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Unification of Training Programs for Aviation Professionals as a Flight Safety Criterion

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ABSTRACT

The research relevance is predefined by the air travel number growth. Accordingly, the relevance of this issue is increasing, especially concerning air travel safety. Also, due to the increasing demand for international flights, it becomes essential to harmonize the standards and methodology of training aviation personnel. The research aims to consider the parameters of flight safety and the impact of the unification of training programs for aviation personnel. The conclusion that unification can significantly affect safety was made with the help of scientific and special methods, including analysis, synthesis, concretization, and generalization. An analysis of existing unification methods was conducted. The multi-crew pilot training program proved to be one of the most advanced compared to standard flight crew training programs. The method was determined to be a specialized training program tailored to the needs of the aviation industry and focused on training pilots for multi-crew and jet operations. The program is more challenging, intensive and dynamic, and includes a significant amount of simulator training. Traditional flight training programs, such as Private Pilot Licenses (PPL), Commercial Pilot Licenses (CPL), instrument qualification, and multi-engine rating, have a broader scope and provide pilots with more career opportunities. Simulator training has been identified as a critical component of many flight training programs and plays a vital role in flight safety. The study may be of interest to a range of readers concerned with the issue of standardizing aviation training and improving safety in aviation, including researchers, faculty, and students of higher education institutions in the aviation field.

Keywords: Aircraft; Pilot support systems; Flight simulators; Flight training.

INTRODUCTION

Aviation is an essential sphere as it plays an important role in global transportation and trade. It connects people, goods, and services around the world and has a significant impact on the global economy. Aviation is just as important to Kazakhstan as it is to the world. It plays a vital role in the economic growth and development of the country, facilitating trade, tourism, and investment. Kazakhstan is strategically located at the crossroads of Europe and Asia, and has several major airports that serve as hubs for regional and international flights. Among other things, small aviation plays a significant role by providing air transport services to remote rural areas, which helps accelerate local economic development, improve access to health care and education, and support the country's overall infrastructure (Beljatynskij *et al.* 2010).

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By providing effective and affordable air transportation solutions, small aviation can help connect communities, businesses, and institutions in Kazakhstan. The importance of flight practices cannot be overstated when it comes to ensuring flight safety. Proper training of flight personnel is a key factor in achieving this goal. However, with the current patchwork of training programs across agencies and companies, it can be difficult to ensure that all employees receive the same level of training. This is especially true for institutions with limited budgets, and small aviation schools. Unification is the process of creating uniform standards and guidelines for aircrew training. As a result, these standards and guidelines are accepted and observed by all educational institutions and companies involved in flight crew training. This ensures the same level of qualification for all aviation personnel, which, in turn, increases flight safety (Wetmore *et al.* 2008).

Currently, organizations such as the International Civil Aviation Organization (ICAO) and the International Air Transport Association (IATA) are studying the standardization of aviation training (FlightGlobal 2008). They have concluded that standardization of training programs is necessary to ensure the safety and efficiency of the aviation industry (EASA 2020). To this end, ICAO and IATA have developed training standards and recommended practices for the aviation industry (Mendonca *et al.* 2019). These standards and practices are based on the latest research and evidence in aviation training and are designed to ensure that personnel are trained to the highest standards (Eidhof 2020). In addition, many countries have also developed their national aviation training standards based on ICAO and IATA standards. Ellis *et al.* (2021) studied the issue of flight safety, and based on their work, it is possible to conclude the degree of importance of certain safety criteria on the flight. Several key criteria are considered when creating unification training programs for aviation personnel in terms of their impact on flight safety:

- Airworthiness – This criterion ensures that all aircraft are in safe and airworthy condition. This includes regular checks and maintenance of the aircraft, as well as compliance with industry standards and regulations.
- Pilot qualifications – This criterion ensures that all pilots are properly trained and qualified to fly the aircraft they are operating. This includes compliance with regulatory requirements for hours flown, training, and experience.
- Navigation and communication – This criterion ensures that the aircraft can navigate and communicate effectively to maintain a safe distance from other aircraft and avoid potential hazards (Balbayev *et al.* 2014).
- Weather – This criterion ensures that the aircraft can operate safely in a variety of weather conditions, including thunderstorms, icing, and turbulence.
- Emergency procedures – This criterion ensures that the aircraft is equipped with the necessary safety equipment and procedures to deal with emergencies such as fires, engine failures, and hijackings (Berestovoi *et al.* 2020).
- Human factors – This criterion considers the role of human behaviour and actions in ensuring flight safety. This includes training and procedures to minimize the risks associated with human error, such as fatigue and stress.
- A safety management system (SMS) – A proactive approach to safety aimed at identifying and reducing potential hazards before they lead to accidents or incidents. SMS is a systematic approach to safety management, including the necessary organizational structure, responsibilities, policies0 and procedures (Avdieieva *et al.* 2020; Krayushkina *et al.* 2016).
- Risk management – This criterion is a systematic process of identifying, assessing, and reducing the risks associated with flight operations.

These are just a few examples of the key criteria that are used to ensure flight safety. The aviation industry is constantly evolving, and new technologies and procedures are being developed to improve flight safety. The research aims to study the need for the unification of training programs for aviation specialists and their impact on flight safety, to analyse and study existing methods and their advantages and disadvantages.

METHODOLOGY

This research was based on the qualitative, reliable combination of proven theoretical methods (analysis, synthesis, concretization, generalization, modelling), and empirical methods (study of research experimental works of foreign and Kazakh scientists and their experience in this or a similar area with the application of a similar goal of methods and studying them by experienced specialists).

The research conducted involved a systematic analysis and synthesis of existing methods for unifying aviation specialist training programs, with a strong emphasis on flight safety. This comprehensive study began with an initial analysis of various training program approaches, followed by the synthesis of this information to understand the global landscape of aviation training. The study then concretized its focus by delving into the specific criteria influencing flight safety, exploring their importance and interplay. This was followed by a generalization of findings, highlighting the potential benefits of standardizing aviation training programs worldwide, for enhancing civil and small aviation flight safety. To achieve these goals, the research employed modelling methods to create frameworks for standardization. It conducted a rigorous comparative analysis of materials from diverse sources, including detailed descriptions, theoretical knowledge, practical experiences, and recommendations from international organizations and academics. The study also prominently featured perspectives from foreign experts in countries like South Korea, Germany, and the United States, further enriching the analysis. Key issues in the aviation sector were outlined, and theoretical assumptions about future developments in aviation training programs were made based on factual insights.

