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Evolution of the Aviation Industry: Impact of Digital Transformation of Learning Solutions

(versão final após defesa)

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Abstract

Growing innovation in the aviation industry and the impact of Covid-19 is driving the transformation of learning strategies. Research has demonstrated the need and growth of digital learning solutions for the future workforce and so the purpose of this dissertation is to examine these new learning experiences and their impact on both academic and business environments in the aviation industry.

Based on the literature review of the evolution of the aviation industry, the impact of Covid-19, and the digital transformation of learning solutions, an online survey was made and distributed to potential participants. These participants were part of the aviation industry and were asked to answer eight different questions. The first three questions were aimed at the distribution of the population between academic and business environments, and between student/trainee and teacher/trainer, and the distribution of the different digital learning solutions that are being used by them. The next four questions were asked to see the main strengths, weaknesses, opportunities and threats of using digital learning solutions. The last question consisted in a space to be filled in with additional observations, if that participants had any. Analysis of the answers allowed to make a SWOT matrix on the use of these digital solutions which then allowed to make a TOWS analysis in order to prepare a strategy to mitigate the negative impact. On this basis, it is recommended that academic and business organizations define adequate stratagies in order to promote the use of these solutions in the future.

Keywords

Evolution, Digital transformation, Technology, Learning solutions, Challenges, Adaptability, Academic environment, Business environment

Resumo

A crescente inovação na indústria aeronáutica e o impacto do Covid-19 estão a impulsionar a transformação das estratégias de aprendizagem. A investigação tem demonstrado a necessidade e o crescimento de soluções de aprendizagem digital para a mão-de-obra futura e por isso o objectivo desta dissertação é examinar estas novas experiências de aprendizagem e o seu impacto tanto no ambiente académico como empresarial na indústria da aviação.

Com base na revisão bibliográfica sobre a evolução da indústria aeronáutica, o impacto do Covid-19, e a transformação digital das soluções de aprendizagem, foi feito um inquérito online que foi distribuído aos potenciais participantes. Estes participantes faziam parte da indústria aeronáutica e foram convidados a responder a oito perguntas diferentes. As três primeiras perguntas destinavam-se à distribuição da população entre ambientes académicos e empresariais, e entre estudante/formando e professor/formador, e à distribuição das diferentes soluções de aprendizagem digital que estão a ser utilizadas pelos mesmos. As quatro perguntas seguintes foram feitas para identificar os principais pontos fortes, fraquezas, oportunidades e ameaças da utilização de soluções de aprendizagem digital. E a última pergunta para ser preenchida com observações adicionais, caso existissem. A análise das respostas permitiu fazer uma matriz SWOT sobre a utilização destas soluções digitais que consequentemente permitiu fazer uma análise TOWS a fim de preparar uma estratégia para mitigar o impacto negativo. Nesta base, recomenda-se que as organizações académicas e empresariais utilizem estratégias diferentes como factor chave para prosperar a utilização de soluções digitais no futuro.

Palavras-chave

Evolução, Transformação Digital, Tecnologia, Soluções de Aprendizagem, Desafios, Adaptabilidade, Ambiente académico, Ambiente empresarial

Contents

List of Figures

List of Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
CPS	Cyber-Physical Systems
IT	Information technology
L&D	Learning & Development
NOx	Nitrogen Oxides
ST	Strengths, Threats
SWOT	Strengths, Weaknesses, Opportunities, Threats
TOWS	Threats, Opportunities, Weaknesses, Strengths
USA	United States of America
USSR	Union of Soviet Socialist Republics
UTC	Universal Time Coordinated
VR	Virtual Reality
WO	Weaknesses, Opportunities

Chapter 1

Introduction

This chapter presents an overview of the study, the author personal motivation for this work, the research aim and objectives and the structure of the dissertation, for an easy navigation through this work.

Digital transformation has brought large changes and disruption, both in society and in the working world. This transformation is not only about technology, instead it is about people, process, and workflow.

Aeronautics, like every other scientific field, is being affected by this transformation, and the idea of innovation in this area without digitalization is no longer conceivable. This digital evolution has occurred quickly and is affecting every aspect of businesses, including product and service design, operations, and process.

In a changing world of work, it is not acceptable to just expect people to prepare for change and adapt to it. Careers are being viewed as individual development experiences, with each experience offering the chance to acquire new skills and new perspectives. This is a challenge for Learning culture to both solve and make the most of.

Over the last few years, digital transformation is giving way to innovative learning and teaching methods, especially with the Covid-19 pandemic, as organizations around the world are constantly trying to adjust and thrive in the future.

On the whole, labor market in the 21st century is changing rapidly, and it is irreversible, so the only way to succeed in the future is to adapt and keep evolving.

1.1 Personal Motivation

The world is constantly changing and to survive is necessary to innovate. To achieve the ultimate innovation, it is essential to be resilient, creative and, most importantly, inquisitive. And it is on this thought that this work begins.

The year 2020 changed the world forever. Marked by the Covid-19 pandemic and its negative impact, it put society to the test. In addition to the direct health impact with tremendous loss of life, it created devastating effects especially in the aviation industry with vast job losses and organizational closures. Besides it created a dire need for the digital world and the restruc-

turation of human resources making skilling, reskilling and upskilling more important than ever.

Currently, digitalization is in the base of every business and thanks to the pandemic there was an exponential need to achieve success in the digital transformation of learning solutions not only inside the companies but also in schools and universities. Since nowadays digitalization is a key factor to achieve an efficient learning process, now more than ever it is important to make an analysis about the impact of this transformation inside academic and business organizations.

Addressing a relevant and interesting topic is crucial to achieving success in the end. Firstly, it will allow to learn something new. Secondly, it will maintain the motivation for the subject area. Lastly, it will allow the readers to be aware of what the topic is all about and be inspired by it. That is to say, that Digital Transformation of Learning Solution apart from ticking all the boxes is also a very current topic in the world, which make its study very important.

1.2 Objective

Increasing innovation in the aviation industry and the impact of Covid-19 is leading to the transformation of the Learning strategies. This requires academic and business organizations to adapt and create new reliable solutions to keep and elevate the role of the Learning function. This dissertation seeks to study the impact of digital transformation of learning solutions in the aviation industry. The research will use a survey to analyse the impact of digital learning solution currently use.

The key steps of this research are:

1. To explore the evolution in the aviation industry
2. To examine the impact of Covid-19 in the industry
3. To research the digital transformation of learning solutions
4. To study and identify the digital learning solutions
5. To analyze through a survey the impact of the digital transformation of learning solutions
6. To perform SWOT and TOWS analyse on the digital transformation of learning solutions
7. To critically evaluate the digital transformation of learning solutions

1.3 Structure of the dissertation

This dissertation is divided into five main chapters.

Chapter 1 presents an introduction to the dissertation. It includes the author personal motivation and the aim and main objectives to be achieved with this study.

Chapter 2 briefly summarizes a presentation of umlaut in terms of history and operations

Chapter 3 provides the literature review of the topic studied. It starts with a historical review of the evolution of the aviation industry, followed by a brief description of the impact of Covid-19. Finally an introduction to the digital transformation of learning solutions as well as some solutions currently used are presented.

Chapter 4 presents the case study, a survey done to collect the aviation community's perceptions on the digital transformation of learning solutions. It includes all the data collected and its analysis.

Chapter 5 outlines the conclusion of the work, as well as the recommendations driven from the previous analysis and the indication of future work.

At the end of the dissertation, all the relevant references used across the research are included.

Chapter 2

umlaut

The company umlaut based in Aachen, Germany, was created in 2019 from a rebranding of the P3 Group, which was founded in 1996 [1].

umlaut is a global, full-service, cross-industry, end-to-end company that offers advisory and engineering services to clients all over the world. In-depth domain expertise, broad practical knowledge and interdisciplinary collaboration allow to add value, quality and focus to the clients' organizations, services and products, in disruptive times in which industries are increasingly converging [1].

The mission of the company is: *'As umlaut, we change industrial and organisational advisory and engineering services from regular to special.'* [1]

2.1 Enterprise Overview

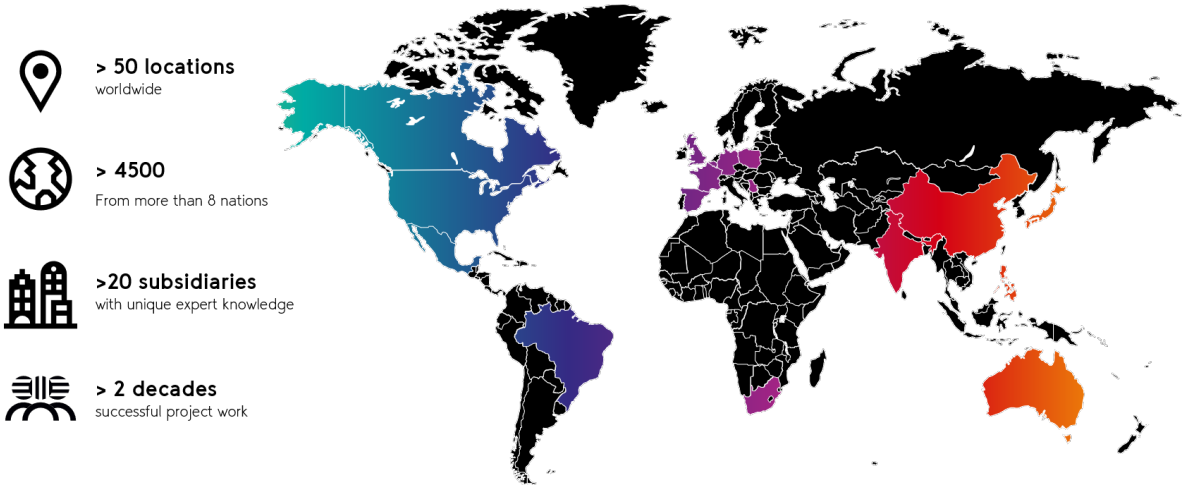

Figure 2.1: Enterprise Overview [1]

Within an able and agile collective of 20 consultancies and engineering firms spread across 50 locations all over the world, 4500 specialized experts and engineers provide innovative solutions and transformations across all industries and the various intersections as well as serving the public sector and developing organizational cultures, structures and processes [1].

