Human Factors Analysis on Business Performance in the Aviation Sector

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ABSTRACT

This study examines the impact of human factors on business processes in the aviation sector since business processes in the aviation sector depend on how effectively airlines, airports or aviation-related companies operate in various aspects, including financial condition, operational efficiency, customer satisfaction, safety and environmental impact. Any aspect of human factors critically undermines the effectiveness of business processes in aviation companies, especially when it comes to ensuring safety during operations. Therefore, the purpose of this study is to conduct an expert assessment and apply the AHP method to determine the impact of the relative significance of human factors criteria and sub-criteria on business processes in the aviation sector. This study applies such research methods as scientific literature analysis, expert assessment (structured survey), and the analytical hierarchy process method (AHP). After conducting an analysis of scientific literature and expert assessment, 3 main criteria and 16 sub-criteria affecting business processes in the aviation sector were identified. The main criteria assessed were human physiology (subcriteria: workload, experience, knowledge, training, attitude, emotional and psychological state), human psychology (subcriteria: nutritional factors, health, leisure, fatigue, chemical dependencies), human physical constitution (subcriteria: physical height, gender, age, strength, sensory limitations) and subcriteria of these criteria that are directly related to human capabilities and directly affect the person.

Keywords: human factors, business processes, business performance, aviation sector.

1. Introduction

Human error has long been identified in the aviation sector as a human factor that determines the cause of incidents (Sandle, 2020). Human factors are the body of knowledge about human capabilities, human limitations, and other human characteristics that are important in design and maintenance (Karunakaran & Babu, 2022). Human error is the cause of differences in the quality of work throughout the aviation sector (Boeing, 2022). To some extent, this can be avoided by investigating human errors that occur and implementing personnel training, using clearer documentation, and increasing automation (Sandle, 2020). It is necessary to find the root cause of the human error that caused the accident (Sandle, 2020). Aviation safety depends heavily on maintenance (FAA, 2023). When it is done incorrectly, it contributes to a large proportion of aviation accidents and incidents (FAA, 2023). The advanced technologies with which people interact today form complex systems that require a high level of integration in both design and management, requiring active interventions at the aviation maintenance organization, workplace, and technician levels formulated in a way that mitigates human factors for the efficiency of business processes (Bohrey & Chatpalliwar, 2024). Business processes in aviation refer to the sequence of tasks, activities, or steps that organizations in the aviation industry perform to achieve specific goals (Linnoit, 2020). These processes are critical to the efficient, safe, and economical operation of airlines, airports, and other aviation-related businesses (Linnoit, 2020). In order to prevent the recurrence or occurrence of errors, root cause analysis is required, which finds the causes of problems that have occurred in order to reduce the risk of accidents

or incidents (Sandle, 2020). Reducing even small errors can yield clear benefits in aviation business processes, including cost reduction, fewer missed deadlines, work-related injuries, warranty claims when a product or service does not meet expectations, and more significant events that can be attributed to a maintenance error (FAA, 2023), all of which increase the efficiency of business processes in aviation.

In the aviation sector, business processes depend on how effectively airlines, airports or aviation-related businesses operate in various aspects, including financial health, operational efficiency, customer satisfaction, safety, and environmental impact (ICAO, 2024). Any aspect of human factors critically undermines the effectiveness of aviation business processes, especially when it comes to ensuring safety during operations (ICAO, 2024). Aviation safety is highly dependent on aviation maintenance work (AL-Hadab, 2023). When done incorrectly, it contributes to a large proportion of aviation accidents and incidents (AL-Hadab, 2023). Compared to many other threats to aviation safety, aviation maintenance technician errors can be more difficult to detect (FAA, 2023). Often, these errors are present but invisible and can remain hidden, which can have a long-term impact on the safe operation of the aircraft. Human factors are, therefore, a direct cause or contributor to many aviation accidents (FAA, 2023). If they are not detected, they can lead to dangerous situations, employee injuries, lost time, and even accidents while also having a negative impact on the organization: disruption of the organization's activities, reduced productivity, reduced profits, people unable to work due to injuries, unmet goals, and increased aircraft operating costs (Ulises & Jose, 2024).

The aim of this study is to conduct an expert assessment and apply the AHP method to determine the relative significance of the human factors criteria and sub-criteria on business processes in the aviation sector. In order to achieve the aim of the study, an analysis of the scientific literature on the impact of the human factor on business processes in the aviation sector, as well as an expert assessment (structured survey) and the analytical hierarchy process (AHP) method were carried out to determine the main significance and impact of the human factors criteria and sub-criteria on business processes in the aviation sector.

