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Факультет аеронавігації, електроніки та телекомунікацій
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ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри АНС
д-р техн. наук, проф.
_____ Ларін В.Ю.
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ДИПЛОМНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «МАГІСТР»
за освітньо-професійною програмою
«ОБСЛУГОВУВАННЯ ПОВІТРЯНОГО РУХУ»

Тема:

АВТОМАТИЗАЦІЯ ПРОЦЕСУ ОЦІНКИ РИЗИКІВ В АВІАЦІЙНІЙ СИСТЕМІ

Виконавець: Грабова Ірина Олегівна
Керівник: Богуненко Микола Миколайович
Нормоконтролер Аргунов Геннадій Федорович

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НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет аеронавігації, електроніки та телекомунікацій

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Завідувач кафедри АНС

_____В.Ю. Ларін

«____»_____ 2023 р.

ЗАВДАННЯ

на виконання дипломної роботи

Грабової Ірини Олегівни

1. *Тема дипломної роботи*: **«Автоматизація процесу оцінки ризиків в авіаційній системі»** від 22.08.2023 № 1443//ст

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4. *Зміст пояснювальної записки:* основи та складові Системи Управління Безпекою Польотів, Управління ризиками, ідентифікація загроз та оцінка ризиків, ux ui методології, дизайн інтерфейсу для автоматизованої оцінки ризиків.

5. *Перелік обов'язкового графічного (ілюстративного) матеріалу:* рисунки, таблиці

6. Календарний план-графік

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3.	Підготовка та написання 3 розділу «Частина дослідження та прототипування дизайну інтерфейсу інструменту для оцінки ризиків»	17.11.23-27.11.23	виконано
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Керівник дипломної роботи _____ __Богуненко Микола Миколайович

(підпис керівника) (прізвище, ім’я, по батькові)

Завдання прийняла до виконання _____ Грабова Ірина Олегівна

(підпис студента) (прізвище, ім’я, по батькові

MINISTRY OF EDUCATION AND SCIENCE, OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Faculty of Air navigation, Electronics and Telecommunication
Air Navigation System Department

PERMISSION TO DEFEND
GRANTED
Head of the Department
_____V.Y. Larin
“__”_____2023

MASTER’S DEGREE THESIS

Theme:

“AUTOMATION OF RISK ASSESSMENT PROCESSES IN AVIATION SYSTEM”

Completed by: Hrabova I.O.
Supervisor: Bogunenko M.M.

Standarts Inspector: Argunov H.F.

Kyiv 2023

NATIONAL AVIATION UNIVERSITY

Faculty of Air navigation, Electronics and Telecommunication

Air Navigation Systems Department

Specialty: 272 “Aviation transport”

APPROVED BY

Head of the Department

_____ V.Yu. Larin

“__”_____2023

Graduate Student’s Degree Thesis Assignment

Iryna Hrabova

1. *The Project topic:* “Automation of risk assessment processes in aviation system” approved by the Rector’s order of 22.08.2023 № 1443/st.

2. *The Project to be completed between:* 23.10.2023 – 31.12.2023.

3. *Initial data to the project:* guiding documents of the International Civil Aviation Organization and national documents in the field of flight safety.

4 *The content of the explanatory note (the list of problems to be considered):* Safety Management System parts and basics, Safety Risk Management, Hazards Identification and risk assessment, ux ui methodologies, interface design for automated risk assessment processes.

5. *The list of mandatory graphic (illustrated) materials:* figures, tables.

6. Calendar timetable

№	Completion stages of Degree Project	Stage completion dates	Remarks
1	Preparation of chapter 1: “General familiarization with SMS processes”	23.10.23-03.11.23	completed
2	Preparation of chapter 2: “Investigation of requirements and methodology for development”	04.11.23-15.11.23	completed
3	Preparation of chapter 3: “Research part and prototyping of risk assessment tool interface design”	17.11.23-27.11.23	completed
4	Preparation of chapter 4: “Interface design realization of service for risk assessment processes and guidance material for users”	28.11.23-05.12.23	completed
6	Preparation of chapter 5: “Labor precaution and environment safety”	06.12.23-15.12.23	completed
7	Preparation of report and graphic materials	17.12.23-25.12.23	completed

7. Assignment accepted for completion “23” October 2023

Supervisor_____M.M. Bogunenko

Assignment accepted for completion _____I.O. Hrabova

ABSTRACT

Explanatory note to the master's thesis, " Automation of risk assessment processes in aviation system ": 125 pages, 47 figures, 2 tables, 13 references.

OBJECT OF RESEARCH: Safety Management System performance of airline

SUBJECT OF RESEARCH: Risk assessment as an element of Safety Management System of airline

PURPOSE: risk assessment software interface design development of air company safety management system performance

INVESTIGATION METHOD: analysis, investigation, research, survey, interview, processing and comparison, studying documents.

RELEVANCE: Safety is paramount in the aviation industry. Automation allows real-time monitoring and assessment of risks. In a dynamic industry like aviation, the ability to identify and respond to risks promptly is crucial for preventing incidents and ensuring the continuous safety of operations.

Automation enables the collection and analysis of vast amounts of data. This data-driven approach enhances decision-making processes by providing insights into trends, potential risks, and the effectiveness of risk mitigation strategies.

Automated risk assessments can optimize resource allocation by focusing attention on high-priority risks. This ensures that resources are directed where they are most needed, contributing to operational efficiency and cost-effectiveness.

Automation allows for the integration of predictive analytics, enabling organizations to forecast potential risks based on historical data and emerging trends. This proactive approach enhances preparedness and risk prevention.

Aviation systems often involve collaboration with multiple stakeholders globally, automated risk assessment processes provide a standardized and efficient means of communication and coordination across diverse entities.

NOTES

CONTENTS

ABBREVIATIONS

AOC Air operator certificate

ATS Air traffic service(s)

CAA Civil aviation authority

CVR Cockpit voice recorder

Doc Document

ERP Emergency response plan

FDA Flight data analysis

FDR Flight data recorder

OSHE Occupational Safety, Health and Environment

SAG Safety action group

SMM Safety management manual

SMS Safety management system(s)

SPI Safety performance indicator

SPT Safety performance target

SRM Safety risk management

UX User Experience

UI User Interface

IA Informational Architecture

MVP Minimum Viable Product

INTRODUCTION

Ensuring operational safety is critical in the dynamic and safety-sensitive field of aviation. Safety Management Systems (SMS) are the cornerstone of aviation service providers' (especially airlines') global commitment to maintaining the highest safety standards. A crucial component of SMS is the methodical evaluation and handling of risks, which necessitates close attention to detail and flexibility in response to the changing aviation environment. With an emphasis on meeting the particular needs of airlines, this thesis undertakes a thorough investigation of the complex field of risk assessment within SMS.

The overall goals of this study include three very important aspects. First and foremost, the foundation for comprehending the complex web of risk assessment within SMS is a thorough investigation into current laws, papers, procedures, and best practices. The goal of this investigation is to clarify the complex relationships between global safety regulations and the practical challenges airlines face in maintaining a constant commitment to the safety of both passengers and crew.

Second, this research explores the technological landscape by carefully examining instruments and solutions intended to automate risk assessment procedures. A variety of software programs serving this field are examined in order to reveal the potential they possess for enhancing the effectiveness and precision of risk management initiatives in the aviation industry.

Thirdly, this research aims to create an interface design solution that is specifically customized to the distinct workflows of airlines, all the while keeping a close eye on the end-user experience. The goal is to develop an intuitive and user-friendly platform that seamlessly integrates with current processes, easing the complexities of risk assessment for aviation professionals. This is done through the lens of UX/UI design methodologies.

The methodological approach incorporates regulatory analyses, literature reviews, and practical investigation of technological solutions. Figma is a powerful tool used in the design and development phase to create an interface that improves the usability and efficacy of risk assessment processes while also complying with industry

standards.

The story will come to light as we read through the upcoming chapters, highlighting the revelations, difficulties, and possible paradigm changes that the proposed interface design solution has brought forth. This research aims to contribute to the ongoing evolution of SMS, fostering a more resilient and safe aviation landscape. It is based on the complex dance of regulations, technology, and user-centric design.

The fundamental idea remains anchored in the cooperation of technological advancement, human-centered design principles, and regulatory compliance as we set out on this investigation. The following chapters will cover interface design principles, technology tools, and safety methodologies, all of which are geared toward improving the usability and effectiveness of risk assessment in the aviation industry. With our combined efforts, we hope to not only meet the strict requirements of safety protocols but also to usher in a new era in which safety is ingrained in the aviation ethos rather than merely being a compliance requirement.

1. GENERAL FAMILIARIZATION WITH SMS PROCESSES

1.1 History and basic models of SMS

1.1.1. Development of the system

Aviation industry is a huge multilayered system which involves vast number of employees all over the world and all of them are important cells of joint organism. Performance of maintenance staff, apron driver, pilot or air traffic controller can influence safety of flights as well as operation of airline's office staff. It is obvious that the impact would be different but it can not be denied that all of system participants affect the process and minor mistake that was not noticed on initial levels under "favourable" circumstances could lead to serious hazards in the future. To forestall potential occurrences which constitute a threat, aviation experts developed and constantly improve Safety Management System. Since every system that involves engagement of human, technology (equipment) and environment and human – human collaboration is potentially dicey there should have been presented means of regulation of interaction between participants to establish rules, procedures, instructions, mitigation actions to prevent or cope with risks. Such a system was created and its main requirements and postulates were described in correspondent documents of ICAO and later other international organizations which regulate transport operations. Unfortunately, many rules and innovations were established after tragic catastrophes, because only serious occurrences bared gaps and shortcomings of existing procedures, rules, patterns, technical permissions and cooperation of involved specialists.

Safety Managements System (SMS) according to Annex 19 – Safety Management is composed of four components and twelve elements:

a) Safety policy and objectives
    1) Management commitment and responsibility
    2) Safety accountabilities
    3) Appointment of key safety personnel
    4) Coordination of emergency response planning
    5) SMS documentation

b) Safety risk management
    1) Hazard identification
    2) Safety risk assessment and mitigation
c) Safety assurance
    1) Safety performance monitoring and measurement
    2) The management of change
    3) Continuous improvement of the SMS
d) Safety promotion
    1) Training and education
    2) Safety communication [1]

This set of components and elements embodies a framework for any aviation establishment and is a minimum requirement for SMS. This project gives only general overview on the whole SMS and focuses on safety risk management issues.

SMS general overview for familiarization with its structure and main demands for processes and performance. Further described fundamentals are significant to figure out before focusing on the peculiarities of safety management.

Aviation is a complex system which includes different functional subsystems such as environment, commerce, security and safety. It is important to understand the distinctions between last two aspects. Indeed, they have similar concerns and associated with risk of occurrences of varying severity. The difference is that security focuses on events that were caused intentionally with the aim of disrupting the performance, while safety relates to occurrences that were unintended outcomes of a set of reasons.

In order to decrease any negative consequences generated by all of the subsystems, risks should be properly controlled. Typically, every subsystem came up with approach to risk management with respect to its peculiarities.

The objective of efficient risk management in aviation system is reduction of risks within the system. To achieve this goal analytical estimation of the whole system is necessary at the highest level of correspondent institution (State, regional organizations, service providers). The assessment and incorporation of subsystems

needs and mutual dependence are referred to as integrated risk management – IRM. IRM concentrates on the general risk reduction of the establishment. Efficiency and influence of sectoral risk management processes as well as intrinsic risks are subjects for qualitative and quantitative analysis, which is the way to accomplish IRM purpose. IRM is a distinctive high-level concept to engage the expert advice of specific with respect to the sector risk management and grant comprehensive feedback to reach the highest level of system performance at a socially acceptable level.

The definition of safety with respect to the studied field is determined as “the state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level”.[2]

Flight safety is ever-changing. There are always new risks and safety hazards to be aware of and addressed. A system as dynamic and open as aviation can be made safe as long as safety risks are managed to an appropriate degree. It is significant to remember that national and international norms and cultures frequently define and have an impact on acceptable safety performance.

There are four approaches to characterize the progress in aviation safety, and they roughly correspond to different eras of activity:

- Technical factors and technological failures were the initial cause of identified safety deficiencies in aviation, which emerged as a mode of mass transportation from the early 1900s until the late 1960s. Therefore, the investigation and improvement of technical factors (such as the aircraft) became the primary focus of safety endeavors. By the 1950s, advances in technology had gradually reduced the number of accidents, and safety procedures had expanded to include oversight and regulatory compliance.
- Human factors: By the early 1970s, significant technological advancements and improved safety regulations had resulted in a significant decrease in the frequency of aviation accidents. The focus of safety efforts was expanded to include human factors, such as the "man/machine interface," and aviation became a safer means of transportation. Human factors are still mentioned as a contributing factor in accidents even after resources have

been allocated towards error mitigation. Human factors have a tendency to overlook the organizational and operational context in favor of the individual.

- Organizational: In the middle of the 1990s, safety started to be seen from a systemic angle, taking into account not only human and technical factors but also organizational factors. An "organizational accident" was proposed as a concept. This viewpoint took into account how organizational culture and policies affected the efficacy of safety risk controls, among other things.
- Whole system. Many States and service providers adopted the safety practices of the past at the start of the twenty-first century and advanced to a higher level of safety maturity. They are starting to use SMSs and get safety benefits. Nowadays, safety systems have paid little attention to the larger context of the entire aviation system, instead concentrating primarily on local control and individual safety performance. As a result, the intricacy of the aviation system and the various organizations involved in aviation safety are becoming increasingly apparent. Numerous incidents and accidents demonstrate how the interfaces between organizations have influenced unfavorable results.

States and service providers are now seriously considering the interactions and interfaces between people, processes, and technologies—the system's constituent parts—due to the steady and compounding evolution of safety. People now recognize more fully the beneficial role they play in the system as a result of this. Collaboration between service providers and between service providers and States improves safety. This viewpoint has fostered numerous cooperative efforts amongst service providers and an understanding of the advantages of teamwork in resolving safety-related concerns.

The way individuals view their roles in safety and collaborate with others to accomplish tasks at work has a big impact on how well their organization performs in terms of safety. Managing safety requires taking into account the ways in which

individuals influence organizational safety, both favorably and unfavorably. Understanding people's interactions with the outside world, their strengths and weaknesses, and how to influence human behavior to enhance job performance are all aspects of human factors. Because of this, taking human factors into account is essential to safety management. It is required to comprehend, identify, and reduce risks as well as to maximize the contributions made by people to organizational safety.

1.1.2. SHELL Model

Several models have been developed to facilitate the evaluation of the impact of human factors on safety performance. The SHELL Model is a well-known and helpful tool for illustrating how various system components affect and interact with humans. It highlights the necessity of taking human factors into account as an integrated component of SRM.

There are four satellite components in the SHELL Model:

- Software (S) refers to policies, instructions, help, etc.;
- Hardware (H) refers to tools and machinery;
- Environment (E): the operational setting in which the L-H-S system as a whole must operate; and
- Liveware (L) refers to other individuals present at work.

a) L-H, or liveware-hardware. The relationship between a person and the physical characteristics of machinery, equipment, and facilities is referred to as the L-H interface. This takes into account the ergonomics of staff using the equipment, the way safety data is presented, and the logical and intuitive labeling and operation of switches and operating levers.

b) L-S (Liveware-Software). The interaction between a person and the workplace's supporting systems, such as policies, guidelines, computer software, checklists, publications, and processes and procedures, is known as the L-S interface. It covers things like recent experience, accuracy, presentation and format, vocabulary, clarity, and symbol usage. L-S takes into account how simple it is to follow and comprehend the processes and procedures.

c) L-L Liveware-Liveware. The relationships and interactions that people have in their workplace constitute the L-L interface. While some of these interactions take place between coworkers, managers, and supervisors within the organization, many of them involve people in different roles from different organizations (air traffic controllers with pilots, pilots with engineers, etc.). It takes into account how crucial interpersonal and communication skills are, in addition to group dynamics, in influencing human performance. Organizational culture and the relationships between staff and management are also covered by this interface.

d) L-E, or Liveware-Environment. The interaction between the physical environment and humans is the subject of this interface. This covers elements like air quality, noise, vibration, temperature, and ambient light. It also takes into account external environmental elements like terrain, weather, and infrastructure.

1.1.3. "Swiss-Cheese" (or Reason) Model

The aviation industry is familiar with Professor James Reason's "Swiss-Cheese" (or Reason) Model, which demonstrates how multiple defenses are successively breached in an accident. Equipment malfunctions or operational mistakes are just two examples of the enabling factors that can lead to these breaches. According to the Swiss-Cheese Model, layers of defenses, or "barriers," incredibly well-defend complex systems like aviation. Seldom is a single-point failure significant.

Decisions made at higher levels of the organization may have a delayed effect on breaches in safety defenses. These decisions may lie dormant until specific operating conditions (referred to as latent conditions) trigger their effects or harmful potential. Human errors (also referred to as "active failures") at the operational level can compromise the last lines of safety defense in certain situations. According to the Reason Model, every accident involves a mix of latent conditions and active failures. Errors and rule-breaking are examples of active failures—actions or inactions that have an immediate negative impact. With the benefit of hindsight, they are seen as dangerous actions. Active failures can have detrimental effects and are linked to front-line staff members such as pilots, air traffic controllers, and aircraft maintenance engineers.

The system may have latent conditions long before a negative consequence occurs. Latent condition effects could take a very long time to manifest. These latent conditions are not thought to be harmful at first, but in some situations, they might become evident if the operational level defenses are compromised. People who are geographically and temporally far from the event may produce these circumstances. Latent conditions in the system can be brought about by management decisions, conflicting organizational goals, flawed organizational systems, equipment selections or procedural design, safety culture, or other factors.

In order to reduce active failures by individuals, the "organizational accident" paradigm helps by identifying these latent conditions on a system-wide basis as opposed to through localized efforts. Most importantly, latent conditions were intentionally created. Decision-makers in organizations frequently have to weigh competing priorities and costs against limited resources. Daily decisions made by decision makers in large organizations may, under certain conditions, unintentionally have a negative effect.

The Swiss-Cheese Model helps explain how managerial and organizational factors interact to cause accidents, as shown in Figure 1.1. The aviation system has several defensive layers in place to guard against variations in human decision-making or performance at all organizational levels. But as the holes in the "Swiss cheese" slices illustrate, every layer usually has flaws. Occasionally, every weakness lines up (as indicated by the lined holes), creating a breach that gets past all defenses and could have disastrous consequences. The Swiss-Cheese Model illustrates how latent conditions can materialize through local trigger factors and are always present within the system.

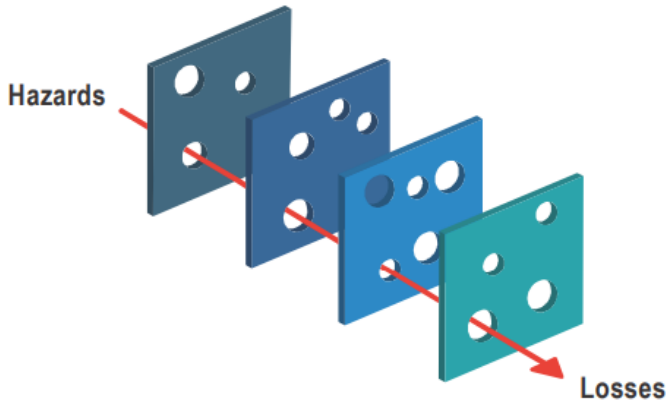


Figure 1.1 – Concept of accident causation

It is crucial to understand that an interacting organization may have an impact on some defenses or breaches. Thus, it is imperative that service providers evaluate and oversee these interfaces.

By focusing on the organizational conditions that may have enabled the situation to arise rather than just the people involved in an incident or recognized hazard, the "Swiss-Cheese" Model can be utilized as an analysis tool by both States and service providers. It can be used for safety monitoring, change management, internal auditing, safety investigation, and SRM. The model can be applied in each situation to evaluate which defenses the organization has in place are effective, which can or have been breached, and where more defenses would strengthen the system. Any defenses that are found to be weak can then be strengthened to prevent similar mishaps and incidents in the future.

1.1.4. Practical drift

Understanding how a system's performance "drifts away" from its original design is possible through the application of Scott A. Snook's theory of practical drift. Equipment, processes, and tasks are frequently first planned and designed in theoretical settings, under ideal circumstances, with the implicit assumption that almost everything can be anticipated and controlled and that everything will work as it should.

This is typically predicated on three main tenets:

a) the technology required to meet system production objectives is accessible;

b) the staff is qualified, capable, and driven to use the technology as intended;

c) System and human behavior will be determined by policies and procedures.

The baseline (or ideal) system performance is based on these assumptions and is represented graphically as a straight line from the beginning of operational deployment, as seen in Figure 1.2

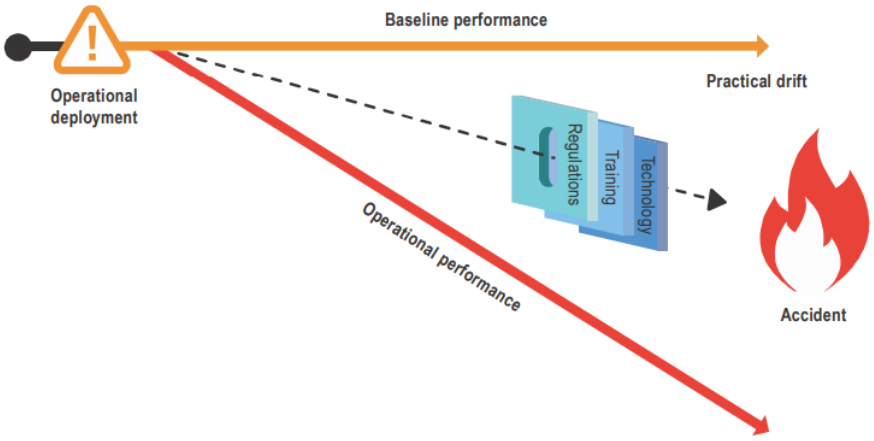


Figure 1.2 – Concept of practical drift

When the system is put into operation, it should ideally function as intended, most of the time adhering to baseline performance (orange line). As a result of real-life operations in a complex, dynamic, and typically demanding environment, operational performance in reality frequently deviates from the assumed baseline performance (red line). The drift is called a "practical drift" because it results from regular practice. In this context, "drift" refers to the gradual veering off of a planned path as a result of outside influences.

