggest issue in organising a workshop since it is a face to face research method, which would stop many of the participants to agree on a meeting due to safety reasons. All of the organisational issues and the possibility to not have the desired results led me to not to choose a workshop as a data collection method for my research.

Statistical data suits my research well because my research questions revolve around topics such as economy and environment and their correlation to civil aviation which is typically provided in numbers. Therefore statistics are the most efficient way to access the needed numbers and find answers to my questions rather than conducting interviews or workshops which would require repositioning my research questions to be better suited for this kind of data collection.

# 3 INTERNATIONAL CIVIL AVIATION AND FACTORS INFLUENCING ON ITS DEVELOPMENT

In this section of the thesis I will collect statistical information and identify the driving forces in the fields of politics, economics, society, technology and the environment, which affect the development of civil aviation operations.

From the statistical data of ICAO for the period of 20 years I can find out exactly how civil aviation developed and what led to the decline or growth of this development. Statistical information on civil aviation from authorities perspective is provided by ICAO (Aviation Benefits Report 2019) and IATA (World Air Transport Statistics 2021) and from the industry leaders perspective the data concerning environmental matters is provided by the Boeing Company (Boeing Global Environmental Report 2020) and Airbus SE (Airbus Environmental Responsibility 2019). The members of the International Air Transport Associations (IATA) are airlines and the members of the International Civil Aviation Organization (ICAO) are sovereign states. IATA is focused on security issues of the aviation industry, efficiency and financial conditions of air travel and on the matter of sustainability and equality. The association promotes cooperation between its member airlines and other stakeholders. Meanwhile, ICAO sets standards for the processes of flight of the civil aviation as well as climate change mitigation and environmental protection. These standards are then followed by the state members around the world. ICAO also performs studies and analyses and provides technical assistance and guidance to member states. (Loh 2023) IATA and ICAO create the rules and laws for civil aviation and its operations, which basically means that these organizations decide how civil aviation operates. That is why all the relevant and statistical information and data these organizations provide is the most accurate for my research and that is why my research is mostly based on statistical information retrieved from IATA and ICAO documents. The technical information about the airplane emissions and performance is taken from the official documents and statistics of the leaders of the industry Boeing and Airbus. Statistics suit as my main source of data because it fits my research topic well, there is an abundance of statistical data available around the topics that I am focusing my research on and I wanted to delve myself into deeper understanding of my research by familiarizing myself with the existing knowledge on this topic.

To begin my research it is necessary to determine what civil aviation is as it is referred to in this study; what components it consists of and according to what principles and norms it operates. To help me define these terms I have used the data provided by ICAO.

### 3.1 Definitions of terms and about ICAO

In this section I will define the key terms my research studies. These are *civil aviation* and its components *airport*, *airplane* and *air navigation*.

*Civil aviation* includes three main categories which are; commercial air transport, which includes scheduled and off-schedule passenger and cargo flights, aerial work where the aircraft is used for specialized tasks and general aviation including all other civil flights, private or commercial (Operation of Aircraft 2010).

An international *airport* is any airport adapted and constructed by a Country Party to the ICAO Convention on whose territory it is located and is an airport of entry and exit for international aviation traffic and where all norms and formalities related to customs, immigration, public health, agricultural quarantine and other procedures are carried out. (Civil aviation statistics 2009.)

*Air navigation* services include air traffic management, communications, navigation and surveillance, meteorological reports for air navigation, search and rescue and information services. These services are provided to air traffic at all stages of operations, including entry, stay at the airfield and departure. Aerodrome is a defined area on land or water, including all buildings, installations and equipment, intended to be used in whole or in part for the arrival, departure and movement of aircraft on its surface. (Civil aviation statistics 2009.)

An *airplane* is an airship that has a fixed wing and is heavier than air, moving with the help of a propeller or jet engine and supported by the dynamic reaction of air against its wings (Vance 2021, 2).

International civil aviation is regulated by the International Civil Aviation Organization (ICAO) which is funded by the national governments of 193 states that signed the Chicago Convention of 1944 in Chicago, USA. This organization operates under the leadership of the countries participating in the Convention and supports their diplomatic efforts in the field of air transport. The main task of ICAO is to administer and support diplomatic cooperation and develop new standards in the field of air transport in accordance with the instructions of governments approved by the ICAO Assembly. In

addition to performing diplomatic functions, ICAO acts as an important platform for coordinating actions in the field of civil aviation, as well as carries out information and educational activities, creates associations and conducts inspections and training activities and capacity building in various countries of the world, taking into account the needs and priorities determined and approved by governments. (About ICAO 2021.)

The objectives of ICAO, according to the Convention on International Civil Aviation, are the development of the principles of international air navigation and the planning and development of international air transport, as well as to:

*(a) Ensure the safe and orderly growth of international civil aviation throughout the world;*

*(6) Encourage the arts of aircraft design and operation for peaceful purposes;*

*(c) Encourage the development of airways, airports, and air navigation facilities for international civil aviation;*

*(d) Meet the needs of the peoples of the world for safe, regular, efficient and economical air transport;*

*(e) Prevent economic waste caused by unreasonable competition;*

*(f) Ensure that the rights of contracting States are fully respected and that every contracting State has a fair opportunity to operate international airlines;*

*(g) Avoid discrimination between contracting States;*

*(h) Promote safety of flight in international air navigation;*

*Promote generally the development of all aspects of international civil aeronautics.* (Weber 2021, 15)

ICAO is the main organization regulating civil aviation operations at the political level. As critical thinking is a key part in any research, next I am going to explore the potential biases that could affect ICAO and, consequently, the civil aviation operations in general.

ICAO, as any other organization, can be prone to bias. ICAO as an organization has its own goals and ambitions but also the national governments have their own interests at play. Subsequently, ICAO is in close contact with major businesses in the industry and might be biased by economical interests. In addition, ICAO's operations might be influenced or impacted by major events such as war, pandemic or natural catastrophe where it needs to make quick decisions to ensure to fulfill the fore-mentioned objectives of the organization.

In case of war for example, ICAO might need to impose some restrictions on flights that can be conducted in the conflict area. ICAO has to follow the principles of international aviation navigation and to act as neutral as possible in such circumstances and to not be biased by national governments' or businesses' interests. As an international organization the ICAO can be faced with difficulties if the countries who have signed the Chicago Convention begin to have disputes or to question some of the policies of the organization. It is also important to note that the United States has been a leading country in the development of the aviation industry and some emerging world powers, such as China, might be inclined to question this balance. In an extreme case, some nation states might form their own coalition and want to part from the ICAO completely.

These are all factors which should be considered when looking at ICAO's current and future part in civil aviation.

In the next section, I will study the statistical information provided by IATA International Air Transport Association related to the interactions between aviation and the economy. Based on the information received, I will be able to determine the driving forces and factors that have an impact on these interactions.

### 3.2 Civil aviation as a business and its contribution to global economy

Air transport is vital for the functioning of global economy, its further development and the sustainable economic growth. It allows the smooth and fast movement of people and goods between different countries and continents and makes a huge part of mass tourism as we know it possible adding value to individual countries´ GDP. Approximately 40% of sales of high-tech goods depend on a well-functioning air transport system. In addition, to date, there is no alternative to air transport for the transportation of perishable goods, such as fresh food and recently cut flowers. At the moment, it is difficult to imagine a world without aviation. (Brutyan 2019, 2).

The air transport system is currently represented as a global network of airlines operating commercial aircraft, airports, air navigation service providers and manufacturers of aviation systems, subsystems and their individual components. Aviation provides the modern world economy with connectivity and integrity, creates millions of jobs and allows the maintaining of a mobile lifestyle. (Brutyan 2019, 3).

From the statistical information of the IATA I got the data of the economic analysis of the industry. IATA has been keeping air transport statistics since the year 2000. This

economic analysis focuses on the strong impact of COVID-19 on air transport. In 2020, the COVID-19 pandemic had a strong negative impact on passenger traffic, lead to a decrease in profits and large financial losses, despite a strong increase in the number of air cargo. ( World Air Transport Statistics 2021)

Listed below are the figures that IATA has provided as clarification on how aviation industry and world economy are connected. These figures provide information on the main spheres of the economy which are affected by or affect aviation industry. All of the information in figures 2-4 is taken from the World Air Transport Statistics report (World Air Transport Statistics 2021) and the graphs are drawn by me on the example of the graphs, showed in the report. The main spheres are the world GDP, global tourism, business activity and labour market. These figures are important to my research to help understand the dependability and relationship between global civil aviation and world economy.

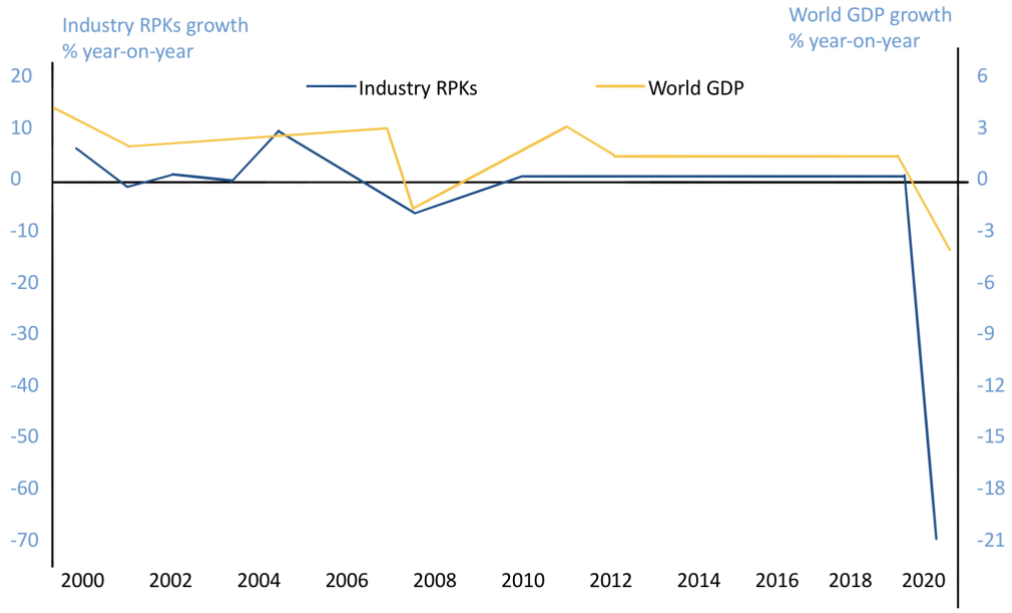


**Figure 2. RKP versus world GDP growth (World Air Transport Statistics 2021)**

The profit of aviation industry are mainly calculated in revenue passenger-kilometers, the so called RPKs (also known as revenue passenger-miles RPM)(figure 2). RPK measures the air traffic for aircraft using the following formula: RPK = P*D where P is the total of revenue paying passengers and D is the distance travelled in kilometers. So, the RPKs are a way of calculating the number of kilometers travelled by paying customers by

multiplying the number of customers and the distance travelled. (World Air Transport Statistics 2021.)

In 2020 the profit of the entire industry in terms of passenger-kilometer (RPKs) fell by 65.9% over the year due to the COVID-19 pandemic. In total, just 1.5 billion passenger trips were counted in 2020. The decline in air travel in 2020 was the strongest since RPKs began to be tracked in early 1950. (World Air Transport Statistics 2021.)

The pandemic had a huge negative impact on economical activity, business, consumers' confidence and even ability to purchase flight tickets, companies' revenues, employment and investments. Indeed, GDP fell by 3.6% globally, the largest fall in recent history. But the decline in RPKs was much larger than that of GDP, due to strict safety and control measures set upon air travel, in particular international air travel. (World Air Transport Statistics 2021.)

Since the beginning of the pandemic passenger capacity has sharply decreased due to the grounding of passenger aircraft. There has as well been uncertainty around the revival of demand of air transportation which has made it difficult for airlines to plan the required amount of capacity. Consequently, at the industry level, available seat-kilometers (ASKs) dropped 56.7% compared to 2019. Passenger traffic in the industry decreased by 17.5% to 65.1%. This is the lowest value since 1993, after which the increase in passenger congestion was constant and reached 82.6% in 2019. (World Air Transport Statistics 2021.)

Unlike passenger transportation, the demand for cargo transportation has greatly increased, and the industry has not had time to meet the demand even despite the fact that airlines have converted passenger planes into cargo carriers (figure 3). As a result, statistics show that available tonne-kilometers (ACTKs) in 2020 fell by 21.2% compared to 2019. This led to a reduction in throughput while the general industrial load factor increased by 7.1 percentage points to 53.9%. This is the highest value in the IATA series started in 1990. (World Air Transport Statistics 2021.)

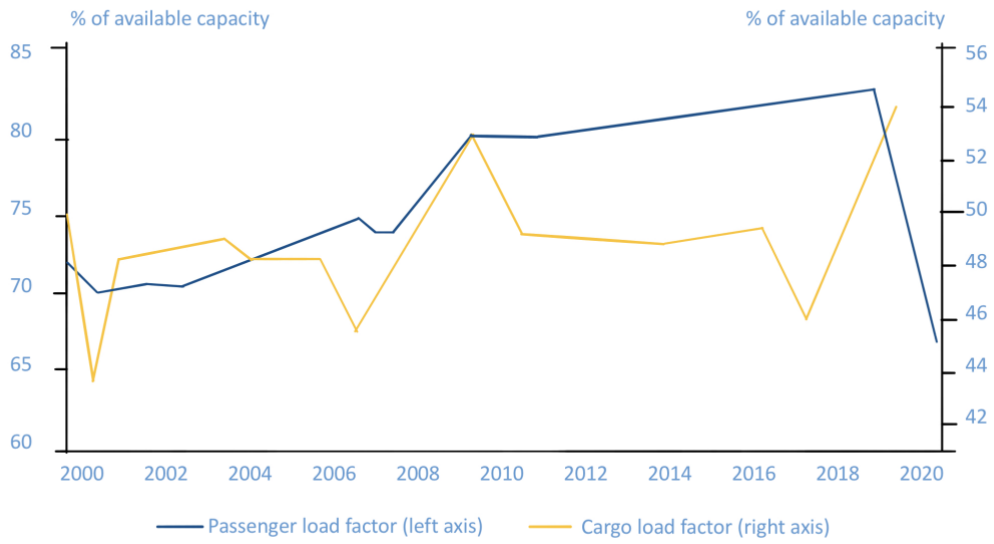


**Figure 3. Industry-wide passenger and cargo load factors (World Air Transport Statistics 2021)**

Aviation affects the global economy and its individual industries not only directly, but also indirectly. One of the largest such beneficiaries is international tourism. Tourism accounts for a significant part of global GDP and provides almost 300 million jobs, in particular, for more than 90 thousand accredited travel agencies around the world. Air transport plays a crucial role in the development of international tourism, as more than 50% of trips are carried out by plane. (Brutyan 2019, 4). The stagnation of aviation due to the coronavirus pandemic affected economic growth and living standards through the lack of tourism and trade. In 2019, tourists traveling the world by air spent about $855 billion in the countries they visited. At that time, the trend of tourism spending was strictly upward, increasing by an average of 5.4% per year since 2000. After the pandemic began, tourist spending in the world fell to $340 billion, which is the lowest figure since 2003. This is particularly devastating for developing countries that are heavily dependent on tourism from abroad. (World Air Transport Statistics 2021.)

The decline in passenger traffic has greatly affected air trade, in particular due to the lack of capacity (figure 4). Consequently, the growth of air traffic in 2020 lagged behind the growth of world trade in goods, despite the rapid recovery of production activity in

the second half of the year. The value of goods transported by air, which account for only a third of total trade, fell by 10% in 2020. (World Air Transport Statistics 2021.)


**Figure 4. Air tourist spending and the value of trade by air (World Air Transport Statistics 2021)**

Aviation has been and remains one of the main beneficiaries of the globalization of the world economy, which has gained momentum since the 1990s. The opening and integration of large emerging markets, for example India and China and the creation of a Single European Market and other regional trading blocs have all impacted aviation industry. Positive changes in the aviation market, such as deeper liberalization of the aviation market in the economies of developed countries and the improvement of the position of airlines operating low-cost transportation on intraregional routes also contributed to the growth of the aviation market. (Brutyan 2019, 3.)

Aviation has a significant impact on the development of world economy, contributing to the strengthening of business activity and accelerating the flow of business processes. The International Civil Aviation Organization (ICAO) has estimated that every $100 spent on air transport ultimately benefits the economy by $325. And every 100 additional jobs in civil aviation lead to the emergence of 610 new jobs in various sectors of the economy in a wider range of professions. At the same time, aviation itself directly provides a fairly large number of jobs for highly qualified specialists. Thus, as of 2015, the global aviation industry directly or indirectly had provided employment for 63 million people. By 2030, this figure may increase to 82-90 million. At the same time, labor

productivity in the industry is on average 3.5-3.8 times higher than that of workers in other industries and professions. The direct contribution of world aviation to global GDP is about $664 billion, which significantly exceeds the GDP of some G-20 member countries and is comparable to the GDP of a country like Switzerland, which ranks 19th in the world by this indicator. According to forecasts of a number of experts, by 2026 the contribution of aviation to world GDP will reach the psychological mark of $ 1 trillion. Aviation plays a crucial role in ensuring the economic growth of countries that rely on the development of major hubs (hub airports). Examples of such countries are the UAE and Singapore. For example, aviation generates about 27% of Dubai's GDP. (Brutyan 2019, 3-4.)

The ICAO also demonstrates how aviation is connected with the global economy. All of the information in figures 5-6 and tables 1-2 is taken from the Aviation Benefits Report (Aviation Benefits Report 2019). The graphs are drawn by me on the example of the graphs, showed in the report. The tables are created by me in “microsoft word” on the example of the tables, provided in the report. Figure 5 shows that since 1995 the global economy measured in gross domestic product (GDP) has grown by 2.8% annually while global passenger traffic measured in RKP has grown by an average of 5% annually. (Aviation Benefits Report 2019.)

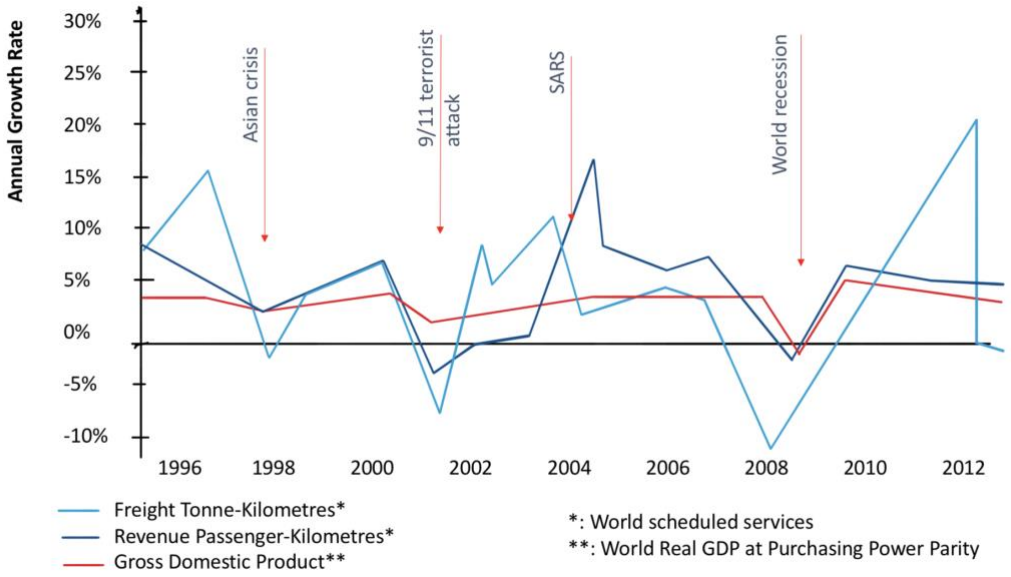


**Figure 5. World economic growth vs. Air traffic growth (passenger and freight) (Aviation Benefits Report 2019)**

Air traffic has doubled every 15 years since 1977, despite the numerous recessive cycles observed since then. All kinds of interference, military conflicts, crises and local downturns did not prevent aviation from continuing to develop steadily. The steadily growing demand for air transportation suggests that investing in the aviation industry can be a key factor in improving the economy, bringing it out of the crisis and post-crisis state. (Brutyan 2019, 2-3.)

