Risk Management and Organizational Considerations for Enhancing Safety State Given the Continuous Technological Development Processes

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Abstract: *Decision-making processes within aeronautical organizations are becoming increasingly challenging not only because of social, economic or flight planning threats, but also because of the need to properly implement new technologies that may require different approaches to allow a high performance operational state in air transport. The paper outlines the organizational management improvements in the complex and dynamic operational environment and analyzes the decision-making processes related to different risk levels which require a strong commitment from organizational management in the context of operational objectives. The authors also analyze the implementation of new technologies that affect the processes carried out within the organization and propose ways to adapt organizational management in order to control safety processes. The authors also analyze the implementation of new technologies that the processes carried out within the organization and propose ways organizational management security processes.*

Key Words: *commercial aviation, decision-making, new technologies, organizational management, risk analysis, safety state*

1. INTRODUCTION

Identifying ways to continuously promote aviation safety state is a permanent commitment of those who have safety prerogatives. However, their efforts are not sufficient if there is no coordination with the organizational management development processes, implicitly with decision makers. By improving operational platforms and organizational systems, safety has improved, passenger comfort has increased and aircraft performances has become superior, but maintaining the systems operating needs an enhanced approach due to extremely limited margin of error. In the case of complex systems, the connected risks increase, resulting new specific consequences. This is why available products must be designed to transfer risks, but transforming risks into a competitive advantage requires a different approach, i.e. understanding the challenges and responding with proper solutions in order to reflect the dynamic growth of the risk management spectrum. The main pillar of the study targets an assessment of safety control and monitoring methods for adapting organizational management. The research approach implies an in-depth literature review on organizational safety management in air transport and analysis of the multiple impacts of new technology implementation on safety performances. Even if the benefits of implementing new technologies are large, the risks associated with the dynamics and unpredictability of technological development can be proportional, so barriers need to be implemented.

2. SYSTEM SAFETY: SUPPORTED BY RISK MANAGEMENT AND RELIABILITY ANALYSIS

System safety, conceptualized by the United States aerospace industry in the late 1940's [15], applies systemic analysis to identify operational hazards and provide countermeasures before an unwanted event occurs. These specific countermeasures can be in several forms (for example warning devices, safety training improvements or regulatory changes) and their application should be the result of cost-effectiveness analysis [7]. On the other hand, risk mitigation measures should include a cost-benefit analysis. This one step further exploration [3] should determine whether risk mitigation makes more economic sense or whether the organization must accept the risk, or operation should be stopped [9].

A continuity plan should be prepared to respond to a subset of operational risks. Particular attention must be paid to external risks that are outside the organizational competencies and which can threaten the existence of the organization [9]. External organizational risks from a safety perspective include even the ones related to Covid-19 pandemic, reflected in safety occurrences caused by pilots losing their skills after prolonged inactivity or stress as response to perceived medical threat [11, 12]. No organization can achieve its objectives without taking risks, but the level of risk that an organization must accept cannot be specified. There are situations when information on initial operational status does not exist due to the fact that components or subsystems were made using new technologies, new procedural algorithms during design phase or was subject to other conditions in the operating environment that were not anticipated, therefore were not tested. In this case, it may not be possible to use existing experience or data. In order to evaluate the quality of a system dependent on different phases starting from design phase to operation, the following relation (1) is used:

$$Q = f(q_C, q_F, q_E) = q_C \times q_F \times q_E \tag{1}$$

q_C - quality of the initial design phase (conception),

q_F - quality of the manufacturing process (fabrication) - related to technical norms,

q_E - quality characteristic of the operation of the product - reported to safety standards, technical norms/indicators.

The quality of the materials used or of the technological process, etc. are elements which mark the moment of a safety occurrence, influencing the type of faults; therefore, the notion of quality cannot be separated from the technical framework [2]. If the component/subsystem in question is an integral part of a larger system, then the whole system depends on the probability of failure for that certain component/subsystem (see relation 2) [10]:

$$P_F = \frac{n_F}{t_i \sum_1^N i}, i = 1 \dots N \tag{2}$$

P_F - probability of failure,
n_F - number of failures,
t_i - operating time,
N - number of components analyzed.