Snook argues that regardless of how meticulous and well-planned a system is, practical drift will always occur. The following are some of the causes of the practical drift:

a) technology that performs differently than expected;

b) processes that, in certain operational circumstances, cannot be carried out as intended;

c) modifications to the system, such as the addition of new parts;

d) communication with external systems;

e) a culture of safety;

In actuality, people will typically apply personal strategies and local adaptations (or workarounds) to make the system function on a daily basis despite its flaws. The safety risk controls and defenses that are currently in place may be circumvented by these workarounds. Audits, observations, and SPI monitoring are examples of safety assurance procedures that can be used to identify practices that are "practically

drifting." Reducing the safety risks involves analyzing the safety data to determine the cause of the drift. It is easier for the organization to step in when practical drift is discovered closer to the start of the operational deployment.

1.1.5. Management dilemma

There is a connection between production/profitability and safety risks in any organization that provides services. To remain in operation, a company must balance acceptable safety risks (as well as the costs associated with putting safety risk controls in place) with output in order to maintain profitability. Typical safety risk controls consist of processes, procedures, technology, and training. Similar safety risk controls apply to the State, including employee training, proper technology use, efficient supervision, and internal processes and procedures that facilitate oversight. The cost of implementing safety risk controls is money, time, and resources. Generally, the goal of safety risk controls is to improve safety performance rather than production performance.

Nonetheless, by lowering accidents and incidents and the expenses that come with them, certain investments in "protection" can also increase "production." The zone where an organization strikes a balance between required safety protection through safety risk controls and desired production/profitability is referred to as the "safety space." A service provider might want to spend money on new equipment, for instance. Along with the necessary increases in efficiency, the new equipment may also offer better performance in terms of reliability and safety. When making such decisions, the organization's benefits and the associated safety risks are evaluated. The organization's sustainability may be at risk if excessive resources are dedicated to safety risk controls, making the activity unprofitable.

The bounds of the safety space within an organization are shown in Figure 1.3.

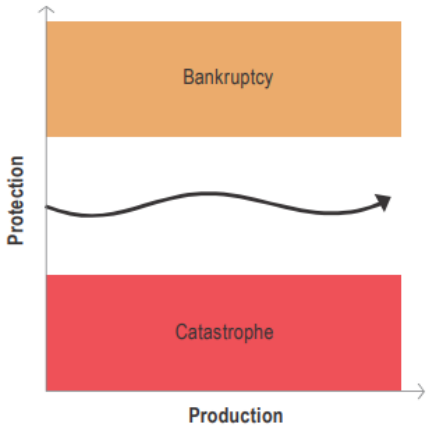


Figure 1.3 – Concept of a safety space

From the standpoint of a service provider, the necessity to strike a balance between production and protection, or profitability and safety, has become widely recognized and understood.

1.2. SRM processes overview

1.2.1. Safety risk management

Hazard identification, safety risk assessment, safety risk mitigation, and risk acceptance are all included in safety risk management (SRM), which is a crucial part of safety management. Because of the ongoing changes in the aviation system, potential introduction of new hazards, and potential evolution of existing hazards and related safety risks, SRM is a continuous activity. Furthermore, it is imperative to oversee the efficacy of executed safety risk mitigation tactics in order to ascertain the necessity for additional measures.

In the context of aviation, a hazard is any potential harm that is present in the system or its surroundings but is dormant. This risk can manifest itself in a variety of ways, such as a natural feature (like the terrain) or a technological state (like runway markings).

Although hazards are an unavoidable aspect of aviation operations, their manifestation and potential negative effects can be managed through risk mitigation strategies that work to reduce the likelihood that the hazard will result in an unsafe situation. As long as risks are managed, aviation can coexist with them. The SRM

process begins with the identification of hazards. It comes before a safety risk assessment and necessitates a thorough comprehension of the dangers and the associated fallout. The focus of hazard identification is on circumstances or items that may lead to or exacerbate the unsafe operation of aircraft or aviation safety-related machinery, supplies, or services.

Upon defining the hazard precisely, potential consequences are easier to recognize. A hazard's potentially harmful effects may manifest in one or more ways. It is critical that safety risk assessments list every potential outcome.

The consequences' description will guide the risk assessment, which will then guide the creation and application of mitigations through resource allocation and prioritization. A more accurate assessment of safety risks will result from a detailed and comprehensive identification of hazards.

There are risks in the company at every level, and they can be found using a variety of methods such as reporting systems, audits, inspections, brainstorming sessions, and professional judgment. The intention is to proactively detect risks before they cause mishaps, incidents, or other events pertaining to safety. A voluntary safety reporting system is a crucial tool for proactive hazard identification. Observations or conclusions made during regular site inspections or organizational audits may be added to the data gathered through such reporting systems.

Examining or analyzing investigation reports from both internal and external sources can also reveal potential hazards. This is especially crucial in small organizations with few events or reports, or when the safety culture of the company is still developing and cannot support efficient voluntary safety reporting. External sources like the ICAO, trade associations, or other international bodies are significant sources of particular hazards related to operations and activities.

Risk identification may also take into account externally generated risks and risks that are not directly under the organization's control, such as severe weather or volcanic ash. Organizations can also benefit from knowing about emerging safety risks in order to better prepare for potential future events.

1.2.2. Hazard identification methodologies.

There are two primary approaches to identifying hazards:

a) Reactive. Analysis of previous results or occurrences is a part of this methodology. Through the investigation of safety incidents, hazards are found. Accidents and incidents can be used to identify the hazard or hazards that contributed to the event because they are a sign of system flaws.
b) Proactive. In order to ascertain whether a hazard has the potential to cause an accident or incident, this methodology entails gathering safety data of less serious events or process performance and analyzing the safety information or frequency of occurrence. Safety reporting systems, the safety assurance function, and flight data analysis (FDA) programs are the main sources of safety information used in proactive hazard identification.

Hazards related to SMS interaction with external organizations.

Companies must also determine the risks associated with their safety management interfaces. Whenever feasible, this should be done in tandem with the organizations that will be interacting with each other. The operational environment and the different organizational capabilities (people, processes, technologies) that could support the safe delivery of the service or product's availability, functionality, or performance should be taken into account during the hazard identification process.

For instance, numerous organizations and operational staff members work inside and around an aircraft during an aircraft turnaround. The interfaces between operational staff, their tools, and the turnaround activity's coordination are probably going to present some risks.

1.2.3. Safety risk estimation

Probability of safety risk

The probability of a safety consequence or outcome occurring is known as the safety risk. To take into account all possible outcomes, it is crucial to envision a range of scenarios.

When estimating the likelihood of the hazard consequences in any foreseeable scenario, it is helpful to take into account any potential contributing factors to these questions.

If a reasonable person could have predicted that a particular kind of event would have occurred given the same conditions, the occurrence is deemed foreseeable. It is impossible to identify every conceivable or theoretically possible risk. Consequently, choosing the proper level of detail in hazard identification requires judgment. When identifying significant and reasonably foreseeable hazards related to their product or service, service providers should take reasonable precautions. A typical safety risk probability classification table is shown in Table 1.1. It has five categories to indicate the likelihood of an unsafe situation or event, along with a description, a value, and an assignment to each category. In order to provide a more accurate assessment, quantitative terms that are used in this example could be defined. This will rely on the organization and operation's level of sophistication as well as the accessibility of pertinent safety data.

Table 1.1 – Safety risk probability table

Likelihood	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

Safety risk severity.

After the probability assessment is finished, the severity of the hazard must be evaluated while accounting for any possible repercussions. The degree of harm that could reasonably be anticipated to happen as a result of the identified hazard is known as the safety risk severity. The following factors should be taken into account when classifying the severity:

a) fatalities or major injuries that could result from:
    1) being in the aircraft;
    2) coming into close contact with any component of the aircraft, even those that have come loose; or
    3) being in close proximity to a jet blast; and

b) Damage:

1) Any harm or structural failure to the aircraft that:
    i. degrades the aircraft's structural integrity, performance, or flying characteristics;
    ii. would typically need the damaged component to be replaced or undergo major repair;
2) harm done to aerodrome or ATS equipment that includes:
    i) has a negative impact on aircraft separation management; or
    ii) negatively impacts the ability to land

The worst-case scenario should be taken into account when evaluating the severity of a hazard, along with all potential outcomes. A typical table of safety risk severity is shown in Table 1.2. It has five categories to indicate the degree of severity, along with a description and a value assigned to each category. Similar to the probability table for safety risks, this table is merely an example.

Table 1.2 – Example safety risk severity

Severity	Meaning	Value
Catastrophic	Aircraft/equipment destroyed/multiple death	A
Hazardous	Serious injury/major equipment damage	B
Major	Serious incident/Injury to persons	C
Minor	Minor incident/operating limitations/nuisance	D
Negligible	Few consequences	E

Safety risk tolerability.

The probability and severity scores are combined to create the safety risk index rating. That is an alphanumeric designator in the example above. Figure 1.4 displays the corresponding combinations of severity and probability in the safety risk assessment matrix. Safety risk tolerability is ascertained using the safety risk assessment matrix.

Safety Risk		*Severity*				
Probability		*Catastrophic A*	*Hazardous B*	*Major C*	*Minor D*	*Negligible E*
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely improbable	1	1A	1B	1C	1D	1E

Figure 1.4 – Example safety risk matrix

After that, the safety risk assessment matrix's index should be exported to a safety risk tolerability table, which will provide a narrative description of the organization's tolerability standards. An illustration of a safety risk tolerability table is shown in Figure 1.5.

Safety Risk Index Range	*Safety Risk Description*	*Recommended Action*
5A, 5B, 5C, 4A, 4B, 3A	INTOLERABLE	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
3E, 2D, 2E, 1B, 1C, 1D, 1E	ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.

Figure 1.5 – Example of safety risk tolerability

Conceptually, safety risks are categorized as acceptable, tolerable, or intolerable. Under no circumstances are safety risks that are first determined to be in the intolerable range acceptable. Because the likelihood and/or severity of the hazards' effects are so great and because they have the potential to be so dangerous for people's safety, either mitigation measures or the cessation of operations are necessary.

Safety risk mitigation strategies.

One common term for safety risk mitigation is safety risk control. By applying the proper safety risk controls and mitigating the risk, safety risks should be controlled to an acceptable level. This needs to be weighed against the time, expense, and difficulty of reducing or eliminating the safety risk. Reducing exposure to the safety

risk, lessening the possibility of it happening, or lessening the severity of the possible outcomes can all help to reduce the level of risk. Reducing the likelihood is more common and easier to do than reducing the severity.

Mitigating safety risks often entails making adjustments to infrastructure, machinery, or operating procedures. There are three types of safety risk mitigation strategies:

- Avoidance: When the benefits of continuing the activity outweigh the safety risk, the operation or activity is canceled or avoided, completely eliminating the safety risk.
- Reduction: The operation or activity is conducted less frequently, or steps are taken to lessen the severity of the safety risk's effects.
- Segregation: Measures are taken to separate the effects of the safety risk's consequences or incorporate redundancy to guard against them.

Since human beings are needed to apply or contribute to the mitigation or corrective actions, taking human factors into account is essential to identifying effective mitigations. Mitigations could involve using procedures or processes, for instance. Without feedback from people who will be utilizing these in "real world" scenarios and/or human factors specialists, the procedures or processes created might not be appropriate for the job at hand and might have unexpected consequences. Moreover, any safety risk mitigation plan should take human performance limitations into account and incorporate error-capturing techniques to deal with human performance variability. In the end, this crucial human factors viewpoint leads to more thorough and efficient mitigations.

The effectiveness of any defenses and their (inability) to achieve a tolerable degree of safety risk should be considered when taking corrective action. A review of earlier safety risk assessments that might have been impacted by the corrective action might follow from this. To make sure safety risk mitigations and controls are working, they must be confirmed or audited.

Safety risk management documentation.

Documentation for safety risk management. All decisions made, actions taken to mitigate safety risks, and any assumptions guiding the probability and severity assessment should be recorded as part of the safety risk management process. A table or spread sheet can be used for this. A database or other software may be used by certain organizations to store and analyze vast quantities of safety data and information.

Keeping a record of recognized risks reduces the possibility that the company will forget about its recognized risks. When a hazard is discovered, it can be checked to see if it has previously been reported and if any mitigation measures have been implemented by comparing it with the known hazards listed in the register. Hazard registers are commonly presented in tabular form and comprise the following information: type of hazard, possible outcomes, evaluation of related risks, date of identification, category, brief description, when/where it applies, person who identified it, and steps taken to reduce the risk.

Organizational safety decision makers can increase the consistency and rationale of their decisions by utilizing safety risk decision-making processes and tools.

1.2.4. Examining concepts of safety performance indicators and safety performance targets

Types of safety performance indicators

Senior management uses SPIs, which can be either qualitative or quantitative, to determine whether the organization is likely to meet its safety target. While qualitative indicators are descriptive and measure quality, quantitative indicators are concerned with measuring quantity rather than quality. Because they are easier to count and compare, quantitative indicators are preferred over qualitative indicators. The availability of trustworthy data that can be quantified determines the indicator to use.

Combining different approaches can be helpful in a variety of circumstances and address many issues that may come up when using just one. An instance of a qualitative metric for a service provider would be the evaluation of safety culture.

Quantitative indicators can be represented as a rate (x incursions per n movements) or as a number (x incursions). A numerical expression will work in certain situations. However, if the level of activity varies, relying solely on numbers could give

the wrong impression of the true safety situation. While the level of scrutiny may not change as a result, this does offer another important piece of information that could be crucial for data-driven safety decision-making.[2]

Because of this, SPIs ought to be expressed in terms of a relative rate when applicable in order to gauge performance levels independent of activity levels. This gives a normalized assessment of performance, indicating a rise or fall in the activity. An additional example would be to use an SPI to count the number of runway incursions. However, the outcome could be deceptive if there were fewer departures during the observed period. The number of runway incursions relative to the total number of movements, or x incursions per 1,000 movements, would be a more useful and accurate performance metric.

Lagging and leading indicators

States and service providers most frequently use two classification schemes for their SPIs: lagging and leading. Event-based measurements are made by Lagging SPIs. They are also known as "outcome-based SPIs" and typically represent the unfavorable consequences that the company is trying to prevent, though this isn't always the case. As they track and evaluate variables that may result in or influence a particular outcome, these are also referred to as "activity or process SPIs."

Lagging SPIs are helpful for long-term trending and in helping the organization understand what has happened in the past. The effectiveness of safety mitigations can be measured by lagging SPIs because they track safety outcomes. They work well for verifying the system's overall safety performance.

Two types of Lagging SPIs are distinguished:

a) High severity/low probability outcomes include accidents and serious incidents. Because high severity outcomes are rare, aggregating data (at the industry segment or regional level) may yield analyses that are more insightful.

b) High probability/low severity: also known as precursor indicators, these are outcomes that did not always show up in a major accident or incident. SPIs for high probability/low severity outcomes are mainly used to track particular safety concerns and assess how well current safety risk mitigations are working.

In the past, aviation safety regulations have favored SPIs with "low probability/high severity" outcomes. This makes sense because major incidents and accidents receive a lot of media attention and are simple to tally. Nonetheless, an excessive dependence on mishaps and significant incidents as a dependable gauge of safety performance has disadvantages from the standpoint of safety performance management. For example, accidents and serious incidents are rare—one accident or none at all may occur in a given year—which makes it challenging to use statistical analysis to spot patterns. This does not always mean that there is safety in the system. Reliance on this kind of data may lead to erroneous beliefs about how well a system or organization performs in terms of safety, when in reality it may be dangerously close to an accident.

Metrics known as leading indicators concentrate on inputs and procedures that are being used to enhance or preserve safety. These are also referred to as "activity or process SPIs" since they track and evaluate variables that could lead to or be a part of a particular result.

Leading SPIs can also tell the company about how its operations handle change, including modifications to the environment in which it operates. Either anticipating weaknesses and vulnerabilities brought about by the change or keeping an eye on performance following a change will be the main focus. "Percentage of sites that have implemented procedure X" is an example of an SPI to track a change in operations.

Selecting and defining SPIs

SPIs are the metrics that give the organization an overview of its safety performance, including its past, present, and future state with regard to safety. The organization uses this image as a strong and convincing basis for its data-driven safety decisions. The organization's performance in terms of safety is thus positively impacted by these decisions. It is imperative that the selection of SPIs, irrespective of their level of complexity or simplicity, be grounded in realism, relevance, and alignment with safety objectives.

SPIs should ideally concentrate on parameters that are significant indicators of safety performance rather than ones that are simple to meet. SPIs ought to be:

a) connected to the safety objective they are intended to highlight;

b) chosen or established in accordance with accurate measurement and accessible data;

c) suitably precise and measurable; and

d) realistic, taking into account the organization's limitations and opportunities.

It's critical to choose SPIs that align with the organization's safety goals. It will be simpler to identify SPTs—which demonstrate the progress made toward the achievement of safety objectives—if SPIs are clearly defined and aligned. Knowing exactly what needs to be done, when to do it, and how to execute it to achieve the desired safety performance enables the organization to allocate resources for maximum safety effect.

In order to calculate metrics standard deviation has to be calculated. For standard deviation calculation, the formula is:

$$\sigma = \sqrt{\frac{\sum(X-\mu)^2}{N}} \qquad (1.1)$$

where “X” is the value of each data point;

“N” is the number of data points and

“μ” is the average value of all the data points.

Setting safety performance targets

The short- and medium-term goals for safety performance management are outlined in safety performance targets (SPTs). They serve as "milestones" that give assurance that the company is headed toward meeting its safety goals and offer a quantifiable means of confirming the efficiency of safety performance management initiatives. Expectations regarding the safety of the specific aviation sector, as well as the current level of safety risk and safety risk tolerability, should all be taken into account in the SPT setting. When setting SPTs, one should first take into account the recent performance of the specific SPI, if historical trend data is available, as well as what is practically achievable for the related aviation sector.

An organization can more successfully demonstrate its safety performance if its safety objectives, SPIs, and SPTs are SMART (specific, measurable, achievable,

relevant, and timely). The objectives of safety performance management can be attained in a variety of ways, chief among them the establishment of SPTs. One strategy is to set broad, high-level safety goals with corresponding SPIs, and then, once a baseline safety performance has been established, to determine acceptable levels of improvement.

Setting targets with high-level safety objectives

Senior management sets targets after reaching consensus on high-level safety goals. Next, in order to demonstrate an improvement in safety performance toward the predetermined safety objective(s), the organization selects the relevant SPIs. Existing data sources will be used to measure the SPIs, though additional data collection may be necessary. After that, the organization begins compiling, evaluating, and showcasing the SPIs. An overview of the organization's safety performance and whether it is moving closer to or further from its safety objectives will become apparent as trends begin to emerge. The organization is now able to determine SPTs for each SPI that are both reasonable and attainable.

By dividing safety objectives into smaller, more manageable concrete safety targets, the process of achieving them becomes easier. Safety objectives can be difficult to articulate and may seem difficult to achieve. Targets serve as a vital link between strategy and daily operations in this way. Establishing a mechanism to measure the critical areas that influence safety performance is imperative for organizations. An organization can begin setting SPTs to provide everyone in the State with a clear understanding of what they should be aiming to achieve once they have established the baseline safety performance and have an idea of their current level of performance.

There are various ways to demonstrate safety performance with SPIs and SPTs. Organizations must carefully consider, pick, and use a variety of measuring techniques and instruments based on the type of measurement being done as well as the unique conditions of the organization. Organizations may, for example, choose to implement SPIs with particular SPTs linked to them. In a different scenario, it might be better to concentrate on attaining a positive trend in the SPIs rather than setting concrete target

values. Usually, a mix of these methods will be used in the package of chosen performance metrics.

1.2.5. Safety reporting systems

Mandatory reporting system

States are required by Annex 19 to set up an obligatory safety reporting system that encompasses incident reporting among other things. It should be as easy as possible to generate, access, and submit required reports using the reporting systems that States and service providers have developed. The goal of mandatory safety reporting systems should be to record all relevant details about an incident, such as what occurred, where it happened, when it happened, and who the report is directed towards. Mandatory safety reporting systems should also allow for the recording of certain specific hazards (such as regular weather patterns, volcanic activity, etc.) that are known to cause accidents and whose prompt identification and communication is thought to be beneficial.

Systems that require mandatory occurrence reporting typically gather more technical data—such as hardware malfunctions—than data pertaining to human performance.

Voluntary safety reporting systems

In order to gather safety data and information not included in the mandatory safety reporting system, voluntary safety reporting systems ought to be set up. Beyond standard incident reporting, these reports go. Reports that are provided voluntarily often reveal hidden issues like improper safety protocols or laws, mistakes made by people, etc.

The majority of the safety data and information that form the foundation of data-driven decision-making originate from regular, day-to-day operations that are accessible from within the company. The organization must first determine the precise issue that needs to be resolved or the question that the safety data and information are intended to address. This will make it easier to identify the reliable source and make sense of the quantity of information or data required.