Despite the fact that global crises have a great negative impact on global aviation, Figure 5 shows that aviation has always recovered post crisis. The question is not whether air traffic will recover after the crisis but when exactly it will recover.

Because of the democratization of international air travel, the real cost of flights has fallen by about 60% over the past 40 years, thereby making them accessible to more people. During this period, the aircraft became 70% more energy efficient and 75% quieter. Many sectors of the economy can only dream of such progress. In 1945, the number of passengers using air transport services was only 9 million people. In 2014, the number of air passengers reached 2.7 billion people, i.e. in 69 years it has increased 300 times. And by 2030, according to some forecasts, the number of air passengers on domestic and international flights will reach 6 billion people. The number of flights at the

same time will be about 50 million per year, twice the level of 2011. At the same time, the number of international flights significantly exceeds the number of domestic flights. Thus, in 2016, the share of international traffic was 63.7%, domestic - 36.3%. (Brutyan 2019, 2.)

The ICAO report (Aviation Benefits Report 2019) also states that economic growth, technological development, market liberalization, growth of low-cost carriers, airport congestion, fuel prices and other trends will continue to influence commercial aviation worldwide (figure 6).

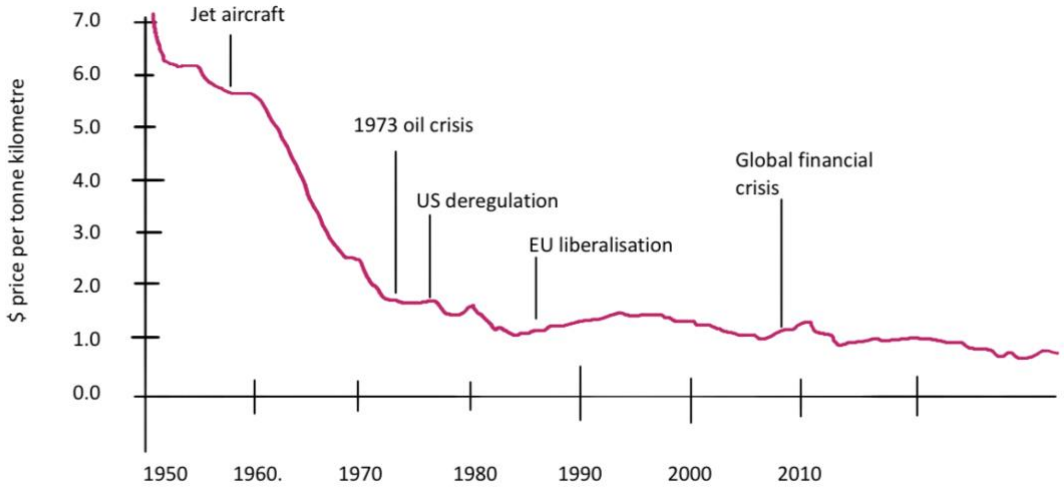


**Figure 6. Evolution of average price of Air travel (Aviation Benefits Report 2019)**

To transport 4.3 billion passengers to destinations around the world and transport 58 million tons of cargo, aviation has created 10.2 million professions and jobs and added $704.4 billion to global GDP. This is approximately 70% of the size of the automotive industry, which accounts for 1.2% of the global GDP. (Aviation Benefits Report 2019.)

Therefore the aviation industry is an important source of economic growth as it creates jobs within airlines, airports, tourism, manufacturers and more. This includes services such as check-in, baggage management, retail, cargo and catering onboard and at airports. Aviation directly creates jobs in the manufacturing sector because of its need for companies producing aircraft, engines and other important technologies used in modern airplanes. (Aviation Benefits Report 2019.)

Aviation is a highly productive industry when measured in terms of GDP per employee (table 1). For an average salary of $69,000 per employee per year, this is about three and a half times the average in the global economy, excluding most other industries. Air transport workers are considered as highly qualified and experienced professionals and in many countries to work for an airline is an aspirational career path. (Aviation Benefits Report 2019.)

**Table 1. Aviation's global employment and GDP impact, 2016 (Aviation Benefits Report 2019)**

| Employment (Jobs)<br>Total: 65.5 million | | Economic benefit (GDP)<br>$2.7 trillion |
|---|---|---|
| 36.7 million | Tourism catalytic | $896.9 billion |
| 7.8 million | Induced | $454.0 billion |
| 10.8 million | Indirect | $637.8 billion |
| 10.2 million | Aviation direct | $704.4 billion |

If considering the European market, it is one of the most liberalized and integrated markets in the world. The single aviation market created by the EU has been expanded to the European Common Aviation Area (ECAA). A single market provides cheaper and safer flights, as well as more jobs and economic growth (table 2). (Aviation Benefits Report 2019.)

**Table 2. Air traffic supports 12.2 million jobs and USD 823 billion in GDP in Europe (Aviation Benefits Report 2019)**

| Jobs total 12.2 million. | | GDP total $823 billion |
|---|---|---|
| 5,100,000 | Tourism catalytic | $293.6 bn |
| 1,500,000 | Induced | $111.4 bn |
| 3,000,000 | Indirect | $225.5 bn |
| 2,600,000 | Aviation direct | $192.6 bn |

Other less obvious benefits for the global economy are associated with the possibility of flying to remote and hard-to-reach places such as islands and overcome geographical obstacles such as mountains, deserts and oceans. In addition, aviation contributes to the development of such important service sectors as healthcare, education and mail. Through aviation it became possible to deliver emergency and humanitarian aid to certain regions for example affected by a natural disaster. Finally, aviation allows data collection for scientific research and meteorological services. (Brutyan 2019, 5).

Over time, the importance of aviation in the development of the world economy will only increase, so it is necessary to forecast possible future economical needs for different types of aircraft. (Brutyan 2019, 5). Partly this can mean also for completely new types of aircraft to appear.

From the statistical data it is clear that the world economy is closely related to aviation. As we already concluded, a global crisis can affect aviation operations and lead to the stagnation of global economy. COVID-19 was a global health crisis but there are other potential crises which could happen due to political or natural disasters. Taking into consideration all the different political states countries can be in I came up with four possible states of the world economy. When world peace prevails the state of the economy could be in a **free world trade** or a **partially restricted market**. In free world trade the economy could function on its own terms and upkeep a relatively stable growth. In a partially restricted market the economy could function rather freely except for some restrictions imposed by nation states. In these cases aviation would operate as the main carrier in the transportation of goods. In case of political crises or natural disasters international air borders might be closed, which could lead to **self-sustainable economy**. This means the reduction or absence of international air transportation and a state where local economies would grow stronger due to the unavailability of air transport. The **preference for local** products (labor and resources) also significantly reduces the need for aviation. Some examples of attempts of a self-sustainable economy are Russia amid the war in Ukraine and as a even more striking example, North Korea. Both of these states have pursued to become self-sufficient; one by its own will to isolate and the other by the political and economical sanctions imposed by other states. As a conclusion; the circumstances and needs for a self-sustainable economy are not always up to countries themselves.

The other very important factors for the development of aviation are the technological factor and the environmental (climate) factor. I will consider them together

since the technological development of aviation is closely related to minimizing harmful emissions and fuel consumption and major technological advancements are more or less the ultimatum for a sustainable air travel of the future. Statistical information on technological development and environmental protection is provided by manufacturers Boeing and Airbus in their annual environmental reports.

### 3.3 Technological development and its impact on civil aviation and environment

Commercial aviation is a fast-growing business. According to the IATA, the aviation industry will increase from 3.8 in billion passengers in 2017 to 7.2 billion in 2035. The commercial aviation fleet, which now has 100,000 units, must meet the demand. According to the International Civil Aviation Organization (ICAO), by 2036, about 94% of all commercial aircraft will be new generation machines. (Brady 2017.)

However, despite ICAO's forecasts the modern aviation is not characterized by rapid adaptation to new technologies. Systems that are resistant to changes due to technological difficulties and social interactions will hinder the introduction of new technologies due to financial risks, the volume of necessary technological changes and the uncertainty of the ultimate benefit of the changes applied. Basically, at least one generation of aircraft with one design must pass before changes are made. Since the design and certification period take an average of 10 years and finished aircraft are used for 30 years, then it may take up to 40 years to introduce new technologies before they replace the old ones. (Kivits et al. 2010, 201).

Even in the case of such skeptical forecasts, technological progress does not stand still. One big test for the aviation industry is how to meet the growing demand with more efficient fuel consumption and low carbon emissions. Since the demand for transport is growing and safety remains the most important requirement, there have been significant changes in the design, operation and power supply of the aircraft. Currently, aircraft use fuel 70% more economically than in 2010 (IATA vision by 2050). (Brady 2017.)

Boeing representatives have made statements about their products and services concluding that they are introducing innovations to improve efficiency and environmental performance. As an example, the 787 Dreamliner which is one of Boeing´s cutting-edge aircraft, reduces fuel consumption and CO2 emissions from 20% to 25% compared to the older models. (Brady 2017.)

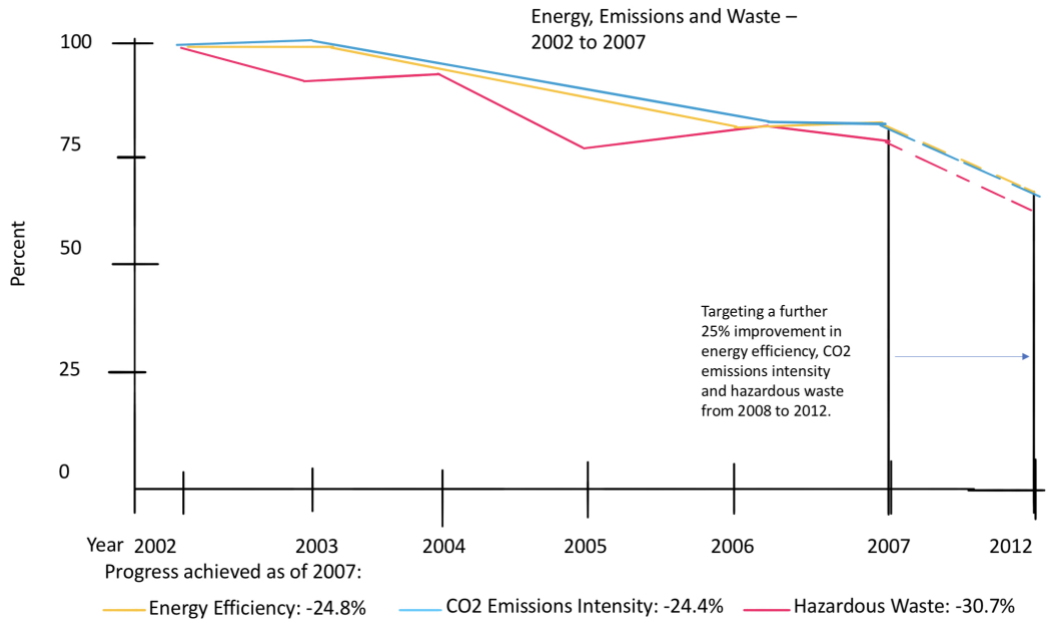


**Figure 7. Energy, emissions and waste 2002-2007 (Boeing Global Environmental Report 2020)**

Figure 7 shows that the harmful emissions decreased significantly from 2002 to 2007, and the company's goal for that period was to further reduce emissions let into the atmosphere by 2012. From these statistics it can be assumed that aircraft manufacturers are achieving at least some results in reducing harmful emissions into the atmosphere and each new engine and aircraft model will be more economical in energy consumption and more environmentally friendly. These changes are not only the result of Boeing´s goodwill but of the realities of political pressure which has lead to multiple commitments and agreements by corporations to minimize their carbon footprint. Boeing is committed to reducing greenhouse gas emissions in its operations by 25% by 2025. (Boeing Global Environment Report 2020) The information in figure 7 is retrieved from the Boeing Global Environmental Report (Boeing Global Environmental Report 2020) and the graphs are drawn by me by the example of the graphs in the report.

Airbus, another aerospace industry leader, is innovating to increase economic efficiency and improve the environmental performance of commercial aviation. Severin Drogoul, Vice President of Business Development and Product Quality Improvement at Airbus Group says that the main objective of environmental efficiency is to build aircraft that minimize the impact on the environment. He says: "In order to achieve our goals, we consider the entire cycle of aircraft construction from model to direct production, and at

each stage of aircraft modelling we find solutions to improve environmental performance." Dragul believes that Airbus is finding solutions to these problems with the help of new ideas, technologies and processes. Therefore, environmental efficiency is present in all Airbus product developments, production operations and services. (Brady 2017.)

Part of Airbus' marketing strategy is to highlight the new developments aimed at reducing the carbon footprint of their aircraft and these ambitions are duly noted on Airbus official information sites. It should be recalled that the Finnair fleet consists entirely of Airbus aircraft.

Airbus invests heavily in research and development to improve the efficiency and noise reduction of the engines used in its aircraft. These actions have led to the fact that today Airbus aircraft have 80% less carbon emissions into the atmosphere than they had 50 years ago, as well as aircraft are 75% quieter. (Airbus environmental responsibility 2019.)

Today, more than 85% of the 130,000 Airbus employees work under ISO 14001, which defines strict criteria for environmental responsibility. The High5+ -program is aimed at reducing environmental footprint and affects five main material aspects of the company which are CO2, energy, water, air and waste (Airbus environmental responsibility 2019). More specifically, Airbus is strengthening its decarbonization plan which aims to reduce industrial emissions by 63% by 2030. All this is possible due to technological development that allows the production and use of Sustainable Aviation Fuel together with increased efficiency of aircraft. Airbus is working to increase the use of renewable and low carbon energy at its sites. This includes increased savings in light, heat and steam, as well as new constructions along with certified building standards. To reduce the use of water, the company is focused on increasing the utilization of water and its reusing in their industrial practices. Emissions into the air relate mainly to cleaning surfaces and painting aircraft. Airbus plans to return to the emissions level of 2015 despite the increase in aircraft orders so in other words produce more aircraft without causing more emissions. Airbus plans to reduce the amount of waste by 20% by 2030 by distributing waste and avoiding waste incineration. (Airbus environmental responsibility 2019.)

The creation of fuel-efficient aircraft does not end at the design stage but also continues by improving fuel combustion with the help of innovative options and services. Airbus was the first in the world to offer customers the option to deliver new aircraft using

a mixture of sustainable fuel. Airbus is also working with partners to develop modern air traffic management systems, which helps to form the shortest flight routes to save fuel and additional emissions into the atmosphere. Airbus also recycles up to 90% of its aircraft parts. Since 2007, 117 aircraft have been recycled, 92% of parts have been reused and 100% of engines have been recycled. (Airbus environmental responsibility 2019.)

Large aerospace companies know how the aviation industry continues to grow so their responsibility is to ensure that the damage caused to nature is minimal. Composite materials play an important role because they make the aircraft lighter and contribute to fuel economy. A good example is the Boeing Company. The aerospace giant has used composite materials in 50% of the designs of its B787 Dreamliners, compared with 5% in the current Boeing 747 since the early 1960s. Furthermore, to emphasize being part of the "green" industry, Boeing recently evaluated the adoption of a system that will help international aviation achieve its goals in reducing emissions. Boeing representatives stated: "The market system of emission quotas and CO2 standards are an integral part of the 4-pillar approach to the industry with the aim of suspending emissions by 2020 and halving them by 2050 relative to 2005 levels." (Brady 2017.)

The aviation industry is also involved in the circular economy. Fibre-based plant products are used to reduce engine weight and increase recycling capabilities, so that almost all aviation materials are made from recycled components. Thanks to nanotechnology, the cabin interior of the aircraft is made of lightweight and autonomously regenerating materials so that they always look "new". EasyJet, for example, was one of the first commercial airlines to use "nano-coating" on its planes and a polymer coating that repels dirt and dust to reduce drag which reduces fuel by as much as 2% in total. (Brady 2017.)

Airlines are already using or testing technologies such as wearable or implantable devices for flight physiological data such as heartbeat and blood pressure to assess blood pressure; sensors embedded in the seat inform flight attendants and provide data to improve future technologies (such as entertainment quality) and in-flight service (such as delivery times and food quality), "smart" luggage with GPS tracking and IoT sensors to transmit location at speed to the airport. (Brady 2017.)

Another improvement in the field of environmental protection will be the transition to an alternative type of fuel. Liquid hydrogen, electricity and biofuels are not to be overlooked when innovating toward a more sustainable fuel for aircraft. *Liquid hydrogen (LH2)* can be used in two roles - as a direct fuel for aircraft engines and as a way of

generating electricity. The advantage of this substance is that when used, it emits mainly water vapors, rather than greenhouse gas. But the disadvantage of using it is that it emits significantly less energy than aviation fuel. In this regard, the aircraft must be much larger to accommodate enough fuel. *Electricity* use in vehicles is not new but the use electricity as the main source of energy over long distances is a challenge to say the least.For example, 1 kg of lithium battery has only 1% of the energy potential of 1 kg of gasoline. This fact is the main reason that electricity is not considered as the most appealing fuel replacement in the aviation industry, at least not until batteries become more developed. Also, in order for this process to be really eco-friendly, the batteries must be charged using renewable energy. *Biofuels* are seen as promising renewable energy sources. Since biofuels can be in liquid form their use will require minimal technological change in internal combustion engines. This type of fuel attracts the greatest attention of the aviation industry. It is considered as a fuel that requires minimal effort to be introduced and used in jet engines. However, there are some challenges. At the moment biofuels can be stored for no more than 6 months. Furthermore, this fuel has a high degree of solidification, and it is solidified at a temperature of -20 degrees Celsius. Accordingly, this fuel must be improved so that it can be used in jet turbines at high altitudes where temperatures can drop lower than that. (Kivits et al. 2010, 201-202).

It goes without saying that all these options are still far from being actually eligable to compete with or overtake oil-based fuels as a source of energy. However, there is a constant motivation and pressure to develop or innovate something more environmental-friendly and so far these are the starting points.

Another important technology for the future of aviation is artificial intelligence. Artificial intelligence (also: AI) is technology for creating intelligent systems and computer programs that can perform creative functions that were originally considered exclusively the prerogative of human. To date, artificial intelligence is used quite narrowly but the possibilities of its application are expanding every day and it is already revolutionizing many aspects of our lives. (Lavrova and Shishkina 2018, 56.)

The creation of cybernetic systems capable of performing highly advanced creative functions initiated a significant increase in productivity in many industries. Aviation was no exception. Air traffic has not yet acquired full automation but leading airlines and aircraft manufacturers are already investing a lot in artificial intelligence. (AI in aviation by Russian Aviation 2021.)

The prospects for the introduction of AI-controlled systems into aviation are truly exciting. They relate to improving the quality of pilot training, reducing the professional risks of pilots and expanding the functions of the autopilot. All these opportunities can significantly reduce the cost of cargo and passenger transportation, increase their volume, as well as improve flight safety. Huge hopes for cheaper air transportation are pinned on unmanned systems which could be possible due to artificial intelligence. Besides that, experts are confident that flight simulators controlled by artificial intelligence will create a complete visual range for pilots trained on simulators. This will increase the professional training level of pilots and create a basis for the transition to a qualitatively different level of flight training capabilities. By collecting the data obtained during training, an AI computer will significantly improve the aircraft control systems and autopilots as well as potentially be able to switch to fully unmanned control. (AI in aviation by Russian Aviation 2021.)

Artificial intelligence will be able to assist pilots in controlling the aircraft adding significantly to flight safety. Controlling the aircraft with voice commands and predicting the flight situation can increase the comfort of piloting and speed up the execution of commands. An equally interesting development is the Alias robot. Installed in the co-pilot's seat, it monitors data from the dashboard using several video cameras. The mechanical manipulator, reacting to the situation, controls the steering column and throttle. Such systems may reduce the number of crew members in the future. The first pilot will remain on board as a supervisor, and Alias will perform all procedures from takeoff to landing. (AI in aviation by Russian Aviation 2021.)