2. Theoretical aspects of assessing the impact of human error on business processes in the aviation sector

Human factors involve the collection of information about human capabilities, limitations, and other characteristics and their application to tools, machines, systems, tasks, jobs, and environments to ensure the safe, comfortable, and efficient use of human resources (Boeing, 2022). The term "human factors" has become increasingly popular as the commercial aviation industry recognizes that the majority of aviation accidents and incidents are caused by human error, not mechanical failure (FAA, 2023). This term encompasses the science of understanding the characteristics of human capabilities, the application of this understanding to the design, development, and implementation of systems and services, and the art of ensuring the successful application of human factors principles in the maintenance work environment (FAA, 2023). Human factors in aviation are the interactions between people and the systems of the aviation environment, including aircraft, procedures, equipment, and organizational structures (BOSTONAIR, 2024). Human factors are concerned with people in their lives and work situations, their relationships with machines, procedures, and the environment, and with people's relationships with other people (School of Aeronautics, 2011). The ultimate goal of human factors experts is to increase the productivity, efficiency, comfort, and safety of human-machine interactions (FLORIDA TECH, 2024). This field requires an understanding of human behavior, human capabilities, and general human characteristics to inform how tools, machines, systems, and products are designed for people (FLORIDA TECH, 2024). In ergonomics, human factors are described as the effects of people, with their unique needs, abilities, and physical and mental limitations, on the performance of a system (APA Dictionary of Psychology, 2022). In summarizing the definitions of researchers, it can be stated that human factors are associated with both the person himself and his capabilities, as well as with the environment, mechanisms, tools, and systems with which

he works. The human factor is not the same for all people - it is constantly changing and depends on the individual's own mental and physical characteristics. From this, the concept of the human factor can be formulated, which is that the human factor seeks to optimize the relationships between people and their activities to ensure the safe and effective use of human resources.

The term "aviation" is most commonly used to describe mechanical air transport using aircraft (Barten, 2024). The two main types of aircraft are airplanes and helicopters, but most modern definitions of the word "aviation" also include unmanned aircraft such as drones (Barten, 2024). With this in mind, the aviation industry can be described as all the industries that surround this activity (Barten, 2024). According to researchers (Abeyratne, 2014; Kearns, 2018; Law Insider, 2024), it can be stated that aviation is the design, development, production, management and operation of aircraft, covering technical, operational and safety aspects, ensuring that every action related to the use of the aircraft is safe. Despite its complex nature, the primary infrastructure of the aviation industry consists of aircraft operations, airports, and agencies that perform work (Price & Forrest, 2013).

In aviation, processes are carried out by pilots, flight crews, mechanics and engineers, logistics personnel, air traffic control personnel, operations, maintenance control departments, and many others (EASA, 2024). Currently, to improve safety and reduce human factors, not only are reported events being analyzed, but proactiveness in organizations is also being promoted to become more resilient to dynamic, constantly changing threats in the aviation environment. Therefore, the following procedures are being implemented (Dekker, 2006): impact assessment, several safety program reviews need to be performed; document operations and training procedures through testing and re-evaluations; define requirements for improving existing procedures, developing new recommendations or procedures, designing feedback, maintenance and training; training for resilience at both the individual and organizational levels must be as prepared as possible for surprises, anticipating problems and developing countermeasures to solve them. Aviation safety cannot continue to improve if attention is focused only on "preventing the last accident."

When assessing risk, the approach to human factors should be appropriate to the hazards faced by the organization (Sandle, 2020). Most human factors research in the aviation sector has focused on flight crews, operating procedures, and cockpit design (Boeing, 2022). However, over the past 15 years, the European Aviation Safety Agency (EASA), the Federal Aviation Administration (FAA), the Air Transport Association (OTA), and the International Air Transport Association have all implemented programs to conduct human factors research, develop programs, and provide aviation maintenance training related to human factors (Maddox, 2006). Human factors have been particularly evident in the equipment used during World War II. The types of "human failures" or "human factors" identified (Sandle, 2020) include impatience, lack of memory, lack of concentration, mood swings, lack of motivation, fears, poor judgment, myopia, color blindness, distraction, ability to perform a limited number of tasks at once; short-term memory, which works differently than long-term memory; it is appreciated that all workers are different; fatigue; lack of need to see and hear information in order to be well understood; need for complex information to be presented hierarchically; lack of practice in order to become a sufficiently skilled worker to perform tasks; resistance to change; people want to learn only practically, not theoretically beforehand; when tasks are memorized, certain details of the task are often missed or forgotten; time constraints, etc.

According to ICAO documents, there is a tendency for the impact of human errors in aircraft maintenance to decrease if proactive actions are taken to eliminate them (International Civil Aviation Organisation, 2003). A number of methods and tools have been developed in the field of aircraft maintenance to identify the causes of human errors and eliminate them (International Civil Aviation Organisation, 2003): reports when employees have recommendations for improving the work process to avoid possible errors in the future; implementing a program in the aircraft maintenance organization reduces maintenance errors, which increases safety and reduces costs.

Most airline business processes can be divided into three categories (PLANEX, 2024): management – implements the management and functioning of the airline; operations – ensures the main activities of the airline and creates the main revenue stream (ticket sales, flight planning, flight supply, aircraft maintenance, marketing, etc.); supporting – ensures the infrastructure and resources necessary for the company to operate effectively (hiring new people, technical support of IT systems, office management, accounting, etc.). Researchers do not directly distinguish common aviation processes. According to the Federal Aviation Administration (FAA, 2023) and the International Civil Aviation Organization (ICAO, 2024), business processes common to the entire aviation sector can be distinguished: flight operations; maintenance, minor repairs and overhauls, airline revenue management; customer service; safety management systems; compliance with legal acts, law; ground operations and logistics; human resources and training; financial management and accounting. In these processes, errors by maintenance personnel may be the most visible aspects of human factors in maintenance, but understanding how and why maintenance errors occur requires an understanding of the organizational context in which they occur (Hobbs, 2008).