1.2.6. Taxonomies

In order to capture and store safety data using meaningful terms, it is ideal for the data to be categorized using taxonomies and supporting definitions. A common language is established through common taxonomies and definitions, which enhances communication and information quality. Having a common language helps the aviation community concentrate on safety issues. Taxonomies make analysis possible and exchange and sharing of information easier.

There are several widely used aviation taxonomies in the industry. Among the instances are:

ADREP is a taxonomy of occurrence categories that is integrated into the ICAO's accident and incident reporting system. The attributes and associated values are compiled to enable safety trend analysis on these categories.

The Common Taxonomy Team (CICTT) of the International Civil Aviation Organization (ICAO) and the Commercial Aviation Safety Team (CAST) are responsible for creating standard definitions and taxonomies for aircraft accident and incident reporting systems.

The Safety Performance Indicators Task Force (SPI-TF) is responsible for creating globally standardized metrics for the SPIs of service providers as part of their SMS. This is done to guarantee consistency in data collection and analysis result comparison.

Taxonomies of hazards are particularly crucial. The process of risk management often begins with the identification of a hazard. Starting with a widely accepted language improves the meaning, classification, and processing ease of the safety data. A hazard taxonomy's structure might have both a generic and a specific component.

Users can record a hazard's characteristics using the generic component to help with coding, analysis, and identification. The CICTT has created a high-level taxonomy of hazards that groups hazards into families known as environmental, technical, organizational, and human hazards.

1.2.7. Safety data management.

The process of modifying safety data to create valuable safety information in formats like tables, reports, and diagrams is known as safety data processing. Processing safety data involves a number of crucial factors, such as data quality, aggregation, fusion, and filtering.

1.2.8. SMS Documentation

A top-level "SMS manual" that outlines the service provider's SMS policies, processes, and procedures to aid in internal administration, communication, and SMS maintenance within the organization should be included in the SMS documentation. It should make it easier for staff members to comprehend how the organization's SMS works and how the safety policy and goals will be achieved. A description of the system that outlines the SMS's boundaries ought to be included in the documentation.

Additionally, the SMS handbook acts as the main means of safety communication between the service provider and important safety stakeholders, such as the CAA, who are involved in the regulatory acceptance, evaluation, and subsequent monitoring of the SMS.

A thorough explanation of the service provider's policies, practices, and goals should be included in the SMS manual. This should include the following:

a) the safety policy and its objectives;

b) a reference to any applicable regulatory SMS requirements;

c) a description of the system;

d) Key safety personnel and their accountability for safety;

e) the processes and procedures of the safety reporting system, both required and voluntary;

f) processes and procedures for hazard identification and safety risk assessment;

g) protocols for safety investigations;

h) the protocols for creating and keeping an eye on safety performance indicators;

i) SMS training protocols, exchanges, and processes;

j) protocols and processes for safety communication;

k) protocols for internal auditing;

l) overseeing change management protocols;

m) The processes for managing SMS documentation; and

n) Coordinating emergency response planning, when appropriate.

The creation and upkeep of operational records attesting to the SMS's existence and continuous operation is another aspect of its documentation. The results of SMS processes and procedures, like SRM and safety assurance activities, are called operational records. Operational records for SMS should be preserved and stored in compliance with current retention guidelines.

The following are examples of typical SMS operational records:

a) hazard/safety reports and the hazards register;

b) SPIs and associated charts;

c) a list of finished safety risk analyses;

d) Records of internal SMS reviews or audits;

e) records of internal audits;

f) SMS/safety training recordkeeping;

g) Minutes of SMS/safety committee meetings;

h) The plan for SMS implementation (during the initial rollout); and

i) Gap analysis in support of the plan of implementation.

CONCLUSIONS TO CHAPTER 1

This chapter has provided a panoramic overview of the aviation ecosystem, underscoring the interconnectedness of participants and the potential impact of each on the safety of flights. The inception of the Safety Management System (SMS) serves as a testament to the industry's commitment to proactively address safety concerns.

This chapter has elucidated the distinction between safety and security, emphasizing that while both entail risks, security deals with intentional disruptions, whereas safety focuses on unintended outcomes. The SHELL Model and James Reason's "Swiss-Cheese" Model have been presented as invaluable tools for understanding the impact of human factors on safety performance and the sequential breaches of defenses leading to accidents.

Theory of practical drift adds another layer to comprehending how systems may deviate from their original designs under real-world conditions. This theoretical framework highlights the importance of considering practical, real-world scenarios in system planning and design.

A critical aspect explored in this chapter is the delicate balance between production/profitability and safety risks. The intrinsic link between maintaining acceptable safety risks and sustaining profitability underscores the need for organizations to judiciously weigh the costs of safety risk controls against their benefits.

Safety risk management (SRM), a cornerstone of SMS, involves a continuous cycle of hazard identification, safety risk assessment, mitigation, and risk acceptance. The need for ongoing SRM activities is accentuated by the dynamic nature of the aviation system, where new hazards may emerge, and existing ones may evolve.

In conclusion, the chapter lays the groundwork for a deeper understanding of SMS, setting the stage for subsequent exploration into the practical implementation of safety risk management processes. The SMS documentation, as outlined, serves as a comprehensive guide for internal administration, communication, and maintenance of the SMS within an organization.

2. INVESTIGATION OF REQUIREMENTS AND METHODOLOGY FOR DEVELOPMENT

2.1 Documentary based requirements for SMS functioning for airline operator

2.1.1.Hazard identification processes

In the dynamic and safety-sensitive realm of aviation, adherence to international safety standards is paramount for service providers, particularly airlines, to ensure the highest level of operational safety. The backbone of this commitment lies in the effective implementation of a Safety Management System (SMS). Here's a comprehensive guide for airlines to keep their SMS in line with international requirements.

The SRM procedure methodically finds risks that are present in the context of providing its goods or services. Systems that are flawed in their technical operation, human-machine interface, design, or interplay with other processes and systems may provide a risk. They might also be the consequence of systems or procedures that are in place not being able to adjust to modifications in the service provider's operational environment. Potential risks can frequently be found at any stage of the operation or activity life cycle by carefully analyzing these variables.

Achieving good safety performance requires an understanding of the system and its operating environment. It will be beneficial to have a thorough system description that explains the system and all of its interfaces. Throughout the operating life cycle, hazards might be found from both internal and external sources. To make sure safety risk mitigations and assessments continue to be successful, they must be assessed often. An overview of a service provider's hazard detection and safety risk management procedure is given in Figure 2.1.

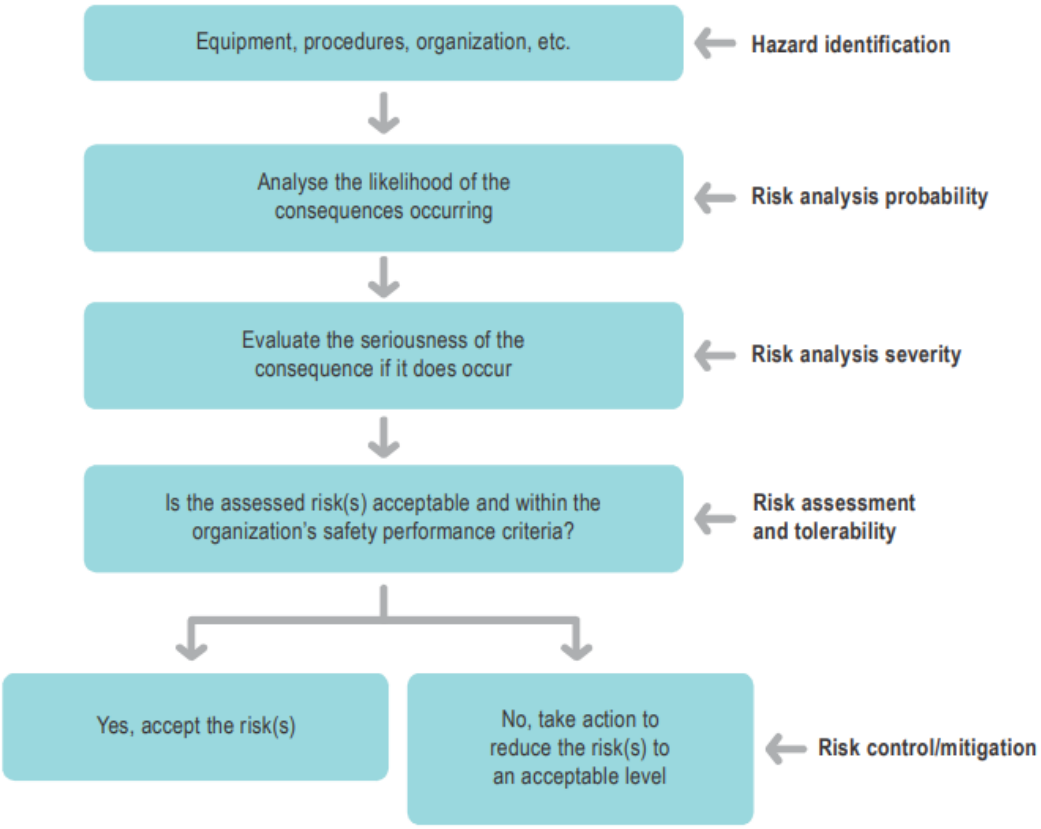


Figure 2.1 – Hazard identification and risk management process

Identification of hazards

The SRM process begins with the identification of hazards. It is recommended that the service provider establish and uphold a structured procedure for identifying potential risks to aviation safety across all operational and activity domains. Systems, facilities, and equipment are included in this. The safety of the operation is enhanced by the identification and control of any hazard related to aviation safety. It's crucial to take into account any potential risks brought about by the SMS's interactions with outside organizations.

Sources for identifying hazards

There are numerous internal and external sources for hazard identification in an organization. Among the internal sources are:

a) Regular operations monitoring: this keeps an eye on daily activities and operations using observational techniques. *such as line operations safety audit (LOSA).*

b) Automated recording systems are used in automated monitoring systems to keep an eye on variables that can be examined. *such as flight data monitoring (FDM).*
c) Systems for mandatory and voluntary safety reporting give everyone the chance to inform the organization about potential risks and other safety concerns, including employees of outside organizations.
d) Risks in the task or process being audited can be found through audits. To identify risks associated with the change's implementation, these should be coordinated with organizational changes.
e) Comments from the training; interactive, two-way training can help participants identify new hazards.
f) Safety investigations by service providers; risks noted in internal safety investigations and accident/incidents follow-up reports.

External resources that can be used to identify hazards include:

a) A review of aviation accident reports, which may be connected to incidents in the same State or to an identical aircraft type, location, or operating environment.
b) Mandatory and optional state safety reporting programs; some states offer summaries of the reports on safety that they obtain from service providers.
c) Third-party and state oversight audits; external audits occasionally reveal risks. These could be recorded as an unidentified risk or, less obviously, included in an audit finding.
d) Information exchange systems and trade associations: A lot of industry groups and trade associations are able to share safety data, which may include identified hazards.

Safety reporting system

The safety reporting system, particularly the voluntary safety reporting system, is one of the primary resources for identifying hazards. While the mandatory system is typically employed for already-occurring incidents, the voluntary system offers an extra avenue for reporting possible safety concerns, like dangers, near misses, or

mistakes. They can give the State and the service provider useful information about less serious incidents.

Systems for voluntary safety reporting should be private, meaning that only the custodian should be aware of any identifying information about the reporter in order to enable follow-up actions. The custodian position ought to be limited to a select group of people, usually the safety manager and those working on the safety investigation. Upholding confidentiality will make it easier to disclose risks associated with human error without worrying about punishment or humiliation.

It is encouraged of all personnel, regardless of position, to recognize and report hazards and other safety issues via their safety reporting systems. Safety reporting systems need to be easily accessible to all staff members in order to function effectively. Offering a variety of entry points increases the possibility that employees will become involved. The advantages of reporting safety incidents as well as what needs to be reported should be explained to everyone.

It should be provided to anyone who files a safety report with feedback regarding the choices or actions made. The sharing of safety data and the comparing of specific safety performance indicators can be facilitated by aligning reporting system requirements, analysis tools, and methods.

When there are a lot of safety reports, it could be necessary to filter them upon entry. To ascertain whether additional research is required and to what extent, this may entail conducting an initial safety risk assessment.

Frequently, safety reports are sifted using a taxonomy, or classification scheme. Finding common problems and trends can be facilitated by applying a taxonomy to filter information. Airlines need to create taxonomies that address the type(s) of operations they conduct. Using a taxonomy has the drawback that occasionally the identified hazard does not neatly fit into any of the established categories. The next challenge is to apply taxonomies with the right level of specificity—enough to make assigning hazards simple, but also sufficiently general to make the hazards useful for analysis.

Additional techniques for identifying hazards involve holding workshops or

meetings where subject matter experts run through in-depth analysis scenarios. Numerous seasoned operational and technical staff members contribute to these sessions. Such activities could take place in the already-existing safety committee meetings (SRB, SAG, etc.); the same group could also be used to evaluate related safety risks.

Documentation of identified hazards and their possible effects is necessary. Processes for safety risk assessment will make use of this.

The process of identifying hazards takes into account any potential risks that might arise from the service provider's aviation operations, including system interfaces with external and internal systems. After hazards have been identified, it is important to ascertain their consequences, or any particular events or results.

Examining potential risks

Continuous hazard identification ought to be a component of the service provider's ongoing operations. Certain conditions might require a more thorough examination. These could consist of:

a) situations in which there is an apparent rise in aviation safety-related incidents or instances of regulatory non-compliance within the organization; or

b) Material modifications to the company or its operations.

Safety risk assessment and mitigation

To enable a consistent and methodical approach to the assessment of safety risks, the service provider must create a model and procedures for safety risk assessment. This ought to incorporate a system for figuring out what safety risks are tolerable or unacceptable and how to rank the necessary actions.

To make sure the SRM tools are appropriate for airline’s operating environment, they might need to be periodically reviewed and adjusted.

All available safety data and information should be used in the safety risk assessment process. Following the assessment of safety risks, airline will use data-driven decision-making to identify the necessary safety risk controls.

Higher authorities may be consulted before making final decisions or accepting control in order to ensure that the right resources are available.

Appropriate safety risk controls can be put in place once safety risks have been evaluated. It is crucial to consult subject matter experts and "end users" when choosing the right safety risk controls. The viability of selected safety risk mitigations will be maximized by making sure the appropriate individuals are involved. It is best to assess any unforeseen consequences before putting any safety risk controls in place, especially if they involve the creation of new hazards.

Documentation of the SRM outputs is necessary. Included in this should be the risk and its effects, the safety risk assessment, and any steps implemented to reduce the risk. To enable tracking and monitoring, these are frequently recorded in a register. When making safety decisions and exchanging safety information, this SRM documentation serves as a historical source of organizational safety knowledge. This safety knowledge serves as a resource for safety trend analyses, safety education, and safety outreach. Internal audits can also benefit from evaluating the implementation and efficacy of safety risk controls and actions.

2.1.2. Considering safety assurance

Processes and actions used to ascertain whether the SMS is performing in accordance with expectations and requirements make up safety assurance. This entails keeping a close eye on both its operational environment and its processes in order to spot any deviations or changes that could lead to the deterioration of safety risk controls already in place or the introduction of new ones. The SRM procedure may then be used to address such modifications or deviations.

Actions taken in response to any issues that are identified as potentially having an impact on safety should be developed and implemented as part of safety assurance activities. The functionality of the service provider's SMS is consistently enhanced by these steps.

Safety performance monitoring and measurement

Internal audits and the creation and monitoring of SPIs must be used in tandem to confirm the safety performance and validate the efficacy of safety risk controls. Since the application of safety risk controls does not always yield the desired results, evaluating their efficacy is crucial. This will assist in determining whether the

appropriate safety risk control was chosen, and it might lead to the implementation of an alternative safety risk control plan.

Safety performance monitoring

The process of collecting safety data and safety information from various sources that are usually accessible to an organization is used to carry out safety performance monitoring. Availability of data to facilitate well-informed decision-making is one of the SMS's most crucial features. The information generated by using this data for safety performance measurement and monitoring is crucial for making decisions about safety risks.

It is important to follow a few fundamental guidelines when measuring and monitoring safety performance.

The safety performance attained serves as a gauge for both organizational behavior and the SMS's efficacy. In order to do this, the company must specify: the first step in addressing safety concerns in an organization's operational context is to establish safety objectives. These should reflect strategic achievements or desired outcomes related to safety. Next, come SPIs, which are tactical parameters related to the safety objectives and serve as the basis for data collection. Finally, SPTs, which are also tactical parameters used to track progress towards achieving the safety objectives, should be established first.

If SPIs cover a broad range of indicators, a more comprehensive and accurate picture of the service provider's safety performance will be obtained. This ought to comprise:

a) high probability/low severity events

b) low probability/high severity events

c) Process performance, which includes report processing, system enhancements, and training.

SPIs are used to gauge how well the service provider performs in terms of operational safety and SMS performance. The safety reporting system is one of the many sources of data and information that SPIs monitor. They ought to be unique to each service provider and connected to the pre-established safety goals.

When defining SPIs, service providers ought to take into account:

a) Measuring the appropriate things: Choose the most appropriate SPIs to demonstrate that the company is meeting its safety goals. Additionally, think about the organization's main safety concerns and hazards, and choose SPIs that will demonstrate efficient control over these.

b) Data Availability: Is data that the organization wishes to measure readily available? If not, it might be necessary to set up more sources of data collection. Trend identification may also be aided by pooling data sets for small organizations with limited data.Industry associations that have the ability to compile safety data from various organizations may support this.

c) Data reliability: Subjectivity and incompleteness are two reasons why data may not be dependable.

d) Common industry SPIs: To enable organization-to-organization comparisons, it could be helpful to settle on common SPIs with comparable organizations. These may be made possible by industry associations or the regulator.

The following tasks can serve as resources for tracking and evaluating safety performance:

a) Safety studies are analyses that help identify trends in safety performance or provide a deeper understanding of safety-related issues.

b) Safety data analysis looks for patterns or recurring problems in the safety reporting data that may need more research.

c) Safety surveys look at methods or procedures associated with a particular operation. Informally conducted confidential interviews, questionnaires, and checklists may all be used in safety surveys.

d) The integrity of the service provider's SMS and auxiliary systems are the main focus of safety audits. Safety audits can also be used to track adherence to safety regulations or assess how well implemented safety risk controls are working.

e) Safety investigation results and recommendations can offer helpful safety information that can be compared to other safety data that has been gathered.

To spot unusual shifts in safety performance, the company should keep an eye on how well-established SPIs and SPTs are performing. When taking into account the resources available to the organization and the related aviation sector, SPTs should be achievable, specific to the context, and realistic.

The main way to confirm the efficacy of safety risk controls is through safety performance measurement and monitoring.

The management of change

A variety of factors, such as organizational growth or contraction and business advancements that have an impact on safety, can cause service providers to undergo change. These factors may lead to modifications to internal systems, processes, or procedures that support the safe delivery of goods and services.Changes that might occur:

a) modifications to the operational environment of the organization;
b) modifications to the SMS interfaces with outside institutions; and
c) Emerging risks, economic shifts, and external regulatory changes.

The efficiency of the current safety risk controls may change. Furthermore, whenever there is a change, it's possible for new risks and associated safety hazards to unintentionally enter an operation. The organization's current hazard identification or SRM procedures should be followed in order to identify hazards, evaluate associated safety risks, and take appropriate control measures.

The following factors should be taken into account by the organization while managing the change process:

a) The ability to be critical. To what extent is the change necessary? The service provider ought to take into account how their actions will affect other organizations, the aviation system, and themselves.
b) Subject matter experts' accessibility. It is crucial that important aviation community members participate in change management initiatives; these participants may come from outside organizations.

c) The accessibility of information and data on safety performance. What information and data are available to allow for the analysis of the change and to provide information about the situation?

Even though tiny, gradual changes frequently go unnoticed, they can have a big overall impact. Small or large changes could have an impact on the organization's system description and necessitate revision. Given that the majority of service providers undergo frequent, if not constant, change, it is imperative that the system description be evaluated on a regular basis to ascertain its continued validity.

The trigger for the official change process should be specified by the service provider. The following modifications are likely to result in formal change management:

a) the addition of new machinery or technology;
b) adjustments to the working environment;
c) modifications to key personnel;
d) appreciable adjustments to staffing levels;
e) modifications to safety regulations;
f) a substantial organizational restructure; and
g) structural modifications (new base or facility, altered aerodrome layout, etc.).

The effect of the change on staff should also be taken into account by the service provider. This might have an impact on how those impacted by the change accept it. Early involvement and communication will typically enhance how the change is viewed and carried out.

The following actions ought to be part of the change management process:

a) comprehend and describe the change, including the rationale behind the implementation of the change;
b) comprehend and define who and what it will affect, including individuals within the organization, other departments, and external individuals or organizations. Systems, procedures, and equipment might also be affected. It might be necessary to review the descriptions of the organizations'

interfaces and the system. This is a chance to decide who ought to be a part of the change. Modifications may have an impact on risk controls that are currently in place to reduce other risks, which could raise risks in areas that are not immediately apparent;

c) Conduct a safety risk assessment and identify any hazards associated with the change. This should reveal any hazards that are directly related to the change. It's important to consider how the modification may affect current risks and safety risk controls. The SRM procedures currently in use by the organization should be used in this step;
d) Create an action plan that outlines the tasks to be completed, who will complete them, and when. A well-defined plan outlining the steps involved in implementing the change, assigning responsibilities, and organizing and timing each task is necessary;
e) approve the change; this confirms that the change is safe to implement. The change plan should be signed by the individual with overall responsibility and authority for implementing the change; and
f) assurance plan; this is to determine what follow-up action is required. Consider how the change will be communicated, as well as whether additional activities (such as audits) are required during or after the transition. Any assumptions that are made must be tested.