Failures are treated as random events, but the classification within certain limits/patterns is useful for highlighting different classes of failures and characterizing their evolution as sudden or progressive (Table 1) [2].

Table 1 – Description of conditions of failure

Category	**Characteristics**
Fault	Failure to meet the conditions / functions of use
Nonconformity	Non-compliance / failure to satisfy specifications

In the case of Boeing 737 MAX, identification of the causes of aircraft flight control problems gave indications whether the conditions of producing the accidents were caused by nonconformity or faults. Boeing's design and self-certification of the MCAS system were not in line with airworthiness and aviation safety standards, thus allowing a simple error (sensor calibration) to lead to catastrophic accidents. The MCAS system used on 737 MAX aircraft was used after deciding to keep the aircraft as similar as possible to previous models and to avoid the need for certification and pilot training costs. An approach to risk assessment in the design phase refers to the occurrence (O), severity (S) and detection factor (D), followed by the adoption of measures to correct the risk or at least its severity.

$$V_R = f(O, S, D) = O \times S \times D \quad (3)$$

For Boeing, the two optional safety features (i.e. an indicator of the position of the angle of attack and the signaling indicating a difference between the actual position and the indication) were not required by the FAA, thus were installed only if the airline paid extra for them. Taking into account relation 3, the detection factor could have been of major importance at least to avoid the second crash (Ethiopian Airlines Flight 302 in 2019). In this case, an important question is how Boeing was able to measure the reliability of the system and what did FAA rely on when it credited it as being safe. Given the above mentioned and the definitions of risk and reliability, reliability analysis can be seen as part of the risk analysis for the entire system (Figure 1).

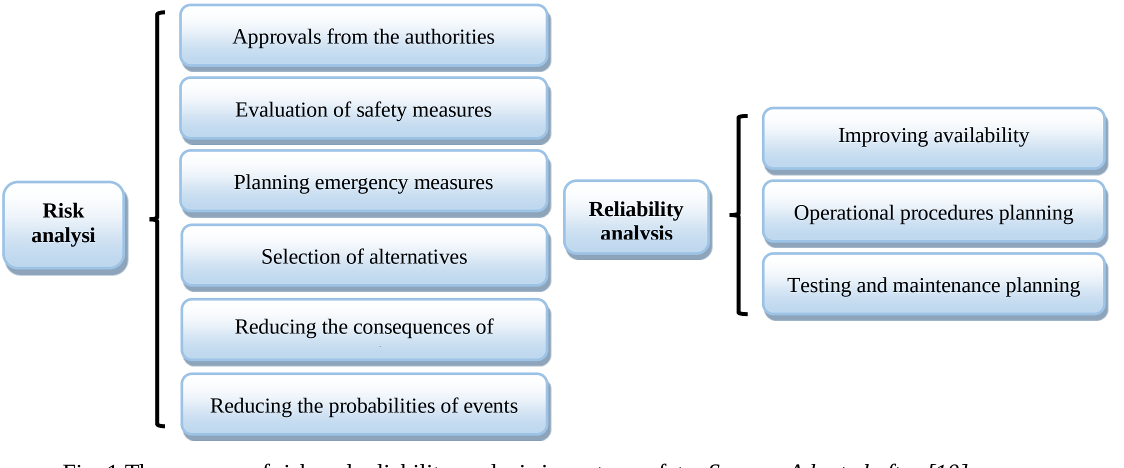

Fig. 1 The purpose of risk and reliability analysis in system safety. *Source: Adapted after [10]*

Assessing the appropriate performance probability is common to both types of analysis, in which the evaluation of the consequences for technical equipment/infrastructure is unique in the risk and safety analysis. Technical development rigor is essential for alignment with safety standards since the implementation of new technologies has multiple impacts affecting all the processes carried out within the organization: decision-making, economic, operational, etc. Surely, the new technologies used on Boeing 737 MAX aimed to improve existing systems by increasing reliability, improving operational processes, efficiency, but especially air safety. The two safety features that were optional on the aircraft: the angle of attack indicator (which displays information about what the sensors detect) and the signaling (which only lights up if a difference is noticed between the two sensors), cost about $ 80,000 and could have helped pilots understand the problem in a timely manner. It is thus a reflection of the fact that these safety features should not have been optional from the start, especially taking into consideration that the price of an aircraft is about $ 120 million.

