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RIGA TECHNICAL UNIVERSITY

Juris Maklakovs

DEVELOPMENT OF THEORETICAL AND METHODOLOGICAL ASSESSMENT APPROACHES OF AIRLINE SAFETY CULTURE AS A RISK FACTOR

Summary of the Doctoral Thesis

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RIGA TECHNICAL UNIVERSITY
Faculty of Mechanical Engineering, Transport and Aeronautics
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Doctoral Student of the Study Programme "Transport"

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DOCTORAL THESIS PROPOSED TO RIGA TECHNICAL UNIVERSITY FOR THE PROMOTION TO THE SCIENTIFIC DEGREE OF DOCTOR OF SCIENCE

To be granted the scientific degree of Doctor of Science (Ph. D.), the present Doctoral Thesis has been submitted for the defence at the open meeting of RTU Promotion Council on 21 April 2023 at 12.00 at the Faculty of Mechanical Engineering, Transport and Aeronautics of Riga Technical University, 6B Ķīpsalas Street, Room 513.

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DECLARATION OF ACADEMIC INTEGRITY

I hereby declare that the Doctoral Thesis submitted for the review to Riga Technical University for the promotion to the scientific degree of Doctor of Science (Ph. D.) is my own. I confirm that this Doctoral Thesis had not been submitted to any other university for the promotion to a scientific degree.

Name Surname ……………………………. (signature)
Date: ………………………

The Doctoral Thesis has been written in Latvian It consists of an Introduction, 5 chapters, Conclusions, 25 figures, 29 tables, 10 appendices; the total number of pages is 108, not including appendices. The Bibliography contains 96 titles.

Contents

GENERAL DESCRIPTION OF THE DOCTORAL THESIS

Relevance of the research

Starting from the beginning of the 21st century, the system approach to solving safety issue began to dominate the field of flight safety. Over time, both the human factor and poor safety culture (SC) have been proven to be risk factors in aviation that directly affect flight safety. The new approach improved the collection and analysis of safety data, allowing organizations to monitor safety risks and identify emerging trends for safety improvement. Thus, the initial foundation of the safety management system (SMS) was created. The result of further progressive development of the approach to ensuring flight safety was that specialists began to pay more attention to interaction between the components of the system: "**aviation personnel–processes–technologies**" (PPT). Therefore, the positive role of man in the safety system received a higher evaluation. In practice, the operating processes and technologies of the aviation company (AC) employ a large number of people of various specialties and skill levels who interact with technical devices and with each other, forming micro-teams (groups, teams, shifts). Therefore, the effective operation of the AC SMS is achieved only with the active participation of all personnel in it. In practice, the specific specialist is the first to discover one or another dangerous factor in the course of his professional activity. Therefore, the timeliness of the identification of dangerous factors mainly depends on the personnel. In addition, employees are always carriers of information about mistakes or violations, as well as about incidents that are not officially registered. Timely communication of this information to the responsible bodies and decision-makers allows to determine their causes and develop effective preventive measures. It becomes obvious that any specialist, in order to become an active participant in the SMS, must be convinced that AC has created a "non-punitive" production environment where personnel are not penalized for mistakes, provoked violations or incident reports. This will allow the staff to develop a new attitude towards flight safety and realize their role in solving this problem. This is the essence of a positive SC. A positive SC is characterized by mutual trust, which is based on communication, common understanding of the importance of safety and employees' faith in the effectiveness of preventive measures.

One of the most important decisions regarding SC was taken at the 40th session of the ICAO (*International Civil Aviation Organization)* Assembly, which took place in 2019. It called on ICAO to continue working on the development of tools to improve safety awareness and SC, making it a priority and declaring 2020 (later also 2021) the year of SC. The Doctoral Thesis is devoted to solving these issues within the framework of one AC.

The aim of the thesis

Evaluation of the state of SC as a risk factor in the airline's flight safety assurance system.

Tasks

1. To analyse the dynamics of airline flight safety assurance approaches.

2. Positive SC as a new stage in air transport flight safety.
3. To characterize different levels of regulatory documents of international civil aviation (CA) organizations in the matter of positive SC.
4. To analyse the methods and means of building a positive SC and evaluating efficiency in AC and other industries.
5. To develop a mathematical model of SC as a risk factor.
6. To develop a methodology for assessing the level of SC in relation to flight safety.
7. To develop a computer program for the airline's automated information database.
8. Approbation of methods and models in the Latvian airline company.

Research object – analysis of research approaches of positive SC as a risk factor at the airline level, implemented on the basis of modern achievements and current regulatory documents in this field.

Research site – medium-sized AC. Limited liability company (LTD) "Airlines" (the name adopted in the study). ICAO, IATA (*International Air Transport Association*), EASA (European Aviation Safety Agency), ISO *(International Standard Organization)*, CAA *(Civil Aviation Authority)* documents, as well as statistical data and documents of other Latvian airlines.

Research methods

1. Statistical analysis methods (analysis of average variation indicators, correlation analysis).
2. Semiotic and mathematical modelling.
3. Probability methods.
4. Expert evaluation methods.
5. Methods of statistical data processing using Microsoft Office Excel 2016 and SPSS software.
6. Methods for risk assessment: ICAO, IATA (IOSA), EASA, ISO, SHELL, DEMATEL, and others.

Scientific novelty

1. Mathematical model of positive SC as a risk factor.
2. Positive culture assessment model based on AGILE management principles.
3. Classification of factors determining the positive SC of the airline.
4. Automated program for assessing the state of positive SC, which complements the informational database of the airline's flight safety management.

Practical significance

1. A program that provides an opportunity to determine and analyse the current level of positive SC in the AC.
2. Practical recommendations that can be applied in the evaluation of the positive culture of the AC.

Theses to be defended

1. Mathematical model based on the risks of absence of positive SC.
2. AGILE evaluation model, as a system for analysing the positive SC of the AC.
3. Approaches to assess the relationship between the level of positive culture and flight safety in AC.

Work results

1. An analysis was carried out of the methods and means developed by various industries for improving the SC in the companies under their responsibility.
2. An analysis of the airline's approaches to ensuring flight safety was carried out.
3. The mathematical model of a positive SC as a risk factor has been developed.
4. A classification of the decisive factors that determine the positive SC of the airline has been developed.
5. A positive culture assessment model based on AGILE management principles has been developed.
6. Criteria for evaluating the level of positive SC in the airline company have been developed.
7. A program has been developed for the Flight Safety Management Automated Information System to monitor and analyse the current positive SC in the AC.
8. Approaches have been developed to assess the relationship between the level of positive culture and flight safety.
9. Approbation of the developed models was carried out at the Latvian airline.

Accuracy of research results

All obtained research results are based on the author's practical calculations, regulatory requirements and AC, CAA, and ICAO documents. The mathematical model, methods, algorithms, and diagrams developed by the author have been tested in practice in the AC.

Work approval

The work has been presented at 6 international scientific conferences in Poland and Latvia and in nine publications in seven scientific journals. The developed method and tool were approved in a medium-sized Latvian aviation company.

Presentations in international scientific conferences

1. 60th International Scientific Conference of Riga Technical University, 16–17 October 2019, "Assessment of the impact of aircraft maintenance on safety indicators" and "Improvement of the aviation safety system during the development stage of unmanned aircraft (UAV)".

2. 2nd Aviation and Space Congress KLiK 2019, 18–20 September 2019, Cedzyna near Kielce, Poland, "Positive culture as an element of safety and effectiveness of functioning of aviation company".
3. 61st International Scientific Conference of Riga Technical University, October 15, 2020. "Analysis of possible aviation safety risks associated with the massive introduction of unmanned aerial systems".
4. Rzeszow University of Technology, POLAND, 15th European Workshop on Aircraft Design Education (EWADE), 21–23 October 2020, hosted by Polish Society of Aeronautics and Astronautics, "Using the Heinrich's (Bird) Pyramid of Adverse Events to Assess the Level of Safety in an Airline" and "Analysis of Possible Risks in Aviation Safety Issues Associated with the Massive Introduction of Unmanned Aerial Systems".
5. Riga Aeronautical Institute VI International scientific and practical conference, TRANSPORTS. EDUCATION. LOGISTICS AND ENGINEERING – 2022, 2–3 July 2021, "Improving the role of the human factor during the rapid development of aviation technologies".
6. 62nd International Scientific Conference of Riga Technical University, October 15, 2021. "Assessment of students' positions about the important qualities of a positive culture of aviation specialist".

Publications

1. Maklakovs J., Bitinsh, A., Bogdane, R., Chatys, R., Shestakovs, V. Using Adverse Event Pyramids to Assess Probabilities in Airline Safety Management. *Transactions on Aerospace Research*, 2021, No. 2, pp. 71–83. e-ISSN 2545-2835. Available: doi:10.2478/tar-2021-0012, indexed in Scopus.
2. Maklakovs, J., Bitinsh, A., Bogdane, R., Shestakovs, V. Using Heinrich's (Bird's) Pyramid of Adverse Events to Assess the Level of Safety in an Airline. *Transactions on Aerospace Research*, 2021, No. 4, pp. 11–20. e-ISSN 2545-2835. Available: doi:10.2478/tar-2021-0020, indexed in Scopus.
3. Shestakovs, V., Tereshcenko, J., Maklakovs, J., Bitinsh, A., Chatys, R. Algorithm for Analyzing Deviations and Irregularities in the Functioning of the Airline's Structural Units and Personnel in the Face of Uncertainty. *Aviation*, 2020, Vol. 24, No. 2, pp. 51–56. ISSN 1648-7788. e-ISSN 1822-4180. Available: doi:10.3846/aviation.2020.12375, indexed in Scopus.
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6. Bitinsh, A., Maklakovs, J., Shestakovs, V., Stefanski, K. Positive Culture as Element of Safety and Efficiency of Airline Operation. No: *Selected Issues of Modern Aviation Technologies*. Ed. T. Stańczyk. Kielce: Kielce University of Technology, 2021. pp. 9–25. ISBN 978-83-66678-03-3. ISSN 1897-2691.
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9. Maklakovs, J., Bitinsh, A., Shestakovs, V., Chatys, R. Positive Culture as an Element of Safety and Effectiveness of Functioning of Aviation Company. In: *2nd Aviation and Space Congress*, Poland, Kielce, 18–20 September 2019. Kielce: 2019, pp.1 24–125.

Thesis structure

The Thesis has an introduction, five chapters, conclusions, bibliography, 25 figures, 29 tables, 9 appendices, 96 literature references; total number of pages is 108.

Chapter 1 examines the possible risks at the AC level, which are specific to the "personnel–processes–technologies" system. It describes positive SC as a new stage in ensuring safety in air transport and gives general assessment of the results of the implementation of regulatory documents and activities in Latvian AC in the year of positive SC announced by ICAO.

Chapter 2 analyses organizational means and mechanisms for implementation of a positive SC in an AC.

Chapter 3 examines the airline's integrated management system (IMS). It presents the analysis of methods for evaluating quantitative indicators of corporate culture and the analysis of the experience of applying methods for assessing the state of SC. It considers modernization of the AGILE model as the most suitable for the research purposes and presents the experience in nuclear power and railway industries in the field of improving the efficiency of SC.