Researchers and business practitioners distinguish between different human factors (International Civil Aviation Organisation, 2003). However, from a practical perspective, it is most useful to have a unified view of the human factors aspects or criteria model that we need to be concerned with when talking about human factors in aviation maintenance (FAA, 2023). For over a decade, the term "PEAR" has been used as a mnemonic to describe human factors in aviation (Federal Aviation Administration, 2012). PEAR describes four important human factors applications that are identified (Federal Aviation Administration, 2012): the people who do the work, the environment in which they work, the actions they perform, and the resources required to perform the work.

Human factors programs in aviation maintenance focus on the people who do the work and address physical, physiological, psychological, and psychosocial factors (Federal Aviation Administration, 2012): physical – physical size, gender, age, strength, sensory limitations; physiological – nutritional factors, health, lifestyle, fatigue; psychological – workload, experience, knowledge, training, attitude, mental and emotional state, drug addiction; and psychosocial – interpersonal conflicts.

The focus should be on individuals, their physical capabilities, and the factors that affect them (Federal Aviation Administration, 2012). It should also take into account their mental state, cognitive abilities, and conditions that may affect their interactions with other people (Federal Aviation Administration, 2012).

Programs focus on individuals, their physical capabilities, and the factors that affect them (FAA, 2023). In most cases, human factors programs are designed with people in mind who fit into the company's workforce (FAA, 2023). It is not possible to apply identical standards of strength, size, endurance, experience, motivation, and certification to all employees (FAA, 2023). The company must match the physical capabilities of the individual to the tasks they can perform (International Civil Aviation Organisation, 2003).

3. Human Factors Research Methods in the Aviation Sector

This study was conducted using expert assessment (structured survey), AHP method. Expert assessment is based on the use of intuition, past experience, analogy, and logic (Boiko, 2018). The procedures of the expert assessment method are based on the use of a person to obtain a quantitative assessment of qualitative judgments that cannot be directly measured (Boiko, 2018). At the same time, experts perform an intuitive-logical analysis of the situation under study with quantitative or ordinal assessments of processes or phenomena, followed by formal processing of the results (Boiko, 2018). The expert assessment method is implemented by processing the opinions of experienced specialists about the possible value impact of criteria and the probability of their occurrence and is applied in non-formalized problem situations when

there is a lack of information or when the unreliability of information does not allow the use of formal mathematical methods (Boiko, 2018).

A structured survey is a survey used to collect data from respondents. It consists of a standardized set of questions with a predetermined framework that determines the exact language and sequence of the questions (Satter, 2024). Specifically, the formulated questions are asked in structured questionnaires (Satter, 2024). In the case of structured surveys, the questions are usually closed, which means that respondents must select answers from a fixed set of options (Satter, 2024). Depending on how they are set up, they can collect a lot of useful information that allows for an in-depth understanding of the thoughts of the vast majority of respondents (Evaluation Observatory, 2022). They are usually employed for market or social research studies (Satter, 2024). Closed answers are predetermined, strict, and completely clear (Satter, 2024). Statements about thematic clusters can be made by examining these results and applying them to various existing hypotheses (Satter, 2024). These findings can be extended and later used to inform key business decisions (Satter, 2024). Results can be confounded by incorrect questions, incorrect sequencing, or the scales used (Satter, 2024).

An expert survey was prepared to assess and analyze the occurrence of the human factor in order to assess the most important criteria of the human factor and their sub-criteria, which have the greatest impact on the occurrence of human errors. The collected data were analyzed using the Analytical Hierarchy Process (AHP) method, during which the criteria and sub-criteria will be distinguished according to their importance.

Despite its wide applicability, the AHP method has a significant drawback: it requires a large number of comparisons to make a decision (Leal, 2020). This condition prevents its application to solving key issues related to the participation of senior managers in organizations (Leal, 2020). Therefore, assuming that decision-makers value consistency, a method is proposed that reduces the number of iterations for each criterion when comparing only one element with all other elements (Leal, 2020). It is proposed that the element taken as the basis is one of the most obviously important - the one whose evaluation inconsistency would be least likely to occur when applying the entire method (Leal, 2020).

The method begins by structuring the decision-making problem as a hierarchy in the form of an inverted tree, with the main objective at the top (Leal, 2020). The sub-objectives corresponding to the main objective are presented at the second level (Leal, 2020). Each sub-objective of the second level can be decomposed into third-level objectives, and each objective set at each level corresponds to the objective of the level to which they are subordinate (Leal, 2020). At the lower level, the alternatives are listed and compared in pairs according to their contribution to achieving each objective or criterion from the lower level (Leal, 2020).

