Technical Review

https://doi.org/10.12985/ksaa.2020.28.4.171
ISSN 1225-9705(print) ISSN 2466-1791(online)

A Study on the Application of Human Factors to the Introduction of PAV & UAM

Kyung Su Ahn*, Won Kyong Jeong*

ABSTRACT

The present and future cities are expanding, and the noise and environmental pollution in cities are getting worse day by day, causing saturation of road and subway traffic. As a result, citizens are spending a great deal of time and money. The use of the sky as a measure to solve this problem has become a reality. However, airplanes that require airstrips and noisy helicopters are difficult to use in cities. As a solution, PAVs and UAMs that generate low noise and enable vertical takeoff and landing using electric energy, motor, hybrid, and hydrogen energy, are attracting attention, with its practicality being promoted in many countries. The development of urban environment and technology has led to the emergence of Personal Air Vehicle (PAV), Vertical Takeoff and Landing (eVTOL), and Urban Air Mobility (UAM) for shipping. Though currently at the level of testing, general commercialization of these air transport means is expected in the next five to fifteen years. This study suggests a plan on the application of human factors to the introduction of PAV and UAM.

Key Words : PAV(Personal Air Vehicle: 개인항공교통수단), eVTOL(Electric Vertical Takeoff and Landing: 전기동력 수직이착륙), UAM(Urban Air Mobility: 도시항공교통수단)

I. INTRODUCTION

The present and future cities are expanding, and the noise and environmental pollution in cities are getting worse day by day, causing saturation of road and subway traffic. As a result, citizens are spending a great deal of time and money. The use of the sky as a measure to solve this problem has become a reality. In particular, development competition for Personal Air Vehicle (PAV) and Urban Air Mobility (UAM) is increasing. PAV refers to an aircraft that has advanced into an personal air vehicle for humans to board through the development of unmanned aerial vehicle (UAV) technology [1].

Surface road and subway traffic congestion have become a serious problem, and airplanes are not available anytime, anywhere since they require airports and airstrips. However, if as small as cars, safe, and unaffected by noise and the surrounding environment, air vehicles may become readily available [2].

The term PAV was first used by National Aeronautics and Space Administration (NASA) that created the Personal Air Vehicle Sector Project as part of the Aeronautics Vehicle Systems Program in 2003 [3-7].

Through the project, NASA sought to create a personal air vehicle that would enable ordinary people to operate only with a driver's

Received: 30. Nov. 2020, Revised: 09. Dec. 2020, Accepted: 14. Dec. 2020

* Propessor, Chodang University
Corresponding Author E-mail : sky@cdu.ac.kr
Corresponding Author address : 380 Muanro, Muan-eup, Muangun, Jeollanamdo, Korea

license. PAV is also called the "passenger drone" because it is a drone for passengers [8].

Related to PAV is the vertical takeoff and landing aircraft (eVTOL) using electric power and UAM for commercial use. eVTOL refers to an air vehicle that takes off and lands vertically using electric power sources that apply various new technologies including pure batteries, hybrid engines, and hydrogen fuel cells. One advantage of eVTOL is that it does not generate any engine noise because its propellers rotate with electric power. Moreover, carbon dioxide emissions are minimized to protect the environment. As a result, eVTOL is on the rise as an alternative to solving problems related to environmental pollution around the world, and PAVs currently under development are mostly eVTOLs that do not require airstrips. UAM, the future urban vehicle that integrates all PAV technologies, is being developed by many countries, aircraft manufacturers, automobile manufacturers, and related companies. Though currently at the level of testing [9], general commercialization of these air transport means is expected in the next five to fifteen years. This study suggests the direction for human and human, human and software, human and the environment, and human and mechanical fields according to the application of human factors to the introduction of PAV and UAM.

II. BODY

2.1 Development of PAV & UAM

The idea of merging cars and aircraft has been around since the early 20th century. A car that usually goes on the road and flies when necessary was called the "flying car", which could be operated by those able to drive both a car and an aircraft. In addition, wings had to be attached to the car for flying, and, most of all, long airstrips were needed for take off.

Unlike flying cars, PAVs can only fly in the sky. The term PAV was first used by NASA that created the Personal Air Vehicle Sector Project as part of the Aeronautics Vehicle Systems Program in 2003.