Chapter 4. In this chapter, the SC evaluation model and SC indicators are selected. Modernizing the AGILE model as the most suitable for our research purposes.

Chapter 5 describes approbation of the developed methods and models on the basis of a real AC. With the help of the expert method, an examination of the impact of the SC improvement on flight safety in the AC was carried out. The chapter presents an evaluation of the level of motivation of the airline personnel involved in the preparation of AP for the flight as an element of a positive SC in the airline.

Conclusions present the results of the conducted research and their approbation in the practical activities of the AC.

1. SECURITY IN CIVIL AVIATION

Analysing aviation documentation, we can find that CA has two security areas: aircraft flight safety and CA security.

Aircraft flight safety is the continuous identification of hazards and the management of safety risks to ensure that no harm to persons or damage to property occurs, reducing the probability of such an incident to a specified level and maintaining it at or below the specified level.

Civil aviation security is a set of measures and human and material resources intended to protect the CA against acts of illegal interference in its operations.

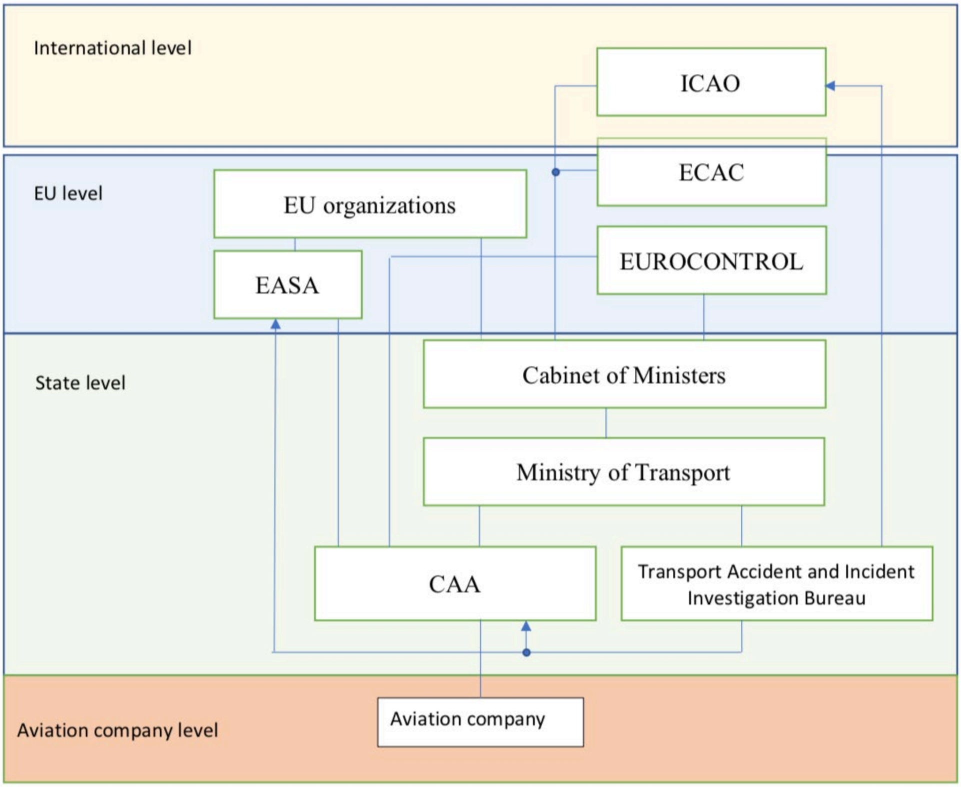

Fig. 1.1. A multi-level structure for ensuring flight safety in international civil aviation.

In other words, aviation security is the absence of unacceptable risk of potential harm caused by unlawful interference in aviation operations.

Both of these areas complement each other because it is not possible to achieve a high level of aircraft flight safety and CA safety if appropriate measures are not taken in the AC.

A multi-level management (including safety) structure has been established in the international CA, see Fig. 1.1, where the main focus is on the lowest level, the airline with the task of ensuring flight safety.

International aviation organizations, such as ICAO and IATA, as well as lower-level regional and national aviation authorities, play an important role in improving safety. ICAO's mission is to provide guidelines for a common approach to aviation development and maintenance promoting its safe application worldwide, namely, the development of standards and recommended practices in various CA areas. They are compiled as annexes to the ICAO Convention.

In ICAO documents there is a clear tendency to use the concept of risk in the following form: "**risk is a measure of the volume of the threat in certain system states**". Such a definition allows to create unified methodological schemes for risk management and ensure flight safety from the point of view of general systems theory, as well as to determine various safety indicators through acceptable risks at the national and AC level. The GASP *(Global Aviation Safety Plan)* outlines the methodology and approaches needed to achieve the ICAO's strategic aviation safety objective, which in turn calls for "enhanced CA safety worldwide".

1.1. Safety management in an airline

Aviation safety management in the AC consists of the development and implementation of organizational processes, technologies, and regulations to ensure the management of potential risks, namely, to minimize loss of human life, property damage, financial, environmental and social losses as a result of aviation accidents. The management of such a system means the planning, organization and management of all resources available in the AC in order to achieve the goals set for the organization, see Fig. 1.2.

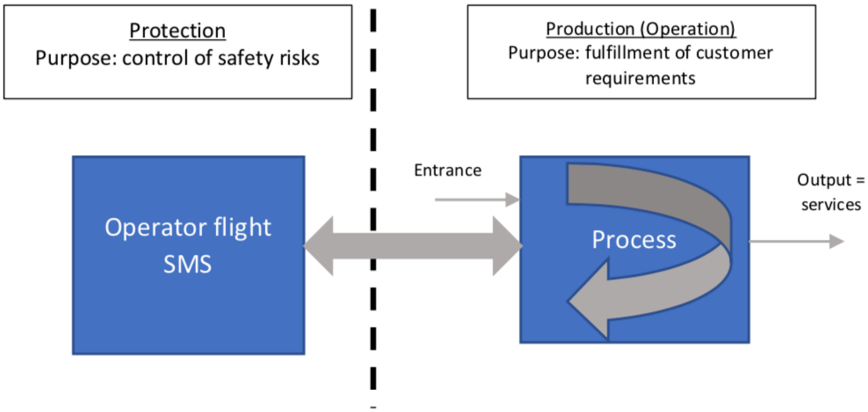

Fig. 1.2. Safety management in an airline.

Figure 1.2 shows the functional roles of the AC, where the contrast between "production" and "protection" refers to functions and requirements for product production (air transport) and other aviation services. Flight SMS is used as a means of system approach to identify and eliminate potential risks.

It is clear that the AC management must deal with both production and risk control and management. This operation must be balanced, otherwise failure to maintain this balance could result in the bankruptcy of the AC or an aviation accident, both of which are undesirable outcomes.

Since safety is defined by the concept of risk, any discussion of security involves the concept of risk, according to which the level of risk can be divided into three broad categories:

- the probability of risk is so high that it is unacceptable;
- the probability of risk is low, and it meets the requirements;
- the probability of risk is between these two categories, requiring constant monitoring.

Based on the study of risk factor trends in various structural units of the AC, as well as on the conditions and requirements of regulatory documents, ensuring flight safety in the AC is carried out by periodically or continuously correcting preventive actions in the field of safety.

Historically, several stages can be distinguished in the dynamics of CA flight safety assurance approaches, which are reflected in DOC 9859:

1. **The technical age.** The 50s–70s of the last century. During the years, the prevention of adverse events by CA was based on their investigation in accordance with the ICAO regulations set out in Annex 13 "Investigation of Aircraft Accidents". This approach has been called a **retroactive safety strategy**: investigating accidents and incidents that must be reported to the management.
2. **The era of the human factor.** The 70s–90s of the last century. In the 1990s, the prevention of adverse events in CA was based on the active search, identification, and prevention of adverse factors affecting safety before they lead to an adverse event. The ICAO “Accident Prevention Manual” (DOC 9422-FN923) became the foundational document for this approach. This approach has been referred to in the literature as a **proactive safety strategy**.
3. At the end of the last century, in order to prevent adverse events in CA, **the development and implementation of SMS** in CA practice began. The ICAO document that sets out this approach is the “Manual of Aviation Safety Management” (DOC 9859). In the literature this approach is called a **prognostic strategy**, where the prevention of adverse events is based on the prediction of possible risks. This approach requires the use of innovative methods for collecting and analysing safety data. Several such safety strategies already exist using existing programs, such as flight data analysis, flight parameter monitoring, flight quality assurance.
4. Ensuring a positive SC in the **system "aviation specialists–processes–technologies"** began to develop at the beginning of this century and still exists. The result of the progressive complex evolution of the approach to ensuring flight safety was that by the beginning of the 21st century, in addition to the already existing achievements in aviation operations in connection with improvements in technical and human aspects in this area, the SMS was introduced in the AC, and flight safety began to yield results. During this period, according to ICAO requirements, flight safety systems in airlines are developed based on risks.

Recent trends in aviation international organizations' approach to safety indicate that organizational, corporate, safety culture, and human factors are important components that need to be considered to improve flight safety. Failure to observe these factors is a risk that contributes to causing aviation accidents.

In June 2007, ICAO adopted a comprehensive document, the GASP, a strategic document containing a planning methodology designed to achieve global harmonization in the field of aviation safety. The document contains a general framework to ensure the coordination of regional, sub-regional, national and individual initiatives aimed at creating a coherent, safe and effective international CA system.

An effective safety culture includes:

- recognizing that effective security is critical to business success;
- establishing an appreciation of positive safety practices among employees;
- aligning safety to the core business goals;
- articulating safety as a core value rather than as an obligation or burdensome expense.

Understanding when and why accidents occur is essential to safety management. In addition to technical and natural factors, the composition of the main factors creating emergency situations also includes human and cultural factors, namely, the SC established in the airline, which has an impact on flight safety, which is shown schematically in Fig. 1.3.

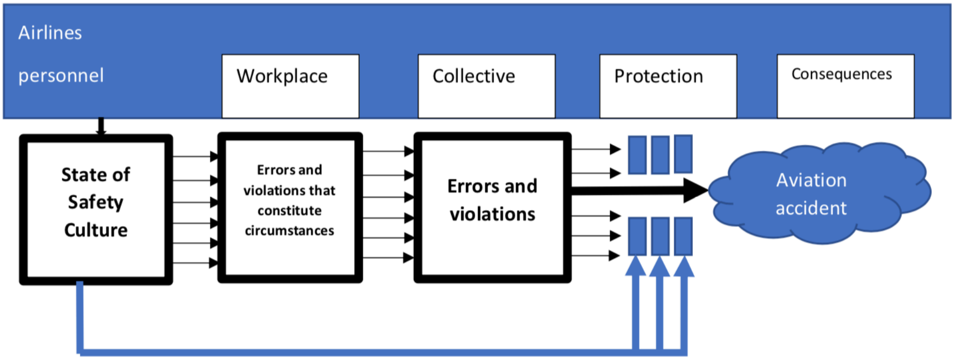

Fig. 1.3. Aviation accident causation model (adopted from Professor J. Reason's scheme).