4. Research Results

Selected experts from the aviation sector were asked to evaluate the human factors criteria and sub-criteria. Initially, the sub-criteria of each criterion were evaluated against each other. After evaluating the sub-criteria, the experts were asked to evaluate the criteria against each other. This order of evaluation was chosen so that the experts, before making a final decision, would better understand the importance of each criterion when they familiarize themselves with the sub-criteria of each criterion: what they are, what importance they have, and who they affect. The results of the expert evaluation were calculated and analyzed in matrices. There were 18 such matrices. The data were summarized, the average of the calculations was taken, and statistics for the criteria and sub-criteria were compiled.

The experts were asked to rate the physical subcriteria in relation to each other (Figure 1). According to the experts, the most important physical subcriteria is sensory limitations, with a weight of 27.0 %. This was predictable, given that sensory limitations can lead to task performance without assessing some aspects of the task, for example, not noticing cracks in the structure due to visual impairment, not smelling chemical

liquids, or burning odors due to olfactory impairment. The second most important subcriteria was physical height, with a weight of 21.1 %, which can be assessed as accessibility to certain environments that may not be accessible to people of greater height; it can also be assessed as accessibility if the work performed is higher than a person of shorter height can reach. The third most important subcriteria is physical strength, with a weight of 19.9 %. It can be stated that the lack of physical strength in performing tasks can occur when the work assigned to a person does not correspond to the person's ability to perform it, especially in cases where the work that the person performs is directly related to safety. In such a case, there is a risk that the person may get injured, damage equipment, or perform the work incorrectly. The fourth-ranked subcriterion is age, reaching 19.3 %. Age affects work productivity if work tasks require sensory perception, selective attention, working memory, information processing, quick reaction, or physical strength. The last-ranked subcriterion in terms of importance is gender, reaching 12.7 %. Of these assessed human factors, sensory limitations are assessed the most and stand out the most from all human factors. Meanwhile, the assessment of age, strength, and physical height differs very little. It can be stated that experts assess these factors very similarly, and they have the same impact on business processes in the aviation sector. Experts believe that gender has the least impact on the human factor in business processes in the aviation sector out of the physical sub-criteria, and this seems like a logical decision because it can be argued that the human factor occurs regardless of gender, so it is impossible to change it in any way.

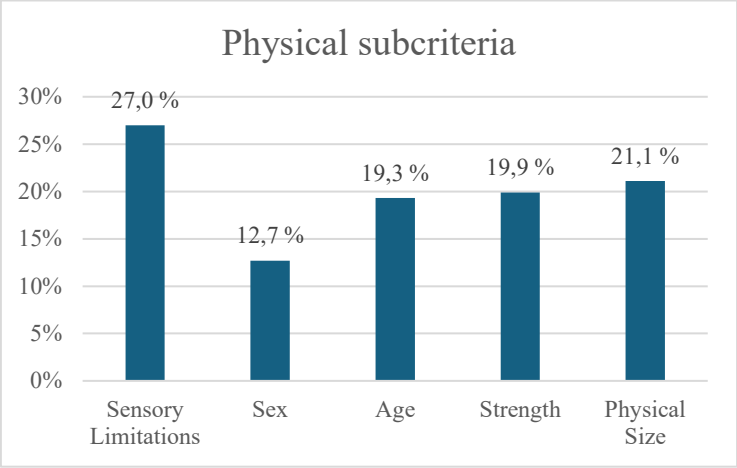

Figure 1. Weights of physical sub-criteria (compiled by the author)

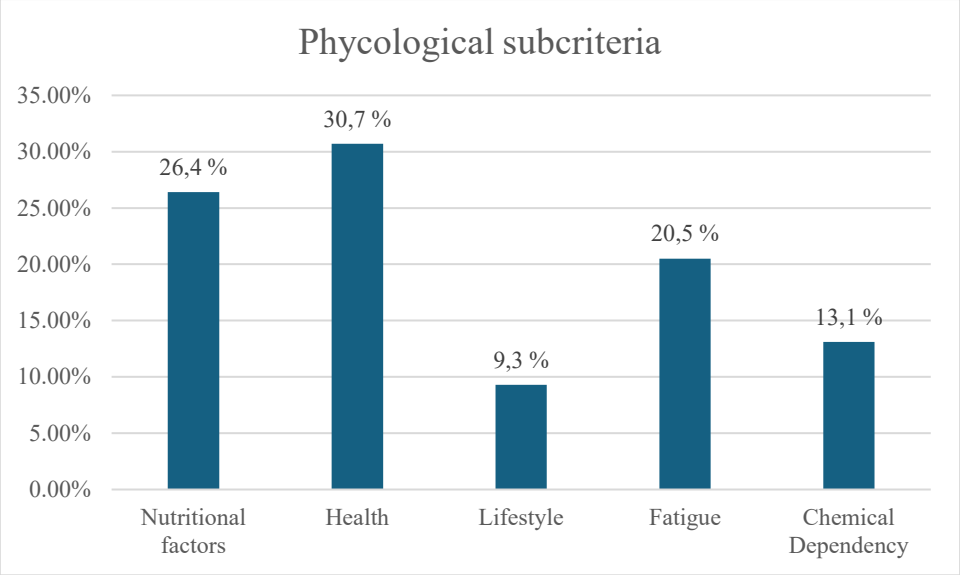

Figure 2. Weights of psychological sub-criteria (compiled by the author)