1.2.3. Considering safety promotion

Together with helping the service provider meet its safety goals, safety promotion fosters a positive safety culture. This is accomplished by combining technical proficiency—which is continuously improved through education and training—with effective communication and information exchange. The leadership needed to spread the safety culture throughout an organization comes from senior management.

Policies and procedures must be strictly followed or mandated in order to achieve effective safety management. In addition to supporting the organization's policies, procedures, and processes, safety promotion influences both individual and organizational behavior and offers a value system that reinforces safety initiatives.

It is imperative for the service provider to institute and execute protocols and guidelines that enable efficient bidirectional communication at every tier of the enterprise. This should involve the organization's top leadership providing clear strategic direction and facilitating "bottom-up" communication that invites candid and helpful input from all staff members.

Training and education

To guarantee that personnel are qualified and capable of carrying out their SMS responsibilities, Annex 19 mandates that "the service provider shall develop and maintain a safety training program." "The scope of the safety training program be appropriate to each individual's involvement in the SMS," according to another requirement. It is the duty of the safety manager to guarantee that an appropriate safety training program is in place. This involves giving the proper safety information pertinent to the particular safety concerns that the organization addresses. No matter their position within the company, employees who are capable and trained to carry out their SMS responsibilities are a sign of management's dedication to a successful SMS. To maintain competencies, the training program should include both initial and ongoing training requirements.

At the very least, the following should be covered in initial safety training:

a) Roles and responsibilities within the organization pertaining to safety;
b) organizational safety policies and objectives;
c) fundamental SRM ideas;
d) systems for reporting safety;
e) the SMS policies and procedures of the company; and
f) Aspects related to people.

Recurrent safety training ought to emphasize any modifications made to the SMS policies, procedures, and processes as well as any particular safety concerns that are pertinent to the company or lessons discovered.

Safety communication

All relevant staff members should be informed of the organization's SMS goals and protocols by the airline safety team. A communication plan should be in place to

ensure that safety information is conveyed using the most effective technique possible, taking into account each person's role and informational needs. Safety bulletins, notices, briefings, newsletters, and training sessions can all be used to accomplish this. The safety manager should also see to it that information about lessons gained from internal and external investigations, case studies, and experiences is shared widely.

Therefore, the goal of safety communication is to:

a) guarantee that personnel are fully informed about the SMS; this is a good method of promoting the organization's safety goals and policy.
b) Disseminate safety-critical information, which is particular knowledge about risks and safety-related issues that could put the organization at risk for safety.
c) increase knowledge of new safety risk controls and corrective measures.
d) Disseminate information on newly added or modified safety procedures. It's critical that the right individuals are informed of any updates to safety procedures.
e) Encourage staff members to recognize and report hazards by fostering a positive safety culture; safety communication is two-way. It is crucial that all employees use the safety reporting system to inform the organization of any safety concerns.
f) Offer feedback; let employees who submit safety reports know what steps have been taken to address any issues that have been found.

Service providers ought to think about whether any of the previously mentioned safety information has to be shared with outside groups.

2.2 Description of existent solutions. Advantages and disadvantages.

21st century is indeed the era of automation and the number of technological solutions is growing exponentially. Informational technology companies offer products that enhance work in many domains. There are innovative tech solutions for finance, medicine, logistics, education, commerce and many other fields of occupations. Aviation is not an exception and frankly speaking there is still a lot of work to do

because aviation is multilevel system which requires strict adherence to the standards and rules. Let's consider airline processes as an example to explore the way IT products can influence the work of the system.

To start with the directions of airlines structural elements. At first glance for ordinary passenger airlines are not that sophisticated. It is clear that such organization needs pilots and flight attendants to operate, aircraft, website for selling tickets, stuff for check-in desk and that is probably all that people who are not connected to the transportation domain would think of. But as soon as you are behind the stage you discover that there are several departments with many employees who have different tasks and responsibilities and there should be done a huge work before the take off of regular or charter flight. Structures of airlines vary all over the world but usually it is necessary for operational sector to include: ground handling department, who will work with the provision of high level service and it does not just catering and cleaning, but also de/anti-icing procedures, fueling, airport services that are crucial to perform the flight procedures, then maintenance support, who works with aircraft and all technical supplies that are needed, compliance with the standards and monitoring continuing of airworthiness, planning division, airnavigation and operational coordination centers who provide strategical and tactical planning of the schedule and provide necessary calculations and detailed routes to carry flight and they stay 24/7 in contact to manage all possible issues that can occur during any stage of flight, flight and training divisions that work with pilots, their certification, roster, keeps them up to date and prepared with respect to international regulations, quality and safety divisions whose responsibilities are to keep all processes of the organization in strict correspondence with national and international standards and demands, monitor updates and inform all other stuff, and finally flight safety provision, risk assessment, flight data monitoring, carrying of inspections, audits and ensure safety culture within organization. It is just an overview for general familiarization and not as detailed as it is in reality but is helpful to have a clue of how difficult and multitask the work actually is. Therefore, all of divisions obviously need tools to perform their duties.

Nowadays many processes are conducted with help of computer programs but there is still the need to develop such an instrument that will take over a part of the working flow. It should be mentioned that it is a difficult task to create unified system that will cover all of the aspects for every division and would be the only one platform for the whole organization. Probably in the future there will be developed service like that which will include everything needed for each department and will give the opportunity to cooperate and interchange necessary information to all employees but nowadays common practice is to use different more narrow-specialized softs and separate platforms for storage of all the documents. Let's consider the tasks that this future system is required to fulfil. First of all the software should give the opportunity to safely store and share documentation and give the acknowledgement that the person, who you share document with is familiar with its content and has read it, so there should be some kind of data base which will serve as confirmation that all employees who should have been familiarized actually were familiarized. There also should be modules for each division with the correspondent functionality which will allow workers to do their specific tasks without using any other applications or services. There should also be envisaged instruments for communication and conducting meetings which might involve employees from different divisions and sometimes even outside the company. That is just superficial description of types of directions that should be elaborated but it shows that it is going to require long term and expensive work of big it-team. It should be also stated that even after long and hard period of development after presenting the product companies who will consider implementing it will obviously need customization, because as it was noted earlier the internal structure and organization of processes may differ. So there are many challenges and risks which airline and IT company will encounter when they start to work on integration and automation on such a global scale. That is why it is common practice to work on softwares that do not cover whole airline workflow but concentrate on the giving solution for certain direction of operation. Since this project is about the risk assessment process as a component of SMS the focus is going to be on the technical solutions for SMS teams.

To demonstrate existing solutions and their functionality the following three systems were chosen: ASQS, ICARUS and Centrik. Comparison table is shown on Figure 2.2. As it was described in previous chapter airline's SMS team that works with risks have to maintain such tasks as: collecting data about state of safety within organization, and one of the means to do that is through safety messages from anyone involved in the process and who witnessed possible finding or violation of procedure or simply hazard to the safety of flights; manage the register of such messages, classifying it, delegating the mitigation actions, investigating if needed and assessing it; work with SPIs and SPTs (were previously discussed) creating of corresponding diagrams for visualization; manage base of performed risk assessments, managements of change, internal audits, safety committee meetings, SMS training provision, documentation sharing and giving detailed instructions. Not less important is that usually Quality and Compliance and Safety departments are working in collaboration cause globally their goals are cognate. There will be shown a proof of that in the description of the web-platforms that will be discussed. There is an overview of each system and the table of the functionality comparison.

a) ASQS Advanced Safety and Quality Software Solutions for Aviation Businesses

According to description given oh the site of the service ASQS is a web-based Safety, Quality and Risk Management System developed with involvement of the experts in the field of aviation safety and quality experts, with respect to regulatory requirements. System currently includes 8 modules allowing operators to easily adapt the solution to their specific needs.[4] These modules are Quality Management, Reporting, Risk Management, Flight risk, FDM(Risk), Document Distribution, Emergency Response Planning, Survey. The system can be customized to the needs of the organization. Developers Stated that their solution may be applied in the work processes of Airlines, Business Jet Operators, Helicopter Operators, Airports Ground Handling, Part-145 and Part 21, UAVs and eVTOLs.

b) ICARUS by INXELO TECHNOLOGIES

According to the information given on the website ICARUS team offer the modern software solution which is again joint system for both Safety and Compliance

management system. The software is suitable for: Airlines, Airports, CAA, ATM, MRO(Part-145), Flightacademies, Businessoperators, Droneoperators, Others that require SMS. [5] Embedded modules are Reporting, Risk Management, Compliance Management, Documentation, Data Analysis, Training, Promotion, Strategy, Mobile apps, ERP, Tasks and Bio-safety. Talking about the methodologies for risk analysis ICARUS offers such methodologies as 5 Why's, HFACS, Bow-Tie etc. On the Figure 2.2 can be found the risk assessment related functions that ICARUS provide for users.

c) Centrik by Trust Flight

According to the information given by TrustFlight about Centrik it is integrated real-time operational management solution which offers to its customers such modules as Personalised Dashboard, Documents, Safety (reporting and register), Risk, Compliance, Workflows, Meetings, Asset Management and Training. It may be applicable for the usage of CAA, Airlines, Airports, etc. Developers promise that every module can be customized to correspond to the requirements and needs of customer. Comparing to ICARUS and ASQS, Centrik covers not only Quality and Safety directions but can also be actively used in the work of other divisions of the airline who are responsible for other directions of the operational processes.

Obviously not all of the functions that are built in the system mentioned in the table, because the focus of this project is on the risk assessment, so by virtue of that all other features for quality and compliance or any other are not listed.

Let us compare the functionality of three chosen services. For that purpose, the table of comparison was created. It consists of the list of functions and separate colomns for each of service. In order to show that feature is implemented into system "1" is put in correspondent cell. In the last row there is the sum of points that each system has got. There are also important for analysis markings: color filling of the rows which contain features that are extremums. If all of the considered systems have the feature we can assume that feature is popular, if no one or just one of the systems got the feature our conclusion is that the feature is not that popular.

#	Function	ASQS	ICARUS	Centrik	
1	24/7 safety reporting online and offline	1	1	1	*popular feature*
2	Customizable reporting forms to meet your requirements	1	1	1	*popular feature*
3	Statistics and interactive dashboards	1	0.5	0.5	*popular feature*
4	Anonymous reporting enabled	1		1	
5	Cooperative risk management tool	1	1		
6	Active monitoring of the effectiveness of implemented safety controls	1		1	
7	Risk Register is created and updated	1	1	1	*popular feature*
8	Integrated Management of Change process	1			*unpopular feature*
9	Automatic alerts when risk assessments need to be reviewed	1	1		
10	Continous review and amendment of your risk assessments via Assessment Revisions	1		1	
11	Distribute and monitor corrective action plans		1	1	
12	Creation of customized graphs (for KPI monitoring)		1		*unpopular feature*
13	Statistical reports and exporting data from graphs creation		1		*unpopular feature*
14	Distribute safety notices or bulletins.		1	1	
15	Instant notifications to employees for each safety notice.		1	1	
16	Read and sign option to all employees to give simple tool to accept the notices.		1	1	
	score	10	11.5	10.5	

Figure 2.2 Comparison of the functions

2.3. UX principles and research methods overview

2.3.1. Core UX design fundamentals

Since this project is aimed to develop high quality solution for automation of risk assessment processes for the airline usage there will be applied strategy of modern informational technology companies. There will not be covered all the phases of development just as it would be in real IT company because it requires large team with different specializations and a big budget for realization such a project. In this diploma the focus is on the development of the convenient user-friendly interface design of the system that will help to automate tasks of the airline employees of flight safety department, whose responsibility is to work with risks, collect the flight safety related data, assess it and classify, control the mitigation actions and SMS training of the staff. Therefore, in this work will be described and used methodologies of UX design. In this chapter these methodologies will be considered and explained.

To start with the defining of what UX actually stands for. User experience (UX)

design is a process used by designers or design teams to develop products that corresponds to the interests of customers and meet user's needs. Let's dive into the fundamentals which it is necessary to understand before further investigations and researches. Design process which is a significant part of this project is a sequence of steps which are used for creation or improvement of the product applying design methods. Design process is very important to manage the development of future solution by creating streamlined order of actions the performing of which will lead to the expected results. Speaking about design process design thinking should be considered. Design thinking can be explained as a non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. Involving five phases—Empathize, Define, Ideate, Prototype and Test—it is most useful to tackle problems that are ill-defined or unknown. [6]

The first person to come up with the term of design thinking was Nobel Prize laureate Herbert A. Simon in his 1969 book, *The Sciences of the Artificial.* Should be mentioned that the concept is really valuable and contributes to improvement of the world and can be called a driving force in business. Due to design thinking specialists have the ability to get behind hard-to-access insights and apply a collection of hands-on methods to help find innovative answers. [6]

Design thinking is usually described as the process that consists of 5 stages. It should be mentioned that stages do not necessarily go strictly one by one and it is common practice to make some of them in parallel and repeat some of them if it is needed. Let's dig deeper and consider all stages and their roles.

The first is Empathise – shortly can be explained as to look for user's needs. Therefore, this phase's goal is to cultivate awareness of the existing problems which have to be resolved, usually for this purpose user research is carried. Since the principle of human-centered design should be followed, empathy is a key to imbued with customers perspective and leave behind your own assumptions about the problem.

The next stage is Define – to formulate user's troubles and needs. At that point design team has already obtained information during Empathise stage, so now it should be analyzed and the core problems should be determined.

Third stage is Ideate – is all about testing hypothesis and ideas generation. After previous stages observations, analysis and requirements are clear therefore it is a high time to "think outside the box", search for non-standard approaches to state the problem and find out innovatory solutions.

Fourth stage is Prototyping – creating visual representation of solution. Time to experiment and produce prototypes to investigate the ideas team came up with. Prototypes should be simple but informative enough.

The fifth stage is Testing – just as simple as it sounds team carries tests in order to identify potentially weak points or flaws and change it on early stages of development. So teams are free to go back to any of previous stages to correct the path change anything that is demanded and offer better solution.

Overall, you should understand that these stages are different modes which contribute to the entire design project, rather than sequential steps. Your goal throughout is to gain the deepest understanding of the users and what their ideal solution/product would be. [6]

2.3.2. Research

There are two categories for all user research methods: quantitative and qualitative. With quantitative methods, the researcher uses questions like "how many, how often, or how much" to quantify and evaluate user behavior. Making decisions can be made easier with the use of quantitative research.

The quality or significance of an end-user's experience is the main focus of qualitative research. Qualitative UX research techniques gather detailed information about individual users. They are essentially concerned with comprehending the nature of the human experience (e.g., Why do users act in certain ways? What encourages users to finish a specific task?).

If the question is answered quantitatively, then the question is answered qualitatively. Qualitative data can be gathered but not always measured, in contrast to

quantitative data, which is readily represented by numbers. The findings of qualitative research are typically presented as observations that accurately capture a user's perspective on their experience rather than as numerical data.

There are several stages to the entire product design process: ideation, creation, validation, and exploration. During the entire process of product design, qualitative user research can be beneficial. Nevertheless, it is particularly helpful in the early stages of the design process (ideation, creation, and exploration) as it can assist you in keeping your users in mind and in understanding what matters to them and why. This data will assist you in more effectively assessing your design solutions.

Qualitative UX research methods

Qualitative approaches concentrate on examining each unique user's experience. A common feature of many qualitative research methods is the use of interviews with test subjects as the main means of gaining understanding of user behavior. Typical qualitative techniques consist of:

Interviews. One-on-one meetings are held by a researcher to talk about subjects related to a product.

Focus groups. Focus groups are meetings in which three to ten people are brought together to talk about a particular topic (or set of topics). A researcher facilitates conversations in focus groups by being present throughout the session.

Moderated usability testing. Tasks are assigned to participants during usability testing, and the moderator monitors their progress. Moderators can delve deeper into topics of interest by watching how users interact with a product. Sorting cards. Examinees are asked to group content items into categories using a card sorting method. Participants in tests can form their own groups or researchers can assign pre-existing categories and ask them to classify the content into those groups.

Qualitative methods can be broadly classified into two categories: behavioral research and attitude research:

Attitudinal research. The self-reported data from test takers serves as the foundation for this study (what people say). The focus groups and interviews use an attitude-based approach. These techniques work best for capturing participants'

recollections and viewpoints regarding their interactions with a product. Researchers can obtain all of this data by directly requesting user feedback regarding their experiences. You can get user expectations and opinions about your product, for instance, by conducting user interviews.

Behavioral research. Direct observation of test subjects is the foundation of this study (what people do). One type of behavioral methodology is moderated usability testing. During a usability test, the moderator watches how test participants use the user interface and draws conclusions about user behavior from that observation. The product team can better understand how users actually use your product and where they run into problems by using behavioral analysis. Because behavioral and attitude research methods complement one another, qualitative research frequently uses both of them.

It is human nature for people to misunderstand things, and researchers are no different. Don't limit your analysis of the user research data to looking for findings that align with your initial hypothesis. Try concentrating on the things that defy your expectations instead. This will assist you in avoiding missing unexpected issues. Recall that conducting qualitative user research is pointless if you are closed to hearing what the participants have to say. [7]

Quantitative UX research methods

Quantitative data provide an oblique evaluation of a design's usability. They may represent participants' opinions of the usability of the tool (e.g., satisfaction ratings) or be based on users' performance on a particular task (e.g., task-completion times, success rates, number of errors). Since quantitative metrics are just numbers, they can be challenging to understand in the absence of a benchmark. Is it good or bad, for instance, if 60% of study participants succeeded in finishing a task? It is difficult to state definitively. Because of this, the main goal of many quantitative studies is not so much to characterize a website's usability as it is to evaluate it against a recognized benchmark, the usability of a rival website, or an earlier design.

Quantitative data can indicate that our design might not be usable in comparison to a reference point, but it cannot reveal the issues that users ran into. Worse still, they

don't advise us on how to improve the design for the next time around. Finding out that only 40% of participants can finish a task doesn't explain why users struggled with it or offer suggestions for how to make it simpler. In order to fully comprehend the unique usability problems with an interface, researchers frequently need to supplement quant data with qualitative approaches.

The statistical significance of quant over qual is one of its advantages. Quant data that are presented well are somewhat protected from randomness. Generally speaking, statistical significance and confidence intervals are mathematical tools that indicate the likelihood that the data represent reality or whether they could be the result of random noise, possibly an artifact of the particular participants we happened to recruit or the conditions under which the study was conducted. There is no official guarantee that the results of a qual study are objective and representative of the entire target population, even though seasoned researchers will employ a variety of best practices to guard against bias and protect themselves from chance.[8]

Some examples of methods to carry quantitative research are:

Quantitative Usability Testing (Benchmarking)

While less common, quantitative usability testing (also known as usability benchmarking) is similar to qualitative usability testing in that it involves asking users to use a product to complete realistic tasks. The main distinction between the two is that observations, such as identifying usability issues, are given priority in qualitative usability testing. Quantitative usability testing, on the other hand, focuses on gathering metrics such as success or time on task.

A/B Testing or Multivariate Testing

Using multivariate or A/B testing, you can design experiments that identify how various user interface designs affect those metrics. Teams build two distinct live versions of the same user interface (UI) and test them against various users to determine which version works best. This process is known as A/B testing. For instance, you may design two different call-to-action button labels. Subsequently, you could monitor how many clicks each of the two versions of the button gets. Similar in nature, multivariate testing tests multiple design elements simultaneously (e.g., the test may test various

button labels, typography, and page placement).

Eyetracking Testing

Specialized equipment that tracks users' eye movements across an interface is needed for eyetracking studies. Meaningful trends begin to show when a large number of participants—30 or more—complete the same task on the same interface. At this point, you can reasonably predict which aspects of the page will catch users' attention. Eyetracking can assist you in determining which elements of the interface and content should be emphasized or deemphasized in order to help users accomplish their objectives. The highly specialized, prohibitively expensive, and somewhat unstable equipment that needs a lot of training to operate is a major barrier to conducting eyetracking studies.[9]

2.3.3. Information Architecture

When developing products, designers typically include information architecture in the UX process. Information architecture is much more than just a sitemap that indicates which pages lead to which; it defines every possible route and path that users can take while using an application or website.

Information architecture describes the hierarchy, navigation, features, and interactions of a website or application, much like building architects use a blueprint to construct every part of a house, from physical structures to more intricate internal workings like electrical and plumbing. Furthermore, information architecture has the potential to be a designer's most potent toolkit, much as blueprints are the most important document an architect uses when building a structure.
But creating one involves more than just compiling a feature list and figuring out how to use it; let's look into the procedure.

The infrastructure, features, and hierarchy of a product are represented visually by information architecture, or IA. IA may also include navigation, content, flows, and application functions and behaviors, depending on the designer's level of detail. IA can be any size or shape, but it should cover the generalized structure of the product so that anyone can read it and understand how the product functions (theoretically).

IA gives product development, engineering, and design teams a panoramic perspective of the whole product. It is essential to have a single document that provides a clear and concise explanation of how the application or website functions in order to develop new features, update current ones, and see what else can be done with the product as it stands.

IA design, which is a step in the UX process, is very similar to flowcharting in that it involves adding shapes to a single document and connecting them in an orderly manner with lines. Understanding how your app or website truly functions from the user's point of view and organizing that information into a readable, legible format are the challenges associated with building an interface architecture (IA).

To truly build an IA, two main steps must be taken: first, it must be arranged using a visual hierarchy, which is a hierarchy of features, functions, and behavior; second, a legend must be made to illustrate the various feature types, interactions, and flows. It is not necessary to adhere to the nomenclature used in a standard flowchart; however, the shapes do follow certain requirements (rectangles represent processes, diamonds represent decision points, etc.).

Put another way, the most crucial aspects of creating your IA are the hierarchical placement of the various architectural components as well as the way in which they are labeled and presented.