Analysis of the accident data shows that the situation before the accident was "ripe" and safety officials could see that it was only a matter of time before the conditions led to an accident. They (and their colleagues) may have made similar mistakes in the past with no ill effects. Often such errors at work are the result of wrong human decisions. These unsafe practices may be the result of frequent mistakes or gross violations of established procedures and operations. The model allows for the existence of many conditions for errors and disturbances in the work environment that affect the individual or group behaviour of personnel. Thus, based on the above, it can be argued that flight safety management is not only the responsibility of the "airline safety department" or "safety manager", but the responsibility of all employees who are involved in the PPT system. It refers SC as a safety-oriented mindset of all personnel, characterized by:

- awareness of personal responsibility for flight safety;
- lack of complacency;
- desire to improve and independent self-improvement;
- a systematic atmosphere of attention to safety issues;
- SMS covers all types of airline operations;
- use of personnel proposals in improving flight safety;
- the opportunity to formally and informally discuss flight safety issues with all employees;
- willingness to admit errors affecting flight safety;
- an atmosphere of honesty and a desire to learn from one's own and others' mistakes.

According to studies conducted by BOING company, about 70 % of aviation disasters are caused by the human factor. In its safety report, Latvian CAA also mentions the human factor as one of the most significant risk factors during the reporting period. During the conducted research it was found that the defects that are caused in the aviation company are described as human factor errors and it amounts to about 70 %.

At the same time, SMM emphasizes that the evaluation of human factor is one of the most difficult tasks when compared to technological and environmental risks.

The term “safety culture” was introduced in 1986 with the publication of a document on the causes and consequences of the Chernobyl nuclear power plant accident. In 1991, Report 75-INSAQ-4 was published entitled “Safety Culture”. The report states that the lack of SC was one of the main causes of the Chernobyl disaster. Further analysis of this concept showed that the occurrence of all accidents and incidents at nuclear power plants in the past is somehow related to human behaviour (namely, their attitude to safety problems), which led to a new perspective on the causes of their occurrence. According to the definition of the International Atomic Energy Agency (IAEA), safety culture is defined as a set of values and behaviours resulting from a collective agreement between senior managers and employees to give safety the highest priority over other priorities, thereby protecting people and the environment.

This document also mentions that SC includes three aspects:

- the psychological aspect, namely, how people feel. It can be described as an organization's 'safety climate', which is related to individual and group values, attitudes, and perceptions;
- the behavioural aspect, that is, what people do – safety-related actions and behaviours;
- the situational aspect, that is, how the organization feels – policies, procedures, regulation, organizational structures and management systems.

1.2. Characterization of regulatory documents of different levels of civil aviation management in the issue of positive safety culture

International CA has established a multi-level safety structure (Fig. 1.2). The upper level includes organizations such as ICAO and IATA. ICAO's main task is to develop standards and recommended practices in various CA areas. They are compiled as annexes to the ICAO Convention.

International aviation organizations such as ICAO, EASA, IATA, CANSO and EUROCONTROL, as well as other regional and national authorities, play an important role in the improvement of SC. Their task is to provide guidelines for a unified approach to the development and maintenance of aviation, promoting its safe use on a global scale. As it was mentioned previously, one of the most important decisions regarding the SC was taken at the 40th session of the ICAO Assembly, which took place on 24 September – 4 October 2019 in Montreal. It determined that the responsibility of all ICAO Member States to comply with these guidelines.

According to ICAO: "Safety culture means a set of norms, beliefs, values, attitudes and assumptions that are an integral part of the daily activities of organizations and are reflected in all activities of departments and personnel of these organizations. Safety is the responsibility of every employee, from junior staff to senior management".

1.3. General assessment of the Latvian airline on the results of the implementation of regulatory documents and activities in the international year of positive safety culture

Looking at the 2019 list of significant risk factors in Latvia and the 2020–2022 planning cycle of the CAA operational strategy, I find that one of the most important risks is human error and low reporting culture in general aviation. In Latvia and the Baltic region, there are mostly small or medium-sized regional ACs that do not have specialists or staff who are well versed in SC theory and deal with these issues on a daily basis. This is the great deficiency, that diminishes the flight safety.

As practice shows, work related to the safety is carried out in each AC or airport complex, which mainly consists of information collection, accumulation and initial assessment of risks arising in structural units, as well as in various categories of personnel.

In order to find out the staff's attitude towards flight SC, a survey was conducted in one of the Latvian ACs. Summarizing the results of the survey, it was found that the management is aware of the importance of SC in the AC, but due to time and resources constraints and other reasons, this information is not sufficiently explained at the lower level of the company's structural units. In their day-to-day operations, ACs are mostly focused on their specific tasks, namely cargo and passenger transportation. As the main risk the company's management sees the human factor and the company's reporting culture, which is part of SC.

The results of the survey showed that aviation specialists are not being trained in sufficient numbers in the country, or the salary is lower than that offered by ACs in other countries.

2. ORGANIZATIONAL MEANS AND METHODS FOR IMPLEMENTING A POSITIVE SAFETY CULTURE IN AN AVIATION COMPANY

The development of an inclusive SC is a prerequisite for effective long-term safety implementation in the aviation industry, which is one of the GASP priorities. Appreciating the concept of a positive SC as a key element of a modern approach to safety management in the aviation sector, and based on the complexity of this problem, ICAO developed the necessary guidance materials for this purpose and organizes staff training on this topic. These issues are addressed by several ICAO bodies:

- ICAO Secretariat;
- working group training (WGT);
- Aviation Security Panel (AVSECP).

Analogous working groups are also organized by other international organizations related to the aviation industry, namely EASA, IATA, CANSO, EUROCONTROL, etc.

2.1. Implementation of a positive safety culture in an aviation company

Means and methods of the AC for the implementation and maintenance of positive SC refer to several ICAO instructions, which are published in several documents, including a special manual. Primarily, this guide provides a "starter kit" designed to help everyone raise awareness of the important role safety plays in the aviation industry and to encourage all personnel, including service providers and members of the wider aviation community, to think and act together. This kit is divided into three parts: Basic Principles, Adaptable Resources and Tools for Improving ICAO's SC. They are grouped by thematic areas and are reflected in Table 2.1 as one of the excerpts of the document.

Table 2.1

Excerpt from ICAO Tools for Promoting a Positive Safety Culture

DESIRED OUTCOME	TOOLS
Work environment that drives and facilitates positive security culture.	Clear and consistent *policy, processes, systems, and procedures* enshrine security in all corporate policy and procedures, including those areas which do not have a primary security focus and document in writing. Ensure that the information is easy to understand, simple to follow, and readily accessible to staff who may want to refresh their understanding.
	Equipment, space and resources provide staff with the resources they need to achieve a strong security performance. This may be in the form of additional screening equipment, or by providing extra staff at a security checkpoint, or the provision of appropriate IT equipment or machinery.
	Prompts help employees to implement good security by reminding them what actions they need to take. These could be notices on doorways or signage; or a pop-up prompt when logging on/off a computer.
	Suggestions box gives staff the opportunity to suggest ways in which security could be improved. Reward suggestions which result in changes and improvements.
	Targeted communications plan includes inviting experts or celebrities from outside of the organization to endorse security practices through messages.
Staff who know what security behaviours are expected of them and who confidently and willingly demonstrate the behaviours.	*Performance appraisals* of every employee assessing their security behaviours against the expected ones. Provide feedback on their security behaviours, recognition for positive security behaviour, and consequences or sanctions for failure to adhere to security policy.
	Thank you messages that may be in the form of a blog or an article on how strong is the impact of positive security culture on the organization. *Corporate communication* on the results of security checks, e.g. 100 % of employees clearly displayed their security pass.
An organized, systematic approach to managing security, which embeds security management into the day-to-day activities of the organization and its people.	*Security Management System (SeMS)* manages security in a structured. A SeMS can provide a risk-driven framework for integrating security into an organization's daily operations and culture. The philosophy of SeMS is a top-to-bottom culture that leads to the efficient provision of a secure operation.

In the study of a positive SC the main thing is to determine the methodology of its diagnosis and measurement. The analysis of the existing methods and means of organizing a positive SC and evaluating its effectiveness allows to identify the advantages and limitations of their use, to determine the most effective of them and, based on this, to develop a more innovative integrated approach.

However, it should be taken into account that there is no specific description of SC, so there is a lack of a single set of components in the literature. It can best be interpreted as follows:

- SC is a multifaceted phenomenon consisting of many contributing components;
- the importance of any particular component in a particular SC; it is determined by the prevailing conditions in the environment in which this culture exists;
- the phenomenon of SC, accordingly, has many different faces, thus making it difficult to promulgate a universal definition and description.

As a result, SC is studied from different angles. For example, Guldenmund distinguishes three broad approaches: academic (anthropological), analytical (psychological), and pragmatic (based on experience). Each of these different approaches involves specific methods and tools to assess an organization's SC.

2.2. An analysis of the means of improving a positive safety culture

The SMM recommends several tools to be used to assess the SC maturity. They are usually used in combination to improve efficiency. These means are:

- questionnaires;
- interviews and focus groups;
- observations;
- document review.

There are three groups of methods used in the study of the corporate culture of a particular company:

- empirical methods (observation, perception, information gathering);
- systems analysis methods (using general systems theory and organization theory methods, systemic and synergistic approaches);
- mathematical, economic, and statistical modelling methods (linear programming method, priority method).

The first of them can be considered qualitative. The second and third method are quantitative methods of corporate culture research. They are based on conducting various surveys to obtain a measurable assessment of the situation.

2.3. Analysis of qualitative and quantitative data

Qualitative method is used to explore people's thoughts, ideas or experiences through interviews, focus groups, case studies, interview analysis, and literature reviews. It is basically a survey conducted to collect data on thoughts and experiences.

Quantitative research method is characterized by the fact that the collected data are usually expressed in numbers and graphs to confirm theories and assumptions. Collected data is information about the area being studied. Using this method, factual information can be collected in the following ways:

- surveys;
- experiments;
- study of existing data;
- observation;
- content analysis.

Quantitative and qualitative research methods allow data to be collected in different ways that allow different research problems to be addressed.

In small and medium-sized regional aviation companies, where a professional specialist in SC issues is not available, it is quite difficult to conduct qualitative research.

2.4. Safety performance improvement process

It is important to remember that the SC improvement process in an AC includes several stages, which are also precisely described in the recommendations included in the documents mentioned above (CANSO, EASA). The essence of the process does not differ strongly in different models.

For SC analysis, it is necessary to select the parameters that will be analysed. Aviation uses indicators that are used to monitor and manage safety performance and SC in public transport and other industries. Those are:

- lagging indicators that measure past results;
- leading indicators that have the inherent and defining characteristic of predicting future performance.

Nuclear energy industry has carried out more detailed studies and expanded this field. One of the more detailed studies, where the possible categories in the characteristics of SC and their future indicators are examined, offers the following classification:

- driving indicators – are performance indicators of selected safety management activities;
- monitoring indicators – indicators reflecting the organization's potential and ability to operate safely;
- lagging indicators – indicators measuring the results of the socio-technical system.

So, SC indicators are parameters that give an organization an idea of its SC level: where it has been; where it is now; and where it is going in terms of safety.