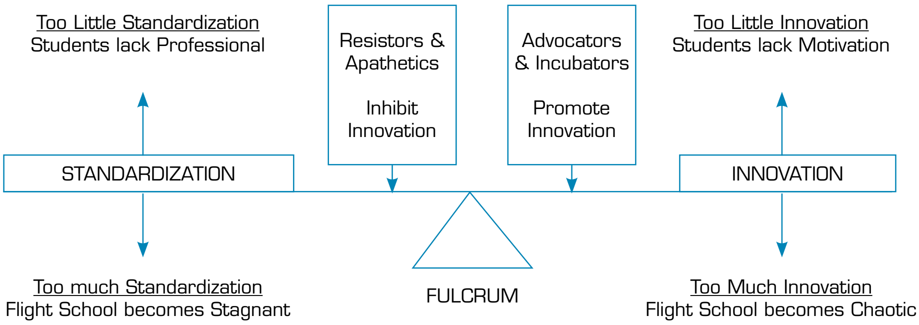
The research utilised a basic theoretical basis, on the analysis of which the basis for further conclusions is built. Various reliable sources of information were searched and analysed. Many information resources dedicated to civil, military, and small aircraft, the development and necessity of flights, and their impact on the economy and living standards in Kazakhstan, South Korea, Germany and other countries were reviewed and filtered. Also, literature was collected on the unification of training programs for aviation personnel, standard training programs for flight personnel, flight practice, simulator practice, flight safety, the use of special simulators for pilot training, and simulators with 3 degrees of freedom. The collected data were studied and systematized for a simplified, quick, and qualitative understanding of the information.

Training of flight personnel in different countries, flight practices, simulator practices, and their impact on flight safety were studied. The differences between civil aviation and small aviation training, levels of training in regions with large resources and opportunities, from regions where resources for training are limited, as well as general differences between training programs, their methods, and requirements depending on countries and regions were considered. The conclusions obtained from the research were analysed, specified, and verified. Then, the materials were finalized and theoretical and practical conclusions were clarified, generalized, verified, and systematized.

RESULTS

General characteristics and global experience of professional training programs in aviation

The purpose of unifying the aviation training program is to ensure that all aviation personnel have the same level of knowledge and skills. This is especially important in the case of emergency procedures, since all personnel must be familiar with the same procedures to respond effectively to an emergency. It also facilitates the movement of the staff between different companies and agencies because they will already have the necessary qualifications. Unification of flight training programs for aviation personnel can have a major impact on flight safety by ensuring that pilots and other aviation personnel are trained to the same high standards and have consistent levels of knowledge and skills, but it is important to balance standardization and innovation to ensure high levels of safety in airspace, as well as the ability to adapt to changing conditions and technologies (Shynkariuk 2022; Wetmore *et al.* 2008). Figure 1 shows the importance of balance.



Source: Elaborated by the authors based on EASA (2020).

Figure 1. Balance of standardization and innovation.

First, the standardization of flight training programs affects such parameters:

- Training consistency – Standardized training programs ensure that pilots and other aviation personnel are trained to the same standards and have a consistent level of knowledge and skills, regardless of where they are trained. This can help reduce the risks associated with human error and ensure that all pilots and aviation personnel are well prepared for the demands of their jobs.
- Efficiency gains – The training programs under consideration can be more time and cost-effective because they can be designed to be more streamlined and focused on the most important aspects of flight safety.
- Improving safety culture – Programs promote safety culture in the aviation industry by making safety a primary focus of training and encouraging all aviation personnel to play an active role in identifying and mitigating risks.
- Improved communication – Standardized-training programs can improve communication between different aviation personnel because they all learn the same language and use the same terminology. This can help reduce the risk of miscommunication and improve communication during flights.
- High classification rating – Standardized training programs can also facilitate easier recognition of pilots' and other aviation personnel's qualifications, making it easier for them to transition between different airlines or countries. This can help improve the mobility of pilots and other aviation personnel and improve the overall efficiency and safety of the aviation industry.
- Mutual recognition – Through standardized training programs, regulators can recognize the training and qualifications of pilots and other aviation personnel from other countries, making it easier for them to work in different countries.
- Harmonization of rules – With such training programs, regulators can harmonize rules across countries, which can help reduce the administrative burden on airlines and other aviation organizations and improve overall flight safety.

To achieve harmonization, a set of uniform standards and guidelines for aviation personnel training should be established. These standards and guidelines should be developed by a group of experts in the field and should be regularly reviewed and updated as necessary. Once approved, these standards and guidelines should be adopted by all aircrew training institutions and companies. There are several current ways to standardize aviation training programs. One of them is the Multi-Crew Pilot License (MPL). This is a new type of license developed by ICAO for commercial pilots in 2006. MPL provides unification of pilot training and evaluation requirements, as well as increased safety in aviation. It provides uniform minimum training and assessment requirements for pilots, allowing airlines and educational institutions to provide a uniform quality standard for pilot training and education. The MPL allows airlines to train people to operate more than one type of aircraft, focusing on common skills and procedures for different types of aircraft. This can lead to more effective pilot training and cost savings for airlines. Among the benefits of this method is the fact that MPL allows pilots to be trained and certified on multiple types of aircraft, which can lead to more effective pilot training and cost savings for airlines. This approach also addresses nontechnical skills such as leadership, communication, and decision-making that are necessary for multi-crew operations (Lee *et al.* 2021). One disadvantage of MPL, however, is that it can require significant investment in initial training and infrastructure, including aircraft and simulators. In addition, it may not be suitable for all types of operators, e.g., those with only one type of aircraft fleet (Schroeder and Harms 2007).