Related to PAVs are the vertical takeoff and landing aircraft (eVTOL) using electric power and the UAM for commercial use. eVTOL refers to an air vehicle that takes off and lands vertically using electric power sources that apply various new technologies including electric power (batteries), hybrid engines, and hydrogen fuel cells. The advantage of eVTOL is that it does not generate any engine noise because the rotors rotate with electric power and a motor. Moreover, most PAVs currently under development are eVTOLs because carbon dioxide emissions can be minimized to protect the environment.

UAM, a broad concept that includes PAV and eVTOL, refers to the overall air transport industry that operates in the city center transporting passengers and cargo. UAM operation is possible anywhere where PAVs can takeoff and land. At the corporate level, Hanwha Systems was first in Korea to announce its entry into the PAV business in July 2019. Currently, the company is developing a PAV called "Butterfly" with Overair, Inc. in the United States, and has also decided to invest in U.S. companies for the technology and experience needed to develop high efficiency, low noise PAVs.

Hyundai Motors also launched its UAM division in September 2019, and aims to commercialize its UAM by 2028. Working with Uber, a global car-sharing company, Hyundai Motors developed the SA-1 featured at the 2020 CES. More than 260 companies around the world are known to have recently started developing PAVs and UAMs, including global conglomerates such as Uber, Airbus, Boeing, Audi, Daimler, and Toyota, as well as various startups from around the world [7].

Along with foreign companies that are preparing for the PAV and UAM era, domestic companies and government agencies are also planning to begin, by 2025, commercialization of PAV and UAM, the key topics of the fourth industrial revolution, with the goal of vitalization between 2030 and 2035 [7].

2.2 The need to introduce PAV & UAM

As human and physical resources are becoming concentrated in metropolitan areas due to the advent of the global competition era, traffic congestion above and below the ground is expected to continue in modern society. As a new measure to solve this problem, PAV and UAM are emerging as air vehicles that fly in three-dimensional space, instead of on the ground. In addition, with the development in core technologies such as control technology for high performance batteries (S/W), up-to-date aviation, and 5G and 6G communication, urban air mobility has emerged as a feasible means of future transportation. UAM, which aims to travel from 30 to 50 kilometers in urban areas, is anticipated to be an innovative transportation service that can reach the distance that takes an hour by ground vehicles in only 20 minutes [7][10].

UAM are expected to be promoted as part of the Seamless service that minimizes transit time by connecting with personal mobility such as buses, subways, and railways. Though UAM flies at an altitude and path similar to existing helicopters, it is zero-carbon due to the use of electric power and motors. Furthermore, noise is greatly reduced (63 to 65 dB, 20% of that of helicopters (80 dB)), making it an eco-friendly means of future transportation that can operate the city sky without environmental pollution [7]. In particular, a more advanced design and form than conventional helicopters, and high-tech equipment and system that support micro weather and up-to-date aviation are believed to ensure high levels of reliability and safety.

2.3 Application of human factors of PAV & UAM

To test for accumulating flight experience, for reliability support, and to establish reasonable safety standards, the domestic aviation industry has proposed government-led investigation of pilot methods, establishment of a system for infrastructure standard preparation, and R&D support for leading venture companies, of which the main contents were reflected in the policy. To provide the Korean operational technical standards suitable for domestic conditions such as the high-tech communication environment, micro weather conditions, and social acceptability of noise, a joint demonstration project of public and private sectors (K-UAM Grand Challenge, '22~'24) should be implemented.

The operational technical standards include concepts and procedures that enable the realization of airspace (altitude), number of operation vehicles, return intervals, and transfer methods associated with the operation of UAM. To proceed simultaneously with the project's design and implementation for software and hardware set up, cooperation with NASA, the leader in the field, should be promoted.

The application of human factors to the introduction of PAV and UAM is presented using the SHELL model of human and human, human and software, human and the environment, and human and machines [8].

The model of human and software combines general and aviation laws, and presents regulations, procedures, various manuals, and programs. On the other hand, the model of human and hardware includes controls, state-of-the-art communication devices, various aviation devices, various instruments, human and environmental weather, cockpit environment, time pressure, worker fatigue and stress management,

conditions for one-man pilot operation, communication with the integrated control center, ground personnel, and ground support personnel.