In order to evaluate the SC level in the AC, it is necessary to conduct questionnaires and check the level of reliability of the test results.

The reliability level of a test is an indicator that characterizes the quality of the test. Testing the reliability level of test results is performed using one of the following two methods: using XYZ analysis or Cronbach's alpha coefficient. Let us consider the assessment of the level of reliability of the survey results using the Cronbach's alpha coefficient, which is calculated according to Equation (2.1):

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N} \delta_i^2}{\delta_s^2}\right), \quad (2.1)$$

where:

- N – the number of points on the scale;
- δ_i – standard deviation of an individual component;
- δ_s – standard deviation of all studied populations.

When the SC evaluation has been carried out, based on the obtained results, it is possible to determine the maturity level of the aviation company's SC. After evaluating several documents, five SC levels in an AC have been determined in civil aviation:

- Level 1 (Pathological): Who cares as long as we don't get caught.
- Level 2 (Reactive): Safety is important, we do a lot every time there is an accident.
- Level 3 (Calculative): We have systems in place to manage all hazards.
- Level 4 (Proactive): We are working on the problems we still find.
- Level 5 (Generative): Safety is how we do business here.

After determining the SC level of a given company, it is necessary to start work on improving its efficiency.

2.5. Means for evaluating safety culture in aviation companies

At the moment, the aviation authorities offer the following means for determining the SC level in AC:

- IATA recommends using the Aviation Safety Culture Survey Tool (ASC-IT). ASC-IT uses a common SC framework that applies to the entire aviation industry, providing opportunities for benchmarking.
- At the meeting of the CANSO – NOM working group in 2019, it was decided to develop a documentation that summarizes the references of the existing knowledge in this field from a practical point of view and to develop a set of tools for the monitoring of normal activities.
- SAFEORG is a toolkit that aims to support aviation managers and employees to improve the safety and security culture in their organizations.

- The Swiss Federal Office of Civil Aviation (FOCA) developed its qualitative safety culture assessment tool.

The CAA of several countries also recommends various types of surveys where, in addition to SMS quality evaluation, SC is also included.

The considered means are standardized and do not give a full opportunity to evaluate any of the specific areas because each AC is specific and the management has access to information about existing deficiencies from other sources of information, such as audits, discussions, surveys, etc. This means that small and medium size ACs need something specific that can help them improve the flight safety.

3. RESEARCH ON THE DEVELOPMENT OF METHODOLOGICAL APPROACHES TO A POSITIVE SAFETY CULTURE

3.1. Comparative analysis of corporate culture research methods

The positive SC assessment methodology should be focused on the scope of a specific AC (specific AC class). This is necessary so that the created tool can take into account the specifics of the economic, social and technological reality of the SC under study. In the Doctoral Thesis the methodology development process for researching a positive SC was adapted to a medium-sized AC with an IMS.

IMS, graphically shown in Fig. 3.1, is a combination of at least two organizational management systems that meet the requirements of two or more international standards for management systems that have fully or partially combined elements and operate as a single entity.

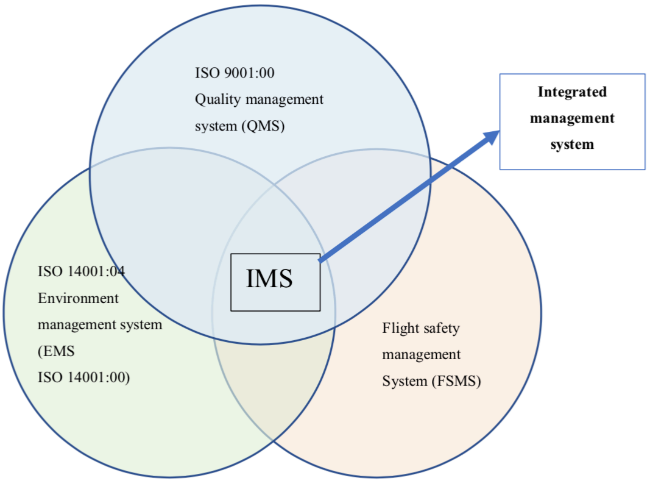

Fig. 3.1. Integrated management system.

Integrated management system consists of:

- SMS – safety management system (SMS, Doc. ICAO 9859);
- QMS – quality management system (QMS, ISO 9001:2015);
- ISO 14001:04 – environment management system (ISO 14001:2015).

These systems have common elements: policy and objectives, work planning, work management, safety (guarantee), continuous improvement, etc.

3.2. Analysis of methods for evaluating quantitative indicators of corporate culture

Corporate culture, which is an integral part of organizational culture, mainly includes the internal values of the organization, ensuring team cohesion in achieving the tasks set by the company, one of which can be a positive SC. Therefore, when we develop our model, it is logical to use the approaches proposed by different authors to assess the quantitative indicators of an organization's corporate culture.

For our purposes, the best solution would be an empirical methods-based approach with quantitative analysis of collected information based on questionnaires, interviews, and observations of AC staff.

Therefore, T. Parson's AGILE model is the most suitable for the given research purposes. It reflects the relationship between corporate culture and organizational performance through a number of functions that any organization must perform in order to be successful and competitive. The AGILE model is a versatile analytical tool (see Fig. 3.2). It can be successfully applied in the analysis of various social systems and structural processes and elements. The logic of the initial concept defines the strategy of sociological research as a structural-functional analysis. A sociologist, observing any social phenomenon, tries to identify its functions and thus provide a functional explanation for the fact of its existence.

The social system, as a subsystem of the general operating system, consists of four subsystems. Any system exists stably if four conditions are met:

- The system must be adapted to the environment.
- The system must be self-regulating.
- The system must be internally integrated.
- The system must be structurally stable.

This is also a four-function social system, which T. Parsons called adaptation, goal achievement, integration, model maintenance. According to the first letters of the English names of the functions: "adaptation", "goal attainment", "integration", "latent pattern maintenance", T. Parsons' concept is usually called the AGILE model. The AGILE model has successfully demonstrated its effectiveness by applying it in various industries, organizing research.

Thus, AGILE creates a value system in the company that helps to achieve the set goals:

- more effective interaction of all its employees and structures, which is not limited to strict internal processes;
- quick management response to any adverse factors (events);
- focus on the main tasks of the company, not on ancillary matters.

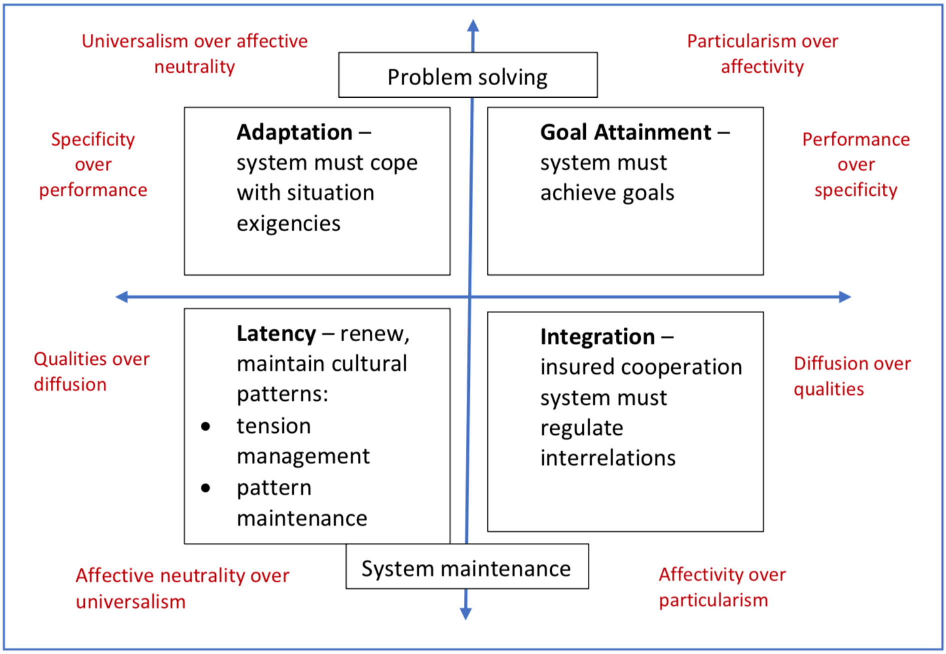

Fig. 3.2. Talcott Parson's AGILE Model of Social Organization.

Table 3.1 shows a comparison between this model and corporate culture fit.

Table 3.1

The Main Parameters for Compliance of the Corporate Culture with the Principles of the AGILE Approach

Blocks of culture's corporate values	Main evaluation parameters
(A) **Adoption** (provide competitor capabilities)	• introduction of new processes and technologies in the company • flexible approach to solving non-standard issues • initiative in solving work issues • learning organization
(G) **Alignment of company culture with goals.** (ensures the achievement of set goals)	• clear understanding of the company's mission, goals and values • employees accept the company's mission and values as their own • common understanding of work goals at all levels of the company
(I) **Involvement of all employees in the performance of tasks and teamwork**	• effective communication between participants of work processes at all levels

Table 3.1 continued

(ensures coordinated and friendly activity of the company's employees)	• high involvement in all activities related to the work process • knowledge-based confidence • assuming personal responsibility • understanding of one's own contribution to the creation of the overall result
(LE) **Recognition of the company's management authority by its employees** (ensures continuity of values)	• high rating of the company as an employer • justified criticism to improve the work • high material and moral motivation • desire to work and improve in the company

3.3. Analysis of the experience of applying methods for assessing the state of safety culture

SC is not limited to aviation. The term "safety culture" has been defined and actively used by various industries. In general, SC is viewed as an organization's shared perceptions, beliefs, values, and attitudes that combine a commitment to safety and efforts to reduce harm. This concept is used in other high-risk industries, such as nuclear power, rail transport, medicine, etc., which seeks to understand security incidents in order to prevent future disasters. The European Union Organization for Safety and Health at Work pays particular attention to these issues and notes that proper management of safety and health at work, which is integrated into the general management and business of the organization and addresses regulatory, technical/engineering, organizational and managerial aspects, is very important, to ensure corporate excellence.

As previously mentioned, the term "safety culture" was introduced after the Chernobyl nuclear power plant accident. In this regard, it can be said that the nuclear power industry has accumulated the most experience with regard to the methods of determining and improving the efficiency of SC. The International Atomic Energy Agency (IAEA), which actively determines policy in this area, plays a major role in the implementation of a SC.

4. DEVELOPMENT OF A MODEL FOR ASSESSING THE STATE OF SAFETY CULTURE IN AN AIRLINE

Let us consider the SC of the AC as a social phenomenon, which is a system of values, beliefs, as well as norms, roles, principles and rules. At the same time, it is also the system described earlier: "personnel–processes–technologies". The formation of a positive SC requires constant mutual interaction of employees within the AC and in the group work process.