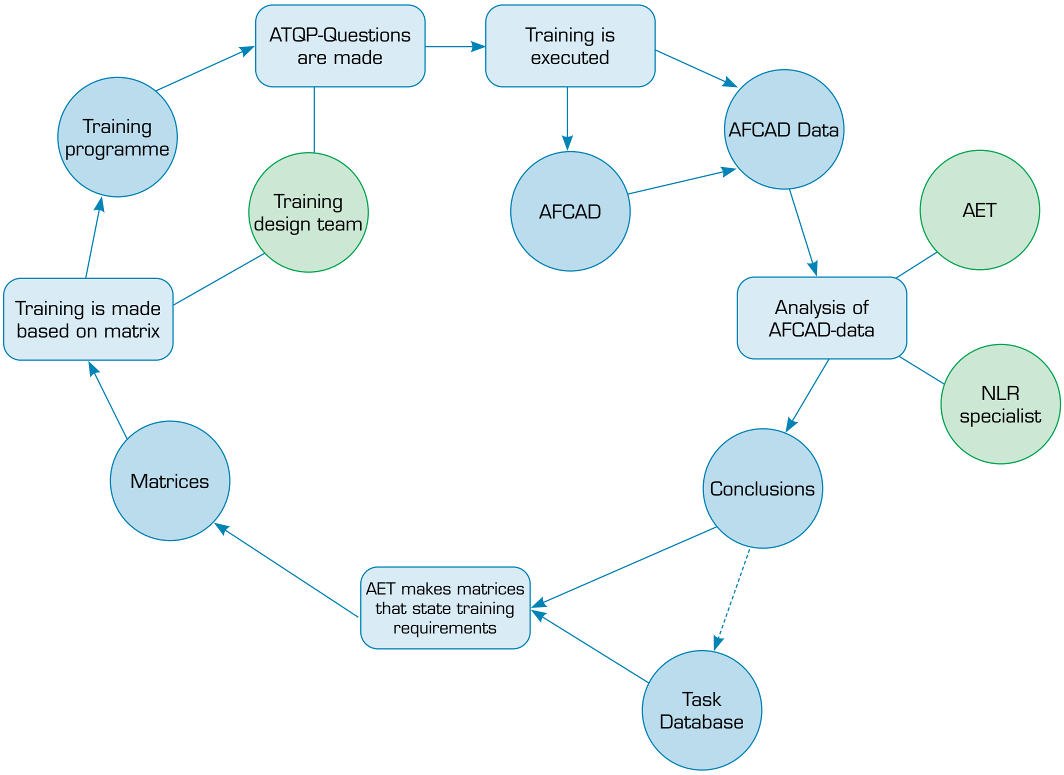
In order to better understand the characteristics of the MPL, the authors decided to compare it with two other pilot licenses (Table 1).

Table 1. Comparison of flight pilot license

Aspect	Multi-Crew Pilot License (MPL)	Private Pilot License (PPL)	Commercial Pilot License (CPL)
Purpose and focus	Airline operations, multi-crew	General aviation	General aviation
Training aircraft	Advanced simulators, multi-engine aircraft	Single-engine aircraft	Single-engine aircraft
Curriculum and duration	Shorter (18-24 months)	Longer (varies)	Longer (varies)
Entry requirements	Specific educational qualifications, aptitude tests	Entry requirements	Entry requirements
Experience and solo flight	Delayed introduction to solo flight	Early solo flight	Early solo flight
Licensing and ratings	MPL license with possible type ratings	Private pilot license, commercial pilot license	Private pilot license, commercial pilot license, additional ratings
Career path	Focus on airline careers	Various aviation careers	Various aviation careers

Source: Elaborated by the authors.

In other ways, the Alternative Training Qualification Programme (ATQP) (CAA 2013), a program designed to standardize Airline Transport Pilot (ATP) worldwide, was also developed in 2006. The program includes a set of minimum standards for pilot training and evaluation, as well as an ATP training program. ATQP uses the Airport Facility CADding (AFCAD) file format. The AFCAD files contain information on take-off and landing lanes, taxiways, parking areas, navigation lights, and other objects necessary for piloting in a virtual space. Its program provides pilots with the necessary knowledge and skills to fly for scheduled commercial airlines. The advantages of the ATP certificate program include its status as the highest level of pilot certification, preparation for a career in scheduled commercial airlines, a fixed-cost pricing structure, and valuable knowledge and experience opportunities. However, disadvantages include the costly and time-consuming 1,500-hour flight experience requirement, challenging written and practical exams, and federal prerequisites that may restrict eligibility. A visualization of the ATQP process is shown in Fig. 2.



Source: Elaborated by the authors based on Schroeder and Harms (2007).

Figure 2. ATQP process visualization.

The ATQP program is designed to enhance the safety and knowledge of airline pilots through advanced training and testing beyond the standard requirements for the commercial pilot certificate. One of the main advantages of the ATQP program is that it provides pilots with a higher level of training and knowledge than is required for a commercial pilot certificate. This includes training in areas such as flight systems, performance, and emergency procedures that can improve their ability to handle difficult situations and make better cockpit decisions.

Another benefit of the ATQP program is that it can help pilots advance their careers, allowing them to apply for higher-paying pilot positions with airlines. An ATP certificate is required for most airline pilot jobs, and the training and testing required by the ATQP program can help pilots meet those requirements. One major disadvantage of the ATQP program is that it can be quite expensive. Pilots will have to pay for the advanced training and testing required by the program, which can be a significant financial burden. In addition, the program can be time-consuming, requiring pilots to take time off from their normal duties to complete training and testing (Guerrero 2022).

Joint Aviation Authorities – Flight Crew Licensing (JAR-FCL 2006) is a set of rules established by the European Union (EU) in 2003 to standardize the training and licensing of pilots and air traffic controllers throughout the EU. The rules include minimum flight hours, training programs, and evaluation standards for pilots and air traffic controllers. This approach ensures that pilots and air traffic controllers in the EU have the necessary knowledge, skills, and experience to work safely and effectively. Advantages of JAR-FCL include its ability to standardize pilot training across Europe, ensuring that all pilots adhere to consistent standards and requirements, encompassing various facets of training, such as medical certification, practical skills, and theoretical knowledge. This standardization ultimately contributes to enhanced safety measures by upholding rigorous training standards. However, it is not without drawbacks, as JAR-FCL's intricate regulations may be challenging to comprehend, and the associated training expenses can be substantial. Additionally, some argue that these regulations might lack the flexibility needed to accommodate unique individual circumstances, potentially posing difficulties aspiring pilots (JAR 2006).

The ICAO Standards and Recommended Practices (SARPS) are a set of international standards and recommended practices established by ICAO in 1996 for various aspects of civil aviation, including pilot training and licensing. SARPS provide a framework for countries to develop their rules and standards based on ICAO recommendations. Advantages of ICAO SARPs include global aviation safety, standardized air navigation facilities, and orderly air transport development. Disadvantages involve operator awareness of differences with state regulations and potential challenges for flight crews in regions with non-ICAO procedures. Although it provides a framework for countries to develop their own rules and standards, even these are difficult for countries with limited resources and small airlines, and they can be difficult to apply to new and modern technology in aviation, as new items are developed slowly (Ng *et al.* 2021). Despite this, these standards are used in more than 190 countries, and their use contributes to the development of international trade and tourism (ICAO 2019).