Experts assessed the following subcriteria as being related to human psychology and well-being (Figure 2). In this assessment, the experts decided that the most important psychological subcriteria of a person is health, with an assessment of 30.7 %. This assessment was predictable since a person's health would be one of the most important aspects related to work. If a person's health has deteriorated, the decisions they make in the work environment may also deteriorate. It should also be remembered that if their health deteriorates significantly, a person cannot perform the work assigned to them, in which case the work process would slow down, especially in a dynamic environment, which would be a great loss for the company. The second most important subcriteria is nutritional factors, with an assessment of 26.4 %. It can be underlined that this subcriterion is evenly correlated with the first and is equally important in ensuring a person's good psychological state. Following healthy eating habits reduces anxiety and stress, allows for clear thinking, and maintains physical fitness. As a result, it increases our confidence. The third-ranked sub-criterion is fatigue, with a score of 20.5 %. Fatigue could also be related to a person's health or nutritional factors if one of them significantly deteriorates. Fatigue can negatively affect safety, health, work performance, and employee productivity, and it can also occur if there are risk factors. Of course, several factors can influence fatigue, but compared to these, nutrition can cause a person to lack energy, and health problems would exhaust a person faster. The fourth-ranked sub-criterion is chemical dependency, with a score of 13.1 %. The body's physical and psychological dependence on psychoactive (mind-altering) substances, such as narcotics, alcohol or nicotine, has a negative impact on a person and how they perform their assigned tasks. Any of these addictions create opportunities for a person to make bad decisions. The decisions made directly affect the productivity of business processes. The fifth and last ranked sub-criterion is leisure, with a score of 9.3 %. According to experts, leisure time has the least impact on the human factor and is not directly related to work. Although this assessment seems to be the most correct, it should be remembered that without leisure time, a person's life would become routine if they had to work and not take time for themselves. A balanced work-life balance can increase productivity. However, experts believe this point is not under the company's control but depends on the person himself.

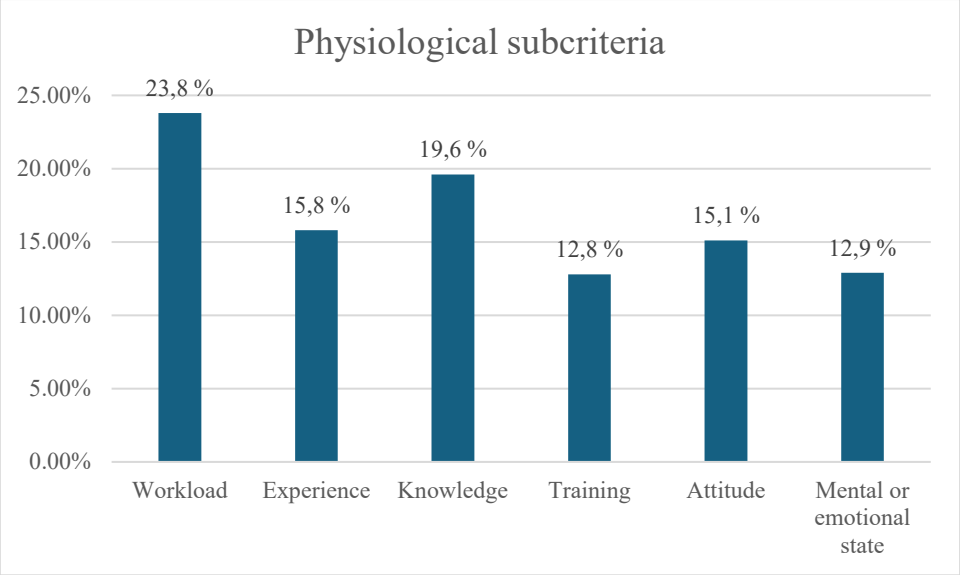

Figure 3. Weights of physiological sub-criteria (compiled by the author)

When assessing the physiological sub-criteria, the experts decided that the most important of them was workload, with an assessment of 23.8 %. It can be stated that the experts made the assessment based on the fact that when the workload level is too high, a person cannot pay attention to any of the tasks because they need to be performed simultaneously. Also, a person may start to feel stress and discomfort and start to make hasty decisions, which can significantly impact the results of tasks or work and lead to errors. People who regularly work more or overtime have a negative impact on their health over time, which leads to the occurrence of errors. The sub-criterion assessed in second place is knowledge, with an assessment of 19.6 %. This criterion is important because it is the basis for how to perform tasks, what procedures must be followed, how to ensure safety, etc. The sub-criterion assessed in third place is experienced, with an assessment of 15.8 %. Experience can correlate with knowledge. The more a person is exposed to certain situations, the faster they make decisions. Most may say that experience and knowledge are the same, but experience is not always useful. According to experts, a person may have experience in performing a specific task but will not always perform it correctly if they do not have the knowledge of how to perform it correctly. In fourth place is attitude, with a rating of 15.1 %. It can be emphasized that attitude is also an important aspect, especially when it comes to work and human error. A person who is irresponsible about their work can make more mistakes than a person who performs their work responsibly. A worrying work attitude is an unwillingness to change - frequent cases related to comments, new procedures, and safety requirements - do not allow for evaluating work and initiating new changes that can make the work environment safer and more efficient. The subcriterion rated in fifth place is a psychological and emotional state, with a rating of 12.9 %. Emotional and psychological state affects perception, thinking, and decision-making. A psychologically or emotionally damaged person may make incorrect decisions, perform tasks more slowly than usual, and fail to pay attention to critical points or situations. There is a tendency to be distracted and not think about the task, especially while it is being performed, which leads to a tendency to make mistakes. The sixth and last rated sub-criterion is training, reaching 12.8 %. Theoretical and practical training – including human factors training – is the most important stage of an aviation maintenance technician's career. Without proper training, aircraft would not be properly maintained and repaired, which would lead to safety problems, and the aviation industry would grind to a halt.