2.2 Industries

umlaut is present in 8 different sectors of activity as follows:

(a) (b) (c) (d) (e) (f) (g) (h)

Figure 2.2: Sectors of Activity [1]

(a) Automotive & Mobility

(b) Aerospace & Defense

(c) Telecommunication

(d) Energy & Utilities

(e) Rail & Logistics

(f) Health & Life Science

(g) Machinery

(h) Public Sector

2.3 Capabilities

A combination of motivation, skills, processes, data, and resources enables umlaut to perform perfectly an all-round end-to-end service [1].

Strategy & Innovation

Process Design & Deployment

People, Organizations & Change

Program Management

Manufacturing & Supply Chain Management

Service & Operations

Systems Engineering

Design & Engineering

Testing & Validation

Prototyping & Products

Software Development

IT Security

User Experience

Data Analytics

Chapter 3

Literature Review

3.1 Evolution of the Aviation Industry

Aviation has advanced at an extreme pace over the past two centuries. In the early 20th century, manned flight was only possible for a few seconds, and several decades later, the first transatlantic flight was made. Technology and aircraft design have changed considerably since the first powered flight, but progress is still ongoing in this sector of activity with a very promising future.

3.1.1 Balloons and Airships

The year of 1783 marked the first steps of aviation. The first creation was a lighter than air balloon, or as it is called today, a hot air balloon, consisting of a paper and silk bag filled with hot air, made by the French brothers Joseph-Michel and Jacques-Étienne Montgolfier [2]. After a successful test flight with a duck, a sheep, and a rooster as passengers, two humans ascended in a Montgolfier-designed balloon (figure 3.1) over Paris on November 21st (1783), traveling 5 miles (8km) in about 25 minutes[2]. But just 10 days after, on December 1st (1783), the brothers faced competition from a French scientist named Jacques Charles, who demonstrated a hydrogen-filled balloon, (figure 3.2), that traveled 25 miles (40 km) [2].

Figure 3.1: A model of the Montgolfier brothers' balloon [3]

Figure 3.2: Contemporary illustration of Jacques Charles' first balloon flight [4]

To jump from balloon to full airship a source of propulsion and a means of changing direction were necessary. In 1852 a French engineer Henri Giffard, who also invented the steam injector, was able to do it, to build the first true airship, the Giffard dirigible. It was a cigar-shaped, non-rigid bag filled with coal gas with a suspended long beam with a triangular rudder at its end, and beneath the beam a platform for the pilot and the steam engine, that powered a three-bladed propeller[2] as shown in the figure 3.3. Besides being the creator, Henri was also the pilot of his airship, which flew for the first time on September 24th (1852) through almost 17 miles (27km) over Paris [2]. This airship was the precursor to modern airships like the Zeppelin.

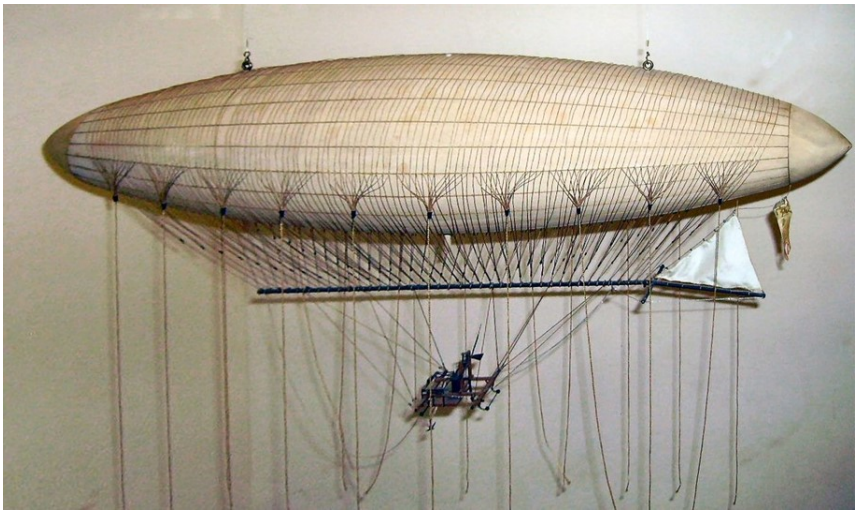

Figure 3.3: A model of the Giffard dirigible [5]

3.1.2 Wright Brothers

One hundred years after the flight of the first hot air balloon, the Montgolfier balloon, many scientists and enthusiastic builders, in order to achieve powered flight, experimented all kinds of machines inspired by nature. At the turn of the 20th century, the dream of heavier than air machines becoming capable of rising above the ground with a pilot on board was close to becoming a reality.

On December 17th, 1903 the American brothers Orville and Wilbur Wright made the first sustained flight from a manned powered machine on a beach in Kitty Hawk, North Carolina (figure 3.4) becoming the true pioneers of the aviation industry [2]. The craft called Wright Flyer I was the first real airplane. It was constructed from spruce, ash, muslin, and piano wire, and equipped with a 12-horsepower water-cooled four-cylinder gasoline engine that powered two propellers [2]. The airplane flew for the first time a total of 12 seconds over a distance of 120ft (37m) and on the fourth and final flight, this model flew a total of 59 seconds over a distance of 852ft (260m) [2].

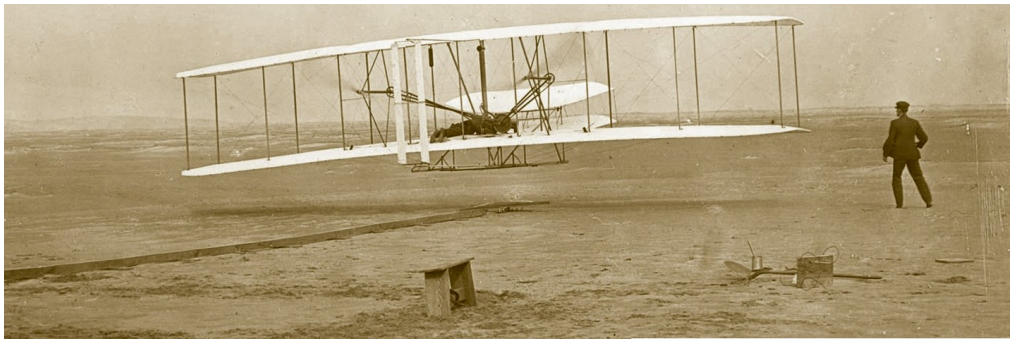

Figure 3.4: The Wright Flyer I first take off, Kitty Hawk, N.C., 1903 [2]

Since those first flights, they have continued to work on building and testing improved models of their flying machine. Between June and October 1905, in the much-improved Flyer III the Wright brothers made flights of up to 38 minutes' duration, covering more than 20 miles (30km) [2].

The Wright Flyer's launched the aerial age and excited people all over the world about the possibilities of flight. The period up to 1914 brought great progress, the creation of large industrial aircraft manufacturing companies and the appearance of the first research establishments and university courses in aeronautical engineering. Aviation developed from an object of curiosity into a modern craze that gripped the popular imagination [2].

3.1.3 World Wars

During World War I, from 1914 to 1918, aviation matured under the stress of combat and for the first time, aircraft were operated on a daily basis [2]. This increase in demand led to an exponential growth of aircraft manufacturers and consequently a massive demand for manpower (figure 3.5). Before the war, aircraft were manufactured in hundreds, but it is estimated that approximately 200 000 aircraft and 400 000 engines were manufactured during the war by all countries [6]. The acquired aircraft were then modified for reconnaissance and used for intelligence gathering missions. They were also fitted for artillery with the aim of shooting down the enemy [6]. Airplanes became war machines and thus aerial warfare was born.

Figure 3.5: Workers construct aircraft at the Royal Aircraft Factory, Britain [2]

In terms of aircraft technology, powerful engines and more robust airframes have made a great leap forward in overall performance. One of the most remarkable and pioneering developments came from the German engineer Hugo Junkers. In 1915 he built the first airplane to have an all-metal fuselage, Junkers J1 (figure 3.6), an important achievement for the future of commercial aviation [2].

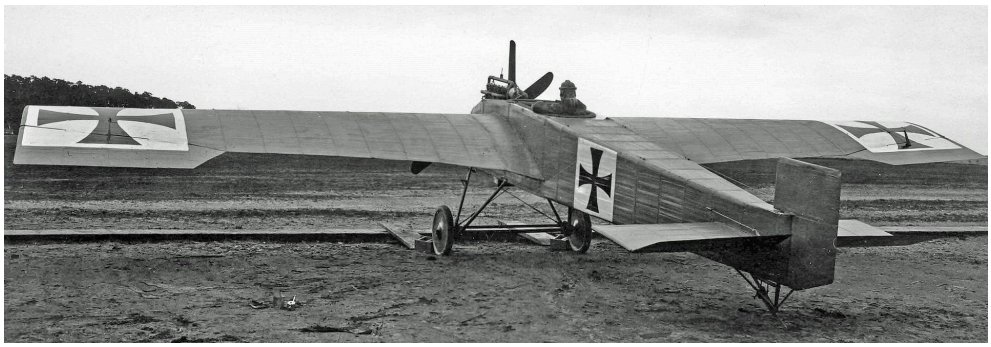

Figure 3.6: Junkers J1 with its all-metal airframe [7]

With the return of peace, pilots and manufacturers were able to devote their time to developing a new civil activity.After the first World War, the development of air routes became the basis of the future air transport network [6]. Airlines sprang up all over the world for the transport of mail, which gradually became the transport of passengers as they added some seats on the aircraft, originating the start of commercial aviation [6].