Unless your website or application follows a standard format, drawing out anything beyond the top level is very challenging when building IA from scratch. It would be like asking a mechanic to assemble a car from the top down as opposed to piece by piece. Every component needs to be built ahead of time, requiring research, design, and development time. With IA, the same holds true.

Putting visual hierarchy on display helps with IA in a number of ways, including better context for the reader and generalization of important areas of the product. The homepage will have the most touchpoints and the greatest value to the product if the main function of your app is the ability to order a ride (just like in Uber or Lyft). Regarding the visual hierarchy, the same will apply.[10]

CONCLUSIONS TO CHAPTER 2

In the ever-evolving and safety-sensitive field of aviation, adherence to international safety standards remains a cornerstone for service providers, particularly airlines. The effective implementation of a SMS is instrumental in upholding the highest levels of operational safety.

The Safety Risk Management (SRM) process, as detailed in this chapter, forms the bedrock for identifying and mitigating risks. Through a structured hazard identification procedure, airlines can enhance the safety of their operations by proactively addressing potential risks at various stages of the operational life cycle.

The chapter delves into the importance of continuous hazard identification and the periodic review of SRM tools. The utilization of safety data for risk assessment and the implementation of data-driven decision-making further contribute to effective safety risk controls.

Safety assurance, as a crucial aspect of SMS, involves monitoring and evaluating the system's performance in line with expectations and requirements. Internal audits, SPIs, and SPTs work in tandem to confirm safety performance and validate the efficacy of safety risk controls. The management of change, discussed in the context of organizational shifts that impact safety, underscores the need for adaptability in safety risk controls. Safety promotion, emphasizes the creation of a positive safety culture through technical proficiency, effective communication, and information exchange.

The chapter concludes with a glimpse into the existing solutions for SMS teams, focusing on three systems—ASQS, ICARUS, and Centrik. The analysis of their functionality provides valuable insights for designing an automated risk assessment system tailored to the specific needs of airline SMS teams.

In the subsequent chapters, the focus will shift towards the development of a user-friendly interface for the proposed risk assessment system, drawing inspiration from core UX design fundamentals, user research methods, and information architecture principles.

3. RESEARCH PART AND PROTOTYPING OF RISK ASSESSMENT TOOL INTERFACE DESIGN

3.1. Analysis of obtained surveys and interviews results

As it was described in the chapter 2 the first stage of development of a new solution is deep dive into the details of existing tools and experience of users using them as well as their requirements. It was also stated that safety management system processes may differ in different organizations. For this project the example of the airline will be considered. Due to that the survey and interviews are conducted with the employees of one of the Ukrainian airlines.

The first step to prepare for the communication with users were learning about the services which are available on the market and functionality that they offer. Then the questions for the interview were formulated. In order to save time of the respondents some there were variants of answers for some of the questions and it was first phase of the survey. Since this airline is using Centrik(is overviewed in the chapter 2) for their processes most questions are about their experience with that service. Here are provided charts which show the answers to questions in percentage.

1. Please rate how satisfied you are with the Centrik service? Responses diagram is on the Figure 3.1.

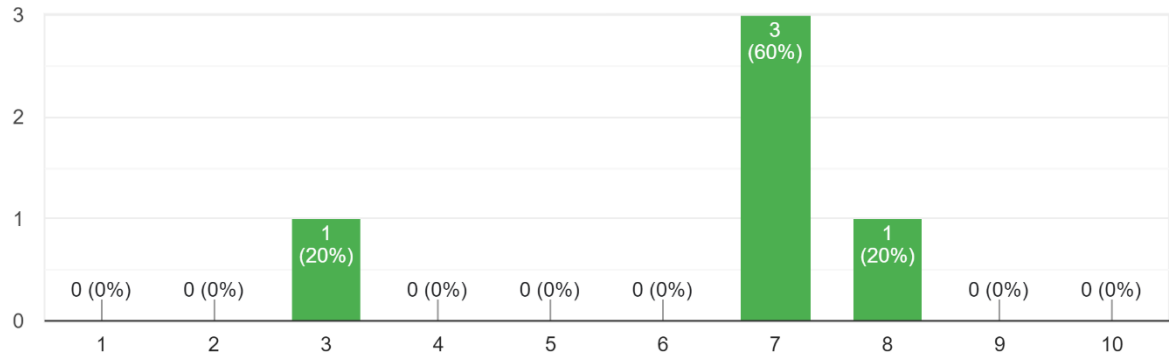


Figure 3.1 – Response Diagram

2. Is it easy for you to navigate the system and perform tasks? Responses diagram is on the Figure 3.2.

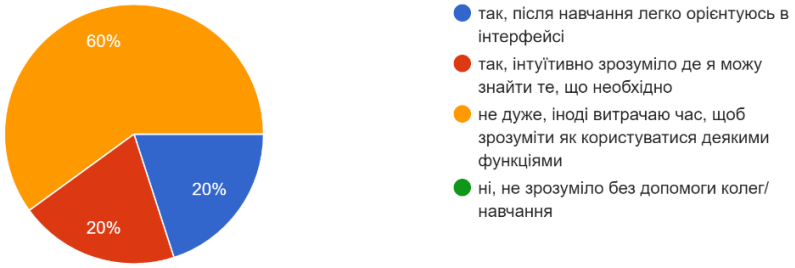


Figure 3.2 – Response Diagram

Blue – yes, after training it easy to navigate within interface

Red – yes, it's intuitively clear where I can find what I need

Orange – not much, sometimes it takes time to find out how to use certain tools

Green – no, it's not clear without external help from coworkers or additional training

3. Do you use other services in your work? Responses diagram is on the Figure 3.3.

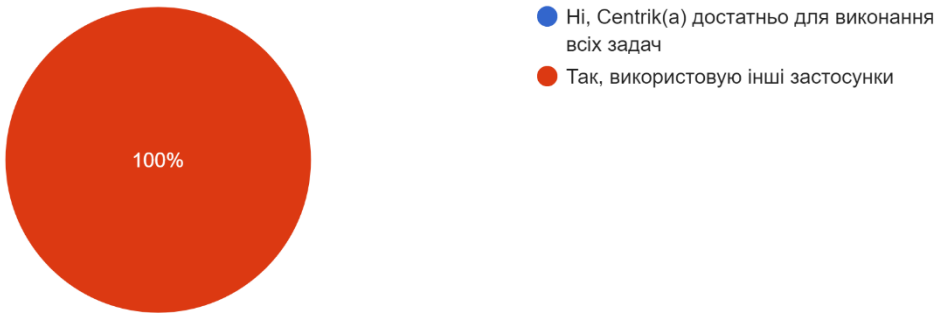


Figure 3.3 – Response Diagram

Blue – no, Centrik is enough for all my tasks

Red – yes, I use other services

4. If the answer to the previous question is yes, which services do you use? Responses diagram is on the Figure 3.4.

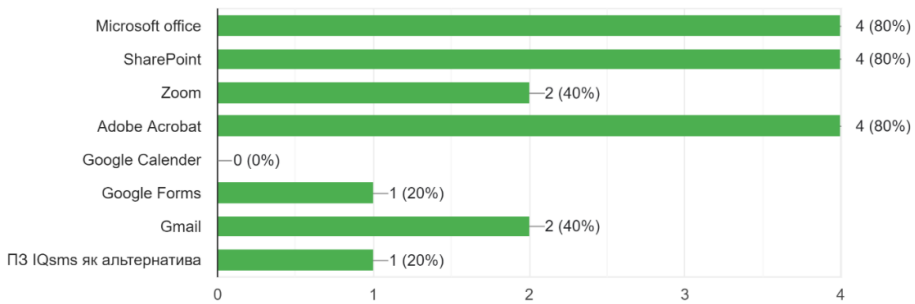


Figure 3.4 – Response Diagram

5. What Centrik features are important to you? Responses diagram is on the Figure 3.5.

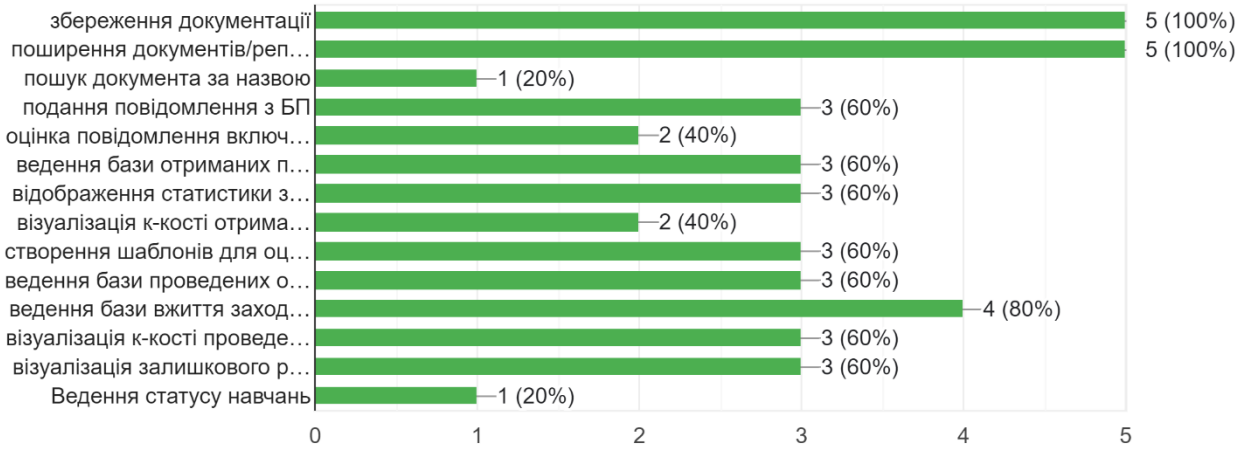


Figure 3.5 – Response Diagram

1. Storing documentation
2. Sharing documents/reports for familiarization/signing
3. Searching document by title
4. Sending safety report
5. Processing report including classification, investigation and involving stakeholders
6. Reports register
7. Showing statistics of chosen reports category during certain period
8. Visualization of quantity of reports and their classification
9. Creation of templates for risk assessment
10. Maintaining a database of risk assessments
11. Database of mitigation actions for reducing risks/hazards
12. Visualization of number of conducted risk assessments showing parameters
13. Visualization of residual risk
14. Training status storing

6. Responses diagram is on the Figure 3.6. The system should include the following processes:

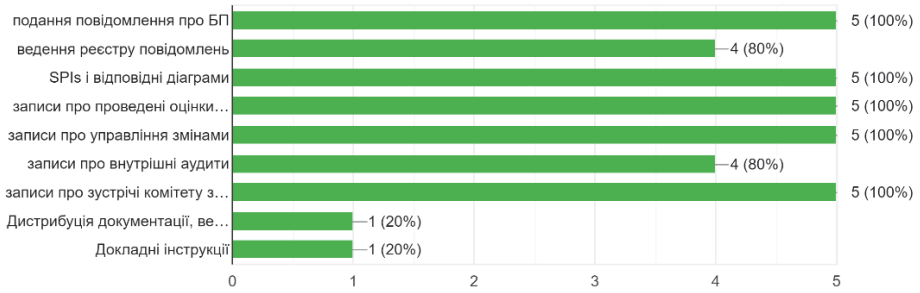
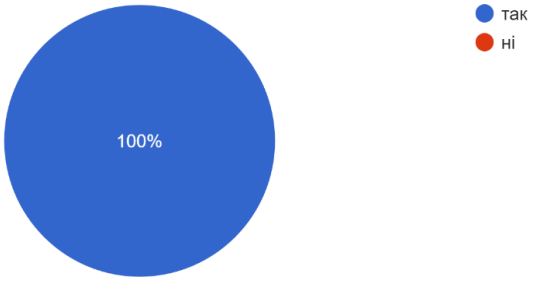


Figure 3.6 – Response Diagram

1. Submission safety report
2. Maintaining of reports register
3. SPIs and correspondent diagrams
4. Notes about performed risk assessments
5. Notes of management of change
6. Notes about internal audits
7. Notes about safety committee meetings
8. Distribution of documents, conducting trainings
9. Detailed instructions

7. Do you find it useful to be able to quickly go to the websites you use for work, eg EASA/SAA/etc? Responses diagram is on the Figure 3.7.



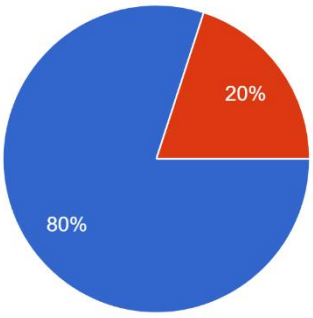
Blue – yes

Red – no

Figure 3.7 – Response Diagram

8. What websites do you visit most often in your work? *EASA, НБРТ, AAIB, aviation safety network, FAA, CAA UK, SAAU, ICAO*

9. In your opinion, would it be useful to be able to describe the potential threats that need to be reported to flight safety department on the page that precedes the notification sending? Responses diagram is on the Figure 3.8.



Blue – yes

Red - no

Figure 3.8 – Response Diagram

10. What information is most important to you when you receive a message concerning flight safety? Responses diagram is on the Figure 3.9.

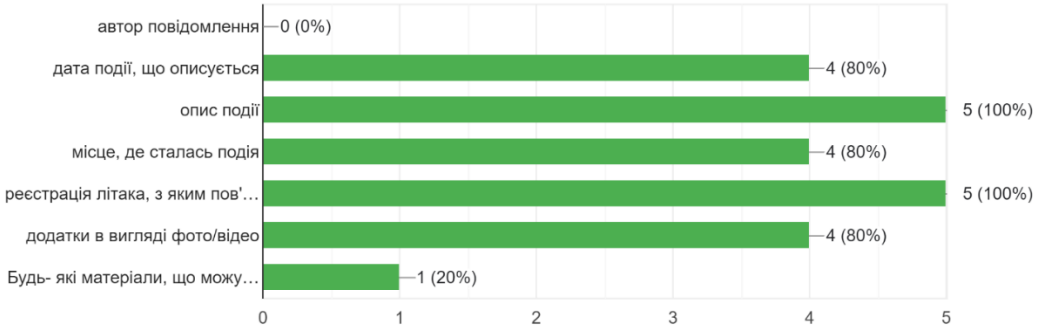


Figure 3.9 – Response Diagram

1. Author of report
2. Date of event
3. Description of event
4. Location of event
5. Involved aircraft registration
6. Attachments like photo/video
7. Any materials that can give more detailed picture of what has happened

11. What stages of working with the message do you consider necessary? Responses diagram is on the Figure 3.10.

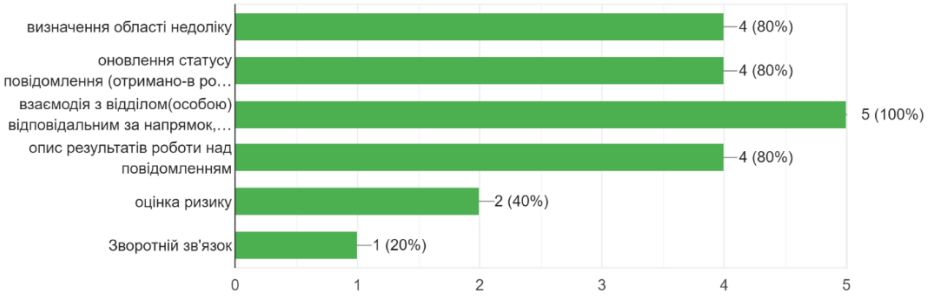


Figure 3.10 – Response Diagram

1. Defining area of deficiency
2. Updating status of report (new – in progress – closed)
3. Communication with division/person responsible for the area that report is about
4. Description of the results of report processing
5. Risk assessment
6. Feedback

12. Which of the following is important when working on a message? Responses diagram is on the Figure 3.11.

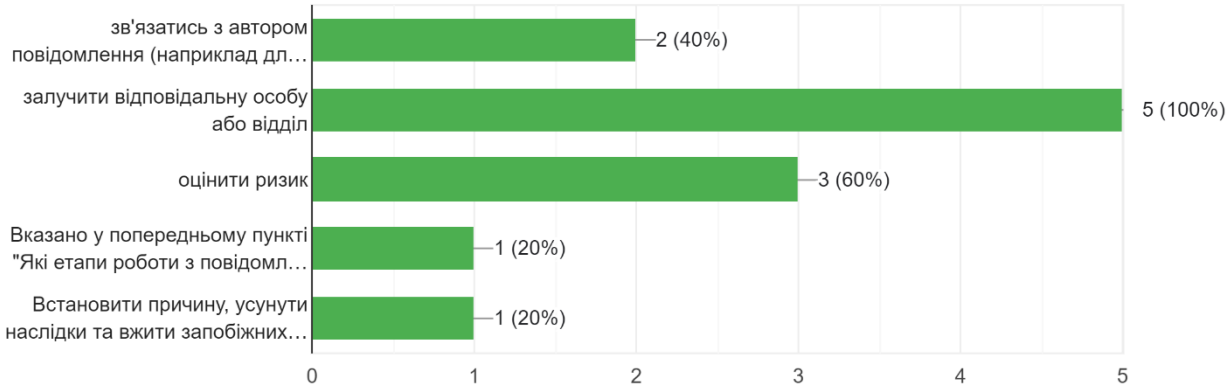


Figure 3.11 – Response Diagram

1. Contact the author of report (e.g. for clarification)
2. Involve responsible person or division
3. Assess risks
4. As in previous question
5. Define root cause, eliminate the consequences and take precautions

13. When viewing the database of received messages, which parameters are important for you to filter messages? Responses diagram is on the Figure 3.12.

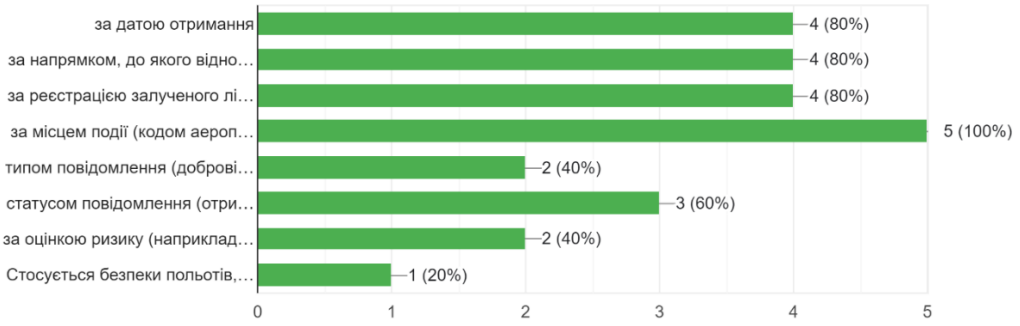
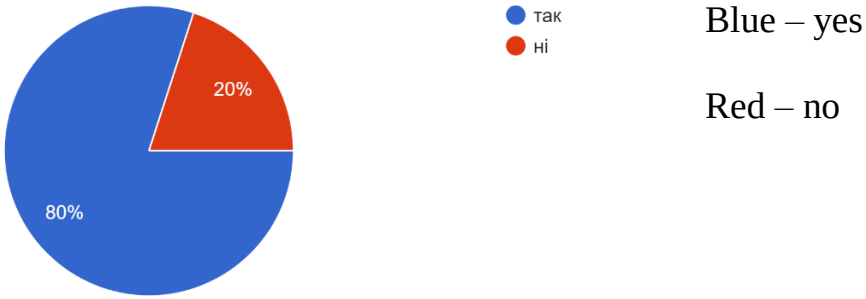


Figure 3.12 – Response Diagram

1. By date of receiving
2. By direction that it refers
3. By registration of involved aircraft
4. By location (airport code)
5. By type of report (voluntary/mandatory)
6. By status of processing (new – in progress – closed)
7. By risk index (for example show only the highest)

14. Do you find it useful to be able to automatically generate hazard reports from received messages in different directions? Responses diagram is on the Figure 3.13.



Blue – yes

Red – no

Figure 3.13 – Response Diagram

15. What risk assessments are necessary for you? Responses diagram is on the Figure 3.14.

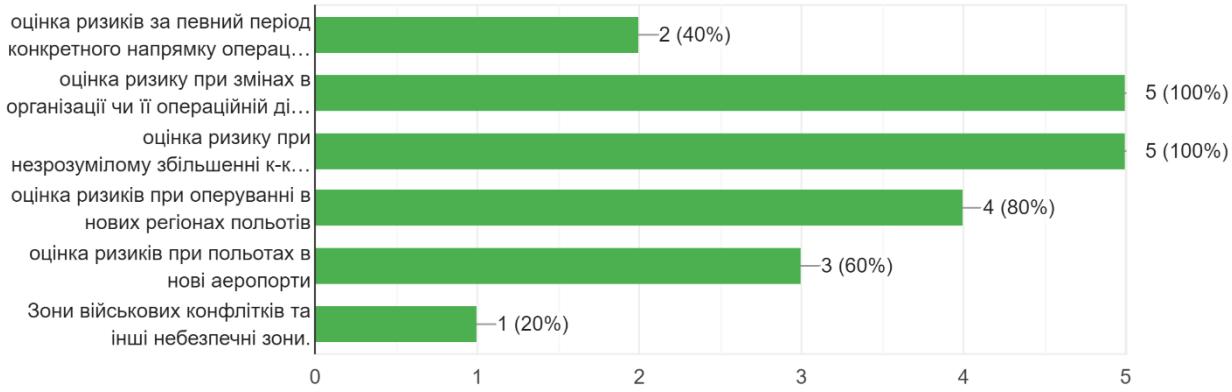


Figure 3.14 – Response Diagram

1. Risk assessment for a certain period of a specific direction of operating activity
2. Risk assessment in case of changes in the organization or its operational activities

3. Risk assessment with unexplained increase of safety related events or non-compliance
4. Risk assessment when operating in new flight regions
5. Risk assessment when flying to new airports
6. When flying over battle zones or other hazardous areas

16. Do you find it useful to be able to receive reminders about pending processes or involve you in a certain process, or the appearance of documents that you need to familiarize yourself with? Responses diagram is on the Figure 3.15.

