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Digital Transformation in Aviation Education: A Review of ICT Tools and Techniques

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ABSTRACT

Aviation education is essential to the aviation industry because it ensures that professionals like pilots, air traffic controllers, maintenance specialists, cabin staff, and other aviation specialists acquire the skills, knowledge, and competences necessary to carry out their roles safely and effectively. In line with this, the increasing significance of technology in aviation education is evidenced by the varied contexts and applications discovered in the chosen studies. This digital revolution in aviation education has fundamentally transformed traditional training paradigms by adding state-of-the-art ICT solutions to satisfy the industry's continuously changing demands and obstacles. Hence, this paper conducted a thorough analysis of academic works pertaining to the digital changes achieved in the field of aviation education via the use of ICT tools and approaches and the factors influencing the adoption of ICT in aviation education. Results showed that the the common ICT tools and techniques in aviation education encompass a diverse range, including TPACK framework, Virtual Reality, specialized computer tools, Big Data, IoT, Cloud Computing, Web 2.0, modular and interdisciplinary study programs, simulator technology, immersive technologies like VR and AR, communication technology, EBT, and AI. Concurrently, the adoption of ICT in aviation education is influenced by factors like social influence, effort expectations, enabling circumstances, motivation, perceived usefulness and ease of use, perceived behavioral control, organization culture, individual traits, content quality, cooperation, institutional-level factors, technological aspects, logistical considerations, and instructor attitudes and abilities.

INTRODUCTION

The aviation industry has recognized the need to enhance passenger convenience and security protocols while simultaneously optimizing on-time performance most cost-effectively. Information and Communication Technologies (ICTs) have a particularly important role to play here because the ambitious agenda of passenger convenience and airport security becomes much more achievable only with the strategic, widespread, intensive, and innovative use of ICT in future airport development policies and programs (Wong, 2006). Ates and Durmaz (2022) explained that aviation is one of the top sectors for using cutting-edge technologies. The aerospace industry has succeeded in transitioning from a specialist sector to a global leader in the previous 40 years (Arnaldo *et al.*, 2019). However, multiple outbreaks have had an impact on the industry's global development. One of the most fundamental ways to escape these situations is to have competent human resources and to receive training in modern technology abilities. Aviation education is vital to the aviation industry because it guarantees that professionals such as pilots, air traffic controllers, maintenance specialists, cabin staff, and other aviation specialists acquire the skills, knowledge, and competencies needed to perform their roles safely and effectively (Jentsch & Curtis, 2017).

Correspondingly, Dincer (2023) clarified the growing importance of technology in aviation education, as seen by the diverse settings and uses found in the selected research. By incorporating cutting-edge ICT solutions to meet the industry's constantly shifting expectations and obstacles, this digital revolution in aviation education has completely changed old training paradigms. With the use of cutting-edge simulators, Virtual Reality (VR), and Augmented Reality (AR) technology, students practice and hone their abilities in safe, highly realistic surroundings. For Fussell and Truong (2020), for many years, educators have integrated technology into aviation instruction. Since the Link trainers of the early 20th century, these devices have become more complex, leading to the creation of full flight simulators, aviation training devices, and other technology that are today utilized in flight training programs. The popularity of computer-based training shows that acceptance has also expanded when game makers changed the design of video games to include educational features. Virtual, Augmented, and Mixed Reality (VR, AR, and MR) are some of the more immersive simulation technologies that educators have recently developed for training reasons. While aviation training programs incorporate immersive technology like virtual reality, educators do not always consider the characteristics that motivate students to use these tools.

Through the provision of practical, experience learning opportunities, these tools improve the transfer and retention of skills. Digital resources and e-learning platforms assist ongoing education and

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career advancement by providing flexible, current, and accessible content. Because of its flexibility and adaptability, training programs may be made to fit individual needs and learning styles, increasing their efficacy and efficiency. Moreover, workforce growth is greatly aided by the incorporation of ICT into aviation education, which provides aspiring aviation professionals with the know-how needed to negotiate the complexity of contemporary airline operations successfully. New tools and training methods have been adopted in the aviation industry due to rapid technology improvements (Risukhin, 2016). By using advanced ICT solutions to improve learning outcomes and operational efficiency, this digital revolution in aviation education has completely changed old training paradigms. ICT play a bigger part in aviation education as the industry develops, bringing in new innovations and raising the bar for quality in instruction and training.