The prospects for the introduction of AI in the aviation industry are significant. Developments using artificial intelligence are already taking place in air travel. However, there are factors which have become obstacles to the full introduction of the new technology. In order to obtain permission for the full use of artificial intelligence in the aviation industry, for example AI as autopilots and unmanned aircraft, a long testing cycle is required. The rapid introduction of unmanned vehicles is impossible due to the lack of legal framework. At the moment, legislative acts regulating the rules of production and movement of unmanned aircraft are being prepared all over the world. As with self-driving cars, ethical questions come to play with AI-controlled aircraft that need to be solved before any human lives are being put at risk. (AI in aviation by Russian Aviation 2021.)

However, there is no denying that artificial intelligence is here to stay and it will form some part in the future of avation; how big that part is, is up to us. AI is the main technological factor in the development of aviation, as it is able to change the entire aviation system including aircraft piloting, navigation and customer service. Innovations for better engines are aimed more at protecting the environment but they do not affect the flight process itself; just with what and how efficiently the plane can move forward. Artificial intelligence can affect everything else and make the decisions of which flight controls and/or safety measures will be used at a certain point of time; which route it should take to get to the destination and in the most extreme case what announcements it should make to the passengers and flight control. The potential of artificial intelligence does not only limit to the functions onboard the aircraft but of those supporting a successful air voyage as a whole. It is highly possible that artificial intelligence will be used more in flight control towers, luggage sortment and cargo department, in handling of passenger data and even the transactions made when purchasing a service from an airline.

Artificial intelligence is for sure one of the groundbreaking inventions of human lifetime and despite the criticism and even fear it has received, it is not something that can be ”uninvented”. Therefore artificial intelligence will keep developing and expanding its horizons becoming more intelligent than before. Based on this idea of constant development I have identified four stages of AI interaction with human specifically in the aviation industry which are collaboration, monitoring, denial and full control. In collaboration, artificial intelligence is to work together with humans and if taken the example of an airline pilot, to share the duties and resposibilities of piloting an aircraft. In monitoring, artificial intelligence would have the control on its own but it would be supervised by a human-pilot. In this way artificial intelligence could work like a tool for humankind and ease off the load of work while still keeping the principle control in human hands - or more specifically, human eyes. In denying, which might be the most unlikely of these stages, humans decide not to trust artificial intelligence and so it would not be used in aviation or in most other fields currently operated by man. In full control, all functions and responsibilities would be handed to artificial intelligence and it would control an airplane without immediate human presence.

### 3.4 Civil aviation in a globalizing society

Aviation creates unique opportunities to empower people regardless of their geographical location by allowing them to have a connection with the rest of the world and to be able to send and receive anything they need. This counts up to improved livelihoods, food, healthcare, education, and so on. In any situation, be it a crisis, humanitarian aid, or leisure time with visiting family and friends, aviation plays a crucial role in promoting social goals and meeting needs around the world. For all vulnerable groups such as migrants and people living in remote or wild areas, air transport services are the way to connect. (Aviation Benefits Report 2019).

The main daily work of aviation is the safe transportation of people through the operation of more than 100,000 air voyages. Today, aviation is the safest and most efficient way of long-distance transportation in the world which overcomes geographical obstacles no other form of travel does. The safety of global commercial aviation is constantly increasing with an accident rate equal to 1.35 accidents per million sectors in 2018 compared to 1.79 on average for a 5-year period from 2013-2017. The safety levels demonstrated by international aviation today represent an achievement built on the efforts of the entire aviation community. (Aviation Benefits Report 2019.)

Aviation provides the only possible means of transportation for special purposes such as humanitarian aid in catastrophe ares where roads might be blocked or for other reasons the only way to reach the destination in need of help is by air. An example of aviation's contribution to the healthcare system is the rapid delivery of medicines and organs for transplantation around the world, as well as emergency transportation of patients by medical-purpose helicopters. Medical transportations are not only sensitive to delivery times but very often the delivery locations are so restricted that delivery by another type of transport is difficult or impossible. Aviation provides provisions and humanitarian aid to areas where natural disasters or war have occurred, with the help of cargo deliveries, transfer of migrants or evacuation of people. If natural disasters completely cut off any territory, humanitarian support can be achieved only with the help of air transport. Though there are some extreme weather conditions which can ground airplanes, modern aircraft are well-equipped to function in many different type of weather phenomena which other means of transport might not be, including heavy rain, storms, snowing and icing. (Aviation Benefits Report 2019.)

Aviation is important for communication with peripheral destinations that cannot be accessed otherwise, such as the Arctic or small island States around the world´s oceans. Even some areas on mainland are nearly impossible to reach by other means than air travel for they might be stranded by deserts, mountains or unnavgable waters or forests making land-approach simply impossible. Aviation makes these places accessible. Aviation also lowens the need to build complicated and expensive infrastructure such as tunnels, roads and bridges and in some cases, it would not even be possible to build them. (Aviation Benefits Report 2019.)

Aviation improves people's quality of life by expanding their usual social circles. Through aviation, millions of people have access to movement and travel which allows them to interact with other cultures. The world has never been as global as it is now, and aviation is at the centre of it. It is an accessible means of visiting distant friends and relatives which allows humans to relocate all around the world, look for interesting career opportunities abroad and that way expand professional skills equally to all parts of the world. The lowered price and convenience of air travel have significantly expanded the number of potential destinations for recreation and relocation in cases where people move for work, study or other reasons, a large number of families are located in different regions of the world. The International Labour Organization (ILO) suggests that migrant workers account for 4.4% of the global workforce, and that one in six workers in a developed country has moved there from abroad. A large number of countries receiving migrants, for example in Europe, have a high-age population, which makes the international labor market significant and important for their economic development and for maintaining the retirement age population. (Aviation Benefits Report 2019.)

Aviation also expands educational opportunities by providing transportation of students to places of their educational exchange. The number of students who choose to study abroad has increased from 2.1 million in 2000 to 5.1 million in 2017 which indicates that the younger generation of people is mobile and eager to broaden their horizons. For many students, access to higher education is associated with traveling abroad, sometimes to the other side of the world. Without aviation, such transfers for education would be impossible, especially for exchange students moving to a foreign university for just one semester or a year. For students from developing countries, studying at a good university abroad is very important, both on a personal level and for the country to which the student will return as a highly educated specialist. Some international experiences related to

studies or work are also highly valued in the working life and many companies appreciate if their recruits have this aforementioned experience. (Aviation Benefits Report 2019.)

In conclusion, while we live in a world of open borders and limitless possibilities, aviation will have a constant demand because as it is now, humankind is used to being able to travel globally and relocate quickly and for flexible amounts of time. Ever since tourism and global air travel became more accessible to more people it has become a common thing for middle-class families to travel for leisure, work or study purposes and even despite the growing awareness of climate change and its correlation with aviation, large masses seem unlikely to willingly give up this habit of air travel they have got so used to. From the time of early discoveries in the late 1400´s humankind has had the aspiration to travel and discover faraway lands and the same curiosity to travel to exotic lands is still installed in us today, and air travel is simply the easiest, fastest and cheapest way to do that.

However, we also need to be prepared for a situation with limited ability to travel by air, for example during global crises. It is possible that due to climate change or some other significant factors, the world will take a step back in globalization and become more local instead. This would mean decline in the need for aviation as countries and communities would prefer to limit their movement and perhaps the movement of goods as well. This kind of shift would work well for communities which already have everything they need to maintain normal or above-average quality of life but would be extremely challenging for communities which partly or totally depend on outside sources for important goods such as food or water.

In the next section of my research I will dive deeper into the most significant factors which might affect the development of civil aviation.

### 3.5 Factors which may influence the aviation industry operations and services by 2042

In my research I am exploring the key factors and wild cards which can influence civil aviation in a timeframe of twenty years. Wild card events are extremely significant for civil aviation and can have a potentially disastrous impact. The COVID-19 pandemic is an example of a wild card event.

Since the beginning of the pandemic in December 2019, lockdown was introduced in Wuhan, China. On of the first measures taken was the closing of Wuhan International

Airport which included suspending all air traffic transiting through Wuhan. However, the virus managed to spread into neighboring provinces and continue its way throughout China. Thailand was the first country where the virus was detected outside of China. In the shortest possible time the virus spread throughout Asia — one of the world's most densely populated areas. On March 11th 2020 the World Health Organization (WHO) announced that the coronavirus outbreak is a pandemic, and on March 13th Europe was already the centre of it. (WHO 2020.)

Starting from the beginning of the pandemic all endangered states begun to introduce safety measures, the kind of which had never been seen before. Many states including Finland declared a national emergency and even passed new legislation to be able to restrict people's physical movement within the country. Quarantine and isolation were thought to be the most effective ways of desperately trying to prevent the virus from spreading and all these restrictions directly and suddenly impacted aviation heavily.

Civil aviation, almost all of its enterprises (airlines, airports, air traffic control companies, maintenance companies, handling, on-board catering, fuel refueling) suffered losses in revenue, cash flow and profit when millions of passengers just simply had to stop traveling.

What made the circumstances worse was the bewilderment and near-chaotic response to this unexpected situation which are side effects to any wild card event. Because they are so sudden and unpredictable, the infrastructure, governments and companies are not ready to face them and for a while, before any plans are put in place, they throw off any organized society into a chaotic survival-mood. The distress in decision-making when these kind of wild cards happen is the lack of understanding of the timeframe of resolving the situation at hand. Scientists and other experts may be able to indicate some timeline but as we also bitterly had to see with COVID-19, those timelines may be extended.

For aviation, it was an extremely distressing thing to go through because the pandemic impacted the industry so practically and so heavily right away. What added to the distress was the possibility of further restrictions and the lack of knowledge on when or if ever the imposed restrictions would be lifted. Because the impact of this wild card was so sudden and because there seemed to be a lack of any kind of prepared answer to that scale of a catastrophe within the industry itself, airlines and their employees were truly put to an awful situation.

After the initial shock airlines started to implement some common anti-crises measures to minimize the negative impact. These measures included cancelling flights,

reducing the amount of aircraft used, putting most ongoing projects on hold and letting go of staff. As other companies, airlines also turned to state governments´ for support.

However, despite these actions taken, the situation developed on a global scale to something totally unprecedented. It has and it will require different approaches and measures and daily joint work and coordination of all heads of airline companies in each country for the aviation industry to fully recover. (IAC about COVID 2021.)

The COVID-19 pandemic is a prime example of a wild card event. Even though there was pre-warnings of the possibility of a global pandemic from scientists they were dismissed and when the unfortunate events lead to the first outbreak which then went onto become a global pandemic, nobody seemed to be prepared. Governments, international organizations and corporations all seemed to be in a state of shock and bewilderment.

### 3.5.1 Factor of Environment

One of the key factors to be considered when analyzing the future of aviation is the environment. For decades now, scientists have warned us about global warming and the greenhouse effect but it seems as though only in the 21st century larger masses have woken to the facts and started paying much more attention to it as before. Climate change is something you learn about in school, read about in the news and run into in almost any aspect of life because it has become so centered for humankind. Aviation among many other fields have gone under scrutiny by consumers who are becoming more and more aware of sustainability and carbon footprint. Aviation is considered by many one of the worst polluters.

However, air pollution from aviation fuel emissions has been subject to less control than air pollution from automobile traffic and a significant increase in aviation is of concern in terms of human and public health impacts. International aviation is attracting more and more attention from the scientific community due to its constant grow. In numbers, aviation accounts for about 1-2% of global greenhouse gas emissions per year. (Harrison et al. 2015, 1-2.) Figure 8 is presented as a Harrison et al. (2015, 1-2.) text supportive demonstration of the global carbon dioxide emissions from aviation. Information for the figure 8 is taken from the work “The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018” (Lee at al. 2020, 4) and the graphs are drawn by me by the example in the work.

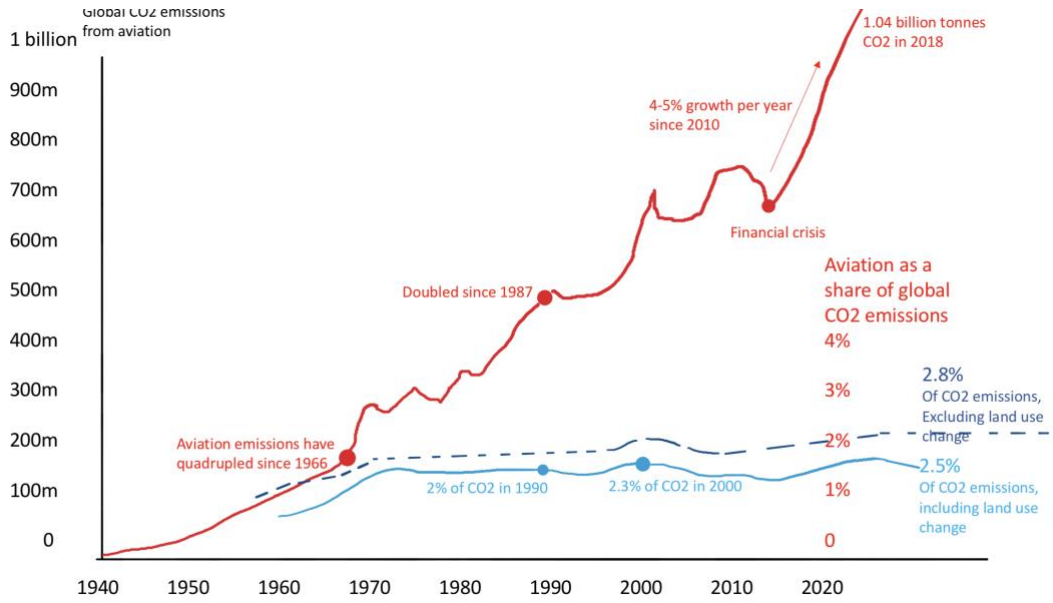


**Figure 8. Global carbon dioxide emissions from aviation (Lee et al. 2020, 4)**

Aviation is the most difficult to study of all the fields or transport since it covers both vertical and horizontal dimensions. People who are dependent on air travel want to believe that pollution from airplanes at low altitude is minimal but scientists have proven that even pollution at high altitude affects the air quality in the atmospheric layers in which people live and breathe. Therefore, the impact of aviation on the environment is the main issue that the scientific society is concerned with. (Harrison et al. 2015, 2.)

The greenhouse effect is a leading factor in the heating of the planet as it retains some of the heat of the planet which would otherwise escape from the atmospheres into outer space. Without the greenhouse effect the average temperature on Earth would be much lower and life on the planet would be impossible. The visible effect of greenhouse gases on the atmosphere is the constant heating we now call global warming. Many human activities including the production and consumption of mineral resources, the use of chemicals in the agricultural industry and other industrial activities have increased the concentration of greenhouse gases in the atmosphere. This increase in the amount of greenhouse gases has led to climate change and global warming. This situation has attracted international attention and led to the creation of initiatives to control the greenhouse effect. (Kweku et al. 2017, 1-3, 6.)

If appropriate measures to control the damages caused by climate change are not taken timely, then, according to NASA and the Environmental Protection Agency,

noticeable climate changes, sea level increases, ocean acidity increases, changes in habitable weather and other natural and social impacts are bound to happen. In many ways the effects of global change are already visible especially in the areas of extreme cold or extreme hot weather and some of them might not be reversible. (Kweku et al.2017, 6-7.)

Climate change is something to be taken seriously and it will affect global civil aviation in the future increasingly. Consumers have already become more and more aware of their own carbon footprint and that of the large corporations. Responsibility is demanded of each and every actor on this planet for it is only the joint efforts of all that can have a lasting and meaningful effect. While the airlines are working on more sustainable opportunities to develop their field, aviation might be affected much more and much sooner than expected.

Aviation operations can be suspect to restrictions imposed by governments or multi-national organizations and political alignments in efforts of neutralizing the harmful emissions. Though aviation operations are unlikely to completely stop existing due to the facts mentioned earlier (its uniqueness in conquering geographical obstacles, the speed with which people and goods can be transported) it is possible some restrictions will be imposed on air travel for leisure. As seen during the strictest COVID-19 restrictions, governments can restrict international traveling to only cover the most pressing reasons to travel abroad such as work, meeting of family members or permanent relocation even in the European Union where supposedly freedom of movement is guaranteed by European law. Other means to control consumers´ flying habits could be to increase the taxes paid for flight tickets, to add a compulsory climate-compensation fee or restrict the amount of times a single individual is allowed to travel by air in a certain amount of time, for example one year.

Even though civil aviation and international tourism are strongly linked together at the time, an increasing amount of consumers are choosing to travel by car or use public transport to get to their destination. During the COVID-19 pandemic and especially in 2020 and 2021 international air travel was still very restricted, consumers were not able to take their usual yearly holiday abroad so instead they resorted to traveling within their home countries. This is a trend which is likely to gain more momentum as consumers become more aware of climate change and what they should do to prevent its most disastrous outcomes and if aviation as a field is not able to come up with innovations which would really make a difference in the sustainability of air travel. Additionally, as mentioned above, climate change is already transforming the weather conditions on Earth

and this first-handedly affects the hottest and coldest areas. As much of international tourism takes place in warm countries it is possible that the areas which have until now served as the dream beach escape destinations will due to global warming become in fact inhabitable.

Besides the movement of people aviation is in key role in transporting goods. Consumers can order goods from anywhere in the world and it will be delivered to them by air or by sea and likewise it is possible to send shipments to anywhere in the world. However, becoming more aware of their carbon footprint consumers have started to prefer locally-produced items and goods which do not need to be transported by air. Therefore the demand for cargo shipments via air is likely to decrease affecting global civil aviation in the future. In the movement of goods it is also possible that governments or multinational organizations will impose restrictions on certain goods for example so that it could be impossible to order some product similar to which a consumer could get from their home country or a nearby area. This kind of restrictions would consequently change our market structure and lead towards local economies which would aim towards self-sufficiency.

Climate change is likely to affect consumers' behavior and consequently through the law of supply and demand other forms of transport might become a serious competition for aviation. As an example, OFCE, an independent researcher, forecaster and evaluator of public policy, has launched a project for the restoration of the European Union, which provides for an investment program of 2,000 billion euros for 10 years. It is expected that most of the funds will be used to finance "large pan-European projects". The flagship project, worth 1,100 billion euros, provides for the creation of a super-high-speed train (250-350 km/h) which will connect all European capitals through the creation of four new rail lines. (European capitals will be connected by a single high-speed railway 2020).

The high-speed railway will strengthen European unity by reducing transportation time and doing so in a climate-friendly way. It is expected to be possible to get from Paris to Berlin by train in just four hours instead of the current eight. Even though the fastest trains cannot compete with the speed of an airplane, climate-aware consumers might still prefer to choose something better for the environment even if it takes them longer to get to their destination. Especially if the option is to give up international traveling for leisure completely, I am almost certain that most people will be content with the slower paced transportation as long as it gets them somewhere. (European capitals will be connected by a single high-speed railway 2020).

As a conclusion, it is inevitable that climate change will affect civil aviation operations to some extend. In many ways it can be argued that it already has and the pressure from consumers and politicians to minimize harmful emissions caused by air travel is constant and growing. Although aviation can be seen as too important a pillar for the world economy to function without it is likely that air travel for leisure and shipments made via air will decrease either due to restrictions imposed and/or consumers´ change of habit and preference. Both of these reasons will significantly lower the demand for aviation operations.

### 3.5.2 Factor of War

War or any type of military conflict is always a state of flux where operations casually run during peace time will most likely be suspended or disturbed. Civil aviation is among the first of these sort of daily operations to be affected since war and military conflict create a serious local safety hazard for civilians and civilian airplanes.

During the second World War (1939-1945) the airlines worked together with the military mainly helping to transport people and cargo. The airlines were prepared to take responsibility and help where they could during the hostilities. In the USA plans for mobilization were prepared in 1937 by Edgar Gorrell of the Air Transport Industry Association. The plan was put into effect in the fall of 1944, when the United States took part in the war and the airlines immediately began co-operating with the military. Other non-necessary air travel during that time was ceased in the US. Priority was given only to flights that took part in the war efforts and as a result the planes flew overcrowded by more than 80% and at 20% higher altitudes than in pre-war times. The military requested 200 out of 360 national aircraft to help with military operations including some aviation personnel. (World War II and the Airlines 2007.)