Computer based training (CBT) is a method developed in 1994 that uses computer-based training methods, including simulations, interactive modules, and multimedia presentations to teach various topics such as flight systems, flight procedures, and accident scenarios. This method allows for more adaptive training and can be used for pilot retraining and testing. Among the main advantages over other methods are that CBT provides more flexible and efficient training, allows students to be trained regardless of their location, and allows content to be updated at any time. It is a cost-effective and efficient method that can be used in addition to traditional classroom instruction (Kjulavkovska *et al.* 2021). However, one disadvantage of CBT is that it may not provide the same level of hands-on experience as traditional methods, and the effectiveness of learning may depend on the quality of the software and simulation used (ILO 2020).

The customer relationship management (CRM) method was developed in 1988 and is aimed at teaching pilots and other flight crew members how to work effectively as a team and how to manage and use all available resources, including other crew members, the aircraft, and the cockpit. This approach aims to reduce human error, improve communication and teamwork in the cockpit, and improve overall flight safety. However, one disadvantage of CRM is that it requires significant investment in initial training and infrastructure, including aircraft and simulators. In addition, it may not be suitable for all types of operators, for example, for those who have a fleet of only one type of aircraft (Mizrak and Mizrak 2020).

Evidence-based training (EBT) is a research and evidence-based training method created in 1987 (Han 2020). Although it is considered a more efficient and effective training method, the use of EBT in aviation has some drawbacks (Robeck 2014):

- Cost – Implementing EBT can be expensive because it requires significant investment in research and development. It may also require the development of new training materials and equipment.
- Time requirements – EBT often takes longer to develop and implement than traditional training methods. This can lead to delays in training and certification.
- Complexity – EBT can be complex and requires a high level of expertise to develop and implement effectively. This can make implementation difficult for some training providers.
- Limited applicability – EBT may not be appropriate for all types of learning or all students. It may be more effective for certain types of instruction or certain groups of students.
- Lack of standardization – EBT is not yet widespread and standardized, which can lead to confusion and inconsistency in its implementation.

- Limited amount of research – The amount of research and evidence supporting the effectiveness of EBT in aviation, especially compared to traditional training methods, is limited.
- Change unwillingness – Some people and organizations may resist changing their traditional training methods, which can make it difficult to implement EBT.

The unification of flight training programs has significantly bolstered flight safety by instilling standardized procedures, enhancing pilot competency, and promoting a safety-oriented culture within the aviation industry. With consistent training across the board, pilots receive comprehensive instruction in essential skills and emergency protocols, resulting in reduced error rates and improved risk management. This standardization also facilitates better communication and teamwork among flight crews, ensuring efficient and safe operations. Moreover, the alignment of training with international regulations and best practices ensures that pilots are well prepared to navigate the complexities of modern aviation, contributing to safer skies and reducing the likelihood of accidents and incidents.

Kazakh aviation: history, accidents, and introduction of aviation training programs

Aviation in Kazakhstan dates back to the early 1920s when the first planes were introduced in the country. During the civil war, the planes were used for transportation operations and propaganda. After the war, most military planes were used in the national economy. The first testing civil flight dates back to April 1924, which was a flight from Tashkent to Alma-Ata and back. Regular air traffic by Kazakhstan's only airway began on July 11, 1924, using Yu-13 planes made of metal (SCAT Airlines 2023). Following the dissolution of the Soviet Union in 1991, the Kazakh division of the state-owned airline, Aeroflot, was transformed into Kazakhstan Airlines, with scheduled flights from its hub at Almaty International Airport being launched in 1992. Kazakhstan Airlines served as the national flag carrier of the country from its independence in 1991 until 1996. Following the disaster of the Charkhi Dadri mid-air collision, Kazakhstan Airlines ceased operations, and its role as flag carrier was transferred to Air Kazakhstan (ASN 1996; Makhanov 2020).

Aviation in the Republic of Kazakhstan has been growing rapidly in recent years. The Civil Aviation Committee of the Ministry of Transport of the Republic of Kazakhstan is responsible for the regulation of civil aviation in the country. Kazakhstan Aviation Industry (KAI) was established as a Maintenance and Repair Organisation (MRO) in 2012 to develop the domestic aviation industry and provide maintenance services to the Ministry of Defence. The Aviation Administration of Kazakhstan (AAK) is responsible for ensuring technical aviation control and supervision in the field of flight safety. There are currently 56 airline companies registered in Kazakhstan, but only five of them are involved in regular passenger transportation. Kazakhstan's effective implementation of ICAO safety standards is now 15% higher than the global average (UK Civil Aviation Authority 2021).

In May 2023, the first Kazakhstan Aviation Talks were held in Astana. The talks explored challenges facing the aviation fuel industry in the region, with a focus on energy transition for sustainability and transit development in Central Asia. The talks were a foundation for cooperation between countries, and the director general of AAK stated that the talks were the first of their kind. The talks also addressed the issue of jet fuel shortage and its high cost as one of the main constraints for developing the country's civil aviation (Sakenova 2023). The aviation industry is constantly working to improve safety measures and training programs to prevent future accidents.

Kazakhstan played a significant role in space exploration by hosting the Baikonur Cosmodrome, which has been successfully operated by Roscosmos State Corporation under the leasing agreement with the Russian Federation since 1994. Kazakh pilots have also had the privilege to explore the cosmos, with the first Kazakh person to go to space being Tokhtar Aubakirov, in 1991, followed by Talgat Mussabayev, in 1994, 1998, and 2001, and Aidyn Aimbetov, in 2015 (The Astana Times 2021).

To better understand what errors and gaps are contained in pilot training programs, the authors analysed two of the largest aeroplane crashes in the history of Kazakhstan. On December 27, 2019, a Bek Air plane crashed shortly after take-off from Almaty International Airport, killing 12 people and injuring dozens more (Calder 2019). The cause of the crash was attributed to pilot error, specifically the pilot's failure to de-ice the plane's wings before take-off, which led to loss of control. This incident highlights a gap in the training programs for pilots in Kazakhstan, particularly in the area of safety procedures and protocols. Even though Kazakhstan was rated well above global standards for regulating operations and airworthiness in the most recent oversight check conducted by the ICAO, the crash suggests that there may be weaknesses in the training programs for pilots. Another incident that highlights gaps in the training programs for pilots in Kazakhstan is the 1996 mid-air collision involving a Kazakhstan Airlines jet and a Saudi Arabian Airlines plane (Government of India 1996). The collision occurred shortly after take-off from New Delhi, India, and resulted in the deaths of all 349 people on board both planes. While the cause of the collision was attributed to pilot error, investigators called for an analysis of the training program rather than retraining the pilots. This incident suggests that there may be a need for more comprehensive and effective training programs for pilots in Kazakhstan.