In order to make long-distance flights, air transport industry needed to be developed. All-metal monoplanes led to radical advances in speed and range, while improved flight instruments and navigation devices made the aircraft more reliable and offered greater flight capacity [2].

The first aircraft to achieve widespread success in commercial flight was the Douglas DC-3 (figure 3.7) which entered service in December 1935. The two-engine all-metal monoplane that carried a total of 21 passengers was one of the most successful aircraft in aviation history [2].

Figure 3.7: A Pacific Northern Airlines Douglas DC-3 soars over the mountains of Alaska [2]

Until 1939, progress on other projects was underway, such as the development of the jet engine, designed to increase aircraft speed, the design improvement of fighter aircraft to make them lighter, faster, easier to control and capable of rapid climbing, the development of the first forms of radar and the development of pressurized cabin to protect the crew and passengers from the effects of high altitude [6]. Aviation made enormous technical progress and developed into a potentially devastating weapon that would change the nature of warfare.

During World War II, from 1939 to 1945, aircraft became a major component of military power. They provided ground troops with mobility, supplies, and supporting fire [2]. Right from the start of hostilities in Europe, airplanes were used intensively for all types of missions: reconnaissance, destruction of targets on the ground and protection of planes in the air [6].

World War II was mostly fought with aircraft that were, at least, on the drawing board before the war began and consisted mainly of metal airplanes. One of the most iconic aircraft designed for the Second World War was the Spitfire (figure 3.8), a single-seater fighter, equipped with machine guns in its wings, and characterized for being fast and very agile. But even though it was a success, the improvement of its design continued, and the following models proved to be even more powerful [2].

Figure 3.8: One of the first prototype of the Spitfire [2]

Throughout the war there were important technological advances in navigation, communications, and radar. At the beginning, radar was only used on the ground to monitor enemy aircraft and then proper instructions were given to pilots in the air for the interception of intruders, but rapidly was incorporated into the aircraft, making the interception faster [6].

With the globalization of the war in 1942, distances became too great for land and sea transport, and so aircraft were the only means of rapid transport of troops and equipment. This meant that all commercial aircraft being built at that time were redesigned and adapted for battle. Such an example was the Douglas DC-4, a 4-engine version of the Douglas DC-3, packed with innovations. It had a cabin that could carry between 50 and 80 passengers, and its range gave it transoceanic capability with a single fuel stop. But before it could enter service as an airliner, the DC-4 became the C-54, a military transport airplane [2].

Innovation continued hand in hand with the war. Each year, new advances were made, tech-

nological and technical, that became crucial for the future. One of the most important during this period was the successful launch of the Messerschmitt Me 262 (figure 3.9) the first operational jet fighter in the world that although being ready in 1941, it did not enter service until July 1944 [2].

Figure 3.9: The Messerschmitt Me 262A [2]

3.1.4 Post World Wars to the Present

After World War II, aeronautics was revolutionized by the development of jet engines [6]. This type of powerful engine allows higher speeds and altitudes. In a few years, several different types of jet engine were produced: turbojets, ram jets, and rocket engines [6]. The numerous applications of these engines revolutionized the whole of the aeronautical domain.

As the Cold War set in and industrial activity increased, there was a rapid increase in the number of projects for ever faster aircraft and on October 14th, 1947, the pilot Chuck Yeager broke the sound barrier (1234 km/h) for the first time in a Bell X-1 (figure 3.10) experimental aircraft [2].

Figure 3.10: Photographed from a chaser plane, the Bell X-1 [2]

At the same time as the development of combat aircraft, Great Britain and France innovated, equipping commercial transport aircraft with turbo jet engines [6]. This triggered the boom

of civil aeronautical industry and the big European manufacturers

In 1948, the Vickers company brought out the first commercial aircraft powered by turboprop engines, the Viscount (figure 3.11) equipped with four engines, and designed for continental routes. In 1954 it was the first European aircraft to penetrate the American market [6].

Figure 3.11: The Vickers Viscount [2]

In 1949, De Havilland brought out the first civil turbojet transport aircraft, the Comet (figure 3.12) [6]. Powered by four turbojets, the Comet was capable of carrying 36 passengers at 800 km/h at an altitude of 12000 meters over 3200 km [2]. It gave Great Britain a lead of three years over the rest of the world [2]. However, the Comet was banned from flying in 1954 due to structural fatigue [6].

Figure 3.12: The De Havilland Comet [2]

In 1951, the French government promoted the development of the country's first Sud-Aviation Caravelle, (figure 3.13), jet aircraft [2]. They provided guidelines for an airplane with a capacity of about 60 passengers and a range of 2,000km [2]. The Caravelle prototype first flew in 1955 and entered service in 1959 [2]. The technical and commercial success of the Caravelle was emblematic of the renaissance of the French civil aeronautical industry [6].

Figure 3.13: The Sud-Aviation Caravelle [2]

Until the 1950s, Boeing had a great reputation as a manufacturer of military aircraft [2]. This provided a foundation and paved the way for the aircraft that truly founded the era of the passenger airplane, the Boeing 707 [2]. The Boeing 707 (figure 3.14) entered service in October 1958 flying transatlantic routes [2].

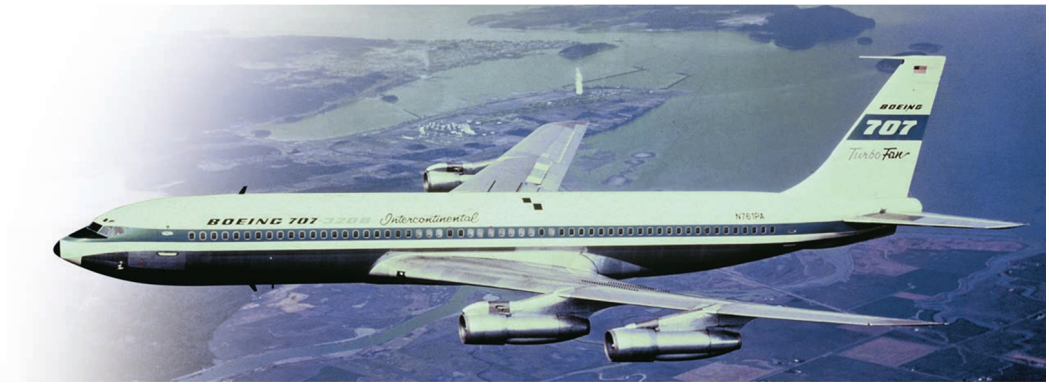

Figure 3.14: The Boeing 707 [2]

The power developed by jet engines made it possible for aircraft to fly at an average of 800 km/h and 11 000 meters altitude [6]. At this speed and altitude, some technical adaptations were necessary, causing substantial changes to the silhouette and architecture of aircraft. Pressurized cabins became essential for jet aircraft as soon as they exceeded an altitude of 2000m [6]. Aircraft structures had to be strengthened to withstand the variations in pressure exerted on the structure at each climb and descent [6]. More powerful engines result in a higher fuel consumption and for long flights more fuel was needed on board, therefore the wings were partially converted into fuels tanks [6]. At high speeds, flight control surfaces are subjected to larger loads when extending into the airflow and to enable pilots to move them, hydraulic actuators were installed, together with a system giving the pilots a sensation of effort in order to limit the amplitude of movement [6].

Starting in the late 1950s, in a society engaged in a race for speed, several manufacturers in Europe, but also in the USA and the USSR, began working on designs for supersonic planes for passenger transport [6]. The technical and commercial challenges were such that states

had to provide support for the projects [6].

Two transport planes reached supersonic speeds, the Soviet Tupolev Tu-144 and the Anglo-French Concorde [6]. But only Concorde (figure 3.15) provided a regular transatlantic service, at twice the speed of other aircraft, for 27 years [6]. Development of this extraordinary aircraft took longer than had been estimated because of major technical difficulties. The aircraft had to perform as well as possible throughout the whole flight envelope, takeoff and landing, in subsonic flight and at Mach 2. The prototype finally made its first flight on March 2nd, 1969 and went supersonic for the first time on October 1st of the same year [2].

Figure 3.15: The Anglo-French Concorde [2]

At this point in time, it was everybody's dream to travel by air. To cope with the increase in demand, airlines called for planes with ever larger fuselages, powered by turbofan engines, more powerful than their predecessors.

In 1963 the American army requested national manufacturers to design a large plane that would meet the logistical requirements of its troops deployed throughout the world [2]. Boeing, although not selected by the army, used its initial design to develop its 'Jumbo Jet' (figure 3.16): the 4-engined 747, which first flew in February 1969 [2]. The first versions of the 747 carried more than 350 passengers, but soon the number was increased to 500 [2].

Figure 3.16: The Boeing 747 [2]

In the 1970s, air travel, previously restricted to the upper classes, became generalized and planes became an everyday sight in the skies [6]. Airlines offered a wider range of services, in particular introducing business class. Tourism became possible for an increasing number of people, and tour operators introduced special charter flights, outside normal schedules.