In the USSR aviation’s abilities were also put to the test during second World War. In the first days of the war the restructuring of Aeroflot, the main national airline in the USSR and nowadays in Russia, began. To help the Red Army in combat, special aviation groups were created among them the Civil Air Fleet. On the basis of the order of the People's Commissar of Defence in July 1941 all the personnel working for the Civil Air Fleet were assigned to work in special aviation groups and were drafted to the military. From the first days of the war, the Civil Air Fleet experienced serious difficulties; there were not enough heavy transport aircraft, there were difficulties with their repair and re-

equipment. Flights on unarmed aircraft in conditions of air domination by enemy aircraft were associated with great risk. The difficulties were compounded by the fact that the Civil Air Fleet had to all of a sudden perform tasks which significantly differed from their description of job at peace-time which required rapid psychological restructuring and adaptation as well as mastering new knowledge and skills. Military actions carried out on USSR soil during the war caused enormous damage to their infrastructure and economy, civil aviation in particular. 57 airfields were put out of operation due to physical damages. In the end, material losses of the civil aviation industry alone amounted to around 185 million rubles which was the equivalent to almost 35 million USD at the time. (Akopov and Lazurevskaya 2020, 3-8).

Even though there has not been another world war since 1945 I might argue there is never such thing as total world peace. Local and broader military conflicts have been carried out in different parts of the world since then, most recently Russia's annexation of Crimea in 2014 and invasion of Ukraine in spring 2022 which has led to an ongoing war in Europe. During this conflict already one civil airplane was shot down by a missile later tracked back to separatists backed by Russia. (Council of Europe 2022).

Two decades ago the world saw one of the most shocking wild card events broadcasted live all around the world when the World Trade Center twin towers in New York City and the Pentagon nearby Washington D.C. were hit by three civilian airplanes hijacked by terrorists on September 11th 2001, amounting to over 3000 casualties. The aftermath of this event was enormous and affected civil aviation operations fundamentally especially in the safety department so that any such future scenarios could be prevented. (History 2010).

Besides the direct safety hazard, military conflicts can have an indirect impact on civil aviation operations for example in the form of no-fly-zones and sanctions. As part of the sanctions packages imposed against Russia by the European Union in 2022, many European airlines including Finnair suspended their flight connections to Russian airports and re-directed all flights that were routed through Russian air space. For Finnair this cost its advantage of providing the shortest flight time from Europe to Asia.

Military conflicts, full-blown war or terrorist attacks can occur almost anywhere, at any given time. They are a significant threat to the safety and function of civil aviation operations. Therefore it is necessary for governments and air navigation services to provide accurate and truthful information to ensure flight safety of all civil aviation flights. All countries who are part of the International Civil Aviation Organization

working under the United Nations (ICAO) are required to report directly on any potential risks related to civil aviation on their territory. (About ICAO 2021.)

As seen with both the examples of the United States and the USSR during the second World War it can be assumed that any country engaging in a major military conflict, or world-scale war, would choose to utilize the civil aviation aircraft and personnel to help in the war efforts. Especially now when the reality of war is much closer to us in Europe than it has been in a long time it is a current and very important factor to look at when scanning the future of aviation.

### 3.5.3 Factor of Technology

Technology and aviation have gone hand in hand from the beginning, for without technology there is no aviation. However, it seems as though technology might be taking onto some new directions which might create flux in the more traditional fields of technology such as aviation. Artificial intelligence is at the forefront of these new directions.

It is somewhat inevitable that the further development of artificial intelligence and its introduction into the spheres of human activity will lead toward automation and cause reduction of jobs when a person is replaced by a computer or a robot. These changes will also be inherent in the field of civil aviation.

The popularity and momentum of artificial intelligence may be due to the fact that the Internet at the moment has allowed to accumulate a large number of different data, the cost of storing which has significantly decreased and the speed of data processing has increased incomparably. Basically, artificial intelligence is able to solve a complicated task faster, more efficiently and with better accuracy than human brain. Therefore it is only inevitable that many jobs currently held by humans will be replaced by robots or other form of AI. At the World Government Summit in Dubai in February 2017 Elon Musk stated that over the next quarter of a Century, about 12-15% of people will be out of work and replaced by AI. Of course, to date and in the near future, such humanoid machines have not yet been invented that could completely replace human labor.

Human capital will still be relevant but it will undergo some changes in its orientation. The use of human labor will change; it will consist a creative component and the creation of something new while the routine work will gradually be left to AI. Thus,

more human brains will be available to create and innovate. (Lavrova and Shishkina 2018, 57.)

However, not quite everyone will be accepted by big companies to come work for them. Many will lose their jobs and might not be able to find something suitable if their education and experience is only counting towards jobs which machines overtake. Future generations will be much more equipped to step into working life with skills that match the needed jobs. Older generations, however, might not have the chance to update their skillset to match a whole new job description and will subsequently, be left jobless. (Lavrova and Shishkina 2018, 58.)

It is also important to note that in any case, even if artificial intelligence is not going to take over piloting airplanes tomorrow, it is already affecting the way human pilots operate them. The computers built inside modern aircraft today are heavily counting on artificial intelligence to perform functions based on data to make the pilots´ job easier and smoother. Airbus has identified six technical areas of artificial intelligence which it wants to focus on; knowledge extraction, computer vision, anomaly detection, conversational assistance, decision-making and autonomous flight. In a timeframe of just five years Airbus hopes to take some serious steps toward unmanned flight and with the speed with which artificial intelligence is being developed it might be absolutely doable. On the way toward completely unmanned flight Airbus is exploring the use of artificial intelligence in navigation, taxi, take-off and landing (by using computer-vision technologies), organizing the tasks of crew members more efficiently and enhanced cockpit designed for single-pilot operations in future aircraft models. (Autonomous flight. Leveraging machine learning to enable self-piloted operations 2022).

Besides the aforementioned, artificial intelligence is also making its way more deeply into customer service operations, payment platforms, luggage handling, storing and analyzing of passenger data, safety operations, construction and more. All of these will affect the future of aviation and have a part to play in what kind of images of the future we will see for the field.

In this chapter, I have explored the key factors which will affect the future of aviation in the next twenty years. Climate change, war and military conflict and artificial intelligence are all going to play some part in the future of civil aviation. In the next section of the research I will explore futures of aviation from the perspective of published futures researches. I am looking for coherence with my own research and to learn about futurists main concerns about the future of aviation as well as create an understanding of

their research process. Through familiarizing myself with other futurists research I intend to see the compatibility of my own research and to become sure of the novelty of my work. From publications from the past 40 years I will create an understanding of researchers foresights at the time of publishing and can compare their ideas to reality.

# 4. FUTURES OF AVIATION FROM THE PERSPECTIVE OF FUTURES RESEARCHERS PUBLICATIONS

As it is recommended by the Institute of Risk Management, in a horizon scanning process articles written by futurists should be considered. It is very important to think broadly and monitor the development of innovations, as new developments in all areas can have an impact on any given business. (Horizon Scanning: A Practitioner's Guide 2018).

From the articles related to my research questions I will be able to determine which innovations the published futurists pay attention to as well as in which areas of life they are looking for key factors and driving forces affecting the future of aviation.

I studied several articles and divided them into those written in the 22 year period between 2000 and 2022, and those written before 2000 in a 26 year period between 1969-1995. This division will help to determine the changes over a twenty-year period and to compare which forecasts have come true and which have not. Studying the work of futurists of the present and the past will help me to identify whether there is some innovative idea in my research and how it compares to the work of others in the field of futures studies. I am referring to the time period between the years 2000 and 2022 as ”present time” and the years between 1969 and 1995 as ”past”. It is notable that in the articles I have chosen for this research there is a five year gap between 1995 and 2000 but considering that most changes affecting the future of aviation and the key factors.

In the study “A post-carbon aviation future: Airports and the transition to a cleaner aviation sector” (Kivits et al. 2010) to create scenarios for the future of aviation, the authors looked for factors and driving forces in several areas affecting aviation. The main topic of the study is the transition of aviation to a more environmentally friendly type of fuel.

To determine the key factors, the authors investigated existing regime players, in particular airport operators, airlines, aircraft manufacturers, community and government. From the perspective of airport operators, switching to a new type of fuel is unprofitable, as it entails huge costs for changing the airport infrastructure. However, if such a transition is initiated by industry leaders, then airports will have to adapt to new trends. (Kivits et. al 2010, 204).

From the perspective of airlines, this process is very binding, since the fleet of one or another airline consists of aircraft that must be received by world airports. If an airline updates its fleet with a new type of aircraft, and the airport is not ready to service such an aircraft, then the airline will have to leave the airport or purchase a suitable aircraft. (Kivits et. al 2010, 204).

From the perspective of aircraft manufacturers, this transition procedure is also undesirable and very long. By releasing a new technological aircraft, the company expects that it will operate for at least 20 years, since it pays for itself in about such a period. It is unprofitable for the manufacturer to release a new product before the old one has paid for itself. However, anti-pollution activists can press manufacturers, as well as the situation with the rising cost of fuel. (Kivits et. al 2010, 205).

The community is the only link for which the transition to a new type of fuel is beneficial, since it entails less emissions into the atmosphere and a reduction in noise generated by turbines. However, from the point of view of security, the community may be wary, since the introduction of new technologies entails unknown risks. The government is trying to balance the economic benefits of the airport and the well-being of the community. (Kivits et. al 2010, 205).

As a result of this study, it becomes clear that such a transition of the aviation industry will take a lot of time and resources since the main engine of such a transition is the community and environmental regulation. This transition is not in the interests of manufacturers, airlines, airports and the governments. This supports my suggestion of rather imposing restrictions on air travel and putting more resources into other, more environmentally friendly ways of transport such as trains. If it seems unlikely that a new type of environmentally friendly fuel could be utilized in the near future airplane manufacturers and airlines might not be able to come up with a solution that would protect their industry from sanctions and restrictions imposed by governments and/or international organizations wanting to act fast to prevent the most catastrophic consequences of climate change.

In the article “Futures of autonomous flight: Using a collaborative storytelling game to assess anticipatory assumptions” (O. Belton and S. Dillon, 2021) attention is drawn to the future of autonomous flights, and the main goal of the researchers is to determine if the society is ready to trust this kind of a transport.

The study begins with the fact that according to the measurement of the desire to fly it was conducted that more than 50% of the respondents feel some level of discomfort related to flying without a pilot (Mehta, Rice, Winter, & Eudy, 2017). However, there is also a contradictory study from the Ansys Global Autonomous Vehicle Study, which conducted that 58% of respondents are in fact ready for an unmanned flight (Ansys, 2019). Neither study provided explanation of why the respondents chose one or the other option. For this reason, the authors "Futures of autonomous flight: Using a collaborative storytelling game to assess anticipatory assumptions" decided to conduct their survey in the format of a collaborative storytelling game which is a narrative futures method. (O. Belton and S. Dillon 2021, 2).

As a result of their study it became clear that the participants focused more on the problems of unmanned piloting than on the positive aspects. It has been proven that the participants of the study, not being experts with deep understanding of the question at hand, build their opinion of the benefits/doubts of new technologies based on their own cultural and political context. Society has doubts about the integrity behind technological advancements and people question the credibility of businesses and the government. There are also concerns about the climate crisis. Therefore, future stakeholders trying to implement autonomous flight will have to work on explaining the positive aspects of the introduction of such a system to convince people to trust an unmanned flight. (O. Belton and S. Dillon 2021, 12).

This relates to my idea about consumers choosing an alternative way of transport. Even though I mainly explored this from the environmental point of view it is just as possible that consumers will choose something else over aviation if they feel like they cannot trust the flight to be safe enough to get onboard. Even though it is likely that unmanned transportation will become the rule rather than the exception in cars, buses and trains alike, it seems as though people have an easier time in trusting something unmanned when its moving on the ground, not at high altitude.

In the article "Airport futures: Towards a critique of the aerotropolis model" (Charles et al., 2007), the authors aim to explore a possible concept of "aerotropolis" where the airport will be presented as a city with residential quarters for workers, with factories for the production of necessary machines and products along with roads and railway infrastructure.

Such a project was not adequately considered from the point of planning and public policy. This article raises questions about three different dimensions of the long-term sustainability of the aerotropolis, such as energy provisions, infrastructure security and export pathways. (Charles et al. 2007, 1009).

The main drivers of the aerotropolis were identified as B2B (business to business) transactions on which the economy will be built. The Internet and telecommunications can make it possible to have business connections from a distance and tourism would still be considered as an important factor of economy. (Charles et al. 2007, 1013).

Regarding energy for airplanes, the authors are inclined to the popular opinion that the transition to another fuel is not expected in the near future because the transition to a very different energy resource will take a lot of time and resources. The only hope is that soon it will be possible to find a new type of fuel suitable for current aircraft turbines. The authors of this study also pay attention to lithium hydrogel as a possible replacement for aviation fuel, but note that it gives three times less power and requires four times more storage space. Therefore, the transition to lithium hydrogel is impossible without a large-scale change of the entire aviation system. (Charles et al. 2007, 1014-1016).

An important issue in the study is the safety of the aerotropolis from a terrorist threat. Aerotropolis will contain a large amount of critical infrastructure which is a tempting target for terrorist attacks. These infrastructures will require special attention to ensure security which consequently will consume more resources. (Charles et al. 2007, 1020).

As a result of the study, the authors stated doubts that an aerotropolis is a suitable component in economical and regional development. However, they did research this possibility thoroughly. (Charles et al. 2007, 1024).

This study further strengthens the understanding that aviation as an industry might not be able to come up with a suitable alternative fuel option in time because climate change needs action that can be taken right away. Therefore, other action will be taken by another party and aviation might be at the receiving end of these acts. This study also explores the threat of a terrorist attack which I also concider as a major factor in the future of aviation.

The article “The emergence of a new international competitor in the commercial aircraft sector: The China syndrome” (MacPerson, 2009) studies the ability of Chinese passenger aircraft to compete with current market leaders Boeing and Airbus.

Rapid economic development contributes to an equally rapid development of Chinese aircraft construction. It is predicted that by 2020 China will become the largest market for passenger aircraft. The demand is so great that the industry may not have enough qualified personnel to operate these aircraft; however, it will create more educational and job opportunities. Subsequently, the Chinese aviation market will become very competitive. If Chinese aircraft are fully certified according to international standards and their prices are an order of magnitude lower than the industry leaders, they will be able to compete not only in their own market, but also internationally. (MacPerson 2009, 483).

Supported by public subsidies and state technological support, the Chinese aviation program can become a worthy competitor to Boeing and Airbus. With cheaper production, the profit of Chinese manufacturers will be much higher despite the lower price of the final product. All these factors can make Chinese aviation highly competitive in the future. (MacPerson 2009, 488).

The threat of a strong competitor might not only come from alternative types of transport but also from countries such as China which are eager to prove their place as a global superpower on the world stage. China has everything it needs to have a blooming future in aviation; enough consumers of its own to maintain a whole industry, potential to manufacture modern aircraft at high volumes and a government which might be less inclined to impose any sanctions related to climate change if it hinders the country's economical growth.

In the article "Modeling the effect of electric aircraft on airport operations and infrastructure" (F. Doctor et al., 2022), the author's goal is to identify possible ways to introduce and maintain electric aircraft.

In this study, the authors also note that the power from an electric battery at the moment is not comparable with the power of kerosene. For this reason, it is expected to use electric aircraft for short distances of 50-400 km. Also, the use of electric batteries is considered only for the use of small aircraft with 20 seats and in theory it is also considered for narrow-body aircraft and is completely excluded for wide-body airliners. The logistical and operational impact on the airport infrastructure is also questioned in the study. These questions concern the time to charge the aircraft battery and the possible change of parking spaces. (F. Doctor et al., 2022, 1-2).

The analysis of battery charging systems and parking stands carried out in this study are aimed at bringing benefits to this new field of research, seeking to develop an understanding of the introduction and application of electric aircraft. The results of the study, received through developed DES simulation models, show that even the introduction of a large number of electric aircraft will not greatly affect the airport infrastructure. (F. Doctor et al., 2022, 12).

Based on this study it seems likely that at some point in time electric aircraft will be introduced. However, it is also clear that this kind of transformation will take years, maybe even decades and even then it might only make short disatence flights with smaller aircraft possible. Even if this is the wanted direction the change might not be soon enough to compete with the factors I have introduced, including climate change.

In the article “A study of NASA's vision for the future of air travel” (McGrath, 2002), the author analyzes the vision of the future from NASA, in which small planes for one person will be used in the USA. In these miniature planes the passenger will be also the pilot. These planes would be located at all public airports and their main purpose be to save time and provide the ability to get from the point of departure directly to the desired point of arrival. The possibility of using a similar type of transport within cities at a distance of less than 50 km is also being considered.

In order to make this vision possible, it would be necessary to make many advancements in aviation technology related to ownership and cost of operations. This study investigated the cost of acquiring, owning and operating four possible aircraft configurations. The prices were compared with the prices of regular airline flights. During the study, it was revealed that this type of personal flights would be able to compete with airline flights, being quite economical, and in terms of time spent, this type of transport definitely was the winner. However, at the moment it would be technologically and economically necessary to make major adjustments for this system to be able to be put in work. (McGrath 2002, 190-191).

In the article “Forecasting airplane technologies" (Lamb et al., 2010), the aim of the authors is to foresee the introduction of new technologies in aircraft construction. The authors note that although in theory there are several new technological solutions in the field of avionics, composite materials and design, in practice their implementation faces great financial, economic and legal difficulties.

A large number of parameters influence the decision not only to present a new aircraft, but the costs of changing only the structure of the aircraft model is already too

high. For this reason, such a forecast is a big challenge. In order to avoid testing the volatile aviation industry, forecasters concentrate on one or few parameters only. (Lamb et al. 2010, 39).

According to the results of the study, the authors advise practitioners to calculate technological, operational and market goals very carefully. Thus, the authors note that the study shows the complexity of forecasting commercial aircraft introduction due to the strong volatility of all parameters that affect aviation processes. (Lamb et al. 2010, 52).

In the article "Retrostrategy: is there another chance for lighter-than-air vehicles?" (Windischbauer and Richardson, 2005) the aim of the authors is to study the possible return to the use of airships, which would be more economical and environmentally friendly than the use of airplanes and helicopters.

In the past, airships were seized from being used as a means of transportation due to the tragic consequences of using hydrogen as a lifting gas. To replace hydrogen the authors consider non-flammable helium, which, although heavier than air, would reduce the lifting force by 10%. Designers of airships would have to adapt to these changes. (Windischbauer and Richardson 2005, 58-59).

Airships, or LTA (lighter-than-air) have other problems too. For example, becoming lighter during the flight due to fuel consumption, the airship needs to get rid of excess ballast. When using hydrogen to reduce ballast, the pilots released gas into the atmosphere, but with helium this is impossible due to its cost. One of the advantages of LTA is a long stay in the air (up to one week), as well as the fact that there is no need to use any energy to keep it motionless in the air. (Windischbauer and Richardson 2005, 59).

The development of modern airships may be worth it if they are built for the purposes in which they can manifest themselves due to their unique characteristics. In surveillance and tourism tasks, airships could outperform airplanes and helicopters. However, the feasibility of airship construction projects is very small due to physical and economic barriers. (Windischbauer and Richardson 2005, 64).

In the articles above which are written in the modern times, I have found many crossing points with my own theories. Mostly I found that many of the possible changes in aviation itself will take years to complete and will require a lot of resources. All the changes which are needed to make aircraft more environmentally sustainable require drastic remodeling and re-organizing of not just the aircraft itself but of airports and other infrastructure related to aviation. Even though it seems there is potential in designing a more sustainable aviation industry by diverting to a different source of energy or by

replacing traditional aircraft with something else, it is clear these changes are very fundamental and would take many years to complete. What further complicates this type of changes is that they would have to be planned and performed unilaterally between all ICAO countries and agreeing together on something so impactful might prove to be a harder task.

Therefore I see likely that what I explored in my theories of outside-sourced sanctions imposed on aviation due to climate change would happen sooner than a new functioning, sustainable industry is being built. Also I see it likely that some parties might take advantage of the flux in which airlines will be in and introduce some powerful competition whether it be in the form of high-speed trains, LTA´s or one-person miniature aircraft.

Next, I am going to look at articles written between 1969 and 1995 and see how past futurists imagined aviation of our days. In the article “The future of civil aviation” (Boorer, 1969), the researcher's goal is to predict only the physical aspects of the configuration, power source and speed, and how they may affect the future of transport communications.