Kazakhstan has been investing in aviation pilot training programs to enhance the capabilities of its pilots. Air Astana, the national airline of Kazakhstan, recently commissioned a new Flight Training Centre to avoid the need to send pilots abroad for training. Epic Flight Academy has also designed a Kazakhstan Pilot Program to train pilots under Kazakhstan's Civil Aviation Committee with structured flight training (Epic Flight Academy 2023). In addition, Kazakhstan has been expanding its air cargo control through the UNODC-WCO Global Container Control Programme (UNODC 2019). The country has also been collaborating with international aviation training providers, such as CAE and Textron Aviation Defence, to enhance next-generation training and expand its business aviation training network (CAE 2023).

The Kazakh aviation sector has grown significantly in recent years, with a focus on safety and regulatory compliance. Kazakhstan actively participates in international aviation collaborations and discussions, addressing challenges such as jet fuel shortages and sustainability. The country plays a role in space exploration and is investing in pilot training programs to enhance safety. Despite past incidents, Kazakhstan is committed to the growth and improvement of its aviation industry.

DISCUSSION

The MPL program is a type of flight training that is becoming increasingly popular among aspiring commercial pilots. It is considered one of the most advanced programs because it allows the model developer to formulate complicated optimization models in a clear way. Additionally, MPL is used in various fields such as aviation, gaming, and prosthetics, which shows its versatility and adaptability. MPL is designed to provide cadets with the specific skills and knowledge needed to function effectively as a co-pilot in a multi-crew environment. Compared to traditional flight training programs such as Private Pilot License (PPL) and Commercial Pilot License (CPL), MPL has several key differences:

- The MPL is specifically designed to meet the needs of the aviation industry, with an emphasis on multi-crew and jet aircraft.
- MPL training is usually provided by an airline or training organization in partnership with an approved flight training organization. This allows cadets to receive training directly related to the type of aircraft they will be flying in their future careers. Likewise, MPL training includes a significant amount of simulator training that is used to replicate the complex procedures and systems used in today's jets. In addition, the program includes an integrated type of evaluation that allows cadets to complete their training and almost immediately begin flying as airline co-pilots.

Currently, MPL has several disadvantages. MPL is a more complex and demanding program of study than traditional programs. This can increase training costs for students and airlines. In addition, instructors who teach in an MPL program must have a higher level of qualifications, which can also affect costs. Another disadvantage of MPLs is the difficulty with regulation and licensing. Each country has its rules and standards for pilot training and licensing, and some countries may not accept MPL licenses. This can lead to additional difficulties for pilots who are licensed under the MPL and wish to work overseas. Despite these disadvantages, MPL offers many advantages to companies and students. Mostly, it provides a more effective and faster learning experience because it combines theoretical and practical training (EASA 2020). This allows students to start their careers as a pilot faster, which ultimately reduces training costs for airlines. In addition, MPL allows airlines to obtain more qualified pilots who will be better prepared to work on commercial aircraft (Kjulavkovska *et al.* 2021). MPL can also help airlines meet the increasing need for qualified pilots expected in the future, as stated by Carey *et al.* (2012) in their study of the problem of the severe pilot shortage.

PPL training is the first step for novice pilots and focuses on the basics of flight, including take off, landing, navigation, and emergency procedures. PPL training typically includes a minimum of 40 flight hours and pilots are qualified to fly a single-engine aeroplane under visual flight rules. MPL, in other ways, is specifically tailored to the needs of the aviation industry and focuses on multi-crew operations and jets. Analysing a study by Adanov *et al.* (2020) of pilot training and recruitment in Europe, it can be concluded that compared to the PPL program, MPL training is more intensive and faster, with shorter total training time and a significant amount of simulator training.

PPL training typically takes 40 to 60 hours of flight training and 20 to 40 hours of classroom training. Training costs can range from 15 thousand dollars to 30 thousand dollars, depending on the training location and aircraft type. Training for MPLs usually takes anywhere from 18 months to 2 years, depending on the airline and program. It can include both theoretical and practical training. Training costs can range from 100 thousand dollars to 250 thousand dollars, depending on the airline and program (Lee *et al.* 2021). In addition, MPL training often requires additional medical checks and medical consent, which can add additional costs (ICAO 2011).

CPL training builds on the skills and knowledge gained during PPL training and focuses on advanced flight and navigation techniques, including instrument flight rules. CPL training typically includes a minimum of 250 hours of flight time, and pilots are authorized to fly single-engine or multi-engine aircraft for hire. The MPL, in other ways, is specifically tailored to the needs of the aviation industry and includes an integrated type of evaluation that allows cadets to complete their training and almost immediately begin flying as a co-pilot with an airline. The cost of training for CPL and MPL varies by country, air school, and scope of training. Typically, MPL training can be more expensive than CPL because it involves more intensive training and practice on simulators. CPL and MPL may also have different qualifications and medical clearance requirements. For example, CPL requires a Class 1 medical qualification, while MPL may have a Class 2 qualification requirement (Carey *et al.* 2012). It is important to note that CPL and MPL have different purposes and uses. The CPL is for people who want to become commercial pilots and fly as solo pilots, while the MPL is for people who want to become commercial pilots and fly as a team aboard two-cockpit aircraft.

Airline Transport Pilot License (ATPL) programs are one of the highest levels of pilot licensing in aviation and are designed to train professional commercial pilots. Typically, an ATPL program consists of theoretical and practical training, which can take from 18 to 24 months, depending on the intensity of training and airline requirements. During the program, pilots receive a wide range of knowledge, including flight physics, meteorology, navigation, air traffic regulations, flight safety, flight techniques, human resources management, and many other topics. After completing the theoretical part of the training, pilots must go through the practical part, which includes training flights on single-engine and multi-engine aircraft. During the practical part of the training, pilots learn how to perform various manoeuvres, including take-offs and landings, low altitude flight, aviation navigation, emergency management, and more. Upon successful completion of the ATPL program, pilots receive an ATPL license, which allows them to work as aircraft captains for airlines. Typically, to obtain an ATPL license, pilots need to have a certain number of flight hours as pilots, which can be achieved by working for airlines as co-pilots. ATPL training is expensive, but pilots who complete the program can earn high salaries and have career prospects in the aviation industry (FlightGlobal 2008).