In 1972, Airbus, a consortium of European manufactures, proposed the A300 (figure 3.17) a medium-haul wide body, able to carry more than 300 passengers the first to fly with only two

engines and two cockpit crew [6]. In 1990s, Airbus entered the large capacity (more than 350 passengers), long-haul market with the A330 and A340. Throughout this period, competition was intense between the American Boeing, which had absorbed its national competitors, and the European Airbus. For each request made by the airlines, each company proposed a model incorporating state of the art technologies [6].

Figure 3.17: The Airbus A300 [2]

Digital information technology has gradually invaded design office with structural calculation and Computer Aided Design (CAD) software [6]. It has also been introduced into the shop floor where machine tools are programmed by means of Computer Aided Manufacturing (CAM) [6]. The changeover to digital technologies, also known as digitalization, occurred during the third industrial revolution and has made tasks easier by shifting operations from tactical to strategical [8]. In the cockpit, flight control data are now displayed on screens, gradually eliminating the risks of mechanical failures of instruments [8]. Flight management has been automated, and pilots' inputs are analyzed and optimized by means of computers which then send commands to the control surfaces and the engines.

In 1987 the first flight of one of the aeronautics' leading successes of the 20th century, the Airbus A320, occurred. Employing the first fly-by-wire flight controls, where electronic systems interpret the pilot commands and determine how to move the actuators of the control surfaces, as well as the so-called "glass cockpit" with a small number of colored display screens (figure 3.19) marked the beginning of a digital age [6].

Figure 3.18: The Sud-Aviation Caravelle cockpit [2]

Figure 3.19: The Airbus A320 "glass cockpit" [2]

Evolution of the Aviation Industry: Impact of Digital Transformation of Learning Solutions

The Airbus A380 (figure 3.20) was conceived in the early 1990s and made its first flight in 2005 [6]. It is a very large, very long-haul plane with a double deck along the full length of the fuselage, capable of carrying between 550 and 800 passengers according to the seating configuration, over 15000 km [2]. The A380 forms the backdrop to one of the most important technological breakthroughs: integrated modular avionics [6]. Using generic computer architecture, several functions previously spread across multiple units are now brought together, hence reducing the number of on-board computers in the aircraft [6]. After 30 years of supremacy for the Boeing 747, Airbus overtook its American competitor [2].

Figure 3.20: The Airbus A380 [2]

Because of the oil crises and the increase in the price of crude oil, aircraft and engine manufactures have had to combine their efforts to reduce consumption, an obligation amplified by the ecological demands that emerged in the 1980s [6].

This new context has given rise to a general trend toward aircraft that use less fuel, cause less pollution and are quieter. This necessity resulted in the development of new models of aircraft on both sides of the Atlantic: the new Airbus A320 NEO, launched in December 2010, and the Boeing 737 MAX, launched in January 2016 [6]. Both of them have shown a successful reduction in fuel consumption and in emissions of nitrogen oxides (NOx) [6].

By the year 2016, the industrial revolution evolves into a new level, the fourth revolution, currently ongoing. This revolution is characterized by the design of Cyber-Physical Systems (CPS) capable of assisting humans demanding work by helping them to take decisions and to complete tasks autonomously, in other words, a digital transformation revolution [8].

Today, the use of CPS is well advanced in the industry, and new systems continue to emerge with a lot of advantages and different applications. For example, the development of robust aircraft predictive maintenance, which involves using information such as sensor data and maintenance records to predict maintenance needs in advance, enables airlines to perform better maintenance planning with a lesser number of interventions in less time, which improves both efficiency and economy [8].

The aviation industry is still going though remarkable changes and in current times digitalization and digital transformation go side by side to keep this evolution moving forward.

3.1.5 Future

In the early days, air travel was risky, expensive, and highly polluting. As time has passed, technologies have evolved, aviation has evolved, making airplanes safer, cheaper, quieter, and more fuel-efficient than their predecessors. Unfortunately, this efficiency is a double-edged sword, because having all these advantages has caused people to travel more by air. This situation,along with population growth means that aviation's contribution to the world's CO2 emissions is even higher than in the past.

Due to global warming being one of the world's biggest problems, a legally binding international treaty was adopted in December 2015 in order to tackle climate change, the Paris Agreement [9]. This agreement aims to limit global warming to 1.5 degrees Celsius [9]. Nations aim to reach a net zero global level of CO2 emissions by 2050, and to achieve this goal the aviation industry plays a very important role [9]. Thus as this is one of the sectors of activity that emits the most CO2 into the atmosphere it faces a big challenge over the next 30 years, to abate as much as possible these emissions [9]. Bringing new sustainable aviation fuels and producing more efficient airframe and propulsion technologies are two massive changes needed for that success.

Apart from breakthrough physical advances, such as the design of more high-capacity aircraft, with lower fuel consumption, more comfort and lower noise and air pollutant emissions, aviation progress will also depend on conquering cyberspace challenges and adversities, while safely and securely transitioning cyber benefits to the physical world. With the advent of front-line and innovative technology in aviation, all systems are now interconnected to each other, which brings so many advantages and opportunities to the use of all the information. But while this is great, the security problems it poses should be considered and plans should be put in place to counter any threat [8].

All and all for aviation to continue to advance, innovate and become greener, an economical and social effort from all countries is necessary.

3.2 Impact of Covid-19 in the Aviation Industry

The aviation industry is a global business that is characterized by its high standards of quality and safety with tight deadlines, to which the slightest interruption in operations requires immediate attention. Throughout the last century the sector has gone through a drastic change on both the supply chain and the demand side. New advances have been made every day with the aim of improving technologies and operational efficiency.

The outbreak of the Covid-19 pandemic has proven to be one of the biggest shocks the world has ever seen, and as well as directly affecting the health of the population, this virus has also had a profound effect on the way businesses operate. Companies across all sectors have

been and continue to be affected by the economic turmoil of a virus that has spread around the world at a rapid pace [10].

Worldwide, the highest concerns have been focused on aviation, from the impact on airlines, to the impact on their supply chain. The pandemic started to directly affect the airliners due to travel restrictions which resulted in a dramatic drop in demand for airline services as shown in figure 3.21 and figure 3.22, causing hundreds of planes being grounded. The combination of negative demand and the uncertainty surrounding the pandemic outbreak has created an unpredictable position for airlines, with the possibility of bankruptcy and liquidation [11].

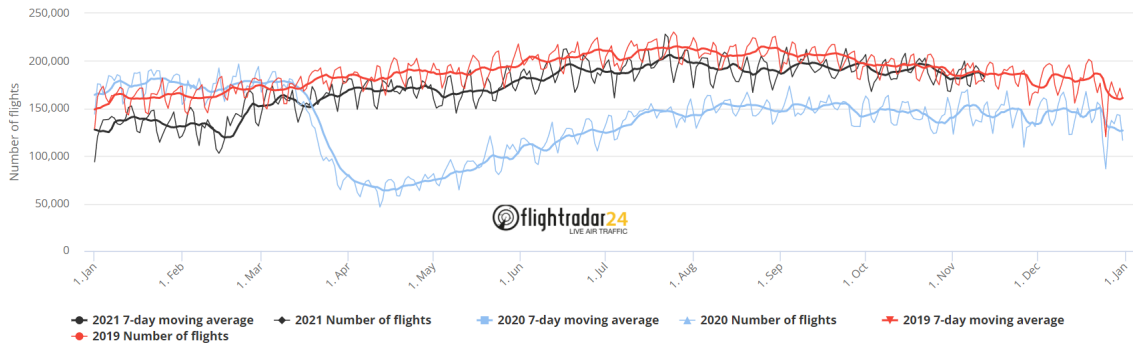

Figure 3.21: Total number of flights tracked by Flightradar24, per day (UTC time), 2019 vs 2020 vs 2021 [12]

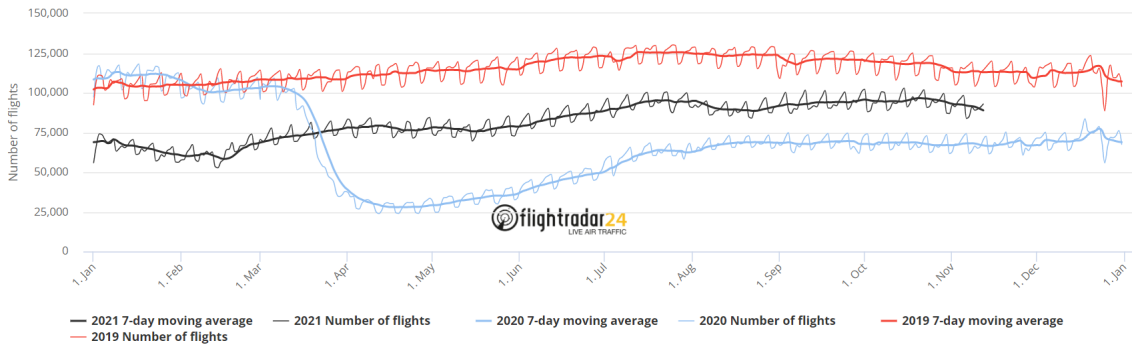

Figure 3.22: Number of commercial flights tracked by Flightradar24, per day (UTC time), 2019 vs 2020 vs 2021 [12]

Due to this problem the aviation suppliers, who are at the beginning of the aviation chain, have faced a devastating halt in demand for airplanes that has led to financial pressure and consequently a shrinking workforce, resulting in a crisis in the industry. In terms of numbers, in 2019 commercial airlines took delivery of around 1500 new aircraft [13], as in 2020 the numbers dropped by almost half, 805 new aircraft [14], an extreme reduction that has put manufacturers to the limit. By the end of this year, 1143 new aircraft are estimated to be delivered [15], still below the 2019 figures, but already on a good path to recovery.