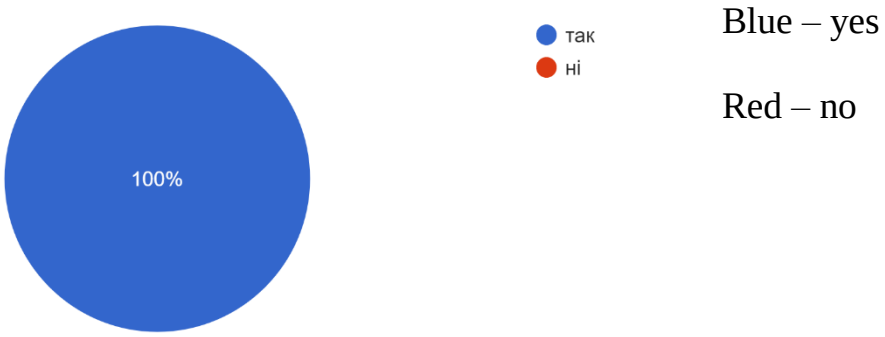


Figure 3.15 – Response Diagram

Then respondents were asked to answer open questions and that are the key points of their responses:

1. How does the service meet your needs? *"there is a problem of customization, since developers are not always able to perform the tasks" "Availability of a flight safety notification system, work with risks, distribution of documentation with familiarization tracking, training.", "Its multifunctionality", "First, you can implement ideas, most fields can be changed, defined as mandatory. Secondly, you can add a pop-up additional list of questions when selecting a field. Thirdly, the system displays a message on the home page that something has not been viewed", "it is almost perfect for working with documentation in terms of familiarization of personnel with documents, storage of documents, relevant and withdrawn from action"*

2. Please tell what you like about Centrik? *"Available tools for sending and working with messages, working with risks, distributing documentation, conducting training.", "Yes, they understood the interface, emerging messages and the ability to*

involve other colleagues, the signature system", "it is quite easy and simple to find documents that regulate the company's activities"

3. Please tell what you don't like about Centrik? *"The interface has been customized for some specific company and the software coloring is not flexible to adapt to the needs of the company. Therefore, in some areas, company procedures need to be changed to reflect the centrik's interface.", "Due to the difficulty of use at the beginning of work, not all functionality is described, it is impossible to configure some placeholders.", "The instructions are insufficiently informative, the functionality of Centrik is not well disclosed", "It takes a long time to wait for a response from the developers, some fields cannot be renamed or changed"*

4. Perhaps there is information about required functionality or risk assessment processes that you would like to share, you can do so here

"All of the above, joint work with risks involving specialists from other divisions (safety officers)", "Making predictions based on risk assessment would be cool"

Analyzing obtained answers, the conclusion can be made that the necessary resources safety team uses for their work are Microsoft office, Sharepoint, Adobe Acrobat. These programs allow to create documents, tables, calculations, send emails, communicate in chats and video/audio calls, assign tasks and monitor calendars and work with documentation.

The other significant issue is the functions necessary for full meeting the needs of workers. The most important functions of the system are document storing, sharing and signing; safety reporting, database of messages (risk register), risk assessments and information about mitigation actions that were applied; SPIs monitoring, notices of safety action group meetings. These are essentials for the system, but actually safety team needs to have wider possibilities for successful performance.
As for the safety reporting it can be summed up that the most important information that safety team should be provided with are description of the event that is being reported, involved aircraft registration, date and location, possibility to attach photo/video/report etc. The author of the message should define which of the divisions their report is concerning, but it should be possible to be edited by safety team.

The process of working with report includes next steps: involvement of employees from division that is responsible for the issues that report is associated with; updating the status of the work process on that report; description of the results of taken actions; assessing the risk; giving feedback.

While working with database of the reports it is necessary to have the opportunity to filter reports by date, area of deficiency, involved aircraft registration, event location, status of the report processing. Attractive feature would also be automatic creation of hazard reports with some initial settings by parameters.

Concerning risk assessments should be stated that the most important assessments are management of change, risk assessment associated with unclear increasing of number of events or non-compliance with regulatory requirements. An attractive feature would be personalized reminders about unfinished processes or involving in a certain process, or the appearance of documents that they need to be familiarized with.

Having the analysis of similar services to the one that is going to be developed and shared experience of the users, the user stories can be created. An informal, broad description of a software feature written from the viewpoint of the end user is called a user story. Its goal is to clearly state how a software feature will benefit the user. User stories are great tool to formulate the requirements for the info-tech project. User stories have a formula: As <a user persona>, I want <to perform this action>, so that <I can accomplish this goal>.

There are several user stories for the project shown on Figure 3.16:

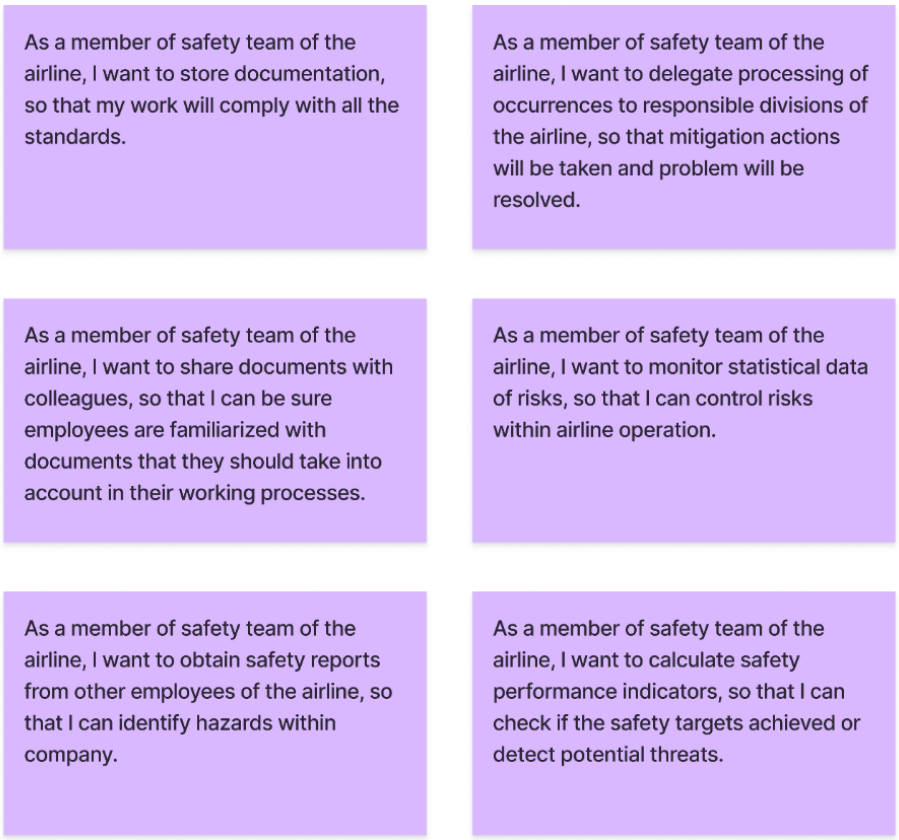


Figure 3.16 – User Stories

We can assume that according to the written user stories the main functions that should be implemented into the system are possibility to store documents, share with colleagues and provision of the evidences that employees are familiarized with documents, there should also be safety reporting tool, workers should have the possibility to submit reports and safety team should be able to obtain these reports and process them, classify and delegate for taking measures, there should be instruments to monitor statistical data and safety performance indicators for the compliance with standards and ensuring safety of performance of airline.

3.2. Graphical realization of informational architecture

The next step is creation of the informational architecture of the service. Theoretical information about that stage of developing is given in 2.3.3.Informational Architecture In order to visualize hierarchy of the service we should take into account all previous conclusions that were made after conducting interviews and surveys, key points of comparison of existing systems and taking into consideration functionality that should be present we start to create IA. In Figure 3.17 we see that service will have

5 main sections which will be included on the home page – the first page after authorization that will appear. Each section is divided to subsections for easier navigation.

Lets consider each of sections one by one. The first one will be “Reports”, it consists of such parts as “new report” which means there should be provided possibility to submit report, should be clarified that even though we look at the system from the perspective of safety team member, the possibility to send report that might concern safety should be given to everyone within the airline and its supplementary organizations. Then there is “cases” which stand for collection of all reports, including those that are new, in the process of resolving and those that are closed – work on them is finished. Then we have “assignments” it is section for convenience of work process organization, there will be information about tasks that were assigned to the user or any update on the processes that user is involved to.

Then we see next big section – “Assessments”, there should be included everything associated with risk assessments for instance storing of all conducted risk assessments, possibility for users to create and save templates for future assessments and SPIs calculation is also included in this section since it is a important part of risk management. Airline that is considered for this project has such types of risk assessments as: Management of Change, Hazard identification and risk assessment minutes, Safety Action Group minutes, therefore they are included into predefined templates but there is also a room for creation totally new risk assessment template correspondent to the particular needs.

Then we got “Documentation” it also consists of several branches, because SMS documents of airline are grouped into different folders in order to easily find whatever might be needed.

Then there is “Training” module, where such categories as SMS training materials which can include documents for familiarization, presentation, videos, etc can be published and separate page for database of training records of all employees who had have this training and completed the test to ensure that they gained knowledge and understanding of the SMS functioning within airline they are working for.

The last section is “Planning” it isn’t some kind of necessity but it is indeed attractive feature to make notes about your work plans and processes that can take some time period.

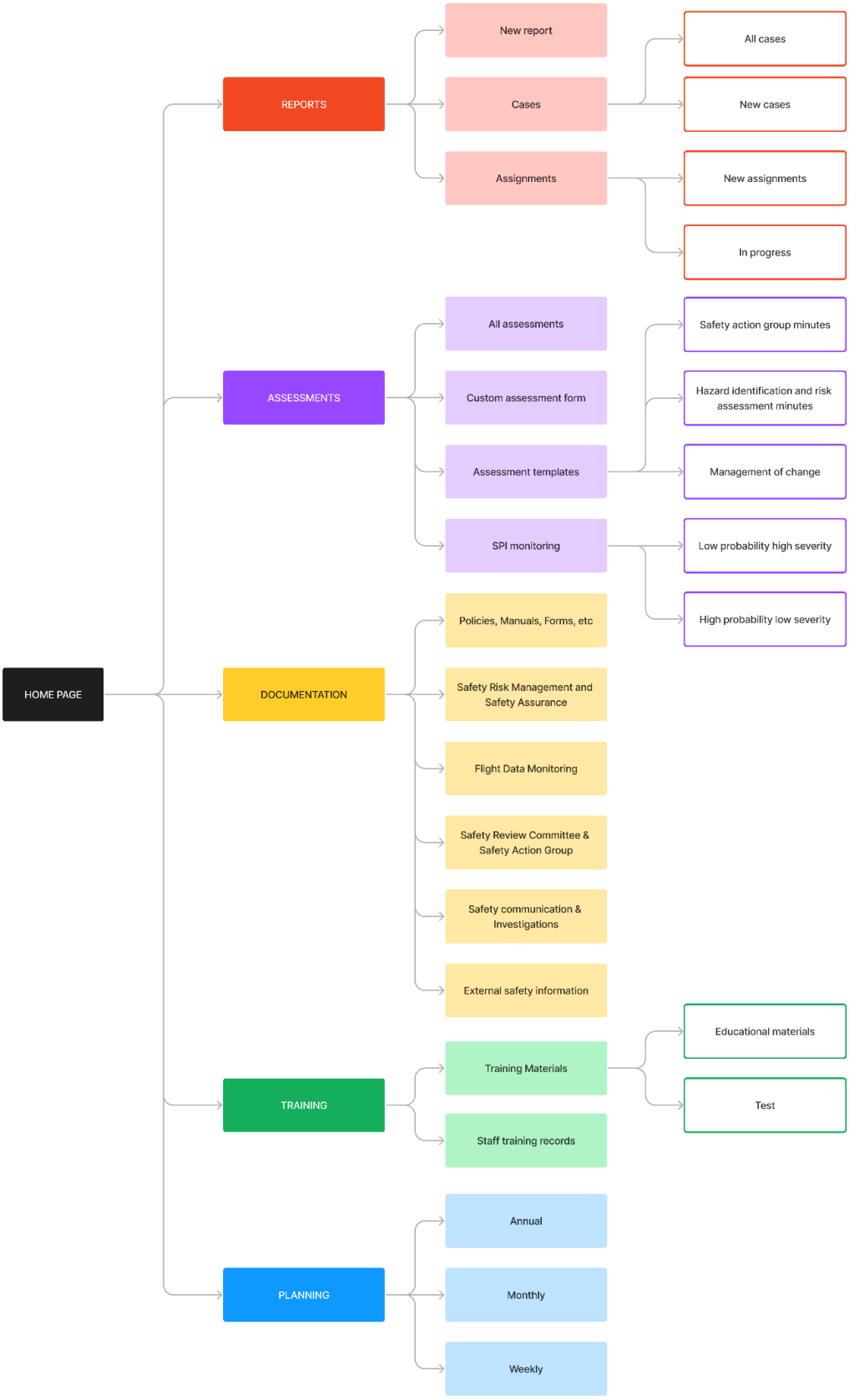


Figure 3.17 – Informational Architecture

3.3. Prototyping and testing of interface design of a system for automated risk assessments for airline

Having finished creation of IA the prototype can be made. Prototype is a technical visualization of of future interface it is usually created in order to anticipate possible paths of user within interface, to help to design and to estimate future functionality as well as define the timeframe of developing. In real development teams and production process prototypes give a chance to validate current hypothesis by conducting test and keep costs low because it is cheaper to make edits on the stage of prototyping. For the creation such service as Figma will be used.

Prototype of the interface design of the service for automation of risk assessment processes is given on Appendix A and Appendix B. There are presented five screens of the future service which show what elements, patterns and layouts will be there. Prototype does not present the real coloring, does not contain illustrations or any graphical design elements it focuses on functional content and the way that content will be arranged on the screen. In order to achieve the goal of this project it is not necessary to present every screen that will be present in real “live” service it is enough to just display main pages that shows in what way it is going to work and what possibilities safety teams that will implement this service will be provided with. It is also worth mentioning that due to the peculiarities of organizations that could adopt this service it will definitely be modified and customized for each individual airline therefore there should be provided just basic screens and features in order to give clear picture of the capacity of the service and what tasks it can work with as well as how to use all the offered features. On the Appendix A Figure 1 will be shown prototype of the “Home page” of the service, in the upper part we see general navigation also known as menu where users can switch between pages and work on the one they need, and menu consists of all the sections that were included in IA as the highest elements of the hierarchy. Then in the right part of the screen above centerline we can see links to the websites that are useful for work of safety team and this information were obtained while interviewing part of the research and is described in 2.3.2 Research. Then we see tabs that shows new documents publications that user should be familiarized with so

this is highlighted on the home page in order to be easily accessed, as well as shortcut to the work user was doing and not finished yet and new assignments to the user, so they can easily switch between tabs and choose whatever is needed. It is the same with recently obtained safety reports, new comments and probable tags of user in the report processing part that user should be aware of. Clearly it was placed on the first page that user opens in order to draw attention because it is something new or urgent so needs to be highlighted.

Then on the Appendix A Figure 2 we see another important page – Reports. There is menu in the upper part of the screen and we see also side menu to switch between sections, it can also be hidden in order to extend displaying of necessary tab. On this page user has access to report processing which consist of such parts as:

a) safety reports register which contains reports (can be shown all or just new) and risk register;
b) and assignments which contains users work in progress and new assignments.

There are also buttons for filtering and statistical report creation, since it was attractive feature while conducting survey.

The next shown page is page of just Report, it is on Appendix B Figure 1. There depicted the way report itself is going to be represented, so there are information about event, description of the event, possibility to check attachments, comments section, history to show who and when changed anything about the report. There are also such crucial for risk assessment sections as Actions where safety team outlines what can be done to reduce outcome of event and Defining risk where risk area category and outcome are defined.

Then we move to Appendix B Figure 2 which represents page of Assessments, and there user is given the opportunity to work on risk assessment which in our service consists of:

a) Assessments contains templates for assessments that were made, drafts that are in the process and possibility to check all the assessments that were performed;

b) Analytics which contains SPIs calculation and monitoring,

The last but not least is a page Documentation, look for Appendix E, there are all safety team documents stored and safety team member can easily set distribution or track familiarization among employees.

It should also be emphasized that such projects are big iterative process of development, testing, editing, adding new features and improvement. Therefore, this project focuses on creating Minimum Viable Product (MVP). Eric Ries defined an MVP as that version of a new product that allows a team to collect the maximum amount of validated learning about customers with the least effort. [13]

It's the quickest and least risky method for completing the validated learning loop (Build-Measure-Learn). The idea of MVP is based on the principle of creating a real product that you can offer to customers and track how they actually use it. It is far more accurate to observe real user behavior with a product than to merely inquire about potential user behavior.

In general, it means that development team can release project earlier that it becomes “perfect”, there is no need to implement many features into the product if they will not be used or users do not need them, because development is expensive and long process and if it should pay off.

Detailed overview of each function of the developed service will be given in Chapter 4.

CONCLUSIONS TO CHAPTER 3

In the course of delving into the intricacies of safety management systems and their diverse applications, this chapter has steered through the foundational stages of crafting a new solution tailored to the specific needs of the aviation industry. Beginning with a meticulous exploration of existing tools and user experiences, the research journey took a profound turn towards the unique processes embedded within the operations of a Ukrainian airline, utilizing Centrik as a primary focal point.

The strategic preparation for user engagement unfolded through a comprehensive survey and interviews with employees, unraveling critical insights into the tools currently employed and the functionalities deemed indispensable for effective safety management.

However, as the chapter meticulously unfolded, it became evident that existing tools, while foundational, fall short of meeting the comprehensive needs of safety teams. The identified gaps coalesced into a set of essential functions necessary for full-fledged performance. These encompassed document storage, sharing, and signing, safety reporting, a database of messages (risk register), risk assessments, and insights into applied mitigation actions, SPIs monitoring, and notices of safety action group meetings.

The chapter culminated in the formulation of user stories, serving as informal yet potent descriptions of software features from the end user's perspective. These narratives set the stage for the creation of an Information Architecture (IA) and, subsequently, a prototype. The prototype, devoid of graphic embellishments, provided a functional visualization of the interface, offering a sneak peek into the envisaged service's main pages, functionalities, and user interactions. As the narrative unfolds, it becomes apparent that this project is not just a linear development but an iterative process aiming for a Minimum Viable Product (MVP) that aligns with user needs and optimizes the balance between functionality and resource investment. This iterative approach ensures that the eventual product is not just a culmination of features but a finely tuned instrument that responds to the dynamic needs of safety management in aviation.

4. INTERFACE DESIGN REALIZATION OF SERVICE FOR RISK ASSESSMENT PROCESSES AND GUIDANCE MATERIAL FOR USERS

4.1. Presenting of interface design of a system for automated risk assessments for airline

Having prepared all necessary artefacts for project final stage of developing can be started. Usually UI part is associated with approving colors, typography, visual elements and style of the project. For our service were chosen font – Inter. Inter is a variable font that works particularly well in responsive designs because it can readily adjust to various screen sizes and resolutions, making content readable on a wide range of devices, including small screens.

One crucial component of the visual experience is color preference. As for the primary color and whole color palette blue and its shades were chosen based on psychological comprehension of that color.

Consider this: would you really want to create a web-service that focused on professionalism, handling money or sensitive data, or managing jobs and transactions to be bursting with vibrant rainbows of happy tones? The answer is probably no. While pink and yellow stripes or vivid splashes of color might be perfect for entertainment apps or young social networks, they just won't cut it when you're trying to convey a more serious tone. Some color schemes are just too lively or lighthearted to be truly taken seriously. When choosing color schemes for "trustworthy" or professional apps, it's best to stay away from bright colors and instead use monochromatic tones with blue integrated into the design. Why? Because blue is the color of trust and financial responsibility in addition to being a soothing, trustworthy hue. We can observe this even in the political arena: blue is typically the color of choice for conservative and centrist parties because it is perceived as the "reliable" color that can be most readily trusted with important matters. [11]. It is worth mentioning that people really like blue, and diagram on the Figure 4.1 proves it.

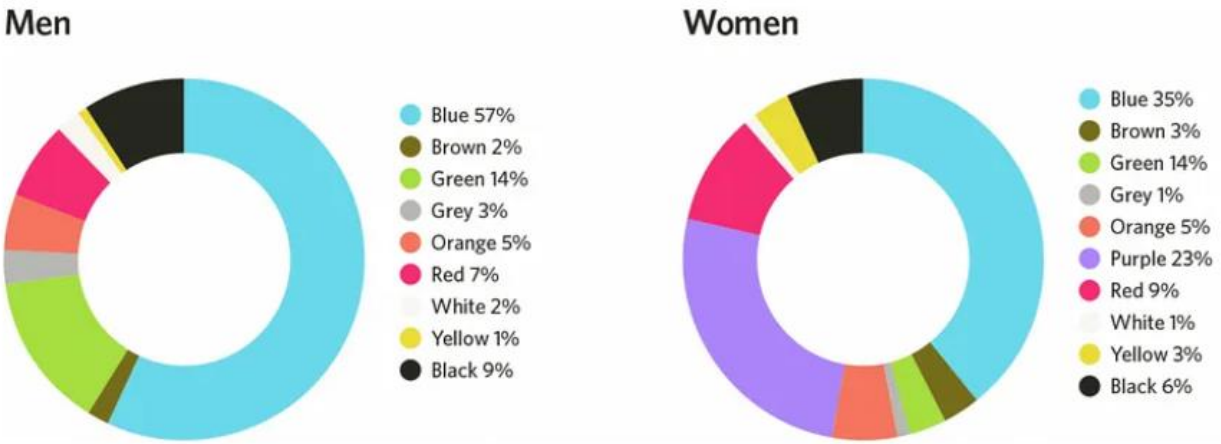


Figure 4.1 – Statistical diagram of color preferences

An important advantage of blue in the web interfaces is that it is visible to the majority of colorblind people (Protanopia and Deuteranopia). Red and green are exceptions to this rule. [12] On the Figure 4.2. we can see the difference between color perception of people with problems with vision and without and obviously blue is a good choice for inclusive interface.