In the study, Boorer considers an increase in the size of aircraft (bigger than Boeing 747 Jumbo-jet) as impossible because an increase in the weight of the aircraft entails a decrease in the carrying capacity, which is unprofitable and therefore undesirable. However, he also notes that with the development and use of lighter materials in the future, an increase in the size of aircraft could be possible. (Boorer 1969, 209-210).

From the examples of Boeing and Airbus we can see that Boorer was right since larger aircraft were created, such as the Airbus A-380 and Boeing 777-900, which are ahead in size and capacity of the Boeing 747 Jumbo jet of that time. Mostly the increase in size has been made possible due to the use of lighter materials and more powerful engines.

When coming to fuel, Boorer notes that the aircraft is filled with fuel by 50% of the entire size of the aircraft, and being more economical with fuel could increase the vessel’s capacity. Boorer considers only lithium hydrogen as an alternative to kerosine but notes that the power generated by this fuel is quite small, and for a flight on lithium hydrogen, its amount should be four times more than aviation fuel. Boorer does not see a speedy transition to a new type of fuel. (Boorer 1969, 211).

Unfortunately, this forecast turned out to be correct, since aviation is still using kerosine today and it is not expected to be replaced soon. The difficulties of switching to a new type of fuel are discussed in the study of Kivits et. al (Kivits et. al, 2010).

Boorer's research focuses on ultrasonic passenger flights and arguments about increasing the flight distance of the Concorde. The author believes that ultrasonic flights are the future. (Boorer 1969, 218). This forecast has also not been confirmed and to date, ultrasonic passenger transportation is not being carried out.

Another article from the not so distant past, "Paths to an air transport future" (Caves, 1995), aims to explore the future of aviation during technological stagnation in the industry.

Most of the assumptions made by forecasters of the 70s; supersonic transport, aircraft with 1,000 passenger seats and intercity planes with vertical takeoff, were thought to prevail by the year 2000. As we now know, none of these have happened even by the year 2022. The introduction of new technologies is a very complex and costly process. Due to the increase in fuel prices, aviation manufacturers have focused their resources on creating more economical aircraft rather than exploring totally new technologies. (Caves 1995, 857).

The article by Caves is based on the idea that the longer the industry holds off before introducing new innovations, the more difficult it will be to present them in the face of even more specific preferences. Caves also highlights that real innovations usually appear unexpectedly rather than being developed to certain specifications. (Caves 1995, 858).

According to the results of the study, the type of technologies useful in the future need to reduce the environmental impact, respect the maximum allowable size of the aircraft and provide the maximum possible increase in passenger seats without additional charge for the consumer. (Caves 1995, 866).

All of Caves' findings seem accurate and relevant still today, which proves that perhaps due to the aforementioned issues related to renewing aviation fundamentally, airlines and aircraft manufacturers have chosen a more careful approach and not so much ventured toward any more exotic innovations. It is also noteworthy that for a long time the improvements introduced in every new aircraft model were considered by consumers satisfactory and exciting enough to the level that aviation as an industry was blooming all the way up to the COVID-19 pandemic which most likely woke the industry to rethink some aspects of its functions and how they can be better secured.

The article Introducing technologically advanced products: ”Strategies in the commercial aircraft industry" (Gillett and Stekler, 1995) explores the planning and implementation of new technologies in commercial aviation.

The paper compares the strategic decision-making of two market leaders at that time — Boeing and McDonnell-Douglas (later bought by the Boeing Company) for the period 1976-1983. Comparing the examples of these two companies the authors hope to identify some basic principles of decision-making by large corporations on the introduction of new technologies. (Gillett and Stekler 1995, 129).

In their study, the authors examined the external environment for the presence of key factors. Fuel prices, deregulation and a new competition were considered. Further, the authors examined in detail the internal environment of both companies in order to understand how companies react to the external environment. (Gillett and Stekler 1995, 131).

The next step in their study was to identify opportunities and risks. The authors drew attention to the fact that the introduction of a new type of transport (a new model of aircraft) carries great risks. In order to achieve the goals of creating more economical and modern aircraft, companies will need to financially mortgage all the property of the companies, which in case of failure will entail an imminent catastrophe for each of them. Furthermore, manufacturers need to wait approximately four years until they see profit. The authors also concluded that healthy competition alone does not guarantee that the companies´ product will be bought at the asking price. As the main opportunity for airlines, the authors considered the need for more economical and smaller aircraft due to the lack of fuel and its high cost. The manufacturing companies Airbus and McDonnell-Douglas on the other hand were expected to get a lot of interest from airlines with an outdated fleet. (Gillett and Stekler 1995, 133-134).

As a result, both companies, assessing the risks and opportunities, ended up making different decisions. McDonnell Douglas, having only a one-time commercial success with its DC-10, planned to release a new DC-11 model, but received a lot of pressure from Wall Street. The company was struggling to get the financial support it needed and their reputation was further damaged when a DC-10 crashed in Chicago. In the end McDonnell Douglas decided not to risk all of their property for the release of a series of the new DC-11 aircraft.

Boeing however, enjoying greater popularity and a good reputation due to its successful aircraft 747, took a risk and released two new aircraft models despite the same pressure from Wall Street. Boeing made this risky decision knowing it was the only way to stay in business. (Gillett and Stekler 1995, 140).

The result of the study shows that the release of new technologies and products entails more than just an analysis of risks and opportunities. Both companies were aware of the risks and opportunities of the commercial market and each company responded regarding to its strategic vision. The strategic decisions of both companies were based on their previous experience and their willingness to take a risk. Boeing innovated faster than McDonnell Douglas, thereby being one step ahead. It can be summed up that strategic decisions can be based on the historical path of the company, its vision of its business fundamentals and the desire to take risks. (Gillett and Stekler 1995, 140-141).

From the studied articles I gathered a large understanding of how aviation has been perceived in the past and in more recent times. Modern futurists see the future of aviation as a future of a modified power resource or a modified design of aircraft. Electricity and biofuels are in the centre of discussion about alternative sources of energy and artificial intelligence and unmanned flights are seen as the inevitable next steps. In all modern articles futurists are most concerned about the complexity of the transition to new technologies due to the need for changing the entire ground service infrastructure. The second concern is the high price of manufacturing new aircraft engines and implementing new aircraft especially while the aircraft models in current use might not have made enough profit to their companies yet. To conclude, a fundamental change in aviation is needed, however it will take a long time and be a costly procedure which companies might be reluctant to rush toward.

It has been concluded that change in aircraft power units will entail a change in ground infrastructure as well. Studies have been conducted to determine the future of airports with special attention to parking spaces and maintenance (F. Doctor et al., 2022) as well as complete modification of airports (Kivits et al., 2010) and their transformation to an aerotropolis (Charles et al., 2007).

From the articles published further in the past it can be concluded that the futurists assumed more dramatic innovations would be introduced by the 21st century, such as development of supersonic passenger aviation (Caves, 1995). Futurists back then were also confident that it was necessary to develop composite materials to build more spacious and light aircraft (Boorer, 1969). To date, aviation has made a big step forward in the use

of composite lightweight materials. Additionally it was discussed how the introduction of new technologies and creation of new aircraft models were concidered high-risk and companies who climbed to the top of the industry today had to take significant risks to make it to their current position (Gillett and Stekler, 1995).

Studying the data of futurists' articles confirmed that in my research I have been looking for key factors and driving forces in the right areas. My theories about the challenges of introducing new technologies, making aviation more sustainable, as well as my ideas of a strong competitor were supported by the research of fellow futurists.

However, these studies did not cover the possibility of a sudden external disasters (wild card event) and their subsequent impact on aviation. The articles I found related to my research topic mostly discussed aviation and its possibilities of development in a positive light. As I have concluded, the future of aviation in the aforementioned articles is considered problematic, yet hopeful.

My research on the futures on aviation will take into consideration many possible futures, including ones impacted with wild card events. This research will be useful in its content for responsible persons in the field of aviation and in particular Finnair to determine, analyze and better understand about a broad variety of factors that are likely to affect futures of aviation in the next twenty years. Taking into account the images of the future presented later in my work, this research can be prepare those involved to deeply understand the threats and opportunities that the future may present.

In the next paragraph I will explore the case of Finnair in more detail and determine its interaction with the macro environment. Finnair is used as a case study of an international modern airline which is set to meet all the same factors and challenges as any other international airline. Therefore it can serve as an example and a more specific analysis of how the futures of aviation come to life through individual operators in the field.

# 5 FINNAIR AS A CASE STUDY

## 5.1 About Finnair

For a more detailed study of the components of an international airline and an international airport, Finnair and Helsinki International Airport will be considered.

Finnair is the national airline of Finland founded in 1923 in Helsinki-Uusimaa. Finnair's fleet consists of more than 80 aircraft, most of which are manufactured by Airbus. The Finnair fleet is one of the youngest in Europe which ensures a reduction in exhaust emissions for they have been manufactured with the goals of sustainability in mind. (Finnair fleet 2021.) This information is confirmed by Airbus whose newest aircraft are much more economical and environmentally friendly than previous generations. The information and statistics of Airbus´ aircraft and their sustainability are discussed in detail in section 3.3.

The largest aircraft of Finnair is the Airbus A350-900. This wide-body long-range aircraft is equipped with a spacious cabin and the latest technologies that provide fresh air, a comfortable landing and natural light penetrating through large panoramic windows. At the moment, the company owns 16 aircraft of this type, three more awaiting delivery. The capacity of each A350-900 is 297/336 passengers, and the length is 66.9 meters. The wingspan of this aircraft is 64.8 meters, the cruising speed reaches 900 km / h, and the maximum flight altitude is 13,100 meters. The production of the eldest A350-900 of Finnair was completed on 6th of October 2015. These aircraft are used for long-distance routes, especially to Asia and North America. (Finnair fleet 2021.)

The company's second largest wide-body long-haul aircraft is the Airbus A330-300. This aircraft can accommodate 289/263 passengers, and its length is 63.6 meters with a wingspan of 60.3 meters. The cruising speed of this aircraft is 890 km / h, the maximum flight altitude is 12,600 meters. Finnair owns 8 aircraft of this type, the oldest of which came out of production on the 26th of March 2009. These aircraft are used for long-distance routes mostly to Asia and North America. (Finnair fleet 2021.)

Finnair’s most numerous narrow-body airplane is the Airbus A321. There are 19 such aircraft in the airline, the oldest of which came out of production on the 28th of January1999. This aircraft accommodates 209 passengers with a length of 44.51 meters and a wingspan of 34.1 / 35.8 meters. The cruising speed of this vessel reaches 840 km /

h, the maximum flight altitude is 11,900 meters. This aircraft model is used by the airline for flights in central and eastern Europe. (Finnair fleet 2021.)

Finnair owns 10 Airbus A320 aircraft which are the bestsellers of the Airbus company. This aircraft accommodates 174 passengers with a length of 37.6 meters and a wingspan of 34.1 meters. The cruising speed of the A320 is 840 km / h, and the maximum flight altitude is 11,900 meters. This type of aircraft is used by the airline for flights to central and eastern Europe. The oldest aircraft was finished on the 28th of February 2001. (Finnair fleet 2021.)

The smallest member of the Airbus family in the Finnair fleet is the A319. There are 6 such aircraft in the company. They accommodate 144 passengers with a length of 33.8 meters and a wingspan of 34.1 meters. The cruise speed of the A319 reaches 840 km/ h, and the maximum flight altitude is 11,900 meters. These aircraft are used at close distances, in this case for flights across Europe and Scandinavia. The oldest A319 Finnair was produced on 31.08.2000. (Finnair fleet 2021.)

Finnair has a subsidiary company Norra, which owns a fleet of narrow-body small aircraft for short-range flights, mainly domestic. One of the most popular small-sized jet aircraft is the Brazilian Embraer 190. Norra owns 12 such aircraft, each of which accommodates 100 people with a length of 36.2 meters and a wingspan of 28.7 meters. The cruising speed of the Embraer 190 is 850 km / h, and the maximum flight altitude is 12,300 meters. The oldest aircraft of this type in the Norra fleet was produced on 14.12.2006. (Finnair fleet 2021.)

The smallest aircraft in the Norra fleet is the turboprop ATR 72-500. There are 12 such aircraft in the airline. Each of them accommodates 68/70 people with a length of 27.2 meters and a wingspan of 27.1 meters. The cruising speed of the ATR 72-500 reaches 463 km / h, and the maximum flight altitude is 7,620 meters. (Finnair fleet 2021.)

From this information, it becomes clear that Finnair is a large international airline with a young fleet of aircraft capable of transporting thousands of passengers daily on long and short distances.

### 5.2 About Helsinki International Airport

Helsinki International Airport was built for the 1952 Summer Olympics in Helsinki so the airport celebrates 70 years in 2022. By 2019, the airport provided jobs for 25,000 people, as well as 1,500 companies operated at this airport. (Helsinki airport 2021.)

The location of Helsinki International Airport is its advantage since the shortest route from Asia to North America lies through Helsinki. The airport is in constant innovative development, maintaining the status of one of the leading airports in the world. This includes efficiency and high quality service at all times for passengers and airlines. Considerable work has been done at the airport to achieve user comfort, including in interior design. Finland is an advanced country in technological innovation and systems have been tested at Helsinki Airport that increase the comfort of travel and minimize flight delays. Such innovative solutions are automation of customs, support of the runway at winter, efficient baggage transportation, etc. (Noronen-Juhola 2012.)

Helsinki Airport is operated by the state-owned Finavia Company and is the fourth busiest in the Nordic countries. Before the coronavirus pandemic, in 2019, the airport received 21.8 million passengers, including 18.9 million international passengers. On average, the airport had about 350 departures per day. Helsinki Airport receives about 50 regularly operating airlines, and also has about 80 destinations to other parts of Europe and 21 destinations in Asia, the Middle East and North America. About 35 charter destinations also pass through Helsinki Airport. Until the year 2022, Helsinki Airport had 2 terminals with 50 gates and bridges for airplanes and 80 free-standing parking spaces for airplanes. (Helsinki airport 2021.) Just this year the airport completed a major construction centering all flights to one modern terminal with new technologies to make security check more efficient and less time-consuming, along with modernizing the look of the terminal building. (Finavia 2022).

Finavia intends to strengthen the position of Helsinki Airport in transit passenger traffic between Europe and Asia, as well as increase the number of direct flights to Europe. The minimum transit time at Helsinki Airport is 35 minutes, which is one of the shortest in Europe. According to Finavia's research, one out of three passengers chooses a flight based on a transit airport. (Helsinki airport 2021.)

### 5.3 Finnair's economy and finances

Finnair is listed on the NASDAQ OMX Helsinki stock market and its biggest shareholder is currently the Finnish Government with holding of 55,90% of their over 1.4 million shares. (Finnair 2022)

For the purposes of economic responsibility, the board of Directors of Finnair has set the financial goals of the company, which are provided on the company's website as information for investors. Finnair is obliged to generate revenue for its investors, and in its financial reports it strives to be as transparent as possible about its financial position and development. (Finnair sustainability report 2019.)

Finnair contributes to the country's economy and acts as a major employer. By 2019, the number of Finnair employees had increased significantly and numbered 6,788 people. Most of the staff works in Finland, at Helsinki Airport and the surrounding area, as well as 645 employees working in 26 different countries abroad. By the end of 2019, 57% of Finnair employees were women and 43% were men. The Board of Directors consists of 7 men and 3 women. Finnair does not keep ethnic statistics in the company. (Finnair sustainability report 2019.)

### 5.4 Finnair's technological development and environmental responsibility

Like any major airline, Finnair follows technological development and uses only advanced materials and technologies to reduce fuel consumption and to reduce environmental pollution. The food and materials used during the flight leave a trace in the environment. Finnair aims to reduce the use of single-use plastic by 50% by the end of 2022, which means eliminating 230 tons of plastic annually. Finnair is looking for ways to achieve carbon-neutral flights. The company's goal is to achieve this by 2045. By 2025, Finnair wants to have reduced emissions by 50% from the level of 2019. (Finnair material management 2019.)

To achieve a reduction in CO2 emissions, Finnair will reduce the weight of aircraft, as this has a direct bearing on fuel consumption. Finnair also increases the use of sustainable aviation fuel. The airline's partner is Neste, the world leader in the production of biological aviation fuel from recycled waste. Finnair also invests in the development of new solutions, such as synthetic fuel and electric power flights. (Finnair material management 2019.)

### 5.5 Finnair's social responsibility

The growth of Finnair and the current network of routes starting from Helsinki makes it possible for Finland to have a more convenient connection with other parts of the world.

This is of great importance for travel opportunities for Finns and for the business sector. Furthermore, the aviation sector is a major job creator in the Finnish society. (Finnair sustainability report 2019.)

Without such a means of transportation and communication as aviation, society will not be able to contact and develop to the same extent. Especially in more remote regions of the planet, such as Scandinavia and the Nordic countries, aviation is the main way of communication with countries important for the development of all spheres of humanity, such as the EU, the USA, and the countries of Central Asia. Finnair provides direct flights to these locations for Finnish citizens, thereby contributing to the development of tourism and business in the country. European and Nordic leaders work closely together in the political field and state leaders often visit each other and attend several meetings throughout the year, which is mainly made possible by fast and direct flight connections between these cities. (Finnair sustainability report 2019.)

In turn, Finnair also takes care of its passengers and employees. An important part of Finnair's social responsibility is taking care of employees and their working conditions. Employee management standards cover all aspects of social responsibility that have been identified as important. The HR policy covers all factors that may affect employees and their working conditions. Finnair regularly improves team and organizational work and monitors the state of the staff through surveys and questionnaires. (Finnair sustainability report 2019).

Finnair is fully responsible for the quality of user experience despite the fact that some operations are performed by airline partners. For this reason, Finnair carefully selects cooperation partners and ensures that they comply with all Finnair policies, norms and standards. (Finnair sustainability report 2019.)

The most important aspects of Finnair's responsibility are flight safety, food safety, responsibility to the individual customer and responsibility for cargo delivery. Finnair's security service covers all aspects of flight safety; security policy, security communications training, and so on. Finnair Kitchen is responsible for preserving food and groceries for all Finnair flight operations to a high standard of quality. Finnair Ground Operations are responsible for the quality criteria and quality control of ground operations provided at the airport. (Finnair sustainability report 2019.) In conclusion, all Finnair operations are aimed at taking care of employees and passengers, ensuring safe flights for any purpose.

### 5.6 Finnair during the COVID-19 pandemic

Since Spring 2020, the Finnish government begun to gradually apply restrictive measures due to the coronavirus pandemic. The country's main airline, Finnair, announced that its passenger traffic in April 2020 counted 16,100 passengers, which is 98% less than April 2019. The same number of airline cargo shipments decreased by 99.2% compared to 2019. Despite the low demand for transportation, Finnair planned to gradually return to full-fledged flights in early June 2021. The airline had to lay off most of its staff. To avoid further layoffs, Finnair was looking for ways to save on real estate prices, aircraft leasing prices and administrative prices in general. Such crisis measures remain in force until now, as the restoration of air traffic to the levels of 2019 will take two to three years. (Impact of COVID-19 on Finnair by Waselius & Wist 2020.)

### 5.7 Key factors explored from the viewpoint of Finnair

As Finnair serves as a case study for my research I will now explore the key factors determined in section 3 from Finnair's perspective. The key factors I identified as most significant for the futures of civil aviation are the factor of environment, factor of technology and factor of war.

As mentioned above in this chapter, Finnair is working hard on innovations and ways to make aviation more sustainable. Finnair claims to contribute to all 17 of the Sustainable Development Goals set by the United Nations which include immediate climate action and responsible consumption and production. (United Nations Sustainable Development Goals 2022).

However, as we have determined in the previous sections of this research, achieving sustainable ways of aviation is not an easy or fast process. Innovations take time and that level of innovations which would really make a difference, say, a more sustainable form of energy that would also work in practice, have not even been invented yet. At the same time, the Finnish Government who is also the main shareholder of Finnair, has to oblige with the international conventions and commit to taking responsibility for slowing down climate change.