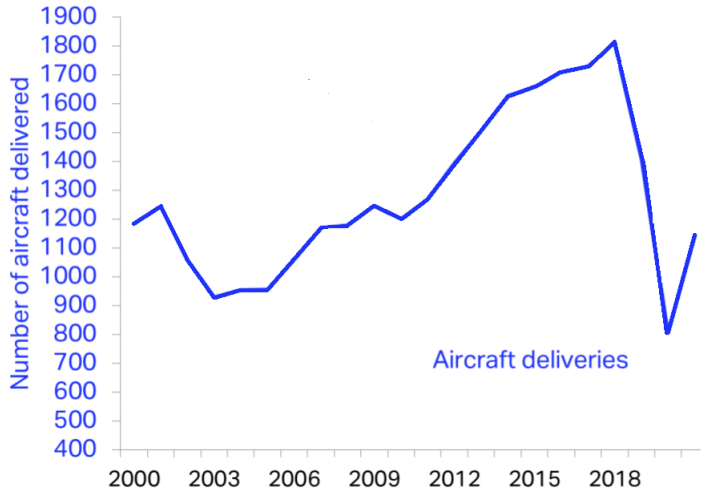

Figure 3.23: Number of aircraft deliveries to commercial airlines in the last 10 years [15]

Although this is difficult for the major airframe and engine manufacturers, the real slaughter took place a few steps down the chain, affecting small and privately owned suppliers are part of. These suppliers found it very difficult to adapt to the problematic situation and therefore a recovery through external support was necessary, resulting in them being bought out by multinational companies [11].

Besides these obvious impacts, there is another activity that has a significant effect on aviation and is being greatly influenced by the pandemic: learning solutions [10]. The learning of aviation professionals in both academic and corporate environments is extremely important for the development of the industry. Since it has not been possible to put trainers and trainees in the same physical classroom, new learning solutions have been put in practice.

The pandemic brought a lot of chaos to the world, but despite all the negative impact it also brought new opportunities for improvement. Particularly in aviation, it opened the eyes of most stakeholders, realizing that in order to succeed, it is necessary to redefine strategies and priorities for the future. Now the focus lays not only on the climate change but in the digital transformation and the reshaping of business models, the key avenues to a resilient and stronger aviation. The industry has started to recover but it is necessary to keep up the effort at all times because success is fragile and difficult to achieve [10].

3.3 Digital transformation of Learning Solutions in Aviation

'Life is a culmination of the past, an awareness of the present, an indication of a future beyond knowledge, the quality that gives a touch of divinity to matter.' – Charles Lindbergh

Learning is an essential tool for both personal and professional careers. It contributes to the

acquisition of knowledge, critical thinking skills, and the ability to develop future opportunities. It underpins any change and is indispensable to the evolution of the world. [16]

Since the Wright Brothers accomplished the first powered flight on December 17, 1903 they began to teach others the art of powered heavier-than-air machines, thus laying the foundation for learning in the industry. Aviation has undergone drastic changes since then, many improvements and technical innovations that have only been possible through the application of learning over the decades. This learning path involves for the most part academic and business environments, both with different impacts but both required for the progress of the industry.

Higher education has a great responsibility in preparing qualified people by providing them the skills and competencies needed to operate in the complex modern society [10]. It aims to create an ability to adapt and apply basic knowledge, so that a graduate is well positioned to develop successfully throughout professional and private life. Access to learning and knowledge not only opens doors to individual and collective opportunity, but also has the potential to reshape the future of the world and drive continued growth of aviation careers.

The aviation environment is becoming increasingly complex mostly due to the challenges surrounding technological innovation and, as a result, workers' knowledge and skills quickly become outdated [10]. In order to close this gap, it is important to continue to take steps to learn, grow, and expand work knowledge throughout the entire person's career. By making the proper investments for adult skilling, reskilling and upskilling, corporations and societies can benefit from extra productivity, additional innovation and a continuous adaptation over the time and challenges.

Learning occurs throughout lifetime and in various contexts, but without a systematic maintenance, some skills and competencies may be lost over time. In business context, Learning and Development (L&D) is a crucial process of Human Resources function and Management. This process guarantees a more regular and consistent assessment of employee training needs, an effective anticipation of skills shortages that identifies who needs it, for what and where. Learning and development within companies is a critical component to their future, it is the difference between continuing to be successful or becoming redundant.

With the fourth industrial revolution taking place, Aviation is on the threshold of a revolutionary technological transformation, and while this brings long-term competitiveness and sustainability, human resources and their learning path are often overlooked challenges that influence that success. Although some digital learning solutions have been present for several years, they have not seen the progress expected to be used intensively and specifically in aviation.

Since the Covid-19 pandemic began, that stimulus has changed; it was not a question of whether or not there were enough advantages and innovation, but rather an urgent need to use digital learning solutions.

During the lockdown phase of the pandemic, businesses and universities faced major disruptions due to the relocation of the labor and education community to work/study remotely from their homes. In corporation context, in order to overcome the challenges of a reorganization of business models while keeping entire companies online and productive, stakeholders saw a dire need to train, reskill, and upskill their workforce as quickly as possible [16]. This need, along with the academic community's necessity to adapt to distance learning, has led to an exponential pursuit and use of digital learning.

The time has come to implement change. The current Covid-19 momentum created an excellent opportunity to review the learning solutions and make them future-safe and sustainable [10].

3.3.1 Video Conferencing Solutions

Based on the principle of traditional synchronous learning, video conferencing solutions allow tutors and learners to be brought together in the same virtual place, extending the reach of traditional classroom.

Due to the Covid-19 crisis, academic and business environments saw themselves obliged to move to online instruction and use video conferencing solutions as a substitute to classic classroom learning [17].

To effectively use video conferencing as a learning tool, tutors must carefully plan in advance for these sessions. They must set goals and expatiations for the learning session, examine all the tools available, learn how they work and what they do, and finally consider the number of participants to choose the correct approach to be used during the session. It is also important that tutors establish ground rules and communicate them to the participants before the start of the learning session. To finish it is essential that all participants have a good electronic device and a good internet connection in order to get the most out of this learning solution [17].

The adoption of this learning tool has been associated with immense benefits for both learners and instructors, mainly because it is a comfortable and convenient solution that allows them to teach/learn anywhere with an Internet connection, while being in the environment that best suits them. But although it has great advantages, it also has negative effects, namely the reduction of social contact and all the negative things that are associated with that.

Zoom (figure 3.24) and Google Meet (figure 3.25) are two web conferencing platforms currently used in the learning field. They are cloud-based online platforms used for web conferencing audio, meetings, live chats, and meeting recordings.

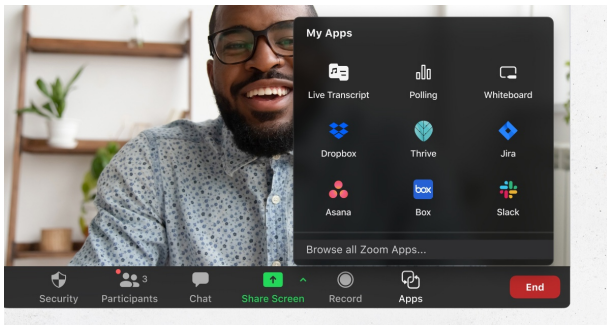

Figure 3.24: Zoom Platform [18]

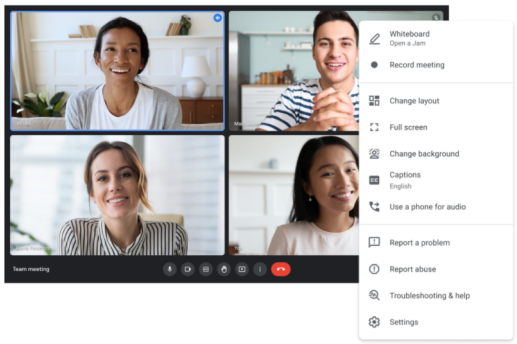

Figure 3.25: Google Meet Platform [19]

3.3.2 Augmented Reality (AR) and Virtual Reality (VR)

New emerging technologies such as Augmented Reality (AR) and Virtual Reality (VR) have arrived in the aviation workplace with various applications, as a training tool, workplace task facilitator, and general force multiplier [20].

Augmented reality (AR) (figure 3.27) allows users to see an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli provided through the technology [21].

Virtual Reality (VR) (figure 3.26) is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, VR places the user inside an experience. Instead of viewing a screen in front of them, users are immersed and able to interact with 3D worlds [21].

The use of AR and VR for aviation training provides improvements in training outcomes through increased repetition of exercises in a failure tolerant environment without detrimental impacts on safety or operational costs. It creates an opportunity to increase process effectiveness while dramatically reducing costs compared to traditional means [20].