Moreover, by incorporating game-based learning into aviation instruction, educators want to increase student engagement, motivation, and retention while also improving the efficiency and enjoyment of the training process for aviation professionals (Ponomarenko *et al.*, 2019). Similar to this, Kuindersma *et al.* (2015) suggested that adding game-based training to airline pilots' highly controlled and standardized simulation-based training could have both practical and educational benefits. Future pilots have different learning preferences than other learners, therefore game-based learning is a good fit for teaching non-technical abilities. It also provides a more adaptable and scalable learning environment, which may lower training costs. It is necessary to expand the corpus of knowledge on the subjects covered in this report by academic research and practical work experiences. It is strongly advised that training providers and research communities work together. In this context, digital transformation refers to the use of interactive software, virtual and augmented reality, and immersive simulations that are all intended to replicate real-world aviation situations.

A more dynamic and interesting learning environment is created by aviation training programs through the use of game-based elements like challenges, prizes, and interactive missions. In addition to keeping students' interest, this helps them acquire critical problem-solving and decision-making skills under pressure, both of which are critical for aviation professionals. Thus, including game-based learning into digital transformation programs is a step in the right direction toward producing aviation professionals who are more capable, self-assured, and prepared. Also, including game-based learning into digital transformation programs is a step in the right direction toward producing aviation workers who are more capable, self-assured, and equipped to handle the changing needs of the sector.

As discussed by Biggs *et al.* (2018), training strategies can be easily modified and tailored to fit the demands of certain learners or organizations. This accommodates the special skill levels and job needs found in the aviation sector. This flexibility is a fundamental component of aviation education's digital transformation, which uses state-of-the-art technologies to provide customized, flexible learning paths. Aviation training can use adaptive learning algorithms, real-time data analytics, and modular content delivery through digital platforms.

These tools make it possible to continuously evaluate training programs and modify them to meet the unique needs and development of each student. For instance, scenarios and simulations that are specifically tailored to the operating settings and difficulties faced by pilots, air traffic controllers, and maintenance personnel can be provided.

In light of the aforementioned discussions, this paper conducted a thorough analysis of academic works pertaining to the digital changes achieved in the field of aviation education via the use of ICT tools and approaches and the factors influencing the adoption of ICT in aviation education. A methodical search strategy was developed in order to identify relevant research that discussed about the predominant ICT tools and techniques utilized in aviation education. The researcher conducted this investigation using a number of internet databases, mostly gathered from Google Scholar, Research Gate, and ScienceDirect. These databases were chosen because they provide a broad range of research publications from the fields of technology, education, and aviation.

METHODOLOGY

The present review article entailed a comprehensive examination of scholarly literature that centered on the digital changes attained in aviation education via the utilization of ICT tools and methodologies, along with the variables impacting the integration of ICT in this domain.

A systematic search approach was created to find pertinent studies that addressed popular ICT technologies and methods used in aviation instruction. Ten (10) articles about ICT tools and techniques utilized in aviation education and five (5) articles about factors influencing the adoption of ICT in aviation education were gathered from different internet databases, including ScienceDirect, ResearchGate, and Google Scholar. These databases were used by the researcher to carry out this study because of their extensive collections of research articles in the fields of technology, education, and aviation. This method made sure that relevant and varied research were included, giving a strong basis for examining the use of ICT and its effects in aviation education.