As Finnair stated itself; ”The aim of the company is to bring revenue for its investors.” Therefore, Finnair is an important source of revenue for the Finnish Government which might make the politicians less inclined to impose sanctions against

their own company. However, Finland is a democracy and the people have a voice. If the citizens, becoming more and more aware of their carbon footprint, start to question this dynamic it could be devastating to Finnair. If aviation can not introduce innovations which would convince especially the young generations that flying is harmless to the environment, the connection between a government that is supposed to be leading the fight against pollution and the polluting companies will go under scrutiny. This kind of of political pressure might lead to the government choosing to sell its shares; an economical disaster for Finnair.

Another result caused by the factor of environment could be that the consumers would minimize their spendings on Finnair and only purchase services when it is absolutely needed. This kind of shift might enhance the question for business trips and cargo services but reduce the question for leisure travel and tourism services. One important selling point for Finnair especially considering business travel are its domestic flights which might become more desired as they are short and pollute less. Finland, being a relatively large country, is well-connected via railway but it is still slow to get from Helsinki to Rovaniemi. Therefore domestic flights might keep their question and under some circumstances even become more wanted if international aviation were to have regulations or limitations.

From the sphere of factor of technology, most are valid when looking at Finnair as an individual airline. Firstly, the company needs and wants to develop and renew itself, and at the core of this development is artificial intelligence. Finnair has already introduced the use of artificial intelligence in their customer service chatbots and mobile apps to use in aircraft maintenance. (Changing the world of travel, Finnair 2022)

From the information Finnair wants to provide it can be concluded that the company is more focused on working with their current infrastructure than putting resources into innovating something completely new. At the core of their development is the personalizing of customer experience and modernizing their existing technologies making customer and worker experience smoother. (Changing the world of travel, Finnair 2022).

Even though Finnair is not currently manifesting about unmanned flights or other more extravagant innovations, it is likely that in the future automation and artificial intelligence will take more of the workload of current Finnair employees eventually leading to such developments as self-driving aircraft or miniature aircraft for one person or a small group.

What comes to the factor of war has recently got more layers due to the ongoing war in Ukraine. When I first started to work on my research there were no significant signs of a war breaking out in Europe, neither that Finland, a country which has maintained neutrality post World War 2, would change its political line and want to apply to NATO (North Atlantic Treaty Organization, founded in 1949). However, both of these things happened in 2022; Russia invaded Ukraine which lead to a war and Finland has applied to NATO together with Sweden, another long-liner of neutrality, and their applications are currently in the process of being ratified by member states.

The geographical fact is that Finland has a more than 1300 kilometer long border with Russia and the historical fact is that Finland has fought two wars against the Soviet Union (The Winter War 1939-1940 and the Continuation War 1941-1944). Russia has also publicly stated multiple times that it does not approve of Finland joining NATO. Currently it is presumable that most of Russia's resources are tied to the prolonged 'military operation' in Ukraine. However, there might come a time in the future when Russia is more available to take action in the north and this is a major concern for Finnair.

Russia's invasion of Ukraine could be seen as the catalyst cause for Finland applying to join NATO and a sign that Finland is seeking more security in case any aggressions are targeted their way. NATO Article 5 concludes that if a NATO member state is the victim of an armed attack, all member states will consider it an attack against them all. Article 5 was first invoked in its history after the 9/11 terrorist attacks. (Collective defense and Article 5, NATO 2022).

Therefore, Finland soon becoming a full member of NATO, it is no longer a question of Russian-Finnish relations but those of Russia and NATO that will affect Finnair and its operations. A military conflict or war between Finland and Russia in the future is bound to take much larger proportions simply due to Article 5.

War and military conflict even in nearby areas can be of trouble for Finnair as we have already seen during the war in Ukraine. Because of the sanctions imposed on one another, Finland is no longer using Russian airspace for its flight routes to Asia but instead has had to divert them hence increasing flight time. This has cost Finnair and Helsinki Airport one of their major selling points which is the fastest route from the USA to Asia via stopover in Helsinki. Because the war in Ukraine is ongoing and because of Finland joining NATO it is unsure if Finnair will ever be able to restore its flight connections through Russian airspace. Due to the closing of Russian airspace all of Finnair's flight

connections to Russian airports have also been cancelled for the time being. (Finnair 2022).

Besides conflict with Russia, acts of terrorism, civil war and conflict between NATO member states are entities within the factor of war that could affect Finnair in the future.

### 5.8 Conclusion

It can be concluded that Finnair makes a great contribution to the economic development of Finland, being a large and responsible employer. Finnair also takes responsibility for the environment by equipping its fleet with the latest Airbus aircraft, using Neste's recyclable biofuels and applying the maximum possible recycling of waste. For the society, Finnair is an important conductor of communication with the EU, the USA and the countries of Asia and Eastern Europe, carrying out direct flights to many world capitals. Technologically, Finnair is an advanced airline that monitors progress and implements new technologies in all areas of its business.

Finnair's challenges lie in having the Finnish Government as its main shareholder which might become a conflict of interests for one of the parties as environmental policies and lawmaking becomes stricter and more immediate. Also the uncertain political environment in Europe lately is a cause for concern for Finnair. The war in Ukraine has already affected Finnair's operations by not being able to use Russian airspace and it might turn into the new norm as Finland will soon become a full member of NATO which Russia disapproves of. (CNBC 2022).

All of the most significant key factors that are going to affect aviation in the future apply to Finnair also. In Finnair's case I would determine the factor of environment and the factor of war as the most pressing and I have explored them more in the images of the futures I have created and will explore later in this research.

By this stage of the research I have collected information about the interaction of aviation with the macro environment, as well as compared the actions of Finnair with the information received. In the following paragraphs, I have composed a research material review with a detailed presentation of the data obtained, its analysis, as well as the creation of images of the future.

# 6 RESEARCH PROCESS

## 6.1 Literature review and method outcomes

For my research of Futures of Civil Aviation Operations and for my case study of Finnair I have used a mixed approach to the creation of the images of the future. The choice of my research approach was based on the experience gained at the Futures Studies program in the University of Turku. The main focus of the program was on such futures studies methods as horizon scanning, scenarios and images of the future. In fact, these are the methods that I studied most closely and that is why I was capable of applying them in my research.

At the first stage of the research I used horizon scanning for gathering information. Web-based data gathering, which is one of the methods of horizon scanning, allowed me to collect enough statistical information from the authorities ICAO and IATA and leaders of the aviation industry Boeing and Airbus as well as to collect information on the topic from articles published by futurists. All the gathered data gave me an understanding about the current state of the civil aviation as well as its development through the years and views about its future from the viewpoints of published futures studies researches and the aviation operators themselves.

I was paying special attention to the key factors and driving forces affecting the aviation sector in the macro-environment; political, economic, social, technological and environmental key factors. As a result, I determined what were, in my opinion, the most meaningful and significant key factors and driving forces for the futures of civil aviation. Since the case study of this research is Finnair, the identified elements are not only global, but also local, and are directly applicable to Finnair as we saw in section 5 of my research.

The second stage of the research was to distribute and analyze the driving forces and key factors identified. I first applied the 2x2 matrix which is an easy-to-use analysis tool that allows to arrange the elements by dividing them into four groups. The elements in these four groups differ in importance and probability. As a result, I determined four groups that radically differ from each other in the presence of elements in them. Since the elements relate to the fields of politics, economics, society, technology and environment, for greater clarity, I decided to place them in the PESTE table. I transferred the elements from the 2x2 matrix into the PESTE table. The result was four rows of elements, placed

in the field to which they belong. These four rows, each representing a viewpoint of their own, served as the basis for creating four different images of the future.

The third and final stage of the research was the creation of images of the future. The essence of images of the future is to provide information about the picture of the future in an accessible form. For example, in the form of a description or a short story. In this research images of the future are presented in a form of short stories describing a day in the life of a fictional character who is a resident of Finland and in one way or another involved in Finnair operations. In my images of the future Finnair serves as an example of an international airline throughout which I am able to demonstrate the key factors that impact all of civil aviation operations' futures.

Each of the four images of the future are based on elements identified during the research and located in the PESTE table. Each row of the table is the basis for one image of the future. There are four rows in the PESTE table, each of which represents the base for a separate image of the future. Therefore, I was able to form four different images of the future.

Below I will explain in more detail how I applied the selected methods for this research. To begin with, I have defined futures of civil aviation operations and Finnair as an example of an individual airline operating in this field as the focal issue of the study for which images of the future will be compiled. I took Finnair as a case study to demonstrate from the point of view of an individual operator, how these identified key factors will affect civil aviation operations.

During the process of horizon scanning attention should be paid to the following sources: threats, opportunities, publications and professional websites, articles written by futurists, industry leaders, innovations in other business sectors, competitors, customers, technology and global prospects. In the horizon scanning process for my research, I drew attention to trends, factors, weak signals and wild cards directly related to aviation, or occurring in areas indirectly related to aviation. As it was mentioned above, my main sources of data used are publications by the civil aviation authorities and the industry leaders as well as futurists publications. (Horizon Scanning: A Practitioner's Guide 2018)

Next I will elaborate on how I used the research materials and determined the key factors of environment, technology and war.

To identify political factors in the field of aviation, it was necessary to turn to the main political regulatory body responsible for civil aviation operations; the International Civil Aviation Organization (ICAO). ICAO is supported by 193 member States and is a

body working under the United Nations and it is responsible for the implementation of all norms of domestic and international flights.

Any changes in the relations between the participating countries on the political arena may lead to changes in ICAO regulations and/or imposing sanctions which affect aviation.

Based on my research from the ICAO web page, which includes topics such as Civil Aviation Statistics – ICAO classification and definition (ICAO 2009) and About ICAO (ICAO 2021), I have identified the political factors that affect the existence of civil aviation operations. Because Finnair is my case study some of these factors are specifically thought out from the point of view of Finnair further explored in Chapter 5. These factors are: that ICAO holds its position as the main regulator of the field and current conventions stay in place; some changes are made to the conventions and/or new conventions are put in place; global peace prevails; world war breaks out; Russian-Finnish relations are stable; Russian-Finnish relations are in crisis; strict environmental lawmaking; liberal political setting for aviation (no strict environmental lawmaking); Finland is denied from NATO membership; Finland becomes a full member of NATO; European Union, United Nations and NATO prevail as main world unions; EU, UN and NATO partly or completely seize to exist; a new Nordic Union is formed.

Next, I focused on identifying the key factors and driving forces in the field of economy. To identify the relationship between aviation and the economy, I turned to the reports by IATA, International Air Traffic Association. World Air Transport Statistics IATA report (2021) consist of statistical information for the past 20 years about RKP versus GDP, industry-wide passenger and cargo load factors and air tourist spending and the value of trade by air, and demonstrate the connection between aviation and the economy. The stable operation of aviation is interconnected with the stable growth of world GDP, with the growth of tourism and its contribution to the economies of countries, as well as aviation being a massive employer which strongly affects the growth of world GDP. During the global crises, economic growth has been falling sharply and always together with the aviation sector which again proves the strong relations between these two areas. (World Air Transport Statistics 2021.)

In this regard, I have identified scenarios within the economical factor affecting aviation based on the state of the world economy. These scenarios are: free trade global market, self-sustainable economies, economical sanctions in place, preference for local resources, products and labour; protectionism (limited market)

To determine the driving forces and key factors within the field of social life and how it connect with aviation, I turned to the information and statistics provided by ICAO Aviation Benefits Report (2019). From the information gathered it became clear that as long as we live in a world of open borders and opportunities, the need for aviation will only increase. Aviation is used for medical purposes, humanitarian aid and for the transportation of people and goods at a speed and capacity yet to be met by other forms of transport. Immigration is largely made appealing because of the fast and relatively affordable way of commuting back to meet one's relatives in another country, as well as taking leisurely trips in far, exotic countries. (Aviation Benefits Report 2019.)

However, it should be noted that with closed borders and restrictions which were introduced lately because of the coronavirus pandemic, the demand for aviation will certainly fall. Changes in the field of politics can greatly affect the social sector of aviation in the form of restrictions or sanctions which affect airlines operations.

In addition, modern technologies and the development of online communications can affect the demand in aviation. The increase in online communication can lead to a decrease in the need for face-to-face communication and therefore to decrease in the demand for air travel. Having reflected on the interconnections between the driving forces in the fields of politics, economics, technology and the environment, I have identified scenarios related to the social factor that are capable of impacting aviation: globalization continues; international social connections are in key role; open borders and free movement and relocating of people; globalization slows down or takes some steps back; focus on local communities; virtual relationships take more of people's time.

Technological and environmental factors in aviation are closely related, since most of the technological development of aircraft fuselages and engines is aimed at fuel economy and reducing harmful emissions into the environment. From the statistical information of the environmental reports of industry leaders Boeing (Global Environment Report 2020) and Airbus (Environmental responsibility 2019) it can be seen that over the past 20 years aircraft have become many times more economical and environmentally friendly than they used to be. Both manufacturers continue to work on creating more environmentally friendly engines and strive to achieve zero emissions in the future. Airlines are working on making their functions more sustainable as well, for example by reducing food waste and using renewable materials in their designs (Finnair 2021).

Despite these and many more efforts, the environmental situation in the world continues to deteriorate due to harmful emissions, and ozone holes in the atmosphere can

lead to critical consequences (Kweku et al., 2017). These facts are noted by consumers who are becoming increasingly aware of their carbon footprint and demand that companies take responsibility in also reducing their carbon footprint. In general, it might be that the efforts of companies in the aviation field are not enough or come too late to have a significant change. However, for the time being, the environmental factor is the main driving force for the technological development in aviation.

Artificial intelligence is another important technological driving force in aviation. AI may in the future completely replace most of the staff in the aviation industry, including the pilots (Lavrova and Shishkina 2018). The broader use of artificial intelligence may lead to a gradual but unavoidable change in the whole aviation infrastructure as airports will have to become more accommodating for new technology. Even though this change might seem distant right now it is certainly in the mix when looking at the futures of civil aviation operations twenty years from now.

Based on the information gathered from the Boeing (Boeing Global Environmental Report 2020), Airbus (Airbus environmental responsibility 2019; Autonomous flight. Leveraging machine learning to enable self-piloted operations 2022) I have identified scenarios in the fields of technology and the environment that can affect civil aviation operations. These scenarios are: new innovations for sustainable source of energy for aircraft will be invented; aircraft models will be renewed; the whole aviation infrastructure will be rebuilt; introduction of self-driving (unmanned) aircraft; innovations nor environmental lawmaking is on time leading to environmental catastrophe; artificial intelligence takes over.

For more help of turning the aforementioned data into images of the future, I turned to Peter Schwartz' 8-steps approach for creating such scenarios (Schwatrz 1991). The process is considered a guide to creating scenarios from the point of view of an organization and does not require strict adherence to each point. This means that other methods covering the basic parts of the process can be used to build scenarios. I thought this method suitable for building images of the future because images of the future are parts of a scenario.

I will briefly describe the 8 step method by Schwartz which is for organizational scenario design;

1. Identify focal issue or decision. The first stage involves making a decision regarding the identifying of a specific issue of interest to the organization or

requiring the organization to consider the future of this issue. (Schwartz 1991, 226).

2. Identify key factors in the local environment. The second stage includes listing of key factors that have an impact on the success or failure of the decision or issue defined in part 1 (Schwartz 1991, 227).
3. Identify and do research on the driving forces. The third part includes a list of driving trends in the macro environment that influence the factors in Part 2. This part requires attention to several areas of social life - political, economic, social, technological and environmental. This part is the most research intensive. (Schwartz 1991, 228).
4. Ranking by importance and uncertainty. In the fourth part, it is necessary to distribute the key factors and driving forces relative to their importance for the issue and relative to the level of their uncertainty, as the predetermined factors will be the same in all scenarios (Schwartz 1991, 228).
5. Selecting the scenario logics. The distribution results will become variables/logics of the axes from which the scenarios will differ. Determining of these axes is one of the main steps of the scenario generation method. The goal is to produce several different scenarios which are relevant to the focal issue. The elements from point 4 can be grouped relative to the logic that will appear after their analysis (Schwartz 1991, 229).
6. Fleshing out the scenarios. This can be done by referencing the elements from Parts 2 and 3, paying attention to each key factor and driving force relative to the logic of the scenario (Schwartz 1991, 230).
7. Implications. How an issue or an organization's decision looks in each of the scenarios, whether the strategy is good enough - these are the main questions, and can be answered by going through all the scenarios (Schwartz 1991, 230).
8. Selection of leading indicators and signposts. To get clarity on which scenario is unfolding, the researcher should spend time and imagination developing indicators and monitoring the environment (Schwartz 1991, 232-233).

Next, I will explain how I applied the Schwartz method to my research. First I identified as focal issue civil aviation operations and its development for the future of the next 20 years. Since civil aviation is constantly in interaction with other aspects of life such as politics, economics, society, technology and environment, it is needed to

determine what kind of driving forces and key factors in these areas will affect the development of the civil aviation and its operations. This leads to the second and third stages of Schwartz' process.

Using the horizon scanning method I was able to identify which I thought were the key factors and driving forces that will affect civil aviation the most. I paid attention not only to global forces, but also local, because the case study of my research is Finnair and I wanted to acknowledge the local factors affecting Finnair.

I continued according to the 4th stage of Peter Schwartz' method; ranking factors by importance and uncertainty. I applied a 2x2 matrix tool or "High Impact and High Uncertainty Matrix" to arrange key factors in the correct order. Subsequently, I determined which elements from the horizon scanning will be placed in the four different quadrants of the tool. At this stage it is important to note that the outcome of the process may be subjective since I determined the positioning of the elements individually, guided by my own understanding and knowledge. Based on my research I determined which of the driving forces can be considered high-risk and which low-risk.

I begun with the high uncertainty and low impact field and placed there which I thought the least possible factors with the least impact. I based this sector on the political setting of relative world peace and other driving forces emanating from it that affect the operations of civil aviation and Finnair in particular. These factors are the following; world peace prevails; some changes to international unions and organizations treaties are made (EU, UN (ICAO), NATO); Finland is a full member of NATO; however Finnish-Russian relations are stable; world economy is in protectionist market; artificial intelligence is considered untrustworthy and therefore not used; climate change is successfully stopped; world is connected; geography is in key role in determining which areas are in closer contact than others.

Next, I moved on to look at driving forces with low impact and low uncertainty. For this section I identified driving forces such as; EU and/or NATO and/or UN (ICAO) operate with status quo; some political tension and local military conflicts occur; Finland is not (yet, or will not be) a full member of NATO; therefore Finnish-Russian relations are stable; artificial intelligence is used but strictly under human supervision; globalization continues; sustainable aviation fuel is innovated; aviation for all purposes is widely used; also other forms of transport such as railways are increasingly popular; free movement of people and goods; free trade global market; developed countries are in efforts of stopping climate change.

Even though these are two rather different settings they both have in common the low impact on aviation. I determined these driving forces as having low impact on aviation because none of them fundamentally changes the way aviation functions. For example, even if alternative ways of transport become increasingly popular it does not affect aviation as long as aviation keeps becoming more sustainable as well or is still needed for the purposes of trade.

Next I moved on to look at driving forces with a significant, high impact. I then divided them into ones that are high uncertainty and the ones that are low uncertainty. In the high impact high uncertainty sector are some of the most terrifying driving forces such as; the decay of EU and/or NATO and/or UN (ICAO); Finland is denied membership of NATO; therefore Finnish-Russian relations deteriorate (Finland's fears of aggression might come true); globalization seizes and/or takes steps back; segregated world, no movement of people and goods; self-sustainable economies; climate catastrophe, inhabitable earth; world war; artificial intelligence outsmarts humans; aircraft models are radically redesigned; aviation infrastructure is rebuilt; aviation is no longer available for the masses but limited for a selected few such as governments and billionaires.

Last I came to the section of high impact low uncertainty which consists of driving forces that have a significant impact on aviation and are most likely to happen. Any one of these could be a weak signal leading to a wild card event and therefore they all should be monitored and considered with importance. The driving forces I identified are; the partly decay of EU and/or NATO and/or UN (ICAO); forming of new unions such as the Nordic Union; Finland becomes a full member of NATO; Finnish-Russian relations deteriorate; artificial intelligence is widely used in collaboration with humans; critical climate emergency; environmental lawmaking (strict); limited movement of people and goods; preference for local products and work force; aviation infrastructure has some developments (to better accommodate the use of AI); aviation is limited and/or no leisure travel via air takes place; globalization slows down.