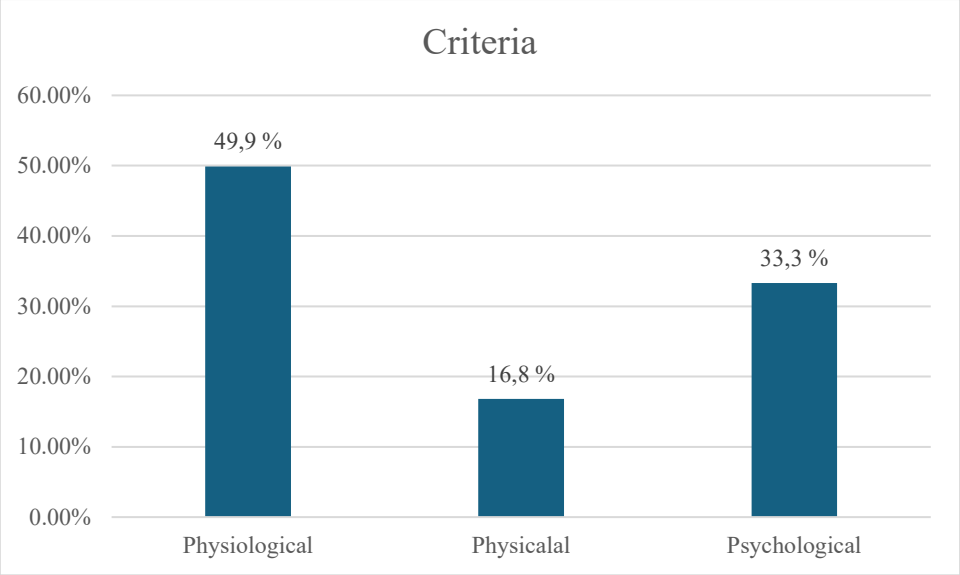

Figure 4. Weights of criteria (compiled by the author)

In the last assessment, experts assessed the criteria. According to experts, the most important criterion related to the occurrence of human error is human physiology, with a score of 49.9 %. Taking into account scientific research, the subcriteria of this criterion have a significant impact on the occurrence of human error, and expert opinion confirms this. In second place in terms of importance, experts assessed human psychology with a score of 33.3 %. Psychology is dynamic, and it changes depending on health, habits, and lifestyle. The subcriteria of this criterion include balancing human well-being, and one is attributed to human health. The criterion assessed in third place is the physical constitution of a person, with a score of 16.8 %. Taking into account scientific sources, the subcriteria of this criterion has a significant impact on the occurrence of human error, and expert opinion confirms this. Aviation maintenance specialists come in a variety of physical constitutions – size or shape. Other variables include age, gender, health, experience, and capabilities. Although the variability of physical characteristics is experienced in various forms, these characteristics are usually the most specific. Physical constitution directly affects the work performed. Although the most important criterion was physiology, the focus on the person should not end there. Knowing that physical and psychological defects are an integral part of a person, companies must do everything to foster good physical and mental health. Therefore, it can be stated that all these criteria are equally important because, in one way or another, they contribute to the occurrence of human error. However, experts believe that the most attention should be paid to the components of human physiology and human psychology.

To create a plan for the impact of the human factor on the efficiency of work processes, it is not enough to find the weights of each criterion and subcriteria. Such a plan provides a fragmentary picture of the occurrence of the human factor since we only know the relative importance of each subcriteria. To improve this, it is necessary to find the total weight index of the subcriteria, i.e., to find out the importance of each subcriteria in relation to the weight of its cluster. In this way, it is possible to find out what impact each subcriteria has on business processes in the aviation sector. This is especially important in order to find out which human factors require the most attention and resources and which require less.

Table 1 shows the full picture of the criteria and subcriteria with their weights, as well as the overall priority weights of each subcriteria.