RESULTS AND DISCUSSION

Table 1: ICT Tools and Techniques Utilized in Aviation Education

Title	Authors	ICT Tools and Techniques
1. The Evaluation of Implementing Digital Pedagogy to Teach English for Aviation	Purwanti, G. N., Syafri, F., & Rukmini, D. (2022). The Evaluation of Implementing Digital Pedagogy to Teach English for Aviation. *English Education Journal, 12*(4), 538-546.	Technological Pedagogical Content Knowledge (TPACK) framework
2. Methodology of implementing virtual reality in education for industry 4.0	Paszkiewicz, A., Salach, M., Dymora, P., Bolanowski, M., Budzik, G., & Kubiak, P. (2021). Methodology of implementing virtual reality in education for industry 4.0. *Sustainability, 13*(9), 5049.	Virtual Reality
3. A computer tool for training pilots' listening skills in aviation English	Moskalenko, O. I., & Didenko, O. V. (2018). A computer tool for training pilots' listening skills in aviation English. *Інформаційні технології і засоби навчання,* (67,№ 5), 187-198.	Computer tool specifically designed for training pilots' listening skills in Aviation English.
4. Big Five Technologies in Aeronautical Engineering Education: Scoping Review	Martinez-Lopez, R. (2019). Big Five Technologies in Aeronautical Engineering Education: Scoping Review. *International Journal of Aviation, Aeronautics, and Aerospace, 6*(3), 12.	Big Data - Used for computer-aided design in engineering education.
		Internet of Things (IoT) - Initially applied in aerospace engineering fields.
		Cloud Computing - Applied for collaborative work and classroom education.
		Web 2.0 - Utilized in the teaching of aeronautical engineering.
5. 2030 agenda in aviation education	Pavel, A. P., Zaharia, S. E., & Pietreanu, C. V. (2020). 2030 agenda in aviation education. In *EDULEARN20 Proceedings* (pp. 5582-5591). IATED.	Integration of modular and interdisciplinary study programs and new specialized disciplines, facilitated by digital platforms and innovative methodologies
6. Technological and educational challenges towards pandemic-resilient aviation	Sun, X., Wandelt, S., & Zhang, A. (2021). Technological and educational challenges towards pandemic-resilient aviation. *Transport Policy, 114,* 104-115.	Simulator technology
7. Elevating aviation education: A comprehensive examination of technology's role in modern flight training	Dinçer, N. (2023). Elevating aviation education: A comprehensive examination of technology's role in modern flight training. *Journal of Aviation, 7*(2), 317-323.	Immersive technologies like virtual reality (VR) and augmented reality (AR)
8. Challenges and Barriers of Education Policy in Air Transportation: Case Study of Civil Aviation Technology College	Changizi, A., & Toorani, H. (2021). Challenges and Barriers of Education Policy in Air Transportation: Case Study of Civil Aviation Technology College. *Science and Technology Policy Letters, 11*(1), 129-139.	Communication technology
9. Competency Based Education: A Framework for a More Efficient and Safer Aviation Industry	Mendonca Ph D, F. A., Keller Ph D, J., & Dillman Ph D, B. G. (2019). Competency Based Education: A Framework for a More Efficient and Safer Aviation Industry.	Evidence-Based Training (EBT)
10. Artificial intelligence in aviation industries: methodologies, education, applications, and opportunities	Shmelova, T., Sterenharz, A., & Dolgikh, S. (2020). Artificial intelligence in aviation industries: methodologies, education, applications, and opportunities. In *Handbook of research on artificial intelligence applications in the aviation and aerospace industries* (pp. 1-35). IGI Global.	Artificial Intelligence (AI)

According to a study done by Purwanti *et al.* (2022) at Institut Teknologi Dirgantara Adisutjipto (ITDA) Yogyakarta, the Technological Pedagogical Content Knowledge (TPACK) framework is the ICT tool utilized in aviation education. TPACK is a complete approach that combines pedagogical and subject knowledge with technological expertise to seamlessly integrate technology into the classroom. This framework, which is especially designed to teach Aviation English, enables teachers to successfully integrate digital resources and approaches into their lessons. TPACK helps instructors to create a more effective and interesting learning environment, which is especially important given the difficulty that many pilots and crew members do not speak English as their first language. The study discovered that ITDA Yogyakarta lecturers were able to successfully implement TPACK, improving their ability to teach English for aviation purposes and assisting students in overcoming language barriers in order to meet the requirements for graduation. This was done through the use of questionnaires, observation checklists, and interviews.

On the other hand, in the study of Paszkiewicz et al (2021) used virtual reality (VR) as the ICT tool utilized in aviation education. This study presents a new approach to VR integration in education that involves designing, developing, implementing, and assessing courses in a virtual reality setting. Because of this methodology's universality and comprehensiveness, it can be used to a wide range of fields, including aviation. Virtual reality (VR) can be used in aviation education to replicate real-world situations that pilots and crew members might face. This allows for an immersive and dynamic learning environment that improves skill acquisition and knowledge retention. The study shows that in addition to lowering expenses and raising safety, VR-based training can greatly increase participants' abilities and knowledge.