2.4 Measures to enhance human factors of PAV & UAM

Regard to the application of human factors to the introduction of PAV and UAM, factors related to the pilot in charge of operation, such as fatigue, conceit, and stress are extremely important. These factors are generally referred to as human factors. Human factors mostly act indirectly or directly as a cause of air accidents. It is no exaggeration to say that 70 to 80 percent of air accidents are caused by human factors. When human factors that can cause such errors are neglected, major accidents can occur due to minor factors.

However, securing safety is the most important part of successful PAV and UAM implementation. To establish safety standards, close cooperation with FAA, EASA, and major airworthiness authorities is needed, and international joint research should be carried out. Moreover, the domestic aviation industry should take part in establishing industrial and collective standards. Accordingly, sufficient research on human factors is needed.

Thus, the enhancement of the human factors of PAV and UAM has led to significant research and technological development in the hardware sector. With the software and environmental sectors, a variety of education and research should be done by subdividing the sectors as in the general aviation sector, thus strengthening human factors based on mutual trust and communication between workers and users of urban air traffic.

III. CONCLUSION

The present and future cities are expanding, and the noise and environmental pollution in cities are getting worse day by day, causing saturation of road and subway traffic. As a result, citizens are spending a great deal of time and money. The use of the sky as a measure to solve this problem has become a reality.

In this study, Fig. 1 the SHELL model was used to present applicable aspects in regards to the application of human factors to the introduction of PAV and UAM. To strengthen these aspects, directions for human and human, human and software, human and environment, and human and mechanical fields were suggested.

Accordingly, global leaders FAA and EASA are working to provide safe, autonomous, and eco-friendly mobility to all, and aim to build a complete platform to support the operation of the UAM ecosystem as well as the manufacturing of the autonomous aerial vehicle (AAV) for UAM.

To that end, cooperation with various parties, including government regulatory agencies and business organizations should be sought. Detailed and diverse studies to possess expertise in aviation and autonomy, to control operational command, and to apply aviation human factors for pilots, users, managers, and developers are

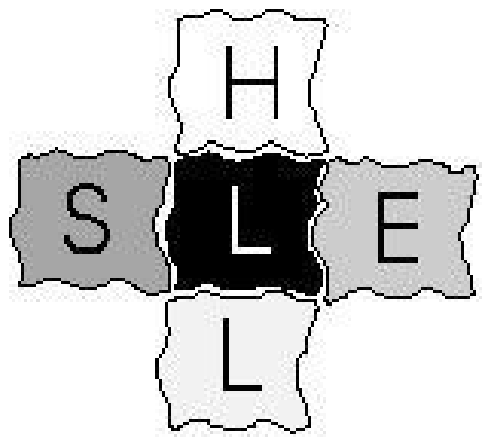

Fig. 1. Humanfactor SHELL model

needed. The outcomes of those studies are expected to contribute to expanding the base for urban air transport (PAV & UAM) on the basis of safety.

References

1. Ahn, K. S., and Jeong, K. W., "A study on the status and development direction of UAM", Korean Society for Aviation Operations, Spring Conference, 2020.7.
2. KARI, "Personal aircraft (PAV) technology market trend and industrial environment analysis report", May 2019.
3. Jeong, J. H., "Drone's development history and future market forecast", KISA, May 2015.
4. Hwang, C. J., "An overview of urban aerial mobility development," Korean Aerospace Society Spring Conference, April 2018.
5. Hwang, C. J., "City aerial mobility development status and tasks", Aerospace Industry Technology Trend, 16(1), 2018, pp. 33-41.
6. Ahn, Y. S., and Jung J. H., "Recent trends and major issues in the drone and personal aircraft (PAV) industry", Issue Paper, 2020-02, Civil and Military Technology Convergence Industry Series.
7. "Korean urban air traffic [K-UAM] roadmap to open the sky of the city", Joint Ministry, 2020.05.
8. Kim, C. Y., "Aviation and Human Factors", Korea Aerospace University Press, 2012.
9. NASA, "Urban air mobility (UAM) market study", 2018.
10. Roland Berger Focus, "Urban air mobility the rise of a new mode of transportation", November 2018.
11. "The future of transportation: White paper on urban air mobility systems", By EHang Jan 15, 2020.