Table 1. Local and global weights of criteria and sub-criteria (compiled by the author)

Human factor criteria	**Weight of criteria, %**	**Sub-criteria**	**Weight of sub-criteria, %**	**Global priority weight, %**

Physiological	49,9	Workload	23,8	11,87
		Experience	15,8	7,89
		Knowledge	19,6	9,78
		Training	12,8	6,38
		Attitude	15,1	7,54
		Mental or emotional state	12,9	6,43
Physical	16,8	Physical size	27,0	3,55
		Sex	12,7	2,14
		Age	19,3	3,25
		Strength	19,9	3,34
		Sensory limitations	21,1	4,53
Psychological	33,3	Nutritional factors	26,4	8,79
		Health	30,7	10,22
		Lifestyle	9,3	3,09
		Fatigue	20,5	6,83
		Chemical dependency	13,1	4,37

Table 1 shows the same criteria but listed in order of the overall priority index. From it, we can see that the most important sub-criteria are workload, health, knowledge, and nutritional factors. The least important sub-criteria are strength, age, leisure, and gender. Human physiology has an importance of 49.9 %, based on expert assessment, but according to the overall priority index, the importance of the sub-criteria is unevenly distributed. Human psychology is estimated at 33.3 %, but health and nutritional factors account for a higher percentage of the occurrence of human factors: health - 10.22 %, nutritional factors - 8.79 %. Although this could be used as a final plan for reducing the human factor, what needs to be paid most attention to, since all these sub-criteria affect the occurrence of human error, is that it needs to be rationalized. To be more effective, the plan should include only the most important aspects to reduce the number of factors that decision makers have to focus on. The sub-criteria are ranked according to their effectiveness, regardless of the importance of the criterion, in order to obtain a direct impact of the sub-criteria on the occurrence of human factors and the efficiency of business processes in the aviation sector. To do this, the least significant sub-criteria will be removed from the plan (Table 2).

Table 2. Summary of global priority weights (compiled by the author)

Sub-criteria	**Global priority weight, %**
Workload	11,87
Health	10,22
Knowledge	9,78
Nutritional factors	8,79
Experience	7,89
Attitude	7,54
Fatigue	6,83
Mental or emotional state	6,43
Training	6,38
Sensory limitations	4,53

Chemical dependency	4,37
Physical size	3,55
Strength	3,34
Age	3,25
Lifestyle	3,09
Size	2,14

The sub-criteria with the least impact is determined by calculating the value of the first quartile of the data, in this case 3.5. All sub-criteria with a value lower than 3.5 are considered insignificant and do not affect the human factor. Each sub-criteria, in this case human factors, affects business processes in the aviation sector. Depending on the nature of the activity, they have an impact more often or less often, greater or lesser, more dangerous or less dangerous. It is important to attribute which decisive factors can affect the activity and take measures to reduce it.

5. Conclusions

Many studies have been conducted on the occurrence of human factor errors in aircraft maintenance, pilot fatigue studies, and the impact of decisions made in operations departments, and many proposals have been made, but human factor errors still remain relevant in business processes. Methods such as adaptation of work and equipment to people, activity analysis, muscle tension analysis, behavior monitoring, cognitive reliability and error analysis method, and research objects such as pilots, aircraft, work, equipment, decision-making, etc., have changed over the years from aircraft reliability to pilot decisions, from pilot decisions to maintenance personnel. At the same time, more safety assurance procedures have emerged, such as safety networks, SMS safety systems, encouraging personnel proactivity, and independent inspections. However, the human factor problem remains in organizations since its impact negatively affects organizational business process efficiency. Business processes in aviation include a number of indicators: workload, customer satisfaction, aircraft delays, aircraft time spent between flights, arrival punctuality, and flight efficiency, which assess the effectiveness and success of an organization's business processes in a competitive and strictly regulated aviation industry. Implemented safety systems such as PEAR or SMS to encourage employee proactivity, study human work processes, and decision-making. According to statistics, people are the main problem that causes accidents or incidents in aviation.

The significance of human factors was determined using the AHP method. The criteria and sub-criteria for each criterion were taken from the PEAR model, which analyzes humans. The main criteria assessed were human physiology (sub-criteria: workload, experience, knowledge, training, attitude, emotional and psychological state), human psychology (sub-criteria: nutritional factors, health, leisure, fatigue, chemical dependencies), human physical constitution (sub-criteria: physical height, gender, age, strength, sensory limitations) and sub-criteria of these criteria that are directly related to human capabilities and directly affect humans

Experts considered physiological human factors to be the most important criterion (49.9 %), which indicates that experts recognize that physiological human factors have the greatest negative impact on aviation business processes. The second most important criterion is human psychology (33.3 %), which is directly related to a person's lifestyle. The third and least important criterion was human physique (16.8 %). The human physiology factor related to workload was rated as the most important factor of this criterion – 11.87 %, and in the experts' opinion, this human factor has the greatest impact on the efficiency of business processes. Meanwhile, training was rated at 6.38 % – the physiological factor with the least impact on business processes. The human psychology factor related to health was rated as the most important factor of this criterion – 10.22 %, and in the experts' opinion, this human factor of psychology has the greatest impact on the efficiency of business processes. Meanwhile, leisure was rated at 3.09 % – the