Next, we will determine the basic rules that would be available for improving the SC efficiency of medium and small level AC. So, the rules will be as follows:

- The system must be understandable and easy to use without the involvement of SC specialists. Let us use the already discussed AGILE SC model, adapting it to the purpose of this work, which is to evaluate SC of AC.
- System evaluation analysis methods must be aligned with the standards introduced by the International Aviation Organizations.
- The SC level can be determined by any AC specialist who is familiar with the instructions for the new method.
- The system provides an opportunity to evaluate SC from different angles, based on the already available information about deficiencies.
- The system gives recommendations for improving SC in AC and checks whether the previously proposed recommendations have been implemented.
- The system should include the currently best elements from existing SC models in aviation and other industries, which will help to better understand and standardize the efficiency evaluation process.
- In the evaluation of SC we will use future-oriented indicators because lagging indicators reflect the result that has happened, which can give an idea of the necessary choice of future indicators in relation to determining the level of SC.
- It is important to be aware of the groups of respondents. Since in the assumptions of the study a medium-sized AC has been chosen, it is desirable to check several structural units, which the management of the company determines according to its own views and based on available data about the state of the SC in it, for example, a large number of new employees.
- It is also necessary to conduct an inspection of the higher management/structural unit of the mentioned structural unit in order to compare the data on a unified approach regarding the information to be checked.

4.1. A general approach to the development of a safety culture assessment model

At the beginning, we will choose the methodology for assessing the situation, and as mentioned in the assumptions, it must be simple enough, without the involvement of additional specialists and able to provide quantitative indicators. The method provides for assigning a certain result (on a five-point scale) to the contribution of each of the considered positive SC indicators. The total summation is carried out according to the following formula:

$$R = \sum_{i=0}^{n} R_i, \quad (4.1)$$

where R is a positive SC level; R_i is the organization's SC indicator; and n is the number of indicators x to be taken into account.

We will consider the level of a positive SC in the AC as an indicator of the quality of functioning of the PPT system, which has developed in the company.

Personnel means groups of specialists of different profiles, different functional specializations, who work in various AC services and whose activities are directly focused on providing flights. Despite the high requirements for professional quality, specialists make many mistakes when performing production functions. The variety of mistakes is as great as the variety of human actions.

Estimating discrepancies and errors, as well as forecasting activities is the main task in organizing **processes** in various areas of activity of the AC. Obviously, their impact on the company's work as a whole is not the same, and it is determined by the degree of interaction with the process of providing flights.

By **technology** we understand discrepancies and errors related to the violation of the sequence of technological activities during the execution of airplanes maintenance and other AC services, namely, in their field of activity (incorrect measurement of parameters, use of damaged tools and equipment).

In general, all these shortcomings (risk factors) are recorded and analysed in the information base of the AC quality management system.

4.2. Development of a multi-level system of positive culture indicators

In order to simplify the tasks related to flight safety analysis, depending on the problem to be solved, the whole variety of risk factors is classified with a different degree of detail and in different positions, in other words, with a different degree of generalization. The risk factor generalization methodology is based on the hypothesis that several measurable random factors, let us call them particular factors, are closely related to each other and to some other value that cannot always be measured quantitatively. Thus, there is some relationship between particular and generalized factors. At the same time it should be borne in mind that the beginning of the development of a special situation is the appearance of a certain particular factor. In our case, it can be a random accident from the PPT system under consideration.

Therefore, to determine the indicator ΣR of the level of AC positive SC, we will use some methodological approaches and qualitative indicators.

Quality indicators is a quantitative characteristic of the properties of the object under study, which is part of its quality and is considered in relation to certain conditions of the life cycle.

According to the number of characteristics there are the following quality indicators:

- **Particular quality indicator** – a measure of quality that refers to only one characteristic of the object.
- **Complex quality indicator** – an object quality indicator that describes two or more properties related to the object.
- **General quality indicator** – a quality indicator associated with such a set of characteristics of the object according to which it was decided to evaluate its quality as a whole, i.e. it describes the general quality level of the evaluated object.

In our case it will be indicator *R* – the level of positive SC. It includes many complex indicators R_i, which describe various aspects of a positive culture in relation to the expected result, which in turn consists of particular indicators R_{ij}, which describe a specific function related to the components of the PPT system, which have formed at the given moment in the AC. In order to define the indicated levels of positive SC indicators with certain content, we will use the ICAO guidelines on positive SC implementation mechanisms. According to this document, in order to implement an effective positive SC system, nine groups are required, which are characterized by general complex indicators R_i:

- R_1 – favourable working environment;
- R_2 – training;
- R_3 – management;
- R_4 – awareness of threats;
- R_5 – attention;
- R_6 – submission of reports;
- R_7 – response to accidents;
- R_8 – information security;
- R_9 – efficiency indicators.

In turn, each of them is also a general complex indicator, which contains several complex indicators R_{ij}. At the same time, each of these indicators includes several particular indicators in the R_{ijk}, which in the study have an unambiguous interpretation, since the document provides a detailed explanation for each of them, which is a landmark in its quantitative assessment. In the general case, it can be represented in the form of a diagram, Fig. 4.1.

Taking into account the multi-level structure of positive SC and the already mentioned ICAO tools for promoting positive SC (Table 2.1), it is possible to transform it in such a way that each of the indicators corresponds to its own result and means. Table 4.1 shows the mentioned case based on the creation of a favourable working environment. However, similar tables can be converted for the other eight general indicators.

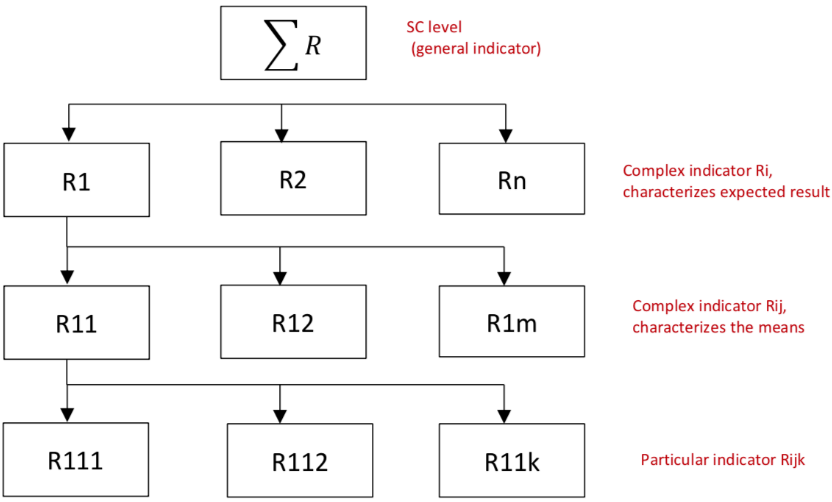

Fig. 4.1. The multi-level structure of a positive safety culture.

Table 4.1

ICAO Tools for Promoting a Positive Safety Culture by Adapting Quality Indicators

R1	**Creating a favourable working environment**
***R**ij*	***R**ijk*
R11 – creating a favourable working environment for a positive SC aviation company.	**R111** – clear and consistent guidelines, processes, systems and procedures.
	R112 – equipment, facilities and resources are necessary means to improve the effectiveness of security personnel.
	R113 – short instructions.
	R114 – the suggestion box is a feature.
	R115 – targeted outreach plan.
R12 – staff's knowledge of their security tasks and willingness to demonstrate confident execution of them.	**R121** – personnel attestation.
	R122 – implementing a just culture.
R13 – development of an orderly and systematic approach to security, which consists of implementing security measures in the daily activities of the organization and its personnel.	**R131** – implementation of the aviation security system.

The above indicators affect the R level of positive safety culture in different ways, therefore, if the exact functional dependence cannot be found, the so-called weight coefficients in the formula are used:

$$R = \sum_{i=0}^{n} R_i k_i, \quad (4.2)$$

where R is the complex indicator of the level of positive safety culture in the AC; k_i is the weighting coefficient of the i^{th} indicator.

To process the data obtained during the study, we used various methods of statistical analysis:

- analysis of dispersion to determine differences between nominative (data from the socio-biographical questionnaire) and quantitative variables;
- correlation analysis to determine the relationship between employees' assessment of SC and their psychological characteristics;
- factor analysis to group SC components;
- regression analysis to identify predictors of employee SC ratings.

Depending on the number of surveyed groups and their size, various non-parametric criteria are used to test the relevant hypotheses. The main condition for the application of the criteria is the possibility to arrange the responders according to the obtained results. In Table 4.2, the main tasks of this type of comparison, the recommended criteria, and the limitations of their application are given.

Table 4.2

The Choice of the Criterion for Determining Group Differences Obtained by Examining the Characteristic under Study

No.	Tasks	Criteria	Restrictions
1	Determine whether there are differences between two independent groups?	Mann-Whitney U-test.	Group size limits: (n_1, $n_2 \geq 3$) or ($n_1 = 2$, $n_2 \geq 5$) (n_1, $n_2 \leq 60$).
2	Determine whether there are differences between three or more independent groups?	Kruskal-Wallis H-test.	Number of groups $c = 3$, size of groups: (n_1, n_2, $n_3 \leq 5$).
		Pearson X2-test.	Number of groups $c = 4$ and more, even if the size of one group is greater than 5. Number of degrees of freedom $v = c–1$.
3	Arrange the created groups according to a qualitative characteristic (gender, profession, etc.) or according to some quantitative characteristic.	Jonker's-criterion (a measure of symptom expression).	The number of groups $3 \leq c \leq 6$, The size of the groups must match, and must be no less than 2 and no more than 10.

It is also important to track whether there have been significant changes (deviations) in the values of the measured indicators as a result of the accumulation of seniority, retraining, and qualification upgrading. The most common types of changes are:

- change of time – research of professionally important qualities (personal, professional) depending on seniority;
- change under the influence of controlled processes – change of parameters of interest to the employee, based on the results of in-depth training, retraining, implementation of self-development programs, training, etc.;
- change of situation – study of indicators in different measuring conditions (computer or conventional testing possibilities).

The criteria for evaluating the statistical significance of the obtained changes are given in Table 4.3.

Table 4.3

Criteria for Evaluating the Statistical Significance of the Obtained Deviations

No.	**Offset type**	**Terms of use and restrictions**	**Criteria**
1	Time, situations.	Number of measurements –2, number of groups –1, Group size $5 \le n \le 50$.	Wilcoxon T-criterion (determines the direction and magnitude of the offset, and zero offsets are ignored).
		Number of measurements from 3 to 6, number of groups – 1, Group size $n \le 12$.	Page's L-criterion (gives an opportunity to determine the direction of displacement).
		Number of measurements –2, number of groups – 2.	Mann-Whitney U-test, Fisher's angular transformation φ′.
2	Affected by controlled processes.	1) No control group	
		Number of measurements –2.	Wilcoxon T-criterion.
		Number of measurements from 3 to 6, group size $n \le 12$.	Page's L-criterion.
		2) In the presence of a control group	
		Comparison of "before" and "after" values separately for two groups.	Wilcoxon T-criterion (if the number of measurements is 2). Page's L-criterion (if the number of measurements is from 3 to 6).
		Comparison of the offsets of the two groups.	Mann-Whitney U-test, Fisher's angular transformation φ′.

The Thesis examines and selects a criterion to assess the reliability of the change in the value of the investigated characteristic for respondents according to the Wilcoxon T-criterion.