Figure 3.26: Rolls Royce Virtual Reality Training for Engineers [22]

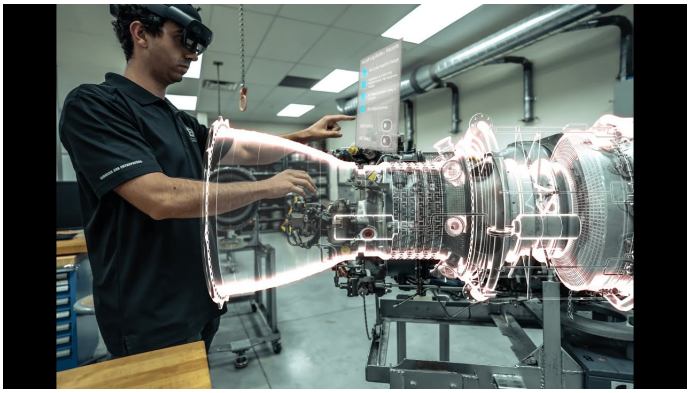

Figure 3.27: Augmented Reality for aircraft maintenance, remote support and training [23]

3.3.3 Adaptive Learning

Adaptive learning is the delivery of personalized learning that addresses the unique needs of each learner, efficiently and effectively [24]. These systems use various learning algorithms that, along with learner interaction make it possible to personalize the learning experience and adjust the path and pace of learning, just as an instructor does with his or her learnings[24].

Using Adaptive Learning Technologies, learning providers can personalize content and educational experiences in innovative ways. This can be an effective way to bring individualized learning to large numbers of students and provide tailored support and guidance to each of them.

This type of learning can be expensive and time consuming to implement. In addition, it requires specific skills for successful content development [24].

Smart Sparrow (figure 3.28) is an example of an Adaptive Learning, 'is a global leader in adaptive and personalized learning technology' [25].

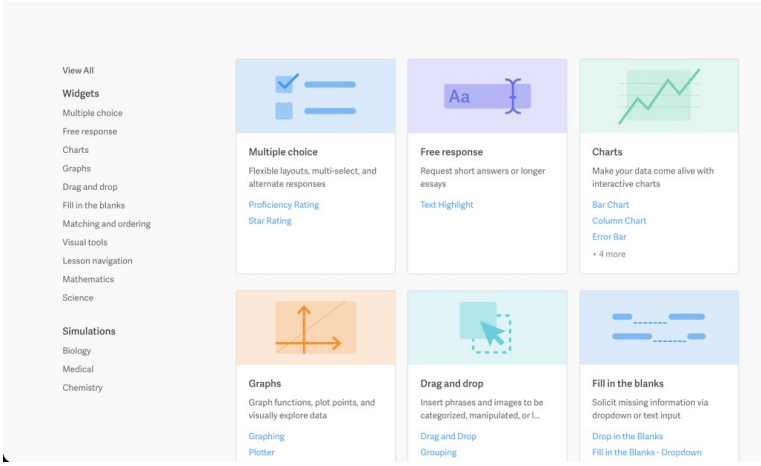

Figure 3.28: Smart Sparrow - solutions component library [25]

3.3.4 Learning Apps/Platforms

Learning platforms are integrated software solutions for learning content and resources that offer a learner and instructor everything they need in one place [26].

Some of the best features of this learning platform are the easy distribution of course material, its permanent access on the plataform, the easy communication between all users (when it is necessary to work together) and the possibility of online training [26].

One of the main advantages of this type of solution is that it helps them continue their learning path without any interruption.

An example of one learning platforms is Moodle (figure 3.29).

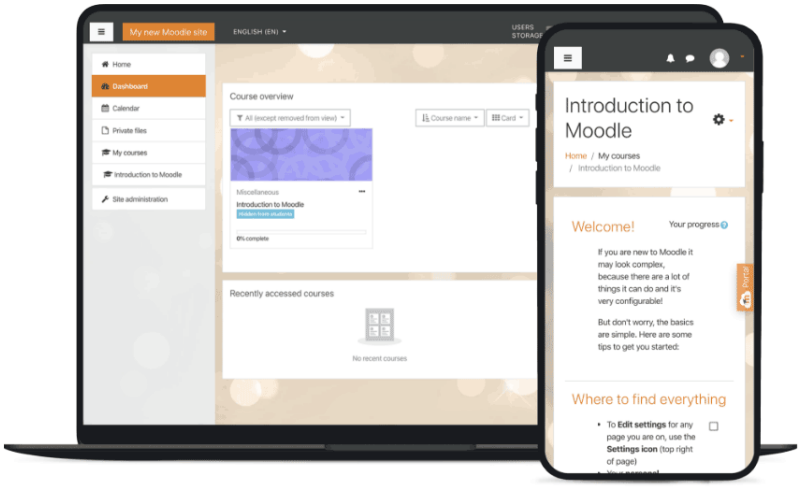

Figure 3.29: Learning Platform Moodle [27]

3.3.5 Artificial Intelligence (AI) and Chatbots

A chatbot is a rules-based computer program, which simulates human interaction with end-users via a chat interface [28].

Chatbots can be classified into two different types, fixed rule-based or machine learning-based.

Fixed rule-based chatbots only respond to specific commands and represent a fixed level of intelligence. They can use simple and complex rules but cannot answer any questions outside the defined rules [28].

Machine learning-based chatbots incorporate artificial intelligence that allows them to self-learn and understand human language. Additionally, the more they are used and interacted with, the more they can learn [28].

AI-enabled chatbots are a successful and useful technology that simplify the learning process. They are used to analyze student/trainee responses and provide them with a personalized learning content based on their choices [29]. Chatbots are an interactive technology that provide immediate response to the user.

Botsify (figure 3.30) is one AI Chatbot used in education context. 'Botsify chatbot for Education is dedicated to students, teachers, administrations and the entire education industry across the globe. It can not only help students learn online but teachers can get assistance in the evaluation, grading and student feedback collection.' [30]

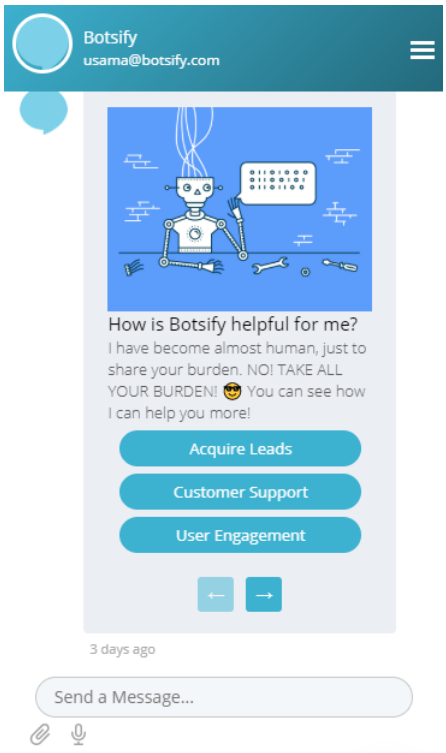

Figure 3.30: AI Chatbot Botsify [30]

Chapter 4

Case Study

The learning experience in the Aviation industry has been moving slowly towards digital transformation, but Covid-19 has changed that, turning this long-term desire into a sudden need. Adapting to this modernization has been a major challenge over the past 2 years, both in academic and corporate environments. But was it a success? Is it possible to improve it? These are the two main questions to be answered after this study.

This study investigates the Aviation community's perceptions of the Digital Transformation of Learning Solutions using a SWOT analysis through a questionnaire and establishes a strategy to mitigate the weaknesses and threats of this transformation using a TOWS analysis.

SWOT is an acronym for Strengths, Weaknesses, Opportunities and Threats and is a structured planning method that evaluates these four elements of a project or business venture. It involves specifying the objective or transformation of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to that transformation or to achieving that objective. The aim for this work is to identify through a survey the top three strengths, weaknesses, opportunities and threats, from those listed, of the Digital Transformation of Learning Solutions in the Aviation Industry.

TOWS analysis is an essential tool that allows transforming the results of SWOT analysis into meaningful actions that could be adopted strategically for the success of a project or business venture. It improves strategy implementation by considering the relationships between Strengths, Weaknesses, Opportunities and Threats, identified in SWOT analysis. For this study only two relationships are considered, ST and OW, where ST aims to define how sustainably leverage strengths can mitigate threats and OW intends to define a strategy on how to utilize opportunities to overcome weaknesses.

4.1 Survey

This research was conducted via an online survey, where the sample population was drawn from students/trainees and teachers/trainers currently involved in the Aviation Industry, with questions related to the current impact of using Digital Learning Solutions. The online survey link was distributed to various universities and organizations using a non-random purposive sampling method in order to approach potential participants. The survey was made available for completion over a four-day period in October 2021.

The survey (figure 4.1) is divided into three sections. The initial section consists of three questions that seek to determine the distribution of the respondents between business and academic environment and between students/trainees and teachers/trainers, as well as the distribution of learning solutions used by them. The next section, with four questions, asks the respondents the Strengths, the Weaknesses, the Opportunities and finally the Threats of using Digital Learning Solutions in the Aviation. In each question respondents are asked to select up to three options from those available. The final section poses a non-mandatory question where the respondents are asked to fulfil with additional remarks related to this study.