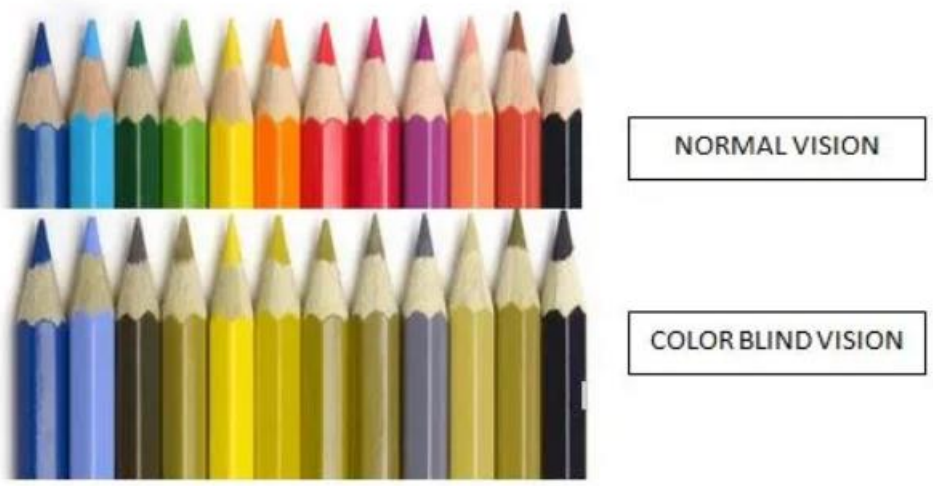


Figure 4.2 – Comparison of vision with colorblindness and without

Since this project aims to build web service for professional usage in the working environment it requires some kind of moderation and conciseness, in order to not distract user's attention from important tasks and support motivation, attention to details and thoughtfulness as the work associated with risks estimation usually involves much analytical activity. Therefore, interface design is supposed to be in minimalistic style without plenty of graphical elements that are not appropriate for the systems like

considered one. As well as we compared different systems in order to determine necessary functions, we go back to analysis of visual part of the interface, its up-to-dateness in terms of design, layouts, shapes, sizes of elements and the way it contributes to general experience of interaction with system. In chapter 2 for the purpose of investigation such systems as Centrik, ASQS and ICARUS were overviewed and on current stage we go back to estimate visual impressions. Just like it was stated before all of the interfaces do not contain unnecessary graphic elements that do not have functional sense. Interfaces encourage users to concentrate on their tasks. In order to have wider variety of references for creation high quality tool for work it is suggested to consider other systems that are created for other industries and fields of occupation just to analyze patterns of design and adopt best practices. For this purpose, Atlassian products can be considered. Atlassian offers software solutions. By using their tools cooperation and teamwork can be improved in results-driven company. One of the most popular products among developer's teams of the Atlassian products is Jira. Jira is made in light colors with blue as an accent color, its design can be described as discreet, user-friendly, intuitively understandable.

On the Figures 4.3 – 4.7 final results of developing – design of several screens of the service are shown. In the next part the detailed overview and instructions for users will be given.

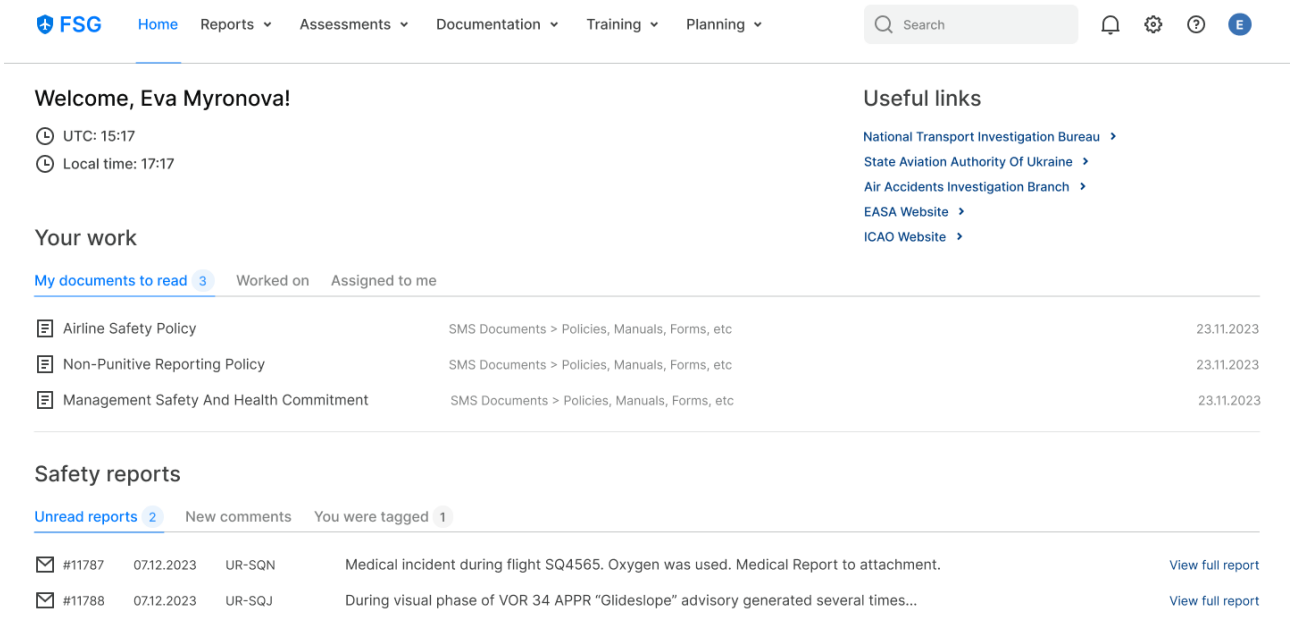


Figure 4.3 – Interface design of the main page

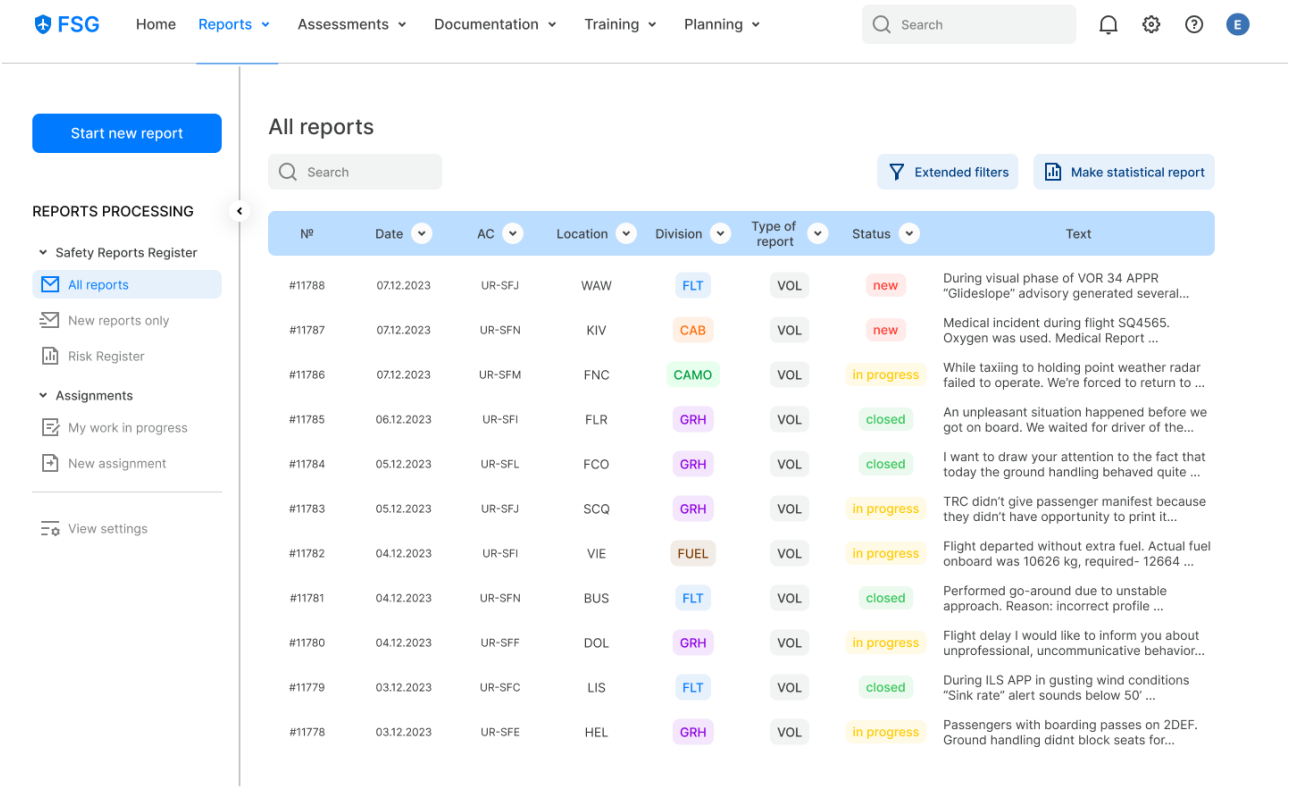


Figure 4.4 – Interface design of the reports page

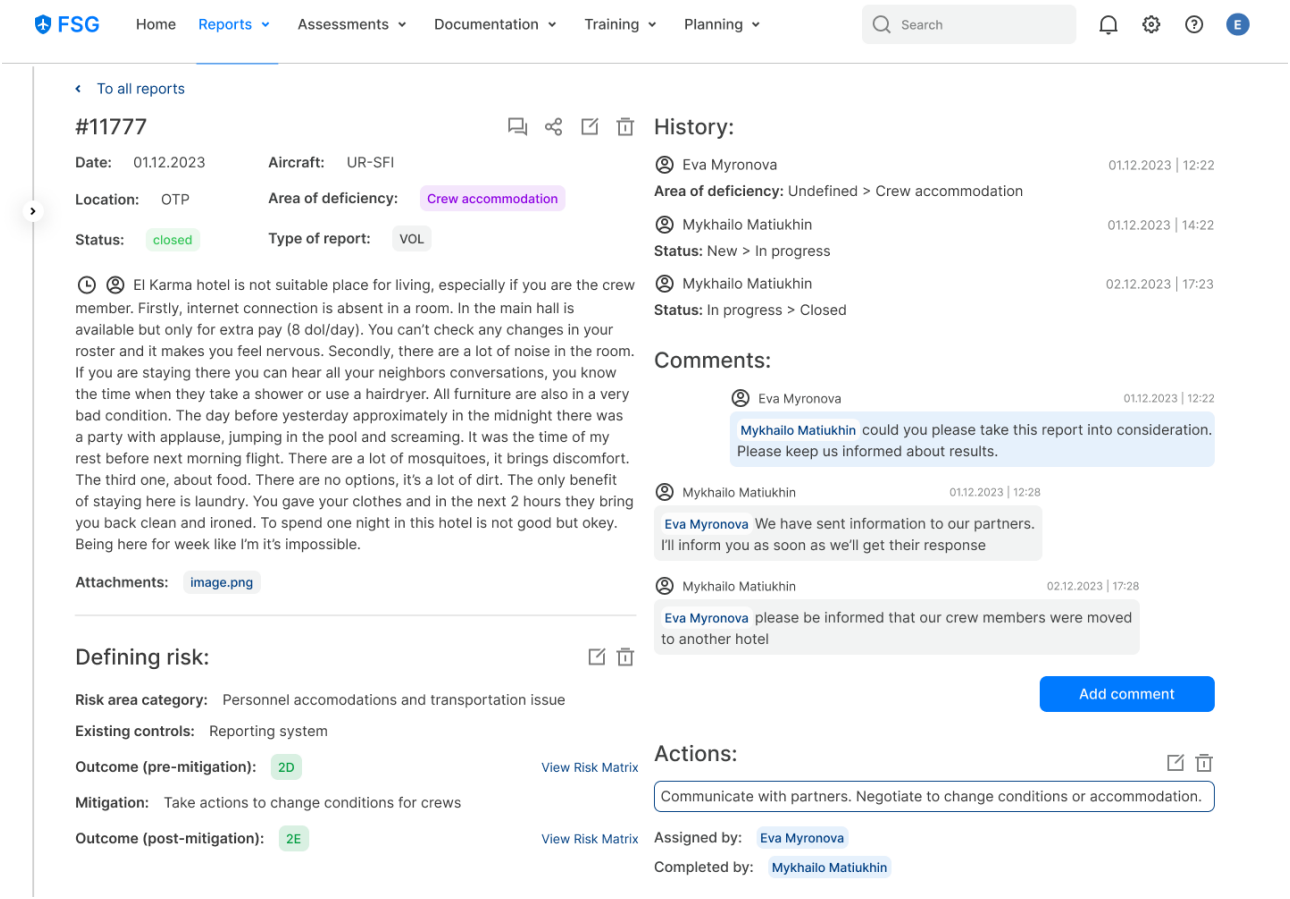


Figure 4.5 – Interface design of the report page

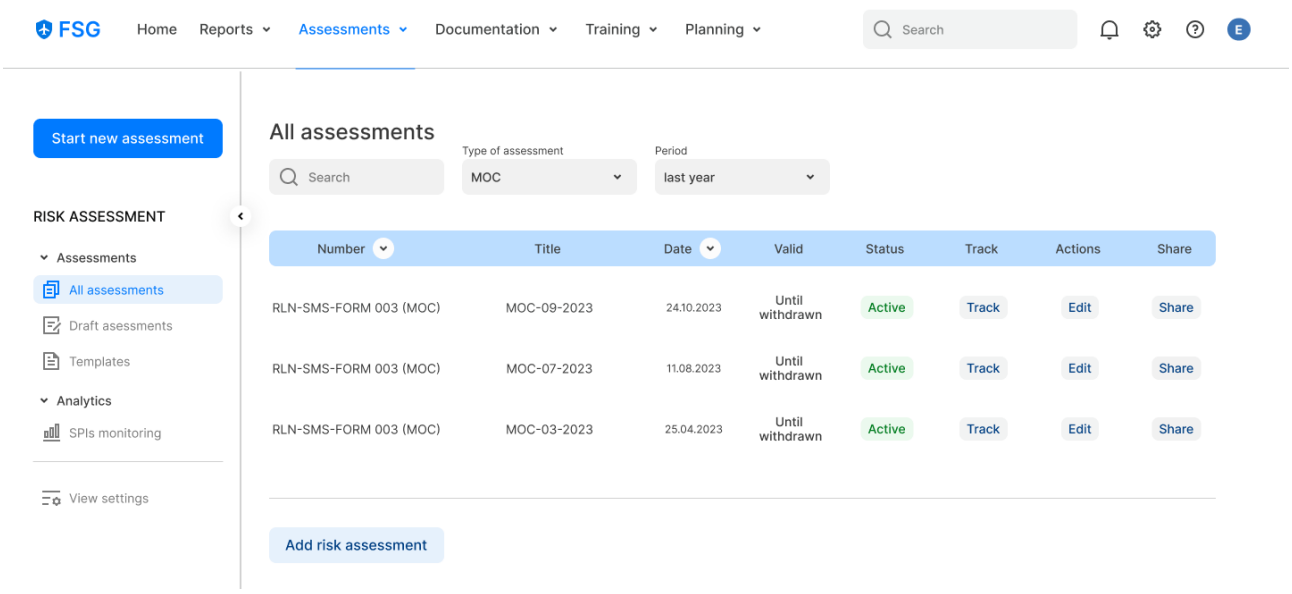


Figure 4.6 – Interface design of the Assessments page

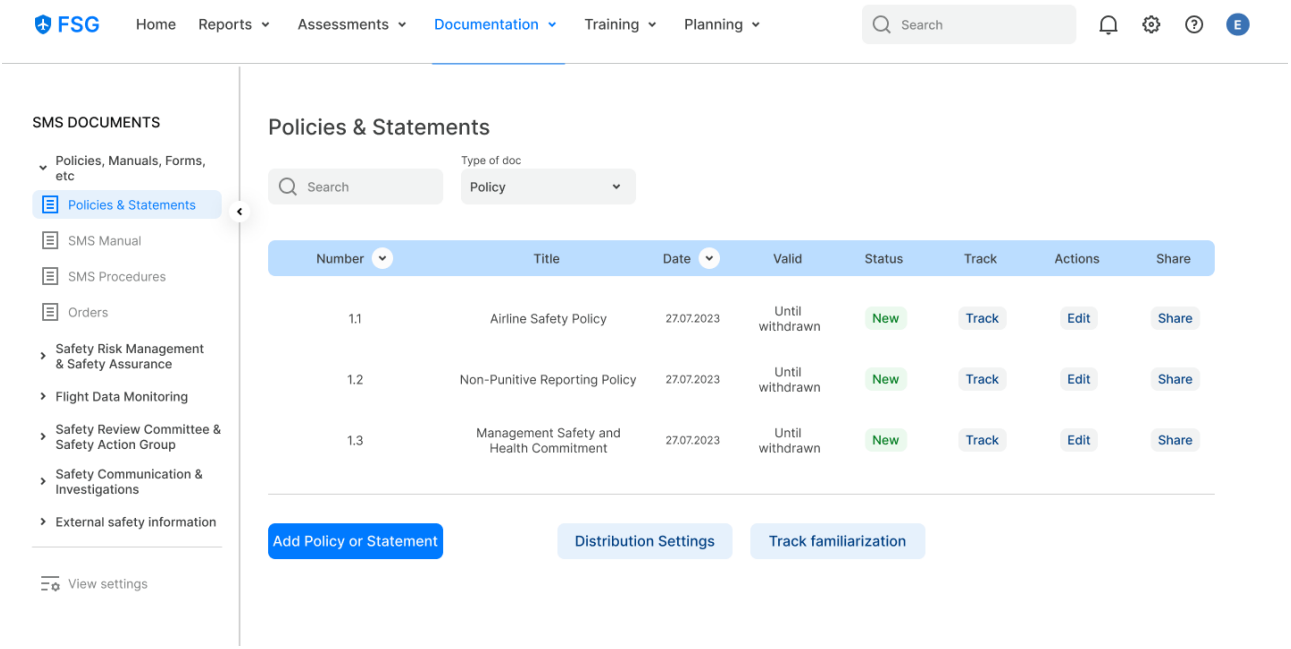


Figure 4.7 – Interface design of the Documentation page

4.2. Guide for users of the developed risk assessment service interface

Guidelines for service users are essential to build a well-organized, productive, and risk-averse workplace. By giving users a road map, they make sure that they complete their tasks consistently, clearly, and in accordance with quality and compliance standards.

For a number of crucial reasons, guidelines are necessary for service users in their work:

a) Clarity and Consistency: Guidelines provide clear instructions on how to use services effectively and consistently. This ensures that all users follow a standardized approach, reducing the likelihood of errors or misunderstandings.
b) Efficiency and Productivity: Clear guidelines contribute to increased efficiency and productivity. Users can streamline their workflows by following established procedures, saving time and resources.
c) Training and Onboarding: Guidelines serve as valuable training materials for new users. They provide a structured way to onboard employees, helping them understand the best practices and protocols associated with the services they'll be using.
d) Risk Mitigation: Guidelines help mitigate risks by outlining security measures, compliance requirements, and best practices. Users are less likely to engage in risky behaviors when they are aware of the potential consequences and the correct procedures to follow.
e) Quality Assurance: Guidelines contribute to maintaining a high standard of quality in service delivery. By adhering to established guidelines, users contribute to a consistent level of quality across the organization.
f) Consistent User Experience: Guidelines ensure a consistent user experience, regardless of individual preferences or variations in the skills of different users. This consistency is crucial for maintaining a positive and reliable service environment.
g) Compliance and Governance: Guidelines often include information about legal and regulatory requirements. Following these guidelines helps users and the organization stay compliant with industry standards and regulations, reducing the risk of legal issues.
h) Adaptability and Scalability: Guidelines can be updated to accommodate changes in technology, industry standards, or organizational needs. This adaptability ensures that users can adjust to evolving circumstances without compromising efficiency or quality.

i) Communication and Collaboration: Guidelines facilitate effective communication and collaboration among users. When everyone follows the same procedures, it enhances collaboration by creating a shared understanding of how tasks should be performed.

j) User Empowerment: Guidelines empower users by providing them with the knowledge and tools to perform their tasks confidently. Empowered users are more likely to contribute positively to the overall success of the organization.

One of the serious drawbacks of the system that is used by the safety team that was involved into survey and interviews for this project is that it is not easy to use without additional explanations and training and it would also be good to have instructions or tips inside the system in order to be able to figure out and resolve some issues without others help. That is why there is a strong necessity to provide guidelines for the users of designed service in this project. This part aims to fulfil this need and give extended explanations and instructions on how to proceed with user's tasks in the system. We will consider each functional element of the service separately in order to describe its purpose and ways to use it.

To begin with the menu of the service that is kind of a control panel with the help of which user can move from one tab to another. It is shown on Figure 4.8. This control panel will be present on each page of the service.