Continuing with trait consistency degree surveys, it is assumed that there are two or more sets of data to determine the degree of consistency:

- the presence of two or more characteristics measured by the same set (for example, the level of motivation and the level of the employee's average salary);
- the presence of two or more subjects for the same set of features;
- the presence of individual values of the characteristic with the group average;
- the presence of two or more groups of the same volume according to the same set of features.

In all four cases, we are talking about correlation, which indicates that a change in one value or set of values causes a change in another value or values. A limitation of the content of correlational analysis is that it allows the discovery of the existence of a relationship but does not provide a basis for establishing causal relationships. In other words, the presence of a strong correlation between X and Y values does not yet mean that Y depends on X (or vice versa) but may indicate the presence of a third latent Z value with which they are both related. This should be taken into account when interpreting the results. The following coefficients were used as a measure of correlation in this study:

1. Coefficient of linear correlation parameters *r*:

$$r = \frac{\sum yx - \frac{\sum y \sum x}{n}}{\sqrt{\left[\sum x^2 - \frac{(\sum x)^2}{n}\right]\left[\sum y^2 - \frac{(\sum y)^2}{n}\right]}} \quad . \tag{4.3}$$

2. Non-parametric multiple concordance coefficient *w* and its special case – pairwise concordance coefficient *w'*:

$$w = 1 - \frac{\sum_{i=1}^{m} \sum_{j=1}^{m} \sum_{k=1}^{n} \left| x_k - x_j \right|}{nm(m-1)(k-1)}, \tag{4.4}$$

$$\mathrm{w}' = 1 - \frac{\sum_{j=1}^{n} \left| x_{1j} - x_{2j} \right|}{n(k-1)} \ . \tag{4.5}$$

Table 4.4

Comparative Characteristics of Value Change Matching Indicators

No.	Characterization	Coefficient of linear correlation parameters	Concordance factor
1	Calculation formula.	• For two quantities, Pearson pair correlation coefficient (Formula (4.3)). • for several quantities is based on the calculation of pairwise correlation coefficients.	• For two values, the concordance coefficient of pairs *w* (Formula (4.5)). • for several values, multiple concordance coefficient *w* (Formula (4.4)).
2	Measurement limits.	$-1 \leq \tau \leq 1$; $R > 0 \rightarrow$ direct link; $R < 0 \rightarrow$ reverse link.	$0 \leq w \leq 1$.
3	Degree of density	Evaluate according to Chedok's table: $0<r<0.1 \rightarrow$ none; $0.1<r<0.3 \rightarrow$ weak; $0.3<r<0.5 \rightarrow$average; $0.5<r<0.7$ noticeable; $0.7<r<0.9 \rightarrow$ tight; $0.9<r<0.99 \rightarrow$ very tight; $r=1 \rightarrow$ functional.	$w = 0 \rightarrow$ none; $w < 0.65 \rightarrow$ weak; $0.65 \leq w<0.75$ average; $0.75 \leq w<0.85$ good; $0.85 \leq w<1 \rightarrow$ high; $w = 1 \rightarrow$ full compliance.
4	Conditions of use	• Value should be measured on an interval scale or a ratio scale. • The values of all quantities have a normal distribution law. • The compared rows of data are of the same size. • Measurements of magnitude values are linear. • Student's t-test is used to determine significance.	• Values should be measured by the quality determined by the researcher. • Subordination to the law of normal distribution is not necessary. • The data sets compared are of the same size. • Quantitative value measurements are arbitrary. • There is no need to determine significance, as it contains a percentage of agreement.

The concordance ratio is more universal, it does not need to normalize subjects' original "raw" test scores, nor does it need to prove its significance. Its disadvantage is the computational complexity (for multiple reconciliation), as it is not automated in special application data processing packages. This shortcoming can be eliminated by creating a special program for determining the value of this coefficient. At the same time, the use of the linear correlation coefficient is justified because the test results standardization procedure described in many psychometric textbooks leads to the fact that all conditions for its application are met and this coefficient is calculated.

The work also examines the analysis of the variability of the selected characteristics under the influence of the controlled factors.

The study of professionally important characteristics of aviation technical personnel based on a questionnaire survey can be attributed to the so-called interrupted statistical observation. Continuous observation error is also called representation error or representativeness error.

The continuous observation error $\xi_{\tilde{x}}$ results from the approximate reproduction with the arithmetic mean x of the general arithmetic mean of characteristic X. The magnitude of this error can be expressed by the following equation:

$$\xi_{\tilde{x}} = \tilde{x} - \bar{X}. \quad (4.6)$$

Currently, there are known methods only for determining the error of a sample observation (in the form of the maximum possible squared error). An error in the selective determination of the professionally important characteristics of an aviation specialist $\xi_{\tilde{x}}$ occurs as a result of an approximate representation of the general arithmetic mean value of this mark $\overline{X}$ in the points of the professionally important characteristics with the selective arithmetic mean value of $\tilde{x}$.

However, the fact that this error exists is by no means a negative fact. The main thing is that, firstly, the size of the error is detectable and, secondly, it should not exceed the permissible size. So, we identify professionally important qualities with the help of a questionnaire, asking several questions to the respondents.

When preparing for a sample observation, the issue of determining the scope of research is always decided. The formulas used to determine the sample size are derived from the marginal sampling error formulas, depending on:

- the type of sample offered;
- the selection method (repeated or non-repeated);
- the calculated parameter (average value or fraction).

In addition, the researcher determines in advance the size of the permissible limit of the individual sampling error and the value of the confidence level. Formulas for calculating the required sample size depending on the selection methods are shown in Table 4.5.

Table 4.5

Formulas for Determining Sample Size

Type of selection	Re-selection	Selection without repetition
When estimating the average value		
Random	$n = \frac{t^2.\sigma_{\bar{x}}^2}{\Delta_{\tilde{x}}^2}$	$n = \frac{t^2.\sigma_{\bar{x}}^2.N}{\Delta_{\tilde{x}}^2.N + t^2.\sigma_{\bar{x}}^2}$
Mechanical		$n = \frac{t^2.\sigma_{\bar{x}}^2.N}{\Delta_{\tilde{x}}^2.N + t^2.\sigma_{\bar{x}}^2}$
Typical	$n = \frac{t^2.\bar{\sigma}_i^2}{\Delta_{\tilde{x}}^2}$	$n = \frac{t^2.\bar{\sigma}_i^2.N}{\Delta_{\tilde{x}}^2.N + t^2.\bar{\sigma}_i^2}$
Serial with equal periods	$r = \frac{t^2.\sigma_{\bar{x}}^2}{\Delta_{\tilde{x}}^2}$	$r = \frac{t^2.\sigma_{\bar{x}}^2.R}{\Delta_{\tilde{x}}^2.R + t^2.\sigma_{\bar{x}}^2}$

n – number of sampling units;

N – number of units of the total volume;

T – reliability coefficient;

$\sigma_{\bar{x}}^2$ – variance of the feature in the total volume, which is calculated as the mean square of the deviations of individual feature values from their average value;

$\overline{\sigma_i^2}$ – characteristic variance in the i^{th} typical group;

Δ – marginal sampling error;

$\bar{x}$ – common average;

$\tilde{x}$ – sample mean;

R – the number of episodes in the general community;

r – the number of selected series in the sample community.

When using the formulas given in the table, the sample size is calculated by rounding up to ensure a certain margin of accuracy.

The above-mentioned studies allow us to fairly objectively formulate the state of AC's positive SC.

We proceed from the fact that the methodology should be quite simple, without the involvement of additional specialists and capable of giving quantitative indicators.

The assessment is carried out by surveying the employees. The SC influence coefficient (K_{sc}) on the efficiency of the AC in security matters is determined by formula

$$K_{sc} = R / 5\ \kappa. \tag{4.9}$$

Thus, if as a result of SC evaluation all analysed indicators received the highest number of points (by five points) in the organization, then the K_{SC} coefficient will be equal to 1. This means that the organization has created a culture that best helps ensure flight safety. The SC level assessment is shown in Table 4.6.

Table 4.6

Assessment of the Level of Safety Culture

Coefficient value limits	Assessment	Hudson levels
$0.90 \le K_{DK} \le 1$	Excellent results	Generative
$0.70 \le K_{DK} < 0.90$	Very good	Proactive
$0.50 \le K_{DK} < 0.70$	Average achievements	Calculative
$0.25 \le K_{DK} < 0.50$	On the edge of necessity	Reactive
$0 \le K_{DK} < 0.25$	Very poor results	Pathological

As can be seen from the table, it is convenient to match the levels with Hudson's linear classification scheme. A linear classification scheme makes it possible to compare the SC also across different target groups, organizational levels, departments or locations.

In the process of improving the efficiency of SC, it is important to pay attention to the management of AC and their communication with the company's employees. Therefore, to improve SC, it is necessary to evaluate management and its communication with subordinate subunits. To determine these two parameters, you can use the formula that determines the compatibility of managers, Formula (4.10).

$$K_{MC} = \frac{I_V - I_D}{I_{max}}, \tag{4.10}$$

where:

- K_{MC} – managers' compliance factor;
- I_V – average assessment of managers according to the criterion;
- I_D – average assessment of employees according to the criterion;
- I_{max} – maximum rating (depending on the rating scale).

The variation of the coefficient can be from –1 to 1, and if the value does not fall within 0.1 in both directions, it indicates a difference of opinion.

4.3. Selection of indicators

The selection and use of SC indicators are always based on the understanding (model) of the socio-technical system and safety. The safety model defines what risks are perceived. It is important that safety indicators can help rethink this model. Key questions to ask when selecting and using safety performance indicators are:

- what is required of the AC to operate safely, and
- what is required of the organization to realize its safety level and improve its safety performance.

In order to be able to use the proposed method, it is necessary to determine the most important indicators (R_n), which will be used in the calculation of the SC efficiency level.

When analysing the shortcomings of the SC efficiency evaluation tools offered in the aviation field, we will supplement these requirements with improved assumptions that we will use in building the model:

- we will use only driving indicators;
- we will use leading and monitoring indicators, because the former gives an idea of the execution of the decisions made, while the latter are proactive in terms of improving the efficiency of the SC.

Unfortunately, when reviewing the regulatory documents, it is not possible to find the standardized SC indicators for the aviation industry. A broad overview of the characteristics of SC and the indicators included in them is provided, which are separated in Appendix 3. For research purposes, we will use only some of them, that is, those that correspond to the selected AGILE model, and we will also slightly modify them according to aviation needs. In this case, it is worth looking at the IATA SC model, which reflects the peculiarities of aviation culture. For a better overview, the indicators are combined by groups with progress and monitoring indicators shown in Table 4.7.