In the study of Moskalenko *et al.* (2018), a specific computer program created to improve pilots' listening comprehension in Aviation English is the ICT tool utilized in aviation education. This software consists of a variety of computer activities designed to help trainees become more proficient in English—a language that is necessary for safe and efficient radio communication between air traffic controllers and pilots. Pilots can practice accurately listening to, interpreting, and responding to information in English by using this application, which simulates real-world flight conditions. With a focus on achieving ICAO Operational Level 4 or above, it is designed to get students ready for the International Civil Aviation Organization's (ICAO) Language Proficiency Requirements. Six tasks covering general aviation English and particular radio communication phraseology are part of the training technique. The study's findings highlight that the use of this computer tool leads to significant improvements in students' listening skills, with a noticeable increase in the number of students achieving high and medium skill levels and a decrease in those with low skill levels. This demonstrates the effectiveness of incorporating computer-based language training tools in aviation education.

Further, the study by Martinez-Lopez (2019) highlighted Big Data and Cloud Computing as the main ICT tools for application in aviation education. To improve learning outcomes, these technologies—which were first used in the field of aeronautical engineering—have been brought into educational research. Cloud computing helps teachers and students work together more effectively in the classroom by allowing them to share resources, work together on projects, and access instructional materials from anywhere. An engaging and interactive learning environment is facilitated by this technology. Conversely, in engineering education, big data is incorporated into computer-aided design (CAD). Large datasets can be analyzed to enhance design procedures and decision-making, giving students practical experience working with data from the actual world. Although they are used less frequently in the teaching of aeronautical engineering, Web 2.0 tools are also mentioned.

In the study of Pavel *et al.* (2020), the integration of new specialist disciplines and modular, interdisciplinary study programs—facilitated by digital platforms and creative methodologies—is the ICT tool employed in aviation education. The report specifically draws attention to the creation of an international master's program called "IT applied in aviation," which centers on the digitalization of air travel. Courses on aviation and the environment, strategic management, ethics, intelligent interfaces, smart data processing, and cybersecurity system management in aviation are all included in this curriculum. The Sustainable Development Goals (SDGs) are the focus of these courses, which are being taught using innovative and varied approaches such as online learning environments and course descriptions that highlight the SDGs' relevance. The relevance and impact of the educational framework are further increased by the worldwide collaboration and stakeholder participation involved in the program's implementation.

As discussed by Sun *et al.* (2021), simulator technology may be one of the most important ICT instruments utilized in aviation education. Aviation workers can participate in realistic situations and simulations thanks to simulation technology, which offers training and hands-on experience in a variety of aviation operations areas, such as airline management, airport operations, and aircraft handling. Aviation workers may strengthen their decision-making abilities, increase their capacity to adapt to unanticipated events like pandemics, and build resilience in order to effectively manage emergencies by employing simulation technologies. Furthermore, collaborative learning and decision-making are made possible by simulation technology, which facilitates the sharing of best practices and knowledge among aviation experts.

Moreover, Dinçer (2023) discussed that immersion technology is one of the main ICT techniques used in aviation education. For aviation trainees, immersive

technologies like virtual reality (VR) and augmented reality (AR) provide extremely dynamic and interesting learning experiences. Immersion technologies provide a safe and regulated environment for learners to practice skills, procedures, and decision-making by imitating actual scenarios and environments. This helps aviation workers become more proficient, grow as critical thinkers, and become more aware of their surroundings. Additionally, immersive technology can support cooperative and remote learning, removing logistical and geographic boundaries and allowing students to work together and learn from any location.

Consequently, Changizi and Toorani (2021) asserted that communication technology is one of the ICT instruments that has been identified as essential to aviation education. The study emphasizes how difficult it is for different aviation industry subsectors to communicate with one another, underscoring the urgent need for efficient communication techniques and technologies. A variety of ICT technologies, including as email, messaging services, video conferencing, and teamwork software, are included in communication technology. Educators, students, business executives, legislators, and other aviation stakeholders may all work together more easily and efficiently with the help of these technologies.

Correspondingly, Evidence-Based Training (EBT) is the Information and Communication Technology (ICT) tool that the study highlighted by Mendonca *et al.* (2019). EBT is a paradigm shift in aviation education and training, departing from conventional approaches that prioritize the acquisition of technical skills and information only. Rather, EBT places a strong emphasis on the thorough evaluation and confirmation of a pilot's competencies throughout their training, utilizing data gathered from training, flight operations, and aircraft accidents. EBT programs can identify, create, and assess the abilities necessary for safe and effective operation in a commercial aviation environment by utilizing data-driven insights. In order to meet or exceed safety standards and improve the quality of education and flight training over flight hours, aviation education institutions, such as the Purdue School of Aviation and Transportation Technology, can use this approach to redesign their professional flight programs and improve the knowledge, skills, and abilities that aspiring professional pilots acquire.