There is also Instrument Rating (IR) training. It focuses on the skills and knowledge needed to fly in instrument weather conditions when visibility is poor and pilots must rely on instruments to navigate and control the aircraft. IR training typically includes a minimum of 50 hours of flight time and pilots are qualified to fly in IFR conditions. MPL, in other ways, is specifically adapted to the needs of the aviation industry and includes a significant amount of simulator training, which is used to replicate the complex procedures and systems used in modern jets, as follows from Hanáková et al. (2020) on the problem of pilot fatigue, helps to better prepare for the workload. Multi-Engine Rating (MER) training focuses on the skills and knowledge needed to fly multi-engine aircraft, which are usually more complex and require more advanced skills than single-engine aircraft. MER training typically involves at least 20 hours of flying time. MPL is specifically adapted to the needs of the aviation industry and focuses on multi-crew operations and jet aircraft, which in consequence through more competent education will increase safety, as stated by Mendonca *et al.* (2019).

Traditional flight training programs, such as PPL and CPL, offer more extensive training that allows pilots to fly different types of aircraft and gives them more flexibility in terms of career options. Simulator training is a key component of many flights training programs, including the MPL program. Simulator training allows pilots to practice and improve their skills in a safe and controlled environment without the risks and costs associated with flying a real aircraft. Several types of flight simulators are used in pilot training, including:

- Full Flight Simulator (FFS) – These are the most advanced and realistic simulators designed to replicate the cockpit and systems of a particular aircraft type (Sadovoy *et al.* 2021; Wikander and Dahlstrom 2020). FFS are typically used for typical evaluation and retraining of commercial pilots (Lee 2020).
- Flight Training Devices (FTD) – These simulators are less complex than FFS and are usually used for early training or in addition to teaching specific procedures or manoeuvres (Pavliuk 2022; Tran *et al.* 2022).
- Basic Aviation Training Device (BATD) – These simulators are the simplest type of flight simulator and are used for basic flight training (Yusuf *et al.* 2019).
- Synthetic Training Devices (STD) – These simulators are used to train pilots in certain procedures, such as instrument approaches and emergency procedures (Kharlamov *et al.* 2015; Tran *et al.* 2022).

Among all flight simulators, it is possible to distinguish simulators with 3 degrees of freedom. They are widely used in aviation training, both for pilots and maintenance crews. They provide an economical and safe way to train pilots and other personnel in various scenarios, including emergencies and other challenging flight conditions. One of the main advantages of using a flight simulator with 3 degrees of freedom is that it provides a high degree of realism and immersion. Trainees can experience the same movements and sensations as in a real aircraft, allowing them to better understand how the aircraft behaves in different situations. It is especially useful for pilot training because it allows them to develop the necessary skills and knowledge to operate the aircraft safely in a variety of conditions.

Another advantage of three-degree-of-freedom simulators is that they can be used to replicate a wide range of aircraft types and models. This allows training on several types of aircraft, which is especially useful for airlines operating fleets of different models. An important aspect of flight simulators with 3 degrees of freedom is the use of sophisticated computer simulation and simulation to reproduce the physical and aerodynamic characteristics of the aircraft. This provides a high degree of accuracy and realism, which is essential for effective training. In addition, these simulators can be used for both initial and refresher training, which means that pilots and other personnel can continue to use them throughout their careers to maintain and improve their skills. Simulator training can include a wide range of exercises, such as normal and abnormal procedures, emergency scenarios, and flying in different weather conditions. Simulator training can also be used to teach specific skills, such as crew resource management and threat and error management (Bondarenko *et al.* 2013; Mageramov *et al.* 2014). Simulator training has several advantages over training on a real aircraft. It allows pilots to practice and improve their skills in a primarily safe and controlled environment without risk or cost. Simulator training also allows for repeated practice of certain procedures and scenarios, which is necessary to master complex skills and procedures.

The MPL program is used by many airlines and flight training organizations around the world. The MPL program was first introduced by the European Aviation Safety Agency (EASA) in 2006 and has since been adopted by several other aviation regulatory agencies (Wikander and Dahlstrom 2020). Countries that have adopted the MPL program include many EU countries, such as France, Germany, Spain, and Italy. Also, the Australian Civil Aviation Safety Authority (CASA), Canadian Transportation Agency (CTA), Civil Aviation Authority of Singapore (CAAS), Directorate General of Civil Aviation in India (DGCA), Civil Aviation Authority of China (CAAC), General of the Arab Civil Aviation Organization (GACAO) in the United Arab Emirates, and other countries have adopted MPL and have several training organizations on this program (Kim 2021). Wikander and Dahlstrom (2020) stated that developing and conducting training for an MPL pilot license can be difficult and complex in many ways. There is no doubt that the initiative to introduce an MPL program was to improve pilot training, but only preliminary information is currently available to determine if this goal will be achieved.

CONCLUSION

It was concluded that several key criteria can be identified that are used to ensure flight safety. These include airworthiness, pilot qualifications, navigation and communication, weather, emergency procedures, human factors, SMS, and risk management. These criteria are regularly evaluated and updated to ensure that flight safety is maintained at the highest level. Unification of flight training programs for aviation personnel can have a positive impact on flight safety by ensuring that pilots and other aviation personnel are trained to the same high standards and have consistent levels of knowledge and skills, and by creating a culture of safety and promoting mutual recognition of qualifications, harmonizing regulations, and reducing administrative burdens.

The information presented in the study highlights the importance of standardizing flight training programs for aviation personnel in terms of safety, consistency, and efficiency. Unification training programs for aviation personnel, such as MPL, ATQP, JAR-FCL, SARPS, CBT, CRM, and EBT are discussed in detail. It was concluded that the MPL program is one of the most advanced. MPL was compared with standard flight personnel training programs, and it was concluded that MPL is a specialized training program designed to meet the needs of the aviation industry and focused on multi-crew and jet aircraft. It is more demanding, intensive, and dynamic and includes significant simulator training.

Traditional flight training programs such as PPL, CPL, IR, and MER have a broader scope and provide more career opportunities for pilots. It has also been found that simulator training is a key component of many flights training programs, including MPL, and has a significant impact on flight safety. In the future, it is worth continuing to monitor the effectiveness of existing unification programs, and actively pursue improvement and development.

Future studies should delve deeper into advanced training programs like MPL, assess the impact of simulator training on safety, explore further standardization and harmonization efforts, investigate human factors and CRM training, and evaluate the integration of emerging technologies.