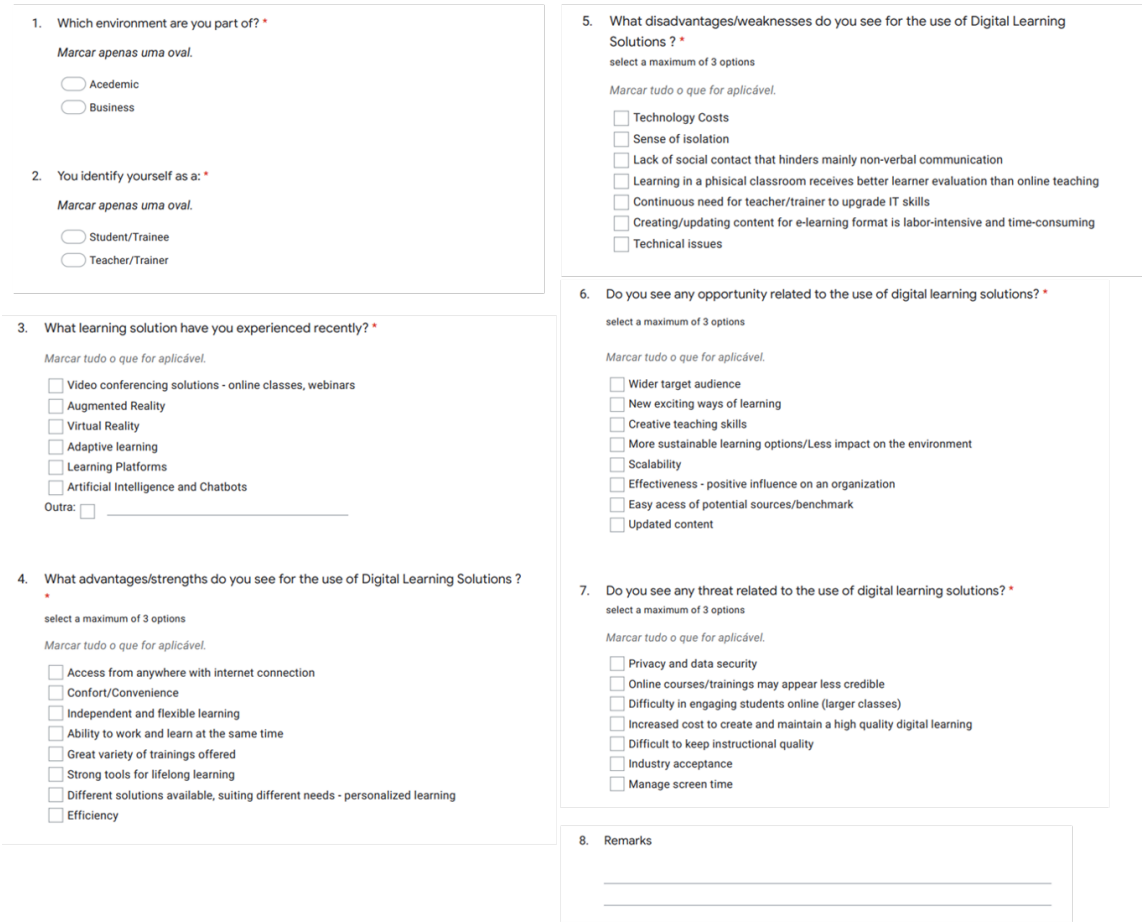

Figure 4.1: Survey distributed

4.2 Results and Discussion

A total of 119 participants who were involved in the Aviation industry completed the online survey. The majority (n = 83) was under an academic environment while the remaining participants were in the business environment (figure 4.2). Approximately one fifth of the participants (n = 24) were teacher/trainers (figure 4.3).

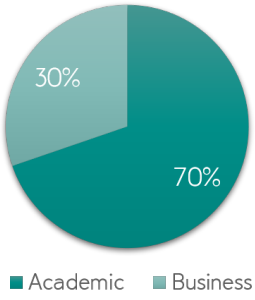

Figure 4.2: Academic vs Business respondents

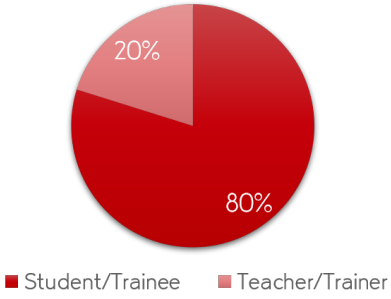

Figure 4.3: Student/Trainee vs Teacher/Trainer respondents

The learning solution most used by survey participants (figure 4.4) is the video conferencing solution with a total of 114 participants using it. The next most used are the learning platforms (n=58).

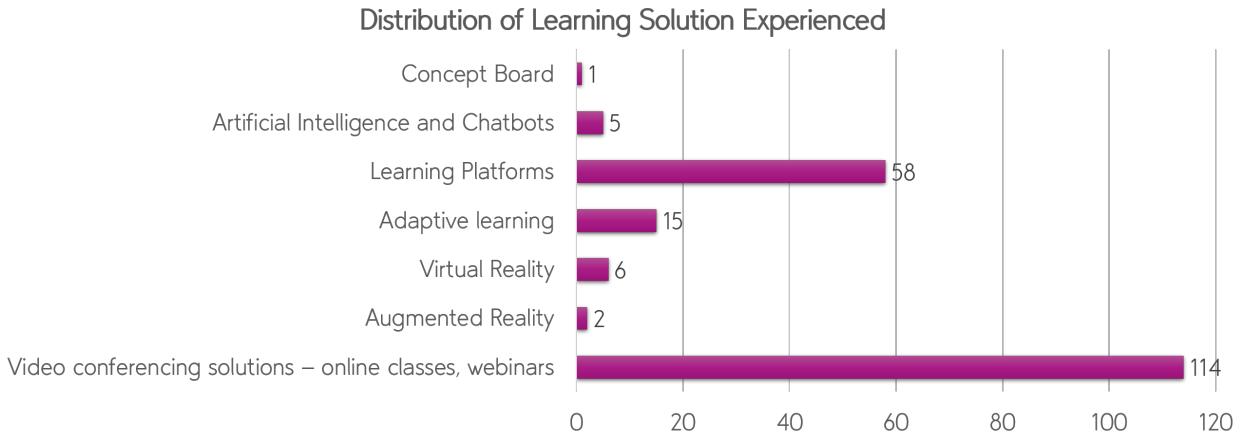

Figure 4.4: Distribution of Learning Solution Experienced

4.2.1 SWOT Analysis

Regarding Opportunities (figure 4.5), the most commonly mentioned is the fact that these kind of solutions have a wider target audience, meaning that more people can be reached with digital learning. The next to be recognized is the creation of new and exciting ways of learning. The fact that there are more options available creates more diversity to better implement a dynamic learning that translates into a better experience for the student/trainee. The third most voted opportunity was the easy access to potential sources/benchmarks, since digital learning solutions offer access to countless resources, which are easy to find, to compare and are available 24 hours a day.

Figure 4.5: Opportunities listed in the Survey

Concerning the Strengths of Digital Learning Solutions (figure 4.6), access from anywhere with internet connection was the most selected by respondents, since this connection allows access to information, knowledge, and learning resources, without having to be in a physical classroom. Another big advantage is the comfort and convenience, because in addition to allowing students and experts to be in the environment that suits them best, at home or in a library, for example, it also allows frequent travelers to continue studying and teaching using these digital solutions regardless of their location. The third to be recognized is that this learning is flexible and independent, as there is more than one method available (blended learning, fully online or technology-enhanced experiences). This makes the learning flexible to learners and, in some methods, it allows them to learn independently while receiving feedback as they progress.

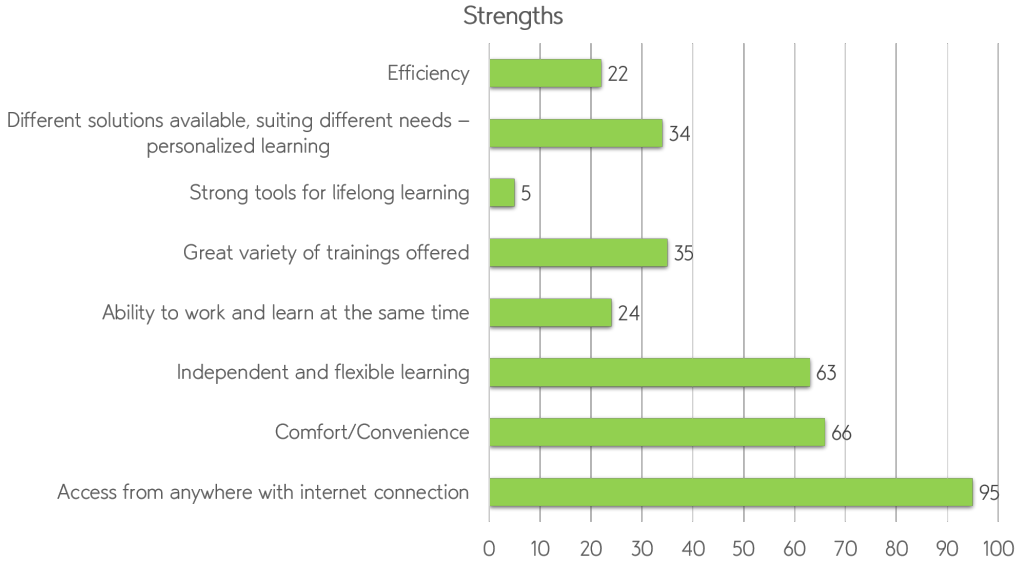

Figure 4.6: Advantages/Strengths listed in the Survey

In terms of Weaknesses (figure 4.7), the first to be identified is that the use of these learning solutions creates a lack of social contact that hinders mainly non-verbal communication. This lack of face-to-face interaction has reduced the non-verbal grasp of individuals, which can have a significant impact on personality development. The second disadvantage is the sense of isolation that learners and experts feel, the lack of social relationships or emotional support that leads to feelings of loneliness, frustration, and lack of motivation. The third one selected is the technical issues behind the use of the necessary technologies to this kind of learning, problems such as internet connection, operating systems, browsers, and laptops for example.