The study of Shmelova *et al.* (2020) emphasized Artificial Intelligence (AI) as a tool for information and communication technology (ICT), with a focus on its applications in the aerospace and aviation sectors. Artificial Intelligence (AI) is acknowledged as a cutting-edge technology that can improve security and safety protocols by increasing the effectiveness of designing aviation systems during their entire lifecycle. AI is essential to optimizing decision-making processes for operators, including pilots, air traffic controllers, engineers, and other aviation professionals, in the setting of Air Navigation Sociotechnical Systems (ANSTS), where there is a significant danger of catastrophic results. Utilizing technologies like Big Data, Data Mining, Artificial Neural Networks, and others to improve the quality of decision-making, a variety of AI systems, such as Expert Systems and Decision Support Systems, are used to help operators make educated judgments.

Table 2: Factors influencing the Adoption of ICT in Aviation Education

Title	Authors	Factors
1. Factors influencing the utilization of learning management system among aviation academy students	Alshaikhi, M. A. A. L. I. (2019). Factors influencing the utilization of learning management system among aviation academy students.	Social influence, effort expectations, enabling circumstances, and motivation
2. *Investigating factors affecting utilization of computer application systems in service sector based on technological acceptance model: case study of Kenya airways limited*	Otieno, E. O. (2015). *Investigating factors affecting utilization of computer application systems in service sector based on technological acceptance model: case study of Kenya airways limited* (Doctoral dissertation, University of Nairobi).	Perceived usefulness and ease of use
3. *Investigating factors influencing the adoption of e-learning: Saudi students' perspective*	Al-Harbi, K. R. A. S. (2011). *Investigating factors influencing the adoption of e-learning: Saudi students' perspective* (Doctoral dissertation, University of Leicester).	Perceived behavioral control: perceived accessibility, internet self-efficacy, and university support
4. Factors analysis that affecting "knowledge sharing" in t-vet instructors at Aviation Polytechnic of Surabaya	Sonhaji, I., Wijayati, D. T., Soedjarwo, S., Supardam, D., Setiyo, S., & Muharlisiani, S. T. (2020). Factors analysis that affecting "knowledge sharing" in t-vet instructors at Aviation Polytechnic of Surabaya. *Talent Development & Excellence, 12*(1), 5317-5328.	Organization factor, which is defined as the company culture, policies, and support for ICT integration
		Individual factor such as personal traits and perspectives regarding ICT
		Content factor such as the applicability and quality of educational resources provided via ICT

		Cooperation factor such as cooperative efforts and teamwork when using ICT
Inhibiting factors influencing adoption of simulation-based teaching from management teacher's perspective: prioritisation using analytic hierarchy process	Bhaskar, P., Bhaskar, P., Anthonisamy, A., Dayalan, P., & Joshi, A. (2023). Inhibiting factors influencing adoption of simulation-based teaching from management teacher's perspective: prioritisation using analytic hierarchy process. *International Journal of Learning and Change, 15*(5), 529-551.	Institutional-level factors
		Technological factors
		Logistical issues
		Individual attitudes, beliefs, and abilities of instructors

According Alshaikhi (2019), a number of factors affect the Saudi Academy of Civil Aviation's (SACA) adoption of ICT, particularly Learning Management Systems (LMS) in aviation education. These elements consist of social influence, effort expectations, enabling circumstances, and motivation. The most important component is shown to be motivation, indicating that both internal and extrinsic student motivations have a major influence on their readiness to adopt LMS. The availability of resources and support, for example, are important circumstances that facilitate the implementation of LMSs. Another important consideration is effort expectancy, or the perception of ease of use of the learning management system. If students find the system easy to use, they are more likely to use it. Though to a lesser level, social influence—the degree to which students feel that significant individuals think they ought to utilize the LMS—also influences its uptake. It's interesting to note that LMS utilization is not greatly impacted by performance anticipation, or the conviction that using the LMS will improve academic performance. The association between these variables and LMS utilization is mediated by behavioral intention, emphasizing the significance of students' intents in the adoption process. According to the study, taking care of these issues could improve the uptake and efficacy of LMS in aviation education.