psychological factor with the least impact on business processes. The factor of the physical constitution related to sensory limitations was rated as the most important factor of this criterion – 4.53 %, and in the opinion of experts, this human factor of the physical constitution criterion has the greatest impact on the efficiency of business processes. Meanwhile, gender was rated at 2.14 % – the physical constitution factor with the least impact on business processes. However, the relatively even distribution of sub-criteria shows that less valued criteria cannot be underestimated, and companies must allocate resources to all of them, applying the company's priority to each of them. Although physiological human factors are considered the most important, human factors of other criteria, such as health (10.22 %) or nutritional factors (8.79 %), fall into the top five most important sub-criteria. Unfortunately, human factors of physical constitution were not rated as factors with the greatest impact on business processes in the aviation sector. This shows how experts view human factors and their impact on the efficiency of business processes in the aviation sector. Although some criteria have the greatest impact on the efficiency of aviation business processes, it is necessary to pay attention to all human factors, even if they occur less frequently, and to eliminate them by prioritizing them from the most important to the least important criteria and sub-criteria.

The fact that each of these causes significant costs to companies due to errors or rework is a recommended human factors plan that companies should consider in order to reduce the incidence of human factors in business processes. These recommendations could be further researched to help reduce the impact of human factors errors on business processes in the aviation sector.

References

Abeyratne, R. (2014). *Convention on International Civil Aviation.* Springer.

AL-Hadab, M. S. (2023). *PEAR Model | Human Factors in Airline Maintenance*. Retrieved from Aviation Professional <https://www.aviation-professional.net/2022/03/PEAR-Model-Human-Factors-in-Aviation-Maintenance.html>

APA Dictionary of Psychology. (2022). *American Psychological Association*.

Barten, M. (2024). *Aviation Industry: All You Need to Know About the Aviation Sector*. Retrieved from <https://www.revfine.com/aviation-industry/#what-is-the-aviation-industry?>

Boeing. (2022). The role of human factors in improving aviation safety.

Bohrey, O. P., & Chatpalliwar, A. S. (2024). Mitigation of human factors in aviation maintenance. *Theoretical Issues in Ergonomics Science*, 642-654.

Boiko, Y. (2018). Methods of forming an expert assessment of the criteria of an information system for managing projects and programs. *Technology Transfer fundamental principles and innovative technical solutions*, 9-11.

BOSTONAIR. (2024). *About Human Factors in Aviation*. Retrieved from <https://www.bostonairgroup.com/what-is-human-factors/>

Dekker, S. (2006). *The Field Guide to Understanding Human Error.* Aldershot, England: Ashgate Publishing.

EASA. (2024). *Overview of Aviation Sector*. Retrieved from <https://www.easa.europa.eu/eco/eaer/topics/overview-of-aviation-sector>

Evaluation Observatory. (2022). Structured Surveys. Retrieved from <https://evaluationobservatory.org/knowledge-banks/structured-surveys>

FAA. (2023). *Aviation Maintenance Technician Handbook.* Federal Aviation Administration.

Federal Aviation Administration. (2012). Human Factors. *Aviation Maintenance Technician Handbook.* Oklahoma: US. Department Of Transportation.

FLORIDA TECH. (2024). *Human Factors in Aviation*. Retrieved from <https://www.floridatechonline.com/blog/aviation-management/human-factors-in-aviation/>

Hobbs, A. (2008). *An Overview of Human Factors in Aviation Maintenance.* Canberra City: Australian Transport Safety Bureau.

ICAO. (2024). *Operation of Aircraft - International Operations.*

International Civil Aviation Organisation. (2003). *Human Factor Guidelines for Aircraft Maintenance.* Montreal, Manchester.

Karunakaran, C., & Babu, A. J. (2022). Impact of human factors in aircraft accident mitigation and aircraft maintenance training needs in post COVID-19 aviation. *Aircraft Engineering and Aerospace Technology*, 1296-1302.

Kearns, S. K. (2018). *Fundamentals of International Aviation.* London: Routledge.

Law Insider. (2024). *Law Insider*. Retrieved from <https://www.lawinsider.com/dictionary/aviation-sector>

Leal, J. E. (2020). AHP-express: A simplified version of the analytical hierarchy process method. *MethodsX*.

Linnoit. (2020). *Business Processes Consulting*. Retrieved from <https://linnoit.com/en/business-processes-consulting/>

Maddox, M. (2006). Human Factors. F. A. Administration, *Human Factors Guide for Aviation Maintenance and Inspection* (p. 1-26).

PLANEX. (2024). *Business Process Management in Airlines (Part 1)*. Retrieved from <https://www.planex.ai/post/business-process-management-in-airlines-part-1>

Price, J. C., & Forrest, J. S. (2013). Overview of the Aviation Industry and Security in the Post-9/11 World. *Practical Aviation Security (Second Edition)*.

Sandle, T. (2020). Error Risk Reduction: Concept and Case Study.

Satter, S. (2024). *QuestionPro*. Retrieved from <https://www.questionpro.com/blog/structured-questionnaire/>

School of Aeronautics. (2011). Fundamental concepts of Human Factors. In Aeronautics, *Human Factors* (p. 1-21). New Delhi.

Ulises, K. R., & Jose, A. B. (2024). Impact of human factor management on company productivity: the moderating effect of digitalization. *Cogent Business & Management,* 11(1). https://doi.org/10.1080/23311975.2024.2371064