Table 4.7

Safety Culture Indicators

Blocs of culture's corporate values	Main evaluation parameters	Indicators	
		Driving	Monitoring
(A) Adoption (provide competitor capabilities).	• Introduction of new processes and technologies in the company. • Flexible approach to solving non-standard issues. • Initiative in solving work issues. • Learning organization.	• Technology management. • Work management.	• Technical condition of the company.
(G) Alignment of company culture with goals (ensures the achievement of set goals).	• Clear understanding of the company's mission, goals and values. • Employees accept the company's mission and values as their own. • Common understanding of work goals at all levels of the company.	• Strategic management. • Leadership. • Human resources management.	• Organization and management.
(I) Involvement of all employees in the performance of tasks and teamwork (ensures coordinated and friendly activity of the company's employees).	• Effective communication between participants of work processes at all levels. • High involvement in all activities related to the work process. • Knowledge-based confidence. • Assuming personal responsibility. • Understanding of one's own contribution to the creation of the overall result.	• Work management. • Human resources management.	• Social processes.
(LE) Recognition of the company's management authority by its employees (ensures continuity of values)	• High rating of the company as an employer. • Justified criticism to improve the work. • High material and moral motivation. • Desire to work and improve in the company.	• Strategic management. • Leadership. • Human resources management.	• Organization and management. • Psychological states and perceptions.

As can be seen from Table 4.7, in the selected AGILE model, there is a different approach regarding the distribution of indicators in IATA and IAEA, as we see that some groups of indicators fit different blocks of corporate values in culture.

4.4. Organization of the survey and compilation of results

We have chosen a survey as the main means of determining the level of SC in the AC. However, this process has some disadvantages, the main one of which is that survey participants may have different understanding of the questions defined in the questionnaire. To avoid this deficiency, it is necessary to combine SC training in the company with questionnaires. The organization of surveys is one of the ways to improve the safety of aviation flights, so this issue is comprehensively addressed in several regulatory documents (e.g. DOC8959). However, as already mentioned in the study, each AC has its own specificities, which are best known by its leadership. The main role in improving SC is the willingness of the AC leadership to do so; if they are not implemented, there will be no SC. To start work, it is necessary to evaluate the company's weak points and risks and then set goals and priorities that would be understandable and clear to every employee. The analysis of priorities and risks will serve as a basis for the selection of indicators. It is desirable that such a list of indicators, according to the characteristics of SC and the specifics of the company, is prepared and is constantly improved.

Based on the processed information from the questionnaires, it is possible to determine the level of SC in the company (see Table 4.6). Starting from the SC level, the process of improving the SC should be started.

4.5. Methods and means for improving safety culture

The process of improving SC is very long-term and requires a lot of effort from both the AC management and its employees. It is not possible to recommend a method or means for any of the organizations that would be ideal and would immediately give positive results because each has its own specifics.

ICAO in its safety culture start-up package recommends measures that should be understood by all civil aviation personnel so that SC can be prioritized.

During the preparation of the work, research was conducted on the influence of motivation on the level of efficiency of SC in the AC. A study of the influence of motivation was carried out on the basis of a survey of the personnel of the aviation services involved in the preparation of the airplane for flight.

Using the Pearson correlation (Equation (4.12)), it was proved that there is a very strong correlation between the motivation of AC employees and the environment of working conditions, pay, and psychological climate in the collective. The mentioned factors are part of the selected SC model AGILE.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}, \tag{4.12}$$

where:

r – Pearson's coefficient;

n – number of pairs;

$\sum xy$ – total number of paired values;

$\sum x$ – sum of x values;

$\sum y$ – sum of y values;

$\sum x^2$ – sum of x squared values;

$\sum y^2$ – sum of y-squared values.

The value of the correlation coefficient reflects the strength of the link. When assessing the strength of the relationship of correlation coefficients, the Chaddock scale is used.

The IBM statistical program SPSS was used to calculate the Pearson correlation coefficient. The obtained results are reflected in Table 4.8.

In this correlation links, the strong correlation between the factors affecting motivation in the AC, namely, the work environment, the evaluation of the quality work of specialists, good pay, the psychological climate in the company, and the desire to continue working in this company is most widely reflected.

Table 4.8

Table of Correlation Strength of Motivational Conditions

	U1	U2	U3	U4	U5	U6	U7	U8	U9
U1	1	.990	.004	.882	–.287	.773	–.092	–.231	.419
U2	.990	1	–.062	.901	–.285	.722	–.077	–.167	.490
U3	.004	–.062	1	–.359	–.819	.637	.807	.011	.316
U4	.882	.901	–.359	1	–.030	.458	–.307	.057	.377
U5	–.287	–.285	–.819	–.030	1	–.737	–.922	–.343	–.801
U6	.773	.722	.637	.458	–.737	1	.436	–.162	.518
U7	–.092	–.077	.807	–.307	–.922	.436	1	.454	.709
U8	–.231	–.167	.011	.057	–.343	–.162	.454	1	.579
U9	.419	.490	.316	.377	–.801	.518	.709	.579	1

So, one of the ways to improve SC of an AC is to work on improving the motivation of employees.

5. APPROBATION OF THE PROPOSED SAFETY CULTURE METHOD IN AN AVIATION COMPANY

To test the developed SC model and its application method, a survey was conducted in a medium-sized Latvian aviation company. The method assumes that several aviation structural units are checked at the same time; both employees from the lowest level structure (subordinates) and the management group of these subordinates (management) are checked, as a result of which the survey data of both groups are compared and the compliance coefficient of the managers is calculated.

In order to simplify data processing and their graphical presentation, a special program based on Microsoft Excel was developed, the graphs of which are also presented in this section. The program also serves as an automated positive safety culture status assessment program that complements the airline's flight safety management information database.

5.1. Analysis of management team and employee survey data

According to the developed method, a survey of AC management and employees was conducted. From the group of managers, 19 specialists and 20 employees took part in the survey.

The degree of SC maturity in the company can be determined by the average indicators:

- from 1 to 1.8 (inclusive) – unsatisfactory level;
- from more than 1.8 to 2.6 (inclusive) – low level;
- from more than 2.6 to 3.4 (inclusive) – average level;
- from more than 3.4 to 4.2 (inclusive) – good level;
- from more than 4.2 to 5 (inclusive) – very good level.

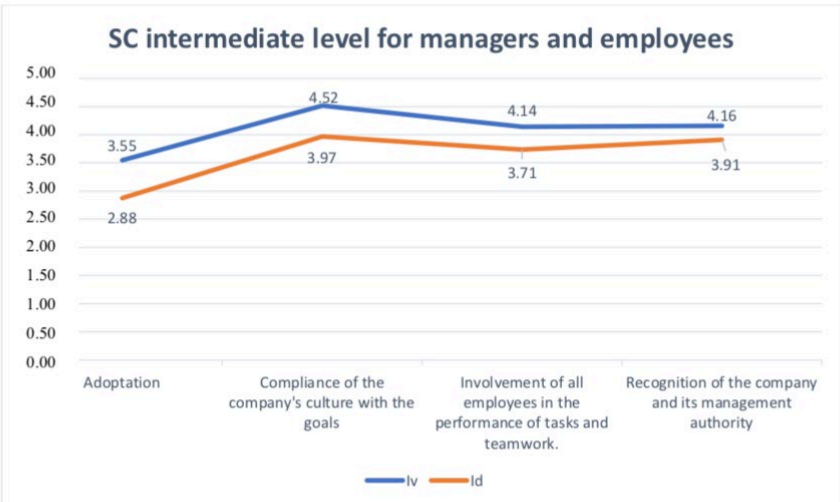

Fig. 5.1. Comparison of SC levels of managers and employees.

Figure 5.1 shows the graphs of average values of the groups analysed in the survey, which show different perceptions regarding the formulated SC indicators. The management group has a much higher assessment of the state of SC in the AC than the employees, which indicates a different perception of SC and possibly poor communication between the structural units.

The driving indicator is an important element that determines the opinion of the respondents about the progress of the implementation of the priority tasks regarding the improvement of the efficiency of the SC. Therefore, special attention should be paid to this issue. From the graph in Fig. 5.2 we can see that the curve has two drops, according to indicators A1 – value 6.3 and 5.1 and I1 – value 6.6 and 5.1. The graph shows two curves, where one of them is the assessment of managers and the other is the assessment of employees. The drops represent underperformance in adoption and integration in the chosen AGILE model. The given indicators are:

- A1 – the company has a suitable system for welcoming new employees, familiarizing them with work duties and starting work;
- I1 – the company's management sufficiently finances the purchase of modern equipment.

The fulfilment of these two indicators regarding the recruitment of new employees and the allocation of funding for the purchase of modern equipment is not sufficient. Accordingly, it shows that the company manager needs to pay more attention in practice to solve these issues.

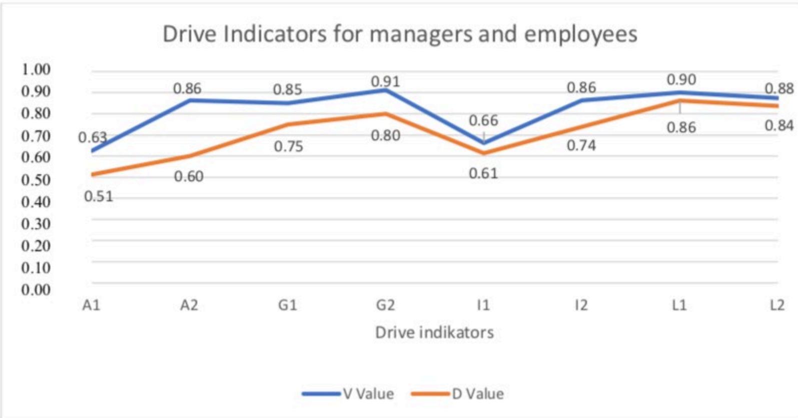

Fig. 5.2. Values of driving indicators for managers and employees.

5.2. Calculation of manager's compliance ratio

One of the advantages of the chosen method is that it is possible to establish inconsistency between management and lower-level specialists regarding the evaluation of SC in the company. Preliminary information on the difference of opinions was obtained by analysing the data of the two groups. Equation (4.4) determines the way this information is processed. Table 5.1 shows the average indicators of evaluation of managers and employee groups in corresponding blocks and the calculated coefficient of managers' compliance.

Table 5.1

Management Compliance Ratio

Characteristics of SC	I_v	I_d	K_{MC}
Adoption	3.55	2.88	0.13
Compliance of the company's culture with the goals	4.52	3.97	0.11
Involvement of all employees in the performance of tasks and teamwork	4.14	3.73	0.08
Recognition of the company and its management authority	4.16	3.91	0.05

A value of the coefficient exceeding the level of 0.1 indicates a difference of opinions in the defined area of SC evaluation. In our case, see Table 5.1, we can notice that in the adoption value block this coefficient of difference is 0.13, which indicates conflicting opinions between the surveyed groups. In that case, management decisions will face internal team resistance and all kinds of initiated transformations will be absolutely ineffective. It is necessary to work on a common understanding of the given issue in the company.

5.3. Expert assessment of safety culture priorities in the company

The examples given in the work on the improvement of SC in companies show that it ensures improvement of work efficiency in AC and correspondingly improves flight safety. We will use the expert assessment method to confirm this statement.

Currently, the most common expert methods are the ranking method, the direct evaluation method and the comparison method. The last one includes two types – pairwise comparison and sequential comparison. These methods have a lot in common, and the only difference is that the evaluation (measurement) of the studied system control objects is carried out in different ways.

In AC, information on deficiencies is accumulated and SC levelling is performed accordingly periodically. Therefore, it is possible for us to compare data over a certain period of time and thus determine whether the flight safety has improved.