3. ADAPTING ORGANIZATIONAL MANAGEMENT WITH THE PURPOSE OF CONTROLLING SAFETY PROCESSES

The manifestation and improvement of contingency ideology have pushed modern organizational theories in the mainstream area. Contingency theory is a part of the ideology that focuses on the construction of systems and emphasizes that the organizational structure is governed by environmental conditions and the result of the exchange between organizations and their operational environments.

Lawrence and Lorsch (1967) [6] stated that an organization is a subsystem of open social systems, affected by environmental factors which encompass all forces that may have a potential impact on performance or operations. The organizational specific environment directly influences manager's decision, actions and it is relevant in achieving the objectives - environmental tasks, while the impact on general environment is not usually a direct one and is often treated as a factor taken into consideration in the managerial decision-making processes [13].

In order to ensure operation and to keep processes under control (aspects directly related to safety and efficiency), decision making must be made in stages. It is much easier to improve existing platforms, but the biggest challenge is to implement and adapt these platforms. New technologies have certain features that can influence the operational capacity of the platform, and these corrections can be made by implementing other systems to compensate/eliminate existing malfunctions - such as the 737 MAX aircraft.

Modern organizational theories treat the organization as an open, dynamic system, that focuses on organizational environment, and when an organization and its operations face hazards, risk management models should propose actions for adaptation and reconfiguration. However, these models do not specify that a certain structure/system must create/impose new solutions. More precisely, the management should focus on a resilience model which insists on the technical and organizational dimension that allows reconfigurations from a systemic and synchronous point of view; but it says very little about the stages by which the human factor involved in management processes can identify new solutions to reconfigure the organizational structure or the agreements and negotiations they have to make for reconfiguration [5].

Mintzberg and Waters [8] showed that an organization achieves a strategic advantage by using its own organizational model. And so did Boeing, who made very good strategic moves against the Airbus rival, and the 737 MAX aircraft had very large orders until the second accident, about 5,000 aircraft were ordered globally. Through commercial decisions Boeing pleased investors by improving aircraft already certified with new engines to fly more and more economically. Before the accidents, the MAX version of the 737 aircraft was quite affordable. Aeronautical analysts said that a lesson in this situation for Boeing is to reorient itself towards engineering excellence and not to let itself be decisively dominated by marketing and sales [4].

But the necessity to make decision is of fundamental importance; threats from internal and external structure often determine the possible future status of the system through the impact on economic aspects, including the competitive position and market value of the shares. All modern organizations operate in risky conditions; for Boeing, the risk arose due to internal factors, but especially environmental conditions that generated direct threats connected with the economic, strategic, organizational, operational and legal aspects.

Risk management supports a much more efficient organizational management due to its capabilities that helps to understand and evaluate the threat. The process should not be confined to an operational structure, but must be part of a much broader process - organizational management - decisions taken at the organizational level, mainly those with a strategic character. The case of Boeing should be studied in its particular environment, but not isolated from others. The two dimensions: technical environment and the institutional one, outlined by control elements, standards and cultural-cognitive aspects [14], are equally important. However, Aldrich (2007) [1] shows that the research on the sub-layer problems specific to the organizational domain improves organizational relationship with each other, and the use of a common technology helps to standardize the steps, legal aspects and the improvement of institutional systems.

4. CONCLUSIONS

New technologies require new skills from individuals, and smart organizations will act proactively, improving the means of identification of risks and being able to find solutions for dealing with a dynamic system. The form of organization used today is strongly influenced by the technical and institutional environment, thus the organization-organization and organization-environment relationship becomes increasingly complex. The form of organization used today is influenced by the so the relationship between organization and organization and organization-environment.

The pace of change, the impact of emerging technologies and the increasing number of regulations globally have played an important role in promoting and prioritizing risk management in decision-making. The importance of this type of management in the hierarchical structures is given by the fact that the tasks are and will be more and more complex nowadays, and the consequences of a failure can be catastrophic.

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