CONFLICT OF INTEREST

Nothing to declare.

AUTHORS' CONTRIBUTIONS

Conceptualization: Dolzhenko N, Assilbekova I; **Formal analysis:** Abzhapbarova A, Mussayeva G; **Research:** Dolzhenko N, Abzhapbarova A, Mussayeva G; **Methodology:** Sarzhanov T; **Supervision:** Dolzhenko N; **Writing - Preparation of original draft:** Assilbekova I, Abzhapbarova A, Mussayeva G; **Writing - Proofreading and editing:** Dolzhenko N, Sarzhanov T.

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REFERENCES

[ASN] Aviation Safety Network (1996) ASN aircraft accident Ilyushin Il-76TD UN-76435 Charkhi Dadri. Virginia: ASN. [accessed Sep 14 2023]. https://aviation-safety.net/database/record.php?id=19961112-1

[CAA] Civil Aviation Authority (2013) Alternative training and qualification programme (ATQP). Gatwick: CAA. [accessed Jul 10 2023]. https://publicapps.caa.co.uk/docs/33/sarg_lts_ATQP%20Stds%20Doc80%20v1_July%2013.pdf

[CAE] Canadian Aviation Electronics (2023) CAE set to expand its business aviation training network with new centre in Central Europe. Montreal: CAE. [accessed Sep 14 2023]. https://www.cae.com/media/documents/CAE_set_to_expand_its_business_aviation_training_network_with_new_centre_in_Central_Europe_-_English.pdf

[EASA] European Aviation Safety Agency (2020) Easy access rules for flight crew licensing (Part-FCL). Strasbourg: EASA. [accessed Jul 8 2023]. https://www.easa.europa.eu/sites/default/files/dfu/Easy_Access_Rules_for_Part-FCL-Aug20.pdf

[ICAO] International Civil Aviation Organization (2011) Personnel licensing. Quebec: ICAO. [accessed Jul 14 2023]. https://web.shgm.gov.tr/documents/sivilhavacilik/files/pdf/saglik_birimi/mevzuat/ICAO_Annex%201-ed11.pdf

[ICAO] International Civil Aviation Organization (2019) ICAO Training. Supporting states in the implementation of ICAO Standards and Recommended Practices (SARPs). Montreal: ICAO. [accessed Jul 11 2023]. https://www.icao.int/training/Documents/ICAO_SARPs_Implementation_Brochure_WEB.PDF

[ILO] International Labour Organization (2020) Competency-based training (CBT): An introductory manual for practitioners. Geneva: ILO. [accessed Jul 12 2023]. https://www.ilo.org/wcmsp5/groups/public/---arabstates/---ro-beirut/documents/publication/wcms_757836.pdf

[JAR] Joint Aviation Authorities (2006) JAR-FCL 1 – Flight crew licensing (aeroplane). Hoofddorp: JAR. [accessed Jul 10 2023]. https://www.caa.md/files/2014_01/556.pdf

[UNODC] United Nations Office on Drugs and Crime (2019) UNODC-WCO global container control programme expands to air cargo control in Kazakhstan. Almaty: UNODC. [accessed Sep 14 2023]. https://www.unodc.org/centralasia/en/news/unodc-wco-global-container-control-programme-expands-to-air-cargo-control-in-kazakhstan.html

Adanov LM, Macintyre A, Efthymiou M (2020) An exploratory study of pilot training and recruitment in Europe. Int J Aviat Sci Technol 1(2):44-51. https://doi.org/10.23890/IJAST.vm01is02.0201

Avdieieva E, Stavinskiy R, Sadovoy O, Shebanin V, Vakhonina L, Andrii R (2020) Technological parameters of the magnetic circuit of the compact transformer for aggregate electric drive. Paper presented Proceedings of the 25th IEEE International Conference on Problems of Automated Electric Drive. Theory and Practice, PAEP 2020. IEEE; Kremenchuk. https://doi.org/10.1109/PAEP49887.2020.9240779

Balbayev G, Ceccarelli M, Ivanov K (2014) An experimental test validation of a new planetary transmission. Int J Mech Contr 15(2):3-7.

Beljatynskij A, Prentkovskis O, Krivenko J (2010) The experimental study of shallow flows of liquid on the airport runways and automobile roads. Transp 25(4):394-402. https://doi.org/10.3846/transport.2010.49

Berestovoi AM, Berestovoi IO, Zinchenko SG, Khliestova OA, Senatosenko VA (2020) Effectometrics of transport technological system. Int J Eng Res Technol 13(12):4870-4879.

Bondarenko IN, Galich AV, Troitski SI (2013) High-Q modes in irregular hybrid structures. Telecommun Radio Eng (Engl Transl) 72(19):1747-1753.

Calder S (2019) Why did the Bek Air plane crash and how safe are Kazakh airlines? New York: Independent. [accessed Sep 14 2023]. https://www.independent.co.uk/travel/news-and-advice/kazakhstan-plane-crash-bek-air-almaty-nur-sultan-aviation-safety-a9261101.html

Carey S, Nicas J, Pasztor A (2012) Airlines face acute shortage of pilots. New York: The Wall Street Journal. [accessed Jul 13 2023]. https://www.wsj.com/articles/SB10001424052970203937004578079391643223634

Eidhof M (2020) Optimization of the ATQP-process in company X. Enschede: University of Twente.

Ellis KK, Krois P, Koelling J, Prinzel LJ, Davies M, Mah R (2021) A concept of operations (ConOps) of an in-time aviation safety management system (IASMS) for advanced air mobility (AAM). Paper presented AIAA Scitech 2021 Forum. Session: Software Challenges in Aerospace II. Reston: ARC. https://doi.org/10.2514/6.2021-1978

Epic Flight Academy (2023) Kazakhstan pilot program. New Smyrna Beach: Epic Flight Academy. [accessed Sep 14 2023]. https://epicflightacademy.com/kazakhstan-pilot-program/

FlightGlobal (2008) Pilot shortages highlight the need for advanced flight simulator technology. London: FlightGlobal. [accessed Jul 8 2023]. https://www.flightglobal.com/pilot-shortages-highlight-the-need-for-advanced-flight-simulator-technology/79882.article

Government of India (1996) Report of Court of Inquiry on mid-air collusion between Saudi Arabian Boeing 747 and Kazakhstan IL-76. Delhi: Government of India. Ministry of Civil Aviation. [accessed Sep 14 2023]. https://www.baaa-acro.com/sites/default/files/2020-12/HZ-AIH.pdf

Guerrero FE (2022) Paradoxes of technology. Reflections on early and late retirement in the digital transition: The case of commercial pilots. E-J Int Comp Labour Stud 11(2):86-114.