In contrast, Otieno (2015), by using the Technology Acceptance Model (TAM) to examine the use of computer application systems in an airline context, finds numerous aspects impacting the adoption of ICT in aviation education. Perceived usefulness and ease of use are two of the crucial elements. The degree to which employees perceive computer application systems to be easy to use has a big influence on how likely they are to adopt new technology. Employee acceptance and usage of the systems are further influenced by their perceived usefulness, which measures how much employees think utilizing the systems would improve their job performance. These elements influence people's attitudes about ICT use generally, emphasizing the need of helpful and user-friendly systems to encourage technology adoption.

Al-Harbi (2011) explored the variables affecting students' intentions to use e-learning and provides information relevant to the use of ICT in aviation education. The model, which takes its cues from the Theory of Planned Behavior, takes into account the attitude, subjective norm, and perceived behavioral control of students as important factors that influence their behavioral intention to use e-learning. The most important aspect affecting students' intention for both distance learning and additional e-learning is perceived behavioral control. Furthermore, while both attitude and subjective norm are important for supplemental e-learning, attitude is more important for remote education. Students' attitudes are significantly influenced by their perceptions of the usability, interaction, flexibility, and simplicity of use of e-learning, while their subjective norm is shaped by the beliefs of their peers, families, and instructors. Three significant factors appear to be crucial antecedents of perceived behavioral control: perceived accessibility, internet self-efficacy, and university support.

For Sonhaji *et al.* (2020), several factors impacting the adoption of ICT in aviation education may be deduced from the research's findings. Information sharing is greatly influenced and positively impacted by the organization factor, which is defined as the company culture, policies, and support for ICT integration. Also, even if it is not statistically significant, the individual factor still has a favorable impact, indicating that personal traits and perspectives regarding ICT may have an indirect effect on adoption. Further, knowledge sharing is greatly impacted by the content element, which indicates the applicability and caliber of educational resources provided via ICT. Lastly, there is a clear beneficial impact on knowledge sharing from the cooperation component, which stands for cooperative efforts and teamwork when using ICT for educational reasons. Knowledge sharing is also greatly impacted by technology.

Moreover, Bhaskar *et al.* (2023) explained that numerous factors influence the adoption of ICT in aviation education that can be deduced from the research findings on impeding barriers to implementing simulation-based teaching in higher education institutions. Institutional-level factors—which have been ranked as the greatest barrier to integration of ICT into educational practices—may involve concerns with institutional resources, policies, and support. Likewise, technological factors may include issues with ICT infrastructure and tools' accessibility, efficacy, and availability in aviation education environments. Also, logistical issues including teacher

training needs, technical assistance, and incorporating ICT into current teaching methods and curricula could be considered operational-level variables. Finally, individual attitudes, beliefs, and abilities of instructors toward the use of ICT in aviation education may fall under the category of personal-level variables. These may include reluctance to adapt, ignorance, or lack of training.

CONCLUSION

It can be concluded that the common ICT tools and techniques utilized in aviation education are Technological Pedagogical Content Knowledge (TPACK) framework; Virtual Reality; Computer tools specifically designed for training pilots' listening skills in Aviation English; Big Data - Used for computer-aided design in engineering education; Internet of Things (IoT) - Initially applied in aerospace engineering fields; Cloud Computing - Applied for collaborative work and classroom education; Web 2.0 - Utilized in the teaching of aeronautical engineering; Integration of modular and interdisciplinary study programs and new specialized disciplines, facilitated by digital platforms and innovative methodologies; Simulator technology; Immersive technologies like virtual reality (VR) and augmented reality (AR); Communication technology; Evidence-Based Training (EBT); and Artificial Intelligence (AI).

Meanwhile, the common factors influencing the adoption of ICT in aviation education are social influence, effort expectations, enabling circumstances, and motivation; perceived usefulness and ease of use; perceived behavioral control: perceived accessibility, internet self-efficacy, and university support; organization factor, which is defined as the company culture, policies, and support for ICT integration; individual factor such as personal traits and perspectives regarding ICT; content factor such as the applicability and quality of educational resources provided via ICT; cooperation factor such as cooperative efforts and teamwork when using ICT; institutional-level factor; technological factors; logistical issues; and individual attitudes, beliefs, and abilities of instructors.

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