I determined these driving forces as the most impactful because they all fundamentally affect or change the operations of aviation. I thought it more probable that aviation will be somehow restricted based on environmental lawmaking because in the findings of my research and other futurists' articles it was clearly stated that it is unlikely that truly sustainable aviation is going to be achieved fast due to the lack of any sustainable form of energy that would suit the current aircraft designs and to redesign an aircraft or the whole aviation infrastructure is a time- and resource-consuming process.

Based on my research it looks more likely that governments and international organizations will have to make stricter climate policies sooner than aviation can become sustainable on its own.

Below are all the aforementioned driving forces presented in the matrix in their correct section.


**Figure 9. High impact high uncertainty matrix**

After determining the driving forces and placing them in the correct order based on their impact and uncertainty I entered the fifth part of the Schwartz method which is determining the logic for scenarios, or in my case, the logic for images of the future. All four sections of the matrix differ from each other due to the state of the environment and the state of politics (peace or conflict). Therefore I though it most suitable to use as my logic to divide the sections based on the state of the environment and the state of politics.

Accordingly, I defined the axes as critical/neutral. As a result, I got 4 different quadrants, which can be used to make images of the future. These images of the future will have logic in the form of: critical climate, neutral climate, critical politics, neutral politics. These serve as a way to distinguish the different levels of the environmental factor and the political state. Neutrality in this case does not refer to a absolute neutrality but one that does not affect aviation as significantly.

Before proceeding to the 6th part of the Schwartz method, I used another tool for illustrating the data obtained — PESTE table. In this table, I will visually arrange the elements in the five key dimensions of the external environment: politics, economy, society, technology and the environment in four columns. Elements were transferred straight from the “2x2” matrix and each column of the PESTE table represents one of the sectors from the matrix. Each column with its own elements will serve as a basis of each image of the future (table 3).

**Table 3. Key factors and driving forces in the PESTE table**

| Factors affecting the industry of civil aviation | Image 1 Critical climate Neutral politics | Image 2 Neutral climate Neutral politics | Image 3 Neutral climate Critical politics | Image 4 Critical climate Critical politics |
|---|---|---|---|---|
| **Political** | *Partly decay of EU and/or NATO and/or UN (ICAO)*<br><br>*New unions are formed; Nordic Union*<br><br>*Finland a full member of NATO*<br><br>*Finnish-Russian relations deteriorate* | *World peace*<br><br>*Some changes to EU and/or NATO and/or UN (ICAO) treaties are made*<br><br>*Finnish-Russian relations stable (Finland in NATO)* | *EU and/or NATO and/or UN (ICAO) operate with status quo*<br><br>*Political tensions and local military conflicts occur*<br><br>*Russian-Finnish relations stable (Finland not in NATO)* | *Decay of EU and/or NATO and/or UN (ICAO)*<br><br>*World War 3*<br><br>*Finland is denied NATO membership*<br><br>*Finnish-Russian relations deteriorate* |
| **Economic** | *Limited movement of people and goods*<br><br>*Preference for local* | *Protectionist market (limited)* | *Free trade global market*<br><br>*Free movement of people and goods* | *Self-sustainable economy*<br><br>*Segregated world; no movement of people and goods* |
| **Social** | *Limited leisure travel via air*<br><br>*Globalization is slowed down* | *Virtual relationships are the main form of communication* | *Globalization continues*<br><br>*Aviation for leisure and all purposes widely used* | *Globalization seizes and/or takes steps back*<br><br>*Aviation only used for government purposes* |
| **Technological** | *Collaboration; AI and human*<br><br>*Aviation infrastructure has some developments* | *AI considered untrustworthy; not being used in aviation*<br><br>*Sustainable aviation fuel is innovated* | *AI used strictly under human supervision*<br><br>*Alternative ways of transport (railway) increase* | *AI takes over*<br><br>*New models of aircraft*<br><br>*Aviation infrastructure rebuilt* |
| **Environmental** | *Critical climate emergency*<br><br>*Environmental lawmaking* | *Climate change is successfully stopped* | *Developed countries are in efforts of stopping climate change; no strict environmental lawmaking* | *Climate catastrophe; inhabitable earth* |

With the help of the PESTE table I got the base for each of the images of the future. The images of the future are presented in the next section of this thesis as the 6th step of Schwartz method “fleshing out the scenarios”.

# 7 IMAGES OF THE FUTURE

Images of the future should present all the considered elements in an understandable form. There are mainly two types of images of the future. The first type is a description of the future, clearly based on key factors and driving forces. This approach is perhaps more conservative, similar to a point-by-point report. The second type of images of the future is narrative, and the images are presented as a short story in which the key factors and driving forces are veiled in the storytelling involving a fictional character located in the image of the future.

Since I was drawn to the more creative options of the second type of images of the future I chose to provide my images of the future in the form of short narratives. Since the images of the future cover only a certain moment in the future, these images do not have a chronology before and after. All four images of the future are focused on a possible picture of the future in 2042, and are based on the identified during the research key factors and driving forces.

All four images of the future include Finnair, my case study, because through its individual example I wish to demonstrate the key factors and driving forces that will affect aviation in the future. The main location in the images of the future is Finland. Tomi, Mikko, Matti and Eve are fictional characters, Finnish citizens who, for various reasons, are participants in Finnair operations at that time. The names of the characters were chosen by me as typical and common Finnish names and they don't have any more specific meaning for the narratives. Finnair, in turn, also operates differently depending on the image of the future in which it is presented.

## 7.1 Image 1: "Smog above the ocean"

The first image of the future is based on the first row from the PESTE table called "Realistic Pollution". It is a short story of a character named Tomi, who in the beginning of 2042 is flying as a flight attendant from Finland to New York on a Finnair's plane. Below are presented the table, including all the elements serving as a base for the image of the future, as well as the image of the future itself.

**Table 4. Elements for Image 1**

| | |
|---|---|
| Political | *Partly decay of EU and/or NATO and/or UN (ICAO)*<br><br>*New unions are formed; Nordic Union*<br><br>*Finland a full member of NATO*<br><br>*Finnish-Russian relations deteriorate* |
| Economic | *Limited movement of people and goods*<br><br>*Preference for local* |
| Social | *Limited leisure travel via air*<br><br>*Globalization is slowed down* |
| Technological | *Collaboration; AI and human*<br><br>*Aviation infrastructure has some developments* |
| Environmental | *Critical climate emergency*<br><br>*Environmental lawmaking* |

Tomi was a ex-flight engineer onboard a wide-body Boeing on his way to New York from Helsinki. Since artificial intelligence had taken over most of the engineering work and many had lost their jobs, Tomi decided to stay in the aviation field and pursue the work of a flight attendant instead. In the cabin, robot-stuarts only stepped in in case some of the flight crew got unexpectedly ill. Customers still preferred the human-to-human service and therefore Finnair among many other airlines had chose to keep its human flight crew. Low-coster airlines however had had to replace most of their staff with robots by now since human workforce was hard to find in aviation nowadays.

It was the New Year's Eve of 2041 and Tomi was about to spend a few days in New York before flying back to the Nordic Union, a newly formed union which included Finland, Sweden, Denmark, Norway and Iceland as members. The new year of 2042 was going to introduce some new restrictions on air travel due to even stricter environmental lawmaking. Since mid 2030's governments had started to restrict leisure travel by air after realizing the climate change goals set some twenty years ago were not going to be achieved. Aviation had not been able to come up with changes to make the industry sustainable enough and therefore most governments begun the restrictions by allowing

each citizen to travel with an airplane 3 times a year. From this new year onwards, only traveling for most necessary reasons such as to meet a sick family member or for important business, would be allowed in the Nordic Union countries. Tomi was considered a lucky one, getting to still visit foreign countries while working. His children had only been on holiday in Norway and Sweden, and as much as they enjoyed it they always expected Tomi to bring some souvenirs from his working trips. This time Tomi intended to find a miniature Statue of Liberty to add to the collection of souvenirs.

The disagreements on how necessary it was to restrict aviation had boiled tension in the European Union; France, the home of Airbus was absolutely against any restrictions and Germany on the other hand was worried it would stagnate globalization and create more problems it could solve. Eventually this lead to the nordic countries wanting to be able to take their own, strictest possible measures, to minimize the most catastrophic outcomes of climate change. Henceforth, the Nordic Union was formed in 2036.

Russia, who was still sour about Finland joining NATO back in 2023 had turned its back on Europe and had never opened its airspace to European airlines even though the war in Ukraine had dimmed down to an occasional border dispute which most of the world considered as the closest thing these two would get to a peace.

The United States on the other hand had been the world leader in climate control measures after the country got re-united over climate crisis which had made most of the southern states inhabitable. Therefore it was an important partner for the Nordic Union in trade and information. Finnair had chose to transform its fleet from Airbus to Boeing because Boeing had a new low-roofed and wide-bodied aircraft model which consumed 5% less fuel due to its horizontal design. The Nordic Union and the US had business to do in other fields as well. Today Tomi's flight had an especially exceptional cargo onboard. Since the Nordic Union had banned all meat production due to environmental reasons Finland had an overload of cattle. The USA on the other hand wanted to purchase some because in efforts of integrating the people of the former southern states in the north, the government wanted to offer land and animals for agriculture. Therefore some fifty cows were now on their way to a new life.

Tomi took a deep breath and inhaled the mild yet inviting smell of Finnair cloud kitchen's all plant-based meal which the flight attendants were about to serve to the customers. Before pushing the food truck into the cabin Tomi took a look outside the window and saw smog above the ocean. A few years ago you would only encounter smog

in and around large cities but now it was spreading as far as hundreds of kilometers from the nearest metropolis. A feeling of worry entered Tomi's heart for a moment.

The lively chatter of his fellow flight attendants brought Tomi back to the present moment and he remembered what was expecting him in New York and a smile came onto Tomi's lips. For now, things were OK.

### 7.2 Image 2: "The Era of Electricity"

The second image of the future is based on the second row from the PESTE table, which is called "Unrealistic Cleanliness". In this story appears a character named Mikko, who in the beginning of 2042 is a passenger on a Finnair plane heading from Helsinki to Moscow. Table with the PESTE elements and the image of the future are provided below.

**Table 5. Elements for image 2**

| | |
|---|---|
| Political | *World peace*<br><br>*Some changes to EU and/or NATO and/or UN (ICAO) treaties are made*<br><br>*Finnish-Russian relations stable (Finland in NATO)* |
| Economic | *Protectionist market (limited)* |
| Social | *Virtual relationships are the main form of communication* |
| Technological | *AI considered untrustworthy; not being used in aviation*<br><br>*Sustainable aviation fuel is innovated* |
| Environmental | *Climate change is successfully stopped* |

Mikko met the New Year 2042 on board a Finnair plane en route from Helsinki to Moscow. Mikko had never been there but the tickets were cheap, so the spontaneous decision turned into reality. Mikko was nervous. He was on board one of the newest

Airbus aircraft powered entirely by electricity. This aircraft had passed all the necessary tests and had proven reliable, but it was Mikko's first time on an electric airplane and the quietness bothered him.

Electricity was only possible to use on short distance flights and the flight tickets for flights still powered by kerosine were insanely expensive because by law airlines had been required to overcompensate carbon footprint since 2030. Therefore Mikko had had to abandon his dream of visiting Portugal and chose a nearby destination instead. Of course he could have got to Lisbon by high-speed train which ran all over Europe, but he only had a few days off of work and preferred to spend more time in the destination and less time traveling.

The quietness of the airplane reminded Mikko of the time he spent in isolation during COVID-19 global pandemic in 2020 when he was just 11 years old. Since those years the multinational organizations and individual governments alike agreed that immediate and effectual action must be taken or otherwise a grim future would be awaiting. After some years of increased political tension and a successful uprising in Russia leading to change of government some compromises were made and the United Nations, European Union and NATO all had to adjust their position to prevent a full collide against Russia and China. Some compromises were more painful than others but Finland came out of negotiations as the winner being both a member of NATO and in good relations with Russia's new progressive government.

Russia had been an important asset to the European Union in pressing China to comply to international climate control measures and it seemed to have finally bared fruit. For the first time in decades scientists had a carefully optimistic view of the planet Earth's future. Part of this development was the slowing down and restricting global trade so that pollution could be controlled. This lead to a protectionist development as countries began to tax the incoming products higher in efforts of compensating the carbon footprint of transporting foreign goods. Even though protectionism was once considered as one of the worst things for world economy, it was a solution that helped stop climate change and was therefore accepted widely at least as a temporary solution while more sustainable ways of free trade would be innovated. The use of electric airplanes was a big step towards a more connected world where people and goods could once again move freely without the restraint on environment.

Mikko looked out of the window and saw the skyline of Moscow's skyscrapers in the horizon. He instinctively reached to his pocket to take a picture with his smartphone

and then remembered he actually had not owned one since 2 years ago. European Union had got into an argument with Apple over the use of intrusive artificial intelligence in their smartphones and ended up banning all use of artificial intelligence in personal gadgets. Artificial intelligence was considered more of a threat than a tool and therefore it was no longer used in technology in Europe. Mikko tapped his empty pocket and smiled. He remembered his childhood was filled with worry and anxiety and he never recalled anyone having the time to sit at a park reading a book. Now things were different and in his opinion, much better. It was as if the world had been given another chance and this time it was going to be done properly.

### 7.3 Image 3: "My colleague iJet"

The third image of the future is based on the row from the PESTE table called "Realistic Cleanliness". In this short story Matti is a Finnair's pilot, meeting 2042 on board, heading from Helsinki to Afghanistan. Table with the PESTE elements and the image of the future are provided below.

**Table 6. Elements for Image 3**

| | |
|---|---|
| Political | *EU and/or NATO and/or UN (ICAO) operate with status quo*<br><br>*Political tensions and local military conflicts occur*<br><br>*Russian-Finnish relations stable (Finland not in NATO)* |
| Economic | *Free trade global market*<br><br>*Free movement of people and goods* |
| Social | *Globalization continues*<br><br>*Aviation for leisure and all purposes widely used* |
| Technological | *AI used strictly under human supervision*<br><br>*Alternative ways of transport (railway) increase* |
| Environmental | *Developed countries are in efforts of stopping climate change; no strict environmental lawmaking* |

Matti met the new year 2042 in the cockpit of the new Airbus of Finnair, flying somewhere over Russia on his way to Afghanistan. Matti was the pilot but who was really flying the plane was iJet, an artificial intelligence technology developed specifically to independently handle all flight commands. Matti had just completed the last phase of his pilot training and was now able to fly alone with iJet without a human co-pilot. This was Matti's second flight alone with the machine, and an important one.

On board he had 5 surgeons, 15 nurses and 25 other people ready to enter Afghanistan to provide humanitarian aid for civilians in the ongoing war with neighboring Pakistan. The conflict had already lasted for 1,5 years but only recently foreign humanitarian helpers were able to enter the territory safely.

Matti found himself missing the chatter of a fellow pilot. Of course he could talk with iJet but the machine's development was mostly aimed at running the aircraft, not small talk, and perhaps that was best. iJet was first introduced for cargo flights but now Finnair

already had 5 passenger aircraft equipped with iJet. They operated on Finnair's most popular flight routes to New York, Los Angeles, Beijing, Dubai and Hong Kong. One of them was now lent for this special mission.

Finnair was a popular international airline for the reason that it operated the fastest route from USA to most Asian cities through Russian air space. For a while it seemed Finnair had lost that selling point back in 2022 when Finland applied to join NATO and it was thought Russia might never allow Finnish planes in its airspace again. However, Turkey had refused to ratify Finland's membership and the problem became so tense and ongoing that eventually Finland saw it best to withdraw its application. It then had to make sure Russia would not be a threat and after some intense peacemaking with the new Russian government all parties interests were aligned and Finnair got the privilege as the first western airline to begin operations in and through Russia.

While Russia was busy rebuilding itself post the Russian civil war of 2025-2030, China and USA enjoyed the shared limelight of world's greatest superpower. The movement of people and goods between these two giants was immense so Finnair had plenty of customers for both passenger and cargo flights. Matti had not yet been offered a permanent position as the pilot of a certain flight route but the one flying daily between Helsinki and Beijing was on his mind. He had heard some rumors that one of the pilots currently flying this route had been offered a job in France where Airbus was already in the process of another big leap; electric airplanes.

The project for making all flights of less than 3 hours inside the EU with electric airplanes had received an enormous amount of interest. The project was directly funded by the member states as a part of the more radical climate change control measures. The US had also taken a special interest in the project and Boeing was planning to do the same so that some national flights in America could be operated fully electrically.

To his right Matti saw the evening lights of Kabul. This meant that somewhere in front of him was the Bagram Military Airport. The airport was dark for security reasons, so Matti had to concentrate and back up iJet if something goes wrong during landing. Matti was aware of the importance of his role in this mission which gave him confidence that the world still does not belong to machines and artificial intelligence.

### 7.4 Image 4: "The End of The World"

The fourth and last image of the future is based on the row from the PESTE table called "Unrealistic Pollution". This apocalyptic story tells about the life of a character called Eve during the third World War. She is a lawyer in the Turku hospital in Finland and she is trying to visit her parents for Christmas using as a transportation what is left from the aviation – drones. The table with PESTE elements and the image of the future are provided below.

**Table 7. Elements for image 4**

| | |
|---|---|
| Political | *Decay of EU and/or NATO and/or UN (ICAO)*<br>*World War 3*<br>*Finland is denied NATO membership*<br>*Finnish-Russian relations deteriorate* |
| Economic | *Self-sustainable economy*<br>*Segregated world; no movement of people and goods* |
| Social | *Globalization seizes and/or takes steps back*<br>*Aviation only used for government purposes* |
| Technological | *AI takes over*<br>*New models of aircraft*<br>*Aviation infrastructure rebuilt* |
| Ecological | *Climate catastrophe; inhabitable earth* |

January 1, 2042. Eve rises from her knees, removing the parachute backpack from her shoulders. Finnair's drone had dropped her in a field above Hämeenlinna, not far from the bunker where her parents were waiting for her. Being outdoors during the war was

dangerous, and nearly impossible in the cold of -50 degrees Celsius, but it was still New Year's Day and celebrations took place among families all over Finland.

Bunkers in Finland were personal, usually for just one family, and were located directly under the house. Bunkers were built to last even the most extreme weather conditions which had become the norm due to climate change. In the bigger cities the bunkers were connected through tunnels so that residents could access the city's food and water supply and in more quiet times of the war even some events were held at the supply halls to entertain people.

Eve had not seen her parents for six months as she was busy working as a lawyer in the military hospital of Turku. Usually she went to see her parents together with her husband, they did not like to be apart during the war, but this time he couldn't make it.

Usually Eve, as everyone else, kept in touch with her relatives and friends through satellite phones as other technology was controlled by artificial intelligence and could be used by the enemy for intelligence purposes. Eve's father had got a cough from the air pollution for years but lately his condition seemed to have taken a turn for worse. That's why Eve chose to use one of Finnair's drones to make a visit to her parents even though it was dangerous and cost her a full month's salary. Before the war and in the Suitable Season, that is, the 3 month period between April and June when the climate was moderately mild and it was not dangerous to be outside, drones were a popular way of transport and were used by citizens to visit family and friends. Real, big airplanes were rare to spot nowadays as they were only used for military purposes and for government-level use.

The world was at war already for the 5th year. The lack of resources, climate refugees and the misuse of artificial intelligence to influence politicians led the world into chaos. The UN and the European Union were just shadows of the past as it turned out that every country had loyalty to only itself when it came to survival. Finland, being in the north, was one of the countries to be struck by climate catastrophes last and therefore it was able to construct a fully functioning underground infrastructure to maintain civil life.

Eve ran towards the bunker trying to breath as little of the poisonous polluted air as possible. Even the air-filtering mask that she was wearing could not fully protect her from the toxins that were in the air. The situation was worse than in years because enemy aircraft had been releasing toxic substances into the air in hope their opponent's infrastructure would fail and toxic air would get into the bunkers. That had happened just

last year in Norway when one bunker door was leaking and all of the country's food reserves got ruined resulting to thousands starving to death.