Han KK (2020) Study on EBT implementation and approval process in Korea. J Korean Soc Aeronaut Space Sci 28(4):141-146. https://doi.org/10.12985/ksaa.2020.28.4.141

Hanáková L, Socha V, Bořil J, Herman L, Štrobl J (2020) Subjective evaluation of fatigue in pilots during 24-hour testing. In: 2020 New trends in civil Aviation (NTCA). Prague: IEEE. p. 111-116. https://doi.org/10.23919/NTCA50409.2020.9291239

Kharlamov MY, Krivtsun IV, Korzhyk VN, Ryabovolyk YV, Demyanov OI (2015) Simulation of motion, heating, and breakup of molten metal droplets in the plasma jet at plasma-arc spraying. J Therm Spray Technol 24(4):659-670. https://doi.org/10.1007/s11666-015-0216-4

Kim BG (2021) Study for implementing multi-crew pilot license (MPL) in Korea. Eumseong: Far East University.

Kjulavkovska M, Serafini GO, Szamosi LT (2021) Integrating training and performance management of civil aviation inspectors: A pilot study of the mediating role of competency-based training. Int J Train Dev 26(1):29-54. https://doi.org/10.1111/ijtd.12234

Krayushkina K, Prentkovskis O, Bieliatynskyi A, Gigineishvili J, Skrypchenko A, Laurinavicius A, Gopalakrishnan K, Tretjakovas J (2016) Perspectives on using basalt fiber filaments in the construction and rehabilitation of highway pavements and airport runways. Balt J Road Bridge Eng 11(1):77-83 https://doi.org/10.3846/bjrbe.2016.09

Lee J-H (2020) A study on the regulation of civil flight simulator. J Aerospace Sys Eng 14(2):12-19. https://doi.org/10.20910/JASE.2020.14.2.12

Lee JR, Kwon M, Kwon H (2021) Flight simulation training device operating standards for MPL training programs in South Korea. J Korean Soc Aviat Aeronaut 29(3):117-121. https://doi.org/10.12985/ksaa.2021.29.3.117

Mageramov LK, Krolenko AI, Slivar EY, Nefedov AV, Gulevskiy YV (2014) Analysis of the structural features of dynamic platforms of simulators. Integr Technol Energy Sav 3:65-69.

Makhanov K (2020) Aviation in Kazakhstan: An economic view. Almaty: Eurasian Research Institute. [accessed Sep 14 2023]. https://www.eurasian-research.org/publication/aviation-in-kazakhstan-an-economic-view/

Mendonca FAC, Keller J, Dillman BG (2019) Competency-based education: A framework for a more efficient and safer aviation industry. J Int Soc Air Safety Invest 54(1):19-23.

Mizrak KC, Mizrak F (2020) The impact of crew resource management on reducing the accidents in civil aviation. J Aviat Res 2(1):1-25.

Ng CBR, Bil C, O'Bree T (2021) An expert system framework to support aircraft accident and incident investigations. Aeronaut J 125(1289):1131-1156. https://doi.org/10.1017/aer.2021.11

Pavliuk L (2022) Electron modelling in conjunction witch vacuum modelling. Sci Herald Uzh Univer Ser Phys (52):27-35.

Robeck V (2014) Evidence-based training. Lima: International Air Transport Association. [accessed Jul 13 2023]. https://www.icao.int/SAM/Documents/2014-AQP/Viktor_Robeck_EBT_Lima_2014v4.pdf

Sadovoy O, Avdieieva E, Vakhonina L, Shebanin V (2021) Comparison of the active parts of single-phase transformers with twisted and laminated magnetic circuits. Paper presented 20th IEEE International Conference on Modern Electrical and Energy Systems. IEEE; Kremenchuk. https://doi.org/10.1109/MEES52427.2021.9598597

Sakenova S (2023) First Kazakhstan aviation talks in Astana explore challenges in aviation industry. Astana: The Astana Times. [accessed Sep 14 2023]. https://astanatimes.com/2023/05/first-kazakhstan-aviation-talks-in-astana-explore-challenges-in-aviation-industry/

SCAT Airlines (2023) History of Chimkent airline. Astana: SCAT Airlines. [accessed Sep 14 2023]. https://www.scat.kz/en/history/

Schroeder C, Harms D (2007) MPL represents a state-of-the-art ab initio airline pilot training programme. ICAO J 62(3):15-16, 31-32.

Shynkariuk IM (2022) Alternative representation of space and time: Geometric solution of problems of relativity theory. Sci Herald Uzh Univer Ser Phys (51):74-82. https://doi.org/10.54919/2415-8038.2022.51.74-82

The Astana Times (2021) On 60th anniversary of Yuri Gagarin's historic flight, Kazakhstan and World Salute Space Explorers. Astana: The Astana Times. [accessed Sep 14 2023]. https://astanatimes.com/2021/04/on-60th-anniversary-of-yuri-gagarins-historic-accomplishment-kazakhstan-and-world-salute-space-explorers/

Tran HQ, Tillett M, Tran NK (2022) Integrating an electronic flight bag (EFB) to flight training devices. Paper presented AIAA SCITECH 2022 Forum. Session: Human-in-the-loop simulation of air traffic management. Reston: ARC. https://doi.org/10.2514/6.2022-2451

UK Civil Aviation Authority (2021) CAAi helps Kazakhstan increase aviation safety ICAO compliance. Crawley: UK Civil Aviation Authority. [accessed Sep 14 2023]. https://caainternational.com/caai-helps-kazakhstan-increase-aviation-safety-icao-compliance/

Wetmore MJ, Lu CT, Bos P (2008) Modeling the balance between standardization and innovation in a flight school. J Aviat Aerospace Edu Res 17(3):39-54. https://doi.org/10.15394/jaaer.2008.1457

Wikander R, Dahlstrom N (2020) The multi crew pilot licence – Revolution, evolution or not even a solution? Lund: Lund University. [accessed Jul 15 2023]. https://www.tfhs.lu.se/fileadmin/tfhs/images/The_Multi-Crew_Pilot_License.pdf

Yusuf AB, Kor A-L, Tawfik H (2019) A simulation environment for investigating in-flight startle in general aviation. Paper presented 10th International Conference on Dependable Systems, Services and Technologies. IEEE; New York. https://doi.org/10.1109/DESSERT.2019.8770028