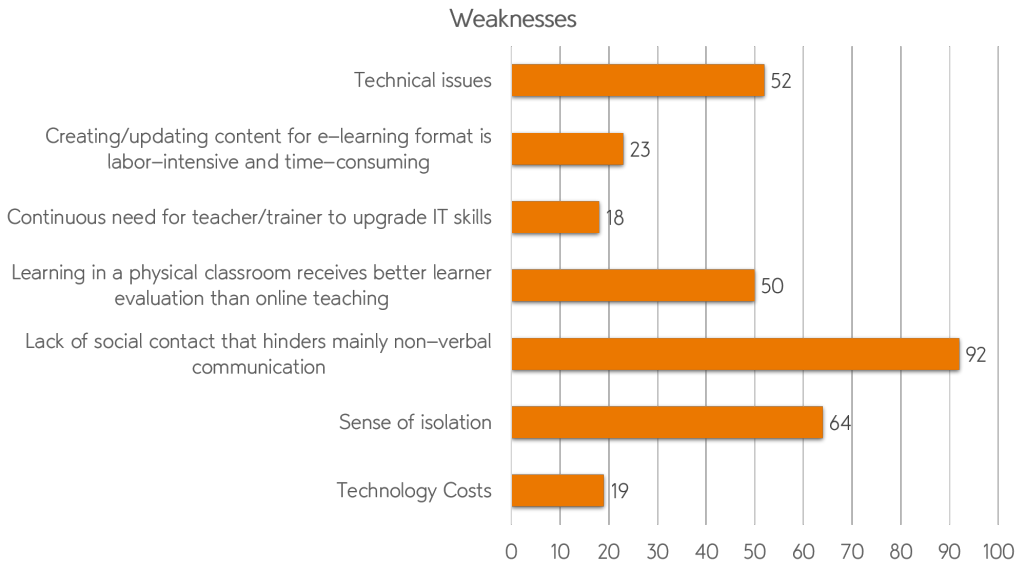

Figure 4.7: Disadvantages/Weaknesses listed in the Survey

Under Threats (figure 4.8), the first most voted was the difficulty in engaging students online. For teachers/trainers, teaching online to a large audience can be very problematic because it not only creates a huge challenge in doing practice exercises during the course, but also originates an absence of student participation, which becomes a difficulty for instructors to measure how well learners are understanding the content. As for the students/trainees, because this type of learning proves to be so monotonous, they often feel disconnected from their instructor. The second most voted threat was the fact that online courses/trainings may appear less credible. Due to the fact that the learning background has a big impact when applying for a job, sometimes not having attended a recognized and good learning institution can cause some poor judgment. The last most voted threat is the privacy and data security. Learners and tutors when connecting online share a lot of information sometimes without realizing it and once online all data is very vulnerable and the risks behind it are enormous.

Figure 4.8: Threats listed in the Survey

After collecting the main Strengths, Weaknesses, Opportunities and Threats it was possible to create the SWOT matrix, represented in the figure 4.9.

Strengths	Weaknesses
1. Access from anywhere with internet connection 2. Comfort/convenience 3. Independent and flexible learning	1. Lack of social contact that hinders mainly non–verbal communication 2. Sense of isolation 3. Technical issues
Opportunities	**Threats**
1. Wider target audience 2. New and exciting ways of learning 3. Easy access to potential sources/benchmark	1. Difficulty in engaging students online 2. Online courses/training may appear less credible 3. Privacy and data security

Figure 4.9: SWOT matrix of Digital Transformation of Learning Solutions in the Aviation Industry

4.2.2 TOWS Analysis

How to sustainably leverage Strengths to mitigate Threats?

One of the biggest threats to digital learning is the difficulty in engaging students online. For example, when there are many participants connected in the same class online, the instructor would find it difficult to engage with them and the class would become less interactive, which would translate into decreased attention from the participants and consequently less effective learning. To reduce this threat, a new strategy should be considered. In this case,

it is possible to use the fact that this type of learning is independent and flexible to create smaller classes with less learning time participants. Thus, the same class could be divided into several ones with a smaller number of learners. In this approach it would not only be easier for the instructor to approach the students, but for the students to feel encouraged to participate in the discussions, which would translate into a more successful class, even if the time spent on it was less.

Another threat is that online courses/training may appear less credible, mainly due to the fact that these types of learning institutions are not fully recognized by society. To ease this threat, it is possible to use the power of comfort and convenience to create a new strategy, a concerted effort to increase recognition and visibility with increased use of this solution. Being comfortable and convenient opens up more advantages to learners and instructors using these types of learning institutions, so the focus should be on promoting more these options in order to create a path for progression and growth in the use of this type of learning. Thus, the more use they have, the more recognition and visibility they will have, which will make this solutions a viable option in the industry.

Finally, in order to mitigate the final threat, privacy and data security, selecting a strategy out of this SWOT analysis should be the best solution. In this case, finding an appropriate technical solution to manage the privacy issues, for example through cross-marketing, would control the problem. Cross marketing is a marketing strategy for when organizations come together to help each other. In this case, having a private company specializing in data security involved in the delivery of digital learning solutions would solve the problem. While using these learning solutions would become more secure, the specialized company would expand the reach of its own brand/products by advertising on multiple marketing channels used by users, eventually contributing to increased sales.

How to utilize Opportunities to overcome Weaknesses?

The growing use of digital learning solutions is creating a lack of social contact that hinders mainly non-verbal communication. Communicating with learners in an online environment requires more thought and planning than communicating in the traditional environment because in some digital solutions there is a lack of body language. In order to overcome this weakness, building a strategy around the fact that digital solutions provide new and exciting ways of learning is the best way to go. Since there are good and highly engaging options available, select the one that best suits the needs of the learner along with the appropriate use of communication would create an effective interaction and thus be able to overcome this problem.

The feeling of isolation is one of the biggest weaknesses of digital learning, for both instructors and students. The lack of social relationships can bring a demotivation and frustration to this type of learning. In this case, the best way to overcome it is to use the fact that this learning has a wider target audience to create a larger online connected community. Organizing an online workgroup, for example, would bring new collaborations, new friendships,

an increase in cultural capital, just like using social media.

The fact that the digital learning solutions had a higher demand and usage in a short period of time, the solutions themselves were not ready for such a high demand and due to this there were many technical issues to overcome. Unfortunately for this weakness it will not be possible to use a strategy within the SWOT analysis, so an outer solution must be found. In this case using extra IT capacity from universities could be a good solution for the problem. For example, IT masters or PhD students, found by a company or university, could use their skills to create solutions to these technical issues.

	Strengths 1. Access from anywhere with internet connection 2. Comfort/convenience 3. Independent and flexible learning	Weaknesses 1. Lack of social contact that hinders mainly non–verbal communication 2. Sense of isolation 3. Technical issues
Opportunities 1. Wider target audience 2. New and exciting ways of learning 3. Easy access to potential sources/benchmark		WO1 = W1 + O2 Best tailoring learner needs, and communication skills set WO2 = W2 + O1 Create a wider connected community
Threats 1. Difficulty in engaging students online 2. Online courses/training may appear less credible 3. Privacy and data security	ST1 = S2 + T2 Reduce class size ST2 = S3 + T1 Increase recognition and visibility	

Figure 4.10: TOWS matrix of Digital Transformation of Learning Solutions in the Aviation Industry

From this study it is possible to understand the Impact of Digital Transformation of Learning Solutions in Aviation Industry through Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis. Similarly, it also allowed to hink of strategies to mitigate the negative impact through a TOWS analysis (figure 4.10).

So was it a success? Yes. Although there are some negative effects, no doubt it had enough positive impact to create effective and efficient learning.

And, is it possible to improve it? Yes. As shown in the TOWS analysis, new strategies can always be created within or outside of the SWOT analysis.

Chapter 5

Conclusions

The continuous evolution of the world, namely in terms of technological innovations, is creating new challenges in all industries.

Since its beginnings, over a century ago, Aviation Industry has seen many changes, a lot of improvements and innovations that have enabled its success in the world, but it does not intend to stop here. During the next 30 years, a new wave of technological change and innovation will come. Plans for a safer and more sustainable industry are on the way.

But is it possible to continue progressing without continuous learning? No. New technologies and innovations demand new skills and capabilities in workplaces. So to close this gap and prepare the workforce for the future it is necessary to look closely at the needs and empower academic and business organizations to take the necessary steps to improve the learning culture. It is essential for evolution that these communities continue to make efforts for better and constant learning.

For some years now, technological innovation has been moving towards learning and teaching methods, with the aim of creating more flexible and personalized learning with more benefits and opportunities. Although most of these solutions were available in the past, they were not being used in Aviation. Thanks to the Covid-19 pandemic their use and improvement gained new momentum, they started to be demanded everywhere since learning could not happen any other way.

Due to the rapid transition from classical learning to digital learning, there was a lack of awareness about the use of the digital solutions and the right skills to deploy effective learning. Therefore, this transition had both positive and negative consequences. Thus, this study examined, through an online survey, the opinions of learners and instructors on the impact of the digital transformation of learning solutions in the Aviation Industry in both academic and corporate environments.

This survey identified the top three Strengths and Opportunities and the top three Weaknesses and Threats of the digital transformation of learning solutions in order to make a SWOT matrix. It is essential to understand this analysis in order to create strategies to mitigate the negative impact of the digital transformation, as shown in the TOWS matrix. Universities and companies need to consider these results to determine the changes needed and ensure the best opportunities for learners.

The use of digital learning solutions is something that cannot be left out in current times.

The future will demand it, as the use of new technologies is inevitable, so society must adapt to it and make the most of its use.

For this to happen it is very important to continue to investigate more about these new learning tools, as well as their continuous evolution, to better understand them and know how they should be implemented so that their use brings the maximum opportunities and benefits to society.

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