Eve successfully made it to her parents' bunker, where delicious food was waiting for her. The family had drinks to the lives of those who were at war, and tried to dispel bad thoughts while watching movies from their old laptop. Two dogs were lying comfortably on the warm floor by the virtual fireplace, adding atmosphere to the home idyll which they all desperately needed to be true in that moment.

# 8 RESULTS

## 8.1 Horizon Scanning research findings

To collect information on what will affect civil aviation in the future I used the horizon scanning method. I paid attention to sources such as publications, industry leaders, innovations, competitors and technologies and global perspectives.

The industry operators have official information channels such as websites where I turned to read their publications. In the field of aviation ICAO (International Civil Aviation Organization) and IATA (International Air Traffic Association) were my main sources of information. For information related to my case study Finnair I turned to their official information channels. I found statistics on the interaction of aviation with the fields of politics, economy, society, technology and the environment. From the statistical information of IATA, ICAO and Finnair, I collected data on the interaction of aviation with the economy, politics and society. Also, in addition to statistical data, I used additional literature in the form of publications of futurists on the topic of civil aviation.

I turned to the leaders of the aircraft industry, Boeing and Airbus, for technological and environmental statistical information to understand how the aircraft industry has changed over the past 20 years and what impact it has on the environment and what aspirations these industry leaders have for the future. Both companies had extensive statistical information related to environment.

After collecting all the necessary information, based on the research and my knowledge, in each area I identified the key factors and driving forces for civil aviation operations, taking into account global and local factors.

Accordingly, as a result of the horizon scanning, I identified the key factors and driving forces of the interaction of aviation with elements of the macro environment. Horizon scanning helped to expand the field of research and look for the interaction between aviation and the spheres that affect it directly and indirectly.

Through the research I discovered that aviation is subject to political restrictions, is directly related to the economy and vice versa, interacts with society and develops together with technological progress, thereby reducing the impact on the environment. As a result, the data obtained shows that aviation is a very important link in the functioning of the world as we know it, capable of both being affected and affecting the development

of the main spheres of life. One of the main goals of the politics is the economic growth, which in turn is dependent on aviation operations, since the world trade turnover functions with the help of aviation supplies. Tourism revenues also have a significant impact on the economy, and world tourism is supported by air transportation. Aviation is also an important element in the social life of people, serving as the main means of physical communication over long distances and geographical challenges. Unfortunately, aviation in turn harms the environment by intense polluting. This challenge is hard to be solved in aviation because of the difficulty of switching to more environmentally friendly technologies and energy source which is time- and resource-consuming.

The elements identified in my research cover a large spectrum of aspects of life which, as I have concluded, will most likely affect aviation in the future.

### 8.2 2x2 matrix and PESTE table

I used a 2x2 matrix, or "High Impact High Uncertainty" matrix to distribute the key factors and driving forces obtained during the horizon scanning across four different quadrants. As a result of this process, I got four quadrants with elements logically arranged by impact and certainty that were different from each other.

These quadrants served as the basis for creating images of the future. For a more visual representation of the elements and their correct order, I used PESTE table. In the PESTE table I have the results of the 2x2 matrix arranged in four columns where the elements are arranged by political, economic, social, technological and environmental sphere. Each of the four columns is the base for one of the four images of the future.

It is these results presented in the PESTE table that are the main results of data collection and analysis in this research. These four columns serve as a base for four descriptions of the world as it could be in the future in 2042.

They cover four different political states of the world, in which economic, social, technological and environmental processes are logically arranged accordingly, as well as their direct and indirect impact on aviation. This information helps to understand that any incidents in the world are possible, as well as that aviation is in full interaction with microenvironment and will be affected easily by even smaller changes.

This information serves as a reminder that we should pay attention to weak signals and be prepared for the worst outcomes. After all, since beginning my research, elements

which could have been presented as results of my study have come true in the form of war in Europe and Finland applying to NATO.

### 8.3 Images of the Future

I provided my images of the future in the form of short narratives, each of which is based on one of the columns of the PESTE table and is taking into account all the key factors and driving forces of the column.

As a result, I constructed four images of the future. Each of them describes a different picture of the world at the time of January 1, 2042. Because Finnair is my case study, the images are specifically thought out from the perspective of Finnair. Finnair is an example of an international airline which will be affected by the same driving forces and key factors as the whole aviation industry and I used this individual example of an operator of the field to demonstrate the most important key factors.

These images of the future cover a wide spectrum of possible events based on the key factors and driving forces identified during the study. This includes four political states transitioning from peace to war, accompanied by a logically possible development of the economy, society, technology and the environment in these conditions. Each image of the future represents a macro environment in which aviation, in particular Finnair, has to operate.

The main result of the exploration of the future of Finnair through the creation of images of the future is the formation of an understanding that aviation, as a very important component of the world economy and social connections, will most likely exist under any political circumstances. The main state fleet, such as Finnair, can be used both in peace and wartime, by reorganizing operational activities.

As a result of my research findings, it became clear that the main issue of aviation of the future could be the race against time and climate change. Aviation, as every aspect of life, will be heavily impacted by worsening climate catastrophes, yet aviation itself may lead us faster towards it. For this reason, today the leaders in aviation manufacturing are working towards sustainable solutions that would make aviation less polluting, more sustainable. The search for a suitable energy source is not easy because so far there is no ready option which would not lead to a serious reorganizing of the entire infrastructure of airports, ground service and the aircraft themselves. Therefore I consider it highly

possible, based on my research, that aviation will be subject to some sort of environmental lawmaking in the near future.

Now I will consider in more detail the results of each of the images of the future, which serves as the 7th step of the Schwartz method; implications. The main questions of this stage are what the issue looks like in each of the images of the future and how it could be solved. As images of the future conducted by futurists work as a guidance for decision makers such as politicians and company leaders, the problem solving part will be left to the consideration of decisionmakers. Next, I will identify describe the problems presented in each of the images of the future.

In the image of **"Smog above the ocean"**, events are based on the low uncertainty high impact driving forces. In other words, this is the image that is most likely to happen and will have a great impact on aviation when it does. In this image, the world is at the brink of a climate catastrophe and environmental lawmaking has kicked in restricting the movement of people and goods via air. These policies have also driven airplane manufacturers to compete against another in producing different styles of aircraft which would work more sustainably. A completely sustainable energy form has not been innovated so manufacturers have to turn to other ways to redesign the aircraft such as body, wings and weight.

From a political standpoint the image describes a shattered co-existance of nations that previously had formed a union but had fallen apart due to disagreements on how to handle the climate emergency. As a result globalization has slowed down and the alignments between nations are strongly based on the shared values. In the image Russian-European relations are presented as cold and unrecovered from the war in Ukraine.

Technologically, artificial intelligence has had advancements and is a vital part of working and personal life. AI has replaced some jobs but is still in collaboration with humans.

In the image **"The Era of Electricity"**, aviation has switched to the use of electric power. However, electricity can only be used in short-distance flights and due to environmental lawmaking and the high taxation of flight tickets, long-haul flights that are still fueled by kerosine are expensive and out of reach for an average citizen.

Politically, Finland is in NATO but thanks to the new more progressive government in Russia, the nations are in stable relations. However, some changes to how EU, NATO and UN work have had to be made in order to achieve world peace.

In this image the environmental crisis is mostly already behind and more neutral times are ahead. The governments and organizations have been able to unite together and make the needed changes so that the planet will not suffer any further. Also a high-speed train has been introduced in Europe as an alternative way of transport.

Technologically, this image describes a world where artificial intelligence has been for one reason or another doomed untrustworthy. The use of AI in data collecting had become a big political and legal problem which EU decided to solve by banning all use of AI in personal gadgets which lead to the decrease of technology use in general.

This image is compiled based on the matrix' low impact, high uncertainty section. Based on my research these are the possible factors that are unlikely to happen and if coming true, would not have a fundamentally changing affect on aviation. That is due to the fact that if aviation were to be able to start using and developing a sustainable energy form, it could perfect it and broaden it in the future until the field could completely change to full electricity or biogas or whichever sustainable energy it would be. In that case, even if alternative ways of transport emerge and become more popular it would not throw off aviation as long as it keeps up with the development and sustainability as well.

In the image **"My colleague iJet"** aviation is operating widely in all its forms contributing to the economy and humanitarian purposes as well as leisure travel. Artificial intelligence is present in most jobs but it is still supervised by a human.

Politically, Finland had decided to withdraw its application from NATO due to the tension and prolonged procedures it created but had still found a way to get into good terms with Russia, with a new political lead in charge there of course. This way Finnair has its advantage of operating the fastest connecting route from US to Asia.

Environmentally the situation is that developed countries are in efforts of stopping climate change and somewhat adequately succeeding in it, although no strict environmental lawmaking has been introduced.

This image is conducted based on the low impact low uncertainty section of the matrix and thus presents events that are quite likely to happen but do not have a fundamental impact on aviation. This is the closest image to the current status quo although with a slightly improved climate status.

The image **"The End of The World"**, is based on the high uncertainty high impact section of the matrix and paints by far the most frightening picture. In this image the world is in a chaotic state with a climate catastrophe that has made Earth inhabitable for

humans. Technology has provided humans to build livable bunkers and masks for staying outdoors but a raging world war is making things even worse.

Aviation is only a shadow of its former self and the infrastructure and design of ”aircraft” has drastically changed. Drones are the main and only way for individual people to transport via air. Airplanes as we know them now are only reserved for the purposes of the elite and military.

The climate crisis had torn multinational unions and organizations apart and eventually lead to a world war. Finland has been denied the membership of NATO and therefore has no protection from any aggressor. The world is segregated and free movement does not exist anymore.

Artificial intelligence is something to be afraid of, not thankful of, as it has been harnessed for evil purposes and also because it is capable of thinking and making decision on its own.

This particular image might seem as the most unrealistic of them all but it is crucial to remember that wild card events can occur very suddenly and force us to rethink what we thought was possible to happen.

In this thesis, I am not able to complete 8th stage of the Schwartz method, since it requires the long-term monitoring of the environment to determine which image of the future will unfold.

The images of the future compiled in this study serve as clear examples of the possible developments of the future. They are meant to be provided for industry operators to help them understand and prepare for the factors in question. It is important that the industry operators take into account a large range of possible threats and opportunities so that they can be well-prepared to even the most unprecedented events.

# 9 CONCLUSION

Civil aviation is an integral part of the development of the modern world and any geopolitical, economical, environmental and social events can greatly affect the development of this industry. The main goal of civil aviation is the fast, smooth and comfortable transportation of people and goods around the world, and today there are no competitors to do it better than airplanes.

However, the operations of civil aviation cause enormous damage to the environment in the form of pollution, which means that the more the industry develops, the greater are the chances of its collapse. Today, a huge number of human minds are working for the benefit of technological development, and technologies are becoming safer and more sustainable every day. Aviation manufacturers are coming up with innovative solutions to reduce harmful emissions and look for other ways to compensate the pollution in the meantime. The entire civil aviation industry invests heavily in the development of innovative technologies and environmental protection, realizing that without these actions the industry operations may come to an end.

However, aviation, due to its specific infrastructure, might be more challenging to change into a completely sustainable form of transport. As climate change is an inevitable fact, governments and international organizations and unions might need to impose strict environmental lawmaking if climate change wants to be stopped. Therefore aviation can be subject to restrictions in the near future.

Besides climate change, I identified the factors of technology and of war as the most significant driving forces that will impact aviation in the next twenty years. The factor of technology has a lot to do with the factor of environment, as technology is used to reach better environmental solutions. However, technology also has a path of its own which centers artificial intelligence and the capabilities to widely use it in aviation. Artificial intelligence is an exciting, yet complex technology which we are only learning the potential of. The things which AI is capable of today are already groundbreaking and the digital advances made in the last twenty years are unprecedented ones. Therefore I look with enthusiasm and also concern what role AI will have in the society and in aviation in twenty years from now. Artificial intelligence has the power to put a lot of people out of jobs and to fundamentally change all jobs imaginable. It has the power to make human life easier and more comfortable but it might also have the power sometime in the future

to think, decide and change society for its own benefit. In the field of aviation, AI can have an impact on many areas of aviation starting from customer service, ground services and flight navigation, culminating in unmanned flights.

The third key factor I identified as the most significant is the factor of war. As we have again seen during the war in Ukraine, wars and military conflicts can easily affect civil aviation operations. Flight routes can be re-routed or cancelled completely, economical sanctions can affect airline operations and most importantly, the safety of civil aviation can be at risk. The terrorist attacks on 9/11 had a profound impact on aviation and it brought the risk of terrorist attacks to the center of civil aviation operations' safety. Now and in the near future, the fear of how open military conflicts and war between nation states can affect civil aviation might take center stage.

It can be concluded that aviation is a field which has some unique advantages compared to any other. No other form of transport can move people and goods with as fast speed, capacity and efficiency as aviation. No other form of transport can overcome all geographical obstacles to get to the most rural and isolated places. No other form of transport serves with such diversity and multipurpose covering all aspects of life; tourism, immigration, humanitarian aid, medicinal transportations, politics, culture, economy, cargo and more. However, aviation is a field that is at crossroads. On the other hand there is the economical growth and the development to enhance profits and make customer experience even smoother, more personalized and comfortable. On the other hand there is the constantly increasing pressure of climate change and the need for immediate action. Companies in aviation have made sustainability their main goal, but the changes in practice are small. To have a real impact, aviation needs a more sustainable form of energy which so far is nowhere to be found. Current aircraft do not accommodate for electricity or biogas but no other options have been invented so far. The resources and time which it would require to change the aviation infrastructure and aircraft models to suit electricity or biogas are enormous, and the planet might not have that time. Based on my research, it also does not seem to be in the plans of any of the main operators of the field to do such changes. Therefore, aviation is in a race with time. Can it become sustainable enough before someone decides it needs to be restricted as a problematic polluter? Besides environmental lawmaking, the awareness of consumers is a factor for aviation. If aviation can not become more sustainable, consumers who are growingly aware of their carbon footprint will choose an alternative, more environmental-friendly way of transportation which will mean a huge economical loss for aviation. Time, and

more specifically, the next twenty years, will tell if aviation can change its reputation from a polluting way of transport to something sustainable and innovative. However, it can already be concluded that climate change is becoming a factor for aviation which it no longer can sweep under the mattress but one that will need to be addressed directly.

### 9.1 The role of Finnair and Helsinki Airport in the study

Since civil aviation is a very broad concept I chose Finnair as my case study to explore the driving forces and key factors which affect global civil aviation from the point of view of a single operator in the field. In this study, Finnair and Helsinki Airport are the case studies of an international airline and an international airport.

Therefore the images of the future I have conducted are also written from the point of view of Finnair, to demonstrate the opportunities, challenges and threats aviation will face in the future. A lot of the factors and driving forces presented in this research might seem abstract but I hope through the depiction of my images of the future they are presented in a more concrete and understandable way.

# 10 DISCUSSION

Firstly I want to say a quick word about the ethics of my research and the research materials I used. Even though one of my main topics in this study is climate change and how it will affect aviation, my sources can be biased on the topic based on the fact that industry operators are prone to want to portray themselves in a more positive light than what the reality may be. As most of my data which involves emissions, climate and aviation is obtained from within the industry instead of an objective outside party, there could be some bias there. However, I have tried to be as objective as I can as a researcher and acknowledge my research findings in the most realistic light possible.

As a result of this study it became clear that civil aviation is an integral part of the society. International trade turnover, migration of people, tourism and other fields depend on the successful functioning of aviation. The state of aviation and the demand for its operations also depend on the state of politics, economics, technology and the state of the environment. Statistics have shown that global crises are disastrous for aviation and the economy alike which demonstrates the strong relationship between these two fields.

With the help of the information obtained during the study, the key factors and driving forces affecting civil aviation operations and Finnair in particular were identified as following; the factor of environment, the factor of technology and the factor of war. These also correlate with each other as the advances in technology may have an impact for the environment and environment might be the main motive for technological advancements.

My study pays special attention to possible wild card events which can quickly and catastrophically affect civil aviation operations and global processes in general. All of the identified key factors entail several possible weak signals that might turn into wild cards.

Based on the identified key factors and taking into account possible wild cards, four images of the future for the year 2042 were compiled. They demonstrate the possible outcomes of the key factors and how they would affect civil aviation.

When I first started my thesis and began conducting the first versions of the images of the future there was no signs of Finland applying to join NATO or of Russia starting a war against Ukraine. At that time, I considered both of these (Finland joining NATO and Russia being at war with a European nation) as potential factors of the future. I was even planning to use them in my images of the future. However, just as suddenly as wild card

events occur, both of these things came to life much sooner than I could have anticipated. As I am now coming to the end of my research, the world and especially Europe is at a much different state than it was since I began my studies. I consider it an honor to be investigating the key factors affecting aviation as they are happening in front of me but it also provides a challenge because such major events are occurring that it could be safe to say we are living in the most uncertain times since the second World War. In the end I decided to revise my images of the future to better fit the current political state.

Accelerating climate change, COVID-19 pandemic and now the war in Ukraine are all events that have had a profound impact on aviation and they will continue to do so. At the moment it is unclear when or how the war in Ukraine is coming to an end, if it will lead to a larger conflict or the use of a nuclear weapon and how the ongoing crisis is going to affect nations and societies not just in Europe but worldwide. It is likewise unclear if and when Finland will get a full membership status of NATO and if Russia is going to react to that somehow as it has previously said it would. These circumstances could have just a while ago been listed on my research as potential factors to happen in the future and now they are happening. This proves that the topic of my research is very relevant and also serves as a reminder that even the factors that might seem unrealistic at one point can easily come true.

Even though the factor of war might be the one I had to work on the most as events kept unraveling in front of me while my studies progressed, it should be noted that the time frame I am looking at is twenty years from now. It is also likely that different things will be relevant at that time in the future and therefore I tried to approach all my significant key factors from various viewpoints and explore the different possibilities within them. A good example of this is the factor of technology; it goes hand in hand with wanting to make aviation more sustainable but it also has different courses to run which might be totally separate from sustainability.

The environmental factor is perhaps my favorite of all of the three. Aviation as an industry has survived several wars and military conflicts and even if they temporarily alter the operations of aviation it has never seized them completely. However, the environmental catastrophe we might soon find ourselves in has the potential to do that and much more.

As I am writing this the international climate summit COP27 is taking place in Sharm El-Sheikh, Egypt. In the opening of the summit the United Nations Secretery-General

António Guterres said: ”We are on a highway to climate hell with our foot on the accelerator.” (United Nations, 2022).

This statement has been true for a while now, in my opinion, yet no real change has happened. The prognosis of our planet is, even at its best, bad. Aviation has, as we saw in the statistics in my research, decreased pollution and is constantly trying to become more sustainable. Modern airlines, such as Finnair, offer the customers a possibility to buy climate compensation for their flight, although how accurate that compensation is is unclear and might mostly be just a way for the customer to clear their conscience.

No matter how you look at it, airlines are among the worst polluters in the world. It is also directly linked to the economy and as we have discovered in Finnair’s case, owned by the national government. Therefore the willingness to restrict or tax aviation highly has been low but soon the politicians might come to the conclusion we have no choice. The biggest problem for aviation is the fuel and the difficulty to fit any existing sustainable energy form into modern day jet engines. On the other hand, any better options have not appeared either. The process of transforming the field to accommodate for electricity or biogas or some yet to be invented form of energy will take a long time and an enormous amount of resources. However, this kind of fundamental re-establishment might become more attractive if true restrictions, not just high taxes, are put in place.

As we saw during the COVID-19 pandemic, in a time of crisis efficient tools can be put in place by governments to restrict the movement of people when it serves a higher cause. And as Guterres said, we are only so far from a full-blown climate catastrophe. Therefore the radical impact on aviation by climate change and environmental lawmaking which will follow, is something to consider with care. It will happen, and it will happen sooner than we think.

Even though my images of the future that I conducted based on my research might seem gloomy, they suit the current political and environmental atmosphere. The core of futures studies is to map out possible outcomes and create images of the future so that we can be better prepared for the events that can happen and impact our everyday lives. When you have understanding of something, individually or collectively humanity is able to prevent undesirable outcomes of events and help steer the progress towards a more hopeful future.

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