Due to the fact that we use the SC model AGILE, the expert commission will be organized simultaneously to achieve several goals in order to:

- determine the future priorities of the AC based on this model;
- check the suitability of experts;
- provide an assessment of the interdependence of SC and flight safety;
- evaluate the usefulness of the AGILE model.

The number of experts was chosen from five employees and eight priorities in the development of the AC according to the four blocks of the model (adoption, goal achievement, latency, integration).

The experts are asked: "Arrange in order of priority the following basic elements of SC, which the AC leadership should pay attention to in the future". The selected list of SC priorities is as follows:

- process and technology automation;
- learning organization;
- clear understanding of the company's goals and values;
- unified strategic direction at all company levels and departments;
- effective communication between participants of work processes;
- assuming personal responsibility;
- desire to work and develop in the company;
- recognition of hierarchical principles of relations and subordination in the company.

Since the estimates of several experts in the table have related ranks (the same rank number), we will transform them. The ranks are created anew without changing the opinion of the expert, that is, the corresponding ratio (greater, smaller or equal) must be maintained between the rank numbers. It is also not recommended to set the rank above 1 and below a value equal to the number of parameters (n = 8 in this case). Reformation of degrees is carried out in Table 5.2.

Table 5.2

Summary of Revised Priorities

Priorities\Experts	**1**	**2**	**3**	**4**	**5**	**Sum of priorities**	**d**	**d^2**
1	2.5	1.5	1	1.5	1	7.5	–15	225
2	1	1.5	3	3	4	12.5	–10	100
3	2.5	3	2	1.5	2	11	–11.5	132.25
4	4	5	4	5	3	21	–1.5	2.25
5	6	7	6	7	6	32	9.5	90.25
6	7	6	7	6	8	34	11.5	132.25
7	8	8	8	8	7	39	16.5	272.25
8	5	4	5	4	5	23	0.5	0.25
Sum:	**36**	**36**	**36**	**36**	**36**	**180**		**954.5**

$$d = \sum x_{ij} - \frac{\sum\sum x_{ij}}{n} = \sum x_{ij} - 22.5, \qquad (5.1)$$

where d is algebraic difference and d^2 is difference squared.

Validation of table compilation is based on checksum calculation:

$$\sum x_{ij} = \frac{(1+n)n}{2} = \frac{(1+8)8}{2} = 36. \qquad (5.2)$$

In the next stage, we evaluate the average degree of agreement of all experts' opinions. The calculation is based on the Spearman's rank correlation method and Kendall's concordance coefficient method for the entire team of experts.

Let us use the concordance coefficient for the case where the ranks are related (one expert will estimate the same rank values):

$$W = \frac{S}{\frac{1}{12}m^2(n^3-n)-m\sum T_i}, \tag{5.3}$$

where $S = 954.5$; $n = 8$; $m = 5$.

$$T_i = \frac{1}{12}\sum(t_{L3} - t_l). \tag{5.4}$$

L_i is the number of links (types of repeating elements) in the estimates of the i^{th} expert, t_l is the number of elements in the lth link for the i^{th} expert (the number of repeating elements).

T_1 = [(23–2)]/12 = 0.5

T_2 = [(23–2)]/12 = 0.5

T_3 = [(23–2)]/12 = 0.5

$$\sum T_i = 0.5 + 0.5 + 0.5 = 1.5$$

$$W = \frac{954.5}{\frac{1}{12}5^2(8^3-8)-5\times1.5} = 0.915 \tag{5.5}$$

Further work with the expert group is desirable only if the concordance coefficient is greater than or equal to 0.70.

W = 0.915 indicates a high degree of expert consensus, so we can proceed to the next step, which involves quantifying the proportion of each priority type.

Based on obtaining the sum of priorities (Table 5.2), it is possible to calculate the weight indicators of the considered parameters. We transform the survey matrix into a transformed rank matrix using formula

$$S_{ij} = X_{\max} - X_{ij}, \tag{5.6}$$

where $X_{\max} = 8$.

Table 5.3

Matrix of Transformed Priorities

Priorities\ Experts	**1**	**2**	**3**	**4**	**5**	**Sum**	**%**
1	5	7	7	7	7	33	0.232
2	7	7	5	5	4	28	0.197
3	5	6	6	7	6	30	0.211
4	4	3	4	3	5	19	0.134
5	2	1	2	1	2	8	0.056
6	1	2	1	2	0	6	0.042
7	0	0	0	0	1	1	0.007
8	3	4	3	4	3	17	0.120
Sum:						**142**	**1**

Thanks to the obtained results, which are reflected in Table 5.3, we can conclude about the priorities of the selected experts in the future regarding SC issues in the AC, based on the adopted AGILE model. According to experts, in the future of the AC important attention should be paid to the following three priorities:

- automation of processes and technologies;
- a clear understanding of the company's goals and values;
- learning organization.

To determine the link between SC and flight safety in the AC, the same method should be used, comparing the detected deficiencies in the AC over a specified period of time, for example, a year.

5.4. The impact of positive safety culture measures on flight safety in an airline

One of the tasks of this paper is to determine the positive impact of SC on flight safety in the AC and to show the effectiveness of the selected AGILE method in improving SC. In this regard, in parallel with the measures to improve the efficiency of the SC, a data collection was carried out in the AC on non-conformities that were recorded in a two-year period. Non-conformities that occur in the AC are considered a risk factor that can lead to a serious accident, incident or disaster. Therefore, this type of information is collected through auditing and other types of assistance that are part of the quality management system. The task of the AC management is to work on the prevention of these accidents, where one of the most important components is the improvement of SC.

All available information was given to the AC expert group, selected as described in Section 5.3. A pairwise comparison method was used, which allows experts to gather information and determine the final result.

After receiving the paired comparison questionnaires from the experts, the results were summarized in Table 5.4.

The following information has been processed to receive transparent information, which is represented as a percentage. Table 5.5 shows the final result, which gives an expert opinion on the improvement of flight safety during the year.

Table 5.4

Survey of Pairwise Comparison Summary

Year	**Decision**	**Improved**	**No changes**	**It got worse**	**Sum**
2019	Improved	*	421	482	903
	No changes	79	*	490	569
	It got worse	18	10	*	28
Total:					1500

Table 5.5

Expert Assessment of Flight Safety

Decision	**Decision values**	
	Parts of values	**Percentage**
Improved	903/1500 = 0.602	60.2
No changes	569/1500 = 0.379	37.9
It got worse	28/1500 = 0.0186	1.9

As can be seen, 60.2 % of experts believe that flight safety in the AC has improved, which indicates a good success in using the method. However, it is necessary to repeat that improving the SC level in the AC is only one of the components and it cannot improve flight safety if the other conditions mentioned in this work are not met.

5.5. Approbation summary

The selected AGILE model and the method to be used in the area of the selected indicators pointed to existing shortcomings in the safety culture of the AC. The main ones are the following:

- The SC level in the company is good. According to the results of the survey, 77 % of the management group and 68 % of the employee group rate it as average or higher. However, the leadership of the AC needs to pay more attention to the following areas:
  - personnel recruitment;
  - implementation of new technological solutions at work.
- The survey and data analysis revealed a difference of opinions between the management group and the lower-level specialists, which indicates insufficient communication in the

relevant areas. These areas are also more related to the recruitment and new technologies.

- The low level of progress indicators (SC coefficient of 0.51 and 0.61 in the employee survey corresponds to average achievements) indicates shortcomings in the implementation of previously accepted priorities.
- A comparison between the compliance of Hudson's SC levels (recommended by EASA) with a certain coefficient of the model shows a coincidence that makes it possible to use the recommendations developed by EASA regarding the improvement of SC efficiency (see Appendix 4).
- Thanks to the expert method, the main priorities of the AC management work in the next period have been determined, where the main attention should be devoted to:
  - automation of processes and technologies;
  - a clear understanding of the company's goals and values, and training organization.
- 60 % of evaluators determined that the SC at the AC improved during the reporting period, which also corresponds to an improvement in flight safety.
- Thanks to the available information on accidents in the AC, it is possible to trace the state of flight safety and thus control the effectiveness of the SC methods.

CONCLUSIONS

In the course of the work, all the tasks that were defined at the beginning were fulfilled. The main ones are:

- An analysis of the dynamics of airline flight safety assurance approaches was carried out.
- The importance of a positive SC as a new stage in air transport flight safety has been confirmed.
- An analysis of the characteristics of the regulatory documents of different levels of international CA organizations on the issue of positive SC was carried out.
- An analysis of the methods and means of positive SC formation and efficiency evaluation in the aviation, atomic energy and railway industries is given.
- Nowadays, when the reliability of aviation equipment is very high, one of the weakest points in its safe operation and use is the human factor and the SC of airlines. This fact must be considered within the framework of all AC structural units, because all the basic elements of the IMS can be the reason for causing accidents. The Thesis provides justification for a positive SC as a component of the AC PPT system.
- A mathematical model of SC as a risk factor has been developed.
- Methodology for SC level evaluation in relation to flight safety has been developed.
- A model for assessing the company's positive safety culture based on the principles of the AGILE system has been developed. The proposed method makes it possible to determine the discrepancy in the perception of the state of SC between employees and management and provides an overview of existing shortcomings in the SC of the airline.
- The automated program for assessing the state of positive safety culture has been developed, which complements the airline's flight safety management information database.
- Approbation of the methods and model was carried out in the Latvian airline company.

Abbreviations used in the Thesis

AC	*Aviation Company*
ASC IT	*Aviation Safety Culture Inquiry Tool*
CA	*Civilian Aviation*
CAA	*Civil Aviation Agency*
CANSO	*The Civil Air Navigation Services Organisation*
EASA	*European Aviation Safety Agency*
EPAS	*European Plan for Aviation Safety*
GASP	*Global Aviation Safety Plan*
AP	*airplane*
FAA	*Federal Aviation Administration*
FAR	*Federal Aviation Requirements*
FAST	*Future Aviation Safety Team*
IATA	*International Air Transport Association*
ICAO	*International Civil Aviation Organization*
IMS	*Integrated Management System*
IOSA	*IATA Operational Safety Audit*
ISO	*International Standard Organisation*
JAA	*Joint Aviation Authority*
QMS	*Quality Management System*
OPC	*IATA Operational Committee*
SC	*Safety Culture*
SMM	*Safety Management Manual*
SMS	*Safety Management System*
SPAS	*State Programme of Aviation Safety*
SPSS	*IBM Statistical Package for the Social Sciences*
SSP	*State Safety Plan*
USOP	*Universal Safety Oversight Audit Programme*

Juris Maklakovs was born in 1964 in the Nukši village, Ludza district. In 1992 he received a Master's degree in Radio Engineering from the Moscow Academy of Military Aviation Engineers. After graduation, until 2004, he served at the National Defence Academy of Latvia. From 2004 to 2006, he served in the Latvian Air Force and from 2006 until 2010, was the Chief of Defence of the National Armed Forces. From 2011 until 2019, he was the Latvian Ambassador to Kazakhstan and Azerbaijan. During his service he graduated from the US Army War College. His scientific interests are related to aviation safety, organizational culture, human factor, and risk management.