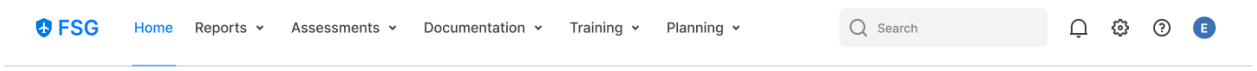


Figure 4.8 – Control panel of webservice interface

In the left corner we see logotype of the service it is abbreviation that stands for F – flight S – safety G – guardian. Moving to the right we see menu which consists of Home page, Reports page, Assessments, Documentation, Training and Planning all these are buttons by clicking on which user will be transferred to correspondent page, little arrow pointed down beside every word means that user can also chose exact section of the page that they want to open before even move to the tab. Then we see input field for search, by easy clicking there and starting to type the results of the search

within the whole system will be shown. Then we see set of symbols which are also buttons, first one – bell represents notifications that will pop up on click, it is followed by cogwheel which stands for general settings, user will be transferred to page of settings, next one is symbol of question mark, by clicking on which user will be moved to instructions and there also will be possibility to contact support of the service. Support team of the product works with requests of users, answers problematic questions and collect information about what needs to be managed or corrected inside the system in order to keep work flows uninterrupted. The last icon is an account symbol it shows the first letter of the name of the authorized user. User can open their account and make changes there if it is needed.

The next section of the Home page screen is Useful links. Figure 4.9 shows how does it look in the system.

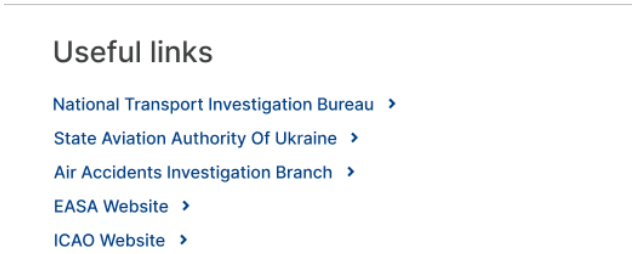


Figure 4.9 – Useful links

The list of links can be changed or expanded if user needs it. They should simply write correspondent request to developers.

Next important part of the Home page is section which consists of header – “Your work” and tabs that users can switch between: “My documents to read” with a number of documents for familiarization, “Worked on” that will open up a list of tasks that were unfinished during previous session, “Assigned to me” will disclose a list of new tasks that were assigned to the user and they haven’t start work on these tasks yet. List of documents to read as well as all other lists of above-mentioned tabs consists of title of document or assignment, then path to it and date of release. The example is demonstrated on the Figure 4.10.

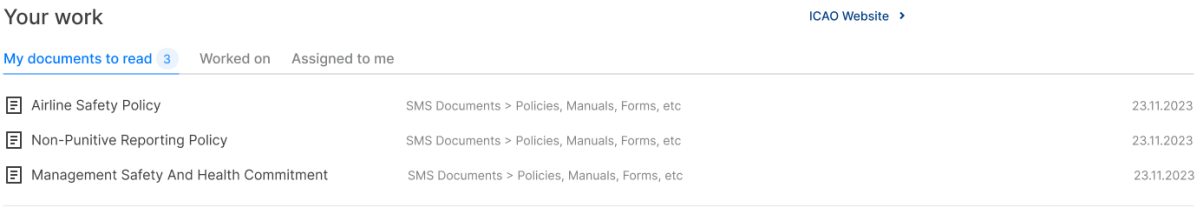


Figure 4.10 – “Your work”

The last section of the Home page is also several tabs under header that describes them – “Safety reports”. The tabs placed there are “Unread reports” that are reports that user haven’t seen yet, the list of these reports shows such information about reports as number of the report, date of submission, involved aircraft registration, short description of event and in order to view full information about the report in the right side of the screen there is a button “View full report”, by clicking on which user will be transferred to the report page; next tab is “New Comments ” this tab will disclose the list of reports, where new comments have appeared from those who work on these reports and as a safety team member user should be aware of these updates and monitor the process of resolving issues. Next tab is “You were tagged” by clicking here users will open up a list of reports where they were mentioned by other participants of the working process. For example if some one would tag user in the comments or action section in one of the reports information about it will appear in this tab. Section is shown on the Figure 4.11 below.

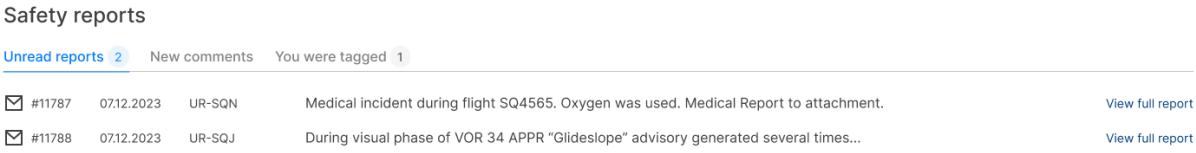


Figure 4.11 – “Safety reports”

The Home page contains shortcuts to the most visited sections of the service, so they can easily move straight to the part of the system where they are needed or be informed about something urgent.

The next page for consideration is Reports. The overview will be started with the side menu which is shown on Figure 4.12. When looking at the menu our attention is instantly drawn to the button “Start new report”. Which will open a form for filling report about events or any concerns about safety or operations of organization. There

should be reminded that even though we look at the system from the perspective of safety team member, the possibility to send report that might concern safety should be given to everyone within the airline and its supplementary organizations. Under the header “Reports processing” there are subdivisions “Safety reports register” and “Assignments”, little arrow to the left of them shows users that content inside of them can be hidden or disclosed if necessary. “Safety reports register” contains such structural elements as “All reports” that will show all the reports within one screen, “New reports only” – there will be shown selected by the system reports which user haven’t seen yet and needs to read, “Risk register” – it is a register of processed reports and will depict to the user such information as defined risk and actions (further would be given more detailed information) taken to reduce outcome. There is also “View settings” button which will allow users to change settings of the section view. And finaly should be noticed that side menu can be easily hidden in order to extend view of the main information on the screen and disclosed back by clicking on the arrow button in order to switch between sections.

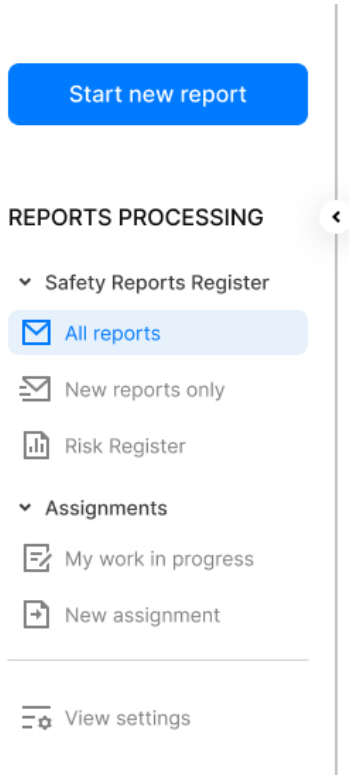


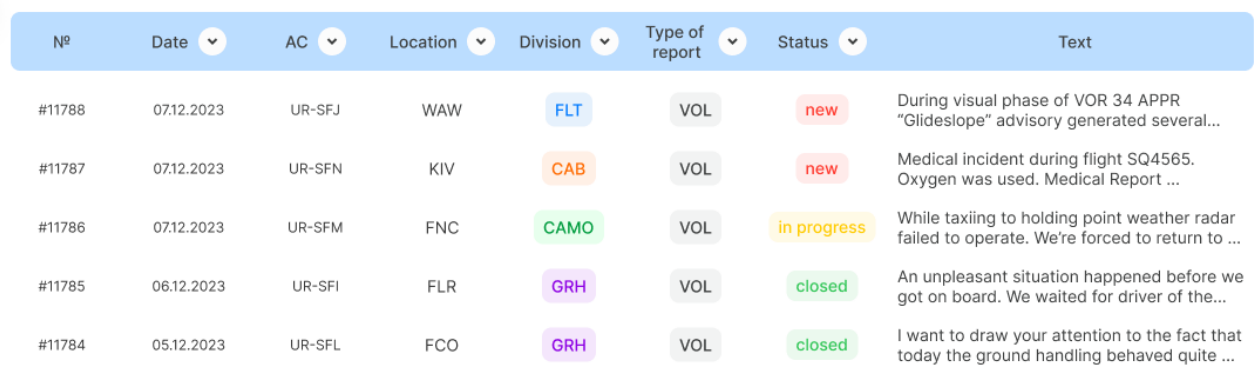
Figure 4.12 – Side menu

Lets consider the elements that are shown when user choses tab “All reports” on the side menu. It is shown on the Figure 4.13 below that there is a heading that confirms

that user is on the page where all reports are shown, under the heading there is input field “Search” for finding certain report by typing in its number. At the right side there are two buttons one of them “Extended filters” allows to set filters by which reports should be filtered and shown to the user according to the chosen parameters, second button is “Make statistical report” and it literally means that there will be opened page for chosing what reports are needed in order to create this report, there user can specify which parameters should be taken into account and what information should be placed in the report.

Figure 4.13 – Buttons

Then we look through database of reports a part of it is shown on the Figure 4.14. Above the list there are titles of every column which explains what will be shown in each of them and we also see round buttons with arrow inside wich means user can press on them and choose parameter to filter by. Now lets look at each colomn separately and discuss them. It is clear that the first one is number, second – date of receiving the report, third one is involved into event described in the report aircraft registration, forth is location where the event occurred, it is IATA airport code, and the fifth one is division of the airline that this report is associated with, it means it is the department which should pay attention to the report and resolve described issue since it is their area of responsibility. Divisions are shown as a clorful tags, each division has its color and short name, for example flight operations is shorten to – FLT and the tag is blue, cabin crew department – CAB, and their tag is orange, continuing airworthiness and maintanance – CAMO and has green tag, and so on. Then we have colomn that shows type of report. It can be voluntary or mandatory, detailed explanation is given in chapter 1. So the correspondent tag will appear in this colomn. The next is status of processing, if the report is recently obtained and employees still didn’t take it into consideration the tag “new” will be red to draw attention, if the process of resolving issue has already been started the tag “in progress” will be yellow and if the case is finished tag “closed” will be green.



№	Date	AC	Location	Division	Type of report	Status	Text
#11788	07.12.2023	UR-SFJ	WAW	FLT	VOL	new	During visual phase of VOR 34 APPR "Glideslope" advisory generated several...
#11787	07.12.2023	UR-SFN	KIV	CAB	VOL	new	Medical incident during flight SQ4565. Oxygen was used. Medical Report ...
#11786	07.12.2023	UR-SFM	FNC	CAMO	VOL	in progress	While taxiing to holding point weather radar failed to operate. We're forced to return to ...
#11785	06.12.2023	UR-SFI	FLR	GRH	VOL	closed	An unpleasant situation happened before we got on board. We waited for driver of the...
#11784	05.12.2023	UR-SFL	FCO	GRH	VOL	closed	I want to draw your attention to the fact that today the ground handling behaved quite ...

Figure 4.14 – Reports register

If user presses on the report they will be transferred to the separate page of report, where the detailed information on exact report will be shown.

Lets examine what this page contains. First of all at the upper right corner we see button which allows user to go back to all reports. Then there is a number of the report and in the opposite side there are buttons in the form of symbols. So the first one means that the author of the report is going to receive all the comments as a feedback, next sybmol will allow user to copy link to the report in order to share it with anyone even beside the organization for example pertners or suppliers who need to be aware of the described in the report situation. Next button allows to make changes in the report, for example if author was in a hurry and didn't fill the field "Date" or "Area of deficiency" or any other, safety team member will do it instead of them. Then we see several informational records about date, location, aircraft, area of deficiency, type of report and status of report. Under that part description is placed. By putting mouse on the symbol of clock or profile safety team member who is allowed to know the author of the report will see correspondent information. Under the text of the report there are attachments part, where those who works on the report can see attached media or docs for more detailed explanation and deeper understanding of concern. It is depicted on the Figure 4.15.

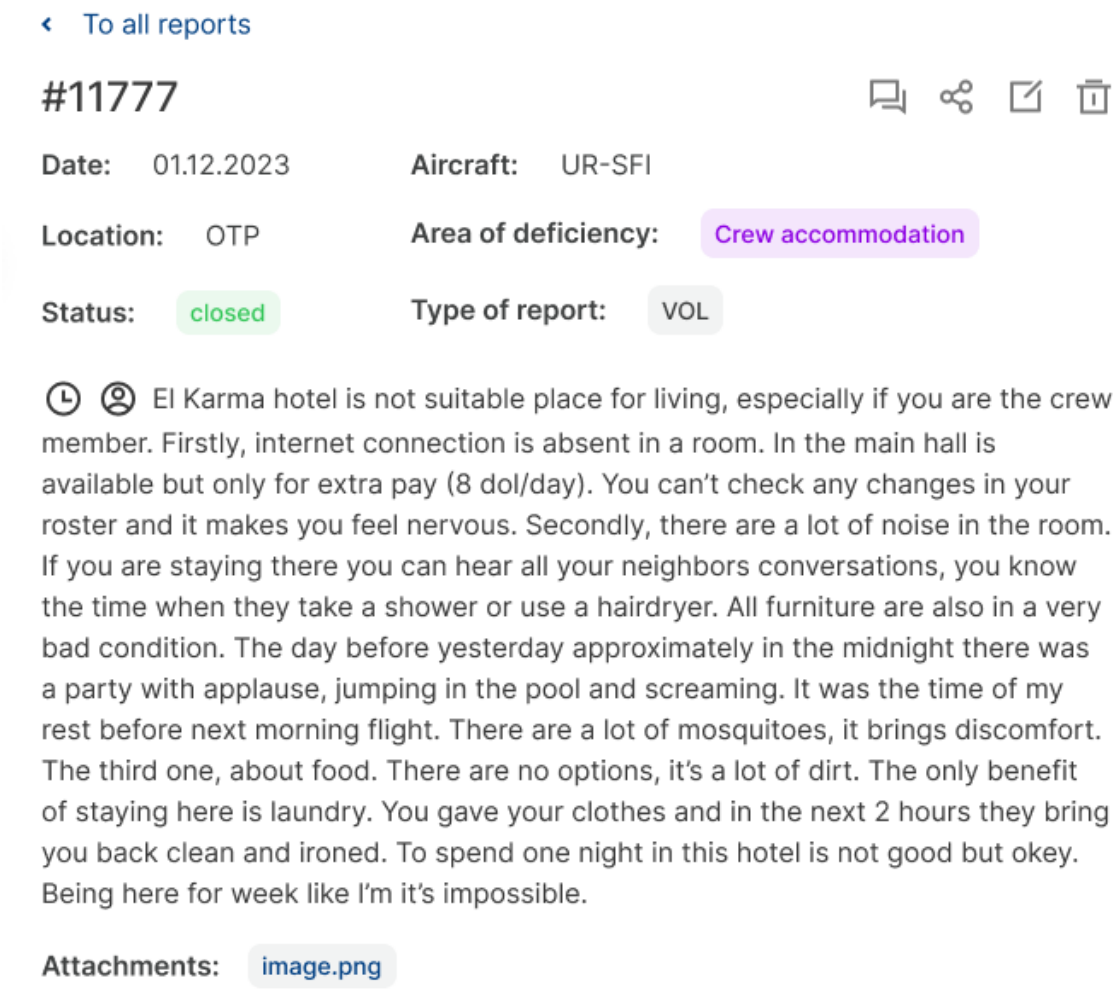


Figure 4.15 – Report description

Under the report itself we see analysis of the described event, section "Defining risk", shown on the Figure 4.16. It can be easily edited or deleted by pressing on the buttons in the right corner above all content. Section consists of "Risk area category" where risk is categorized, "Existing control" where it is specified what current measures are taken to deal with such problems. "Outcome (pre-mitigation)" is an assessment using risk matrix shown on Figure 1.4 in the chapter 1. In the end of the line there is a button that will open up the image of the matrix with explanation for users. Then "Mitigation" which shows action taken to overcome the situation described in the report it usualy refers to actions, which will be overviewed lately. The last string is assessing of "Outcome (post-mitigation)" to check if taken actions where enough to reduce risks and resolve considered problem.

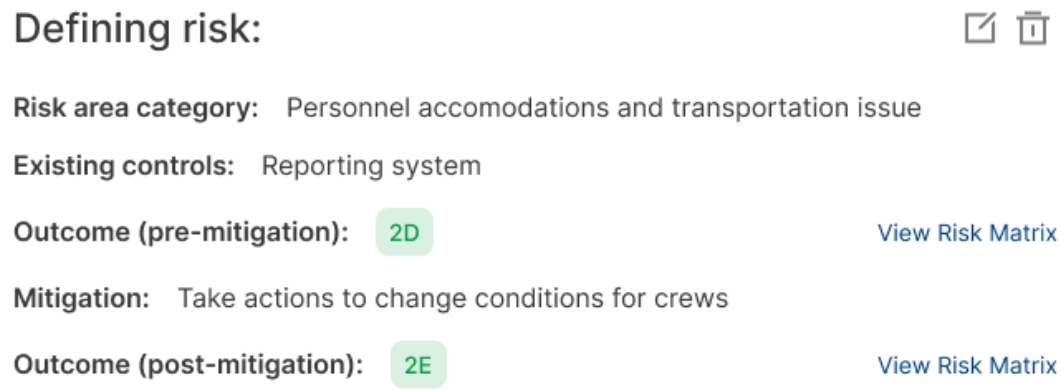


Figure 4.16 – Difining risk

The next section on the screen is History. Depicted on the Figure 4.17. It is on the figure below. It shows who and when edited report or made some changes. It is useful to understand what stages of processing where held and who was involved to resolving. It appears automatically there is no need to make records on your own.

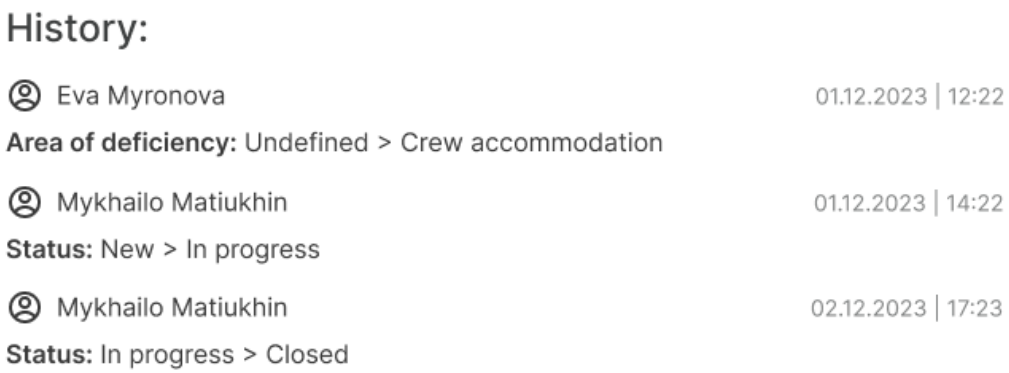


Figure 4.17 – History

Crucial section for this page is probably next one – “Comments”, shown on the Figure 4.18 below. It arranged pretty simple though informative. We see who and when has sent a comment, who was tagged and has to respond. And it should be emphasixed that if comment was sent by authorized user they will see their comments highlighted and colored in light blue. It is also obvoius how to add new comment due to noticeble button “Add comment” in the right corner and prevoius comments.

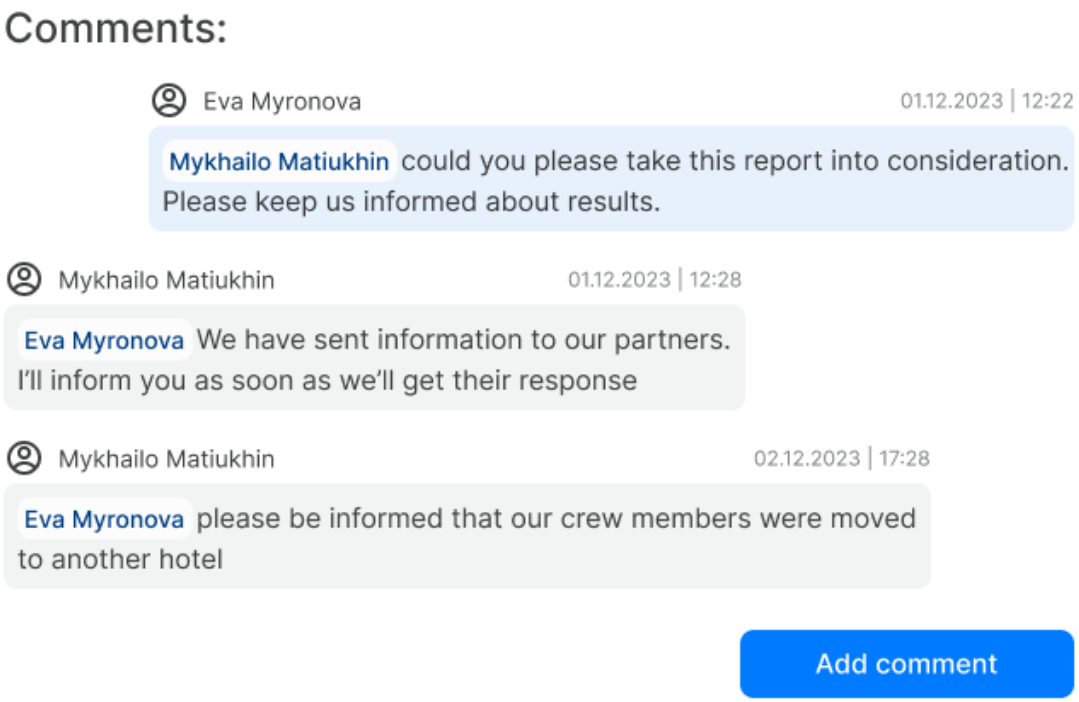


Figure 4.18 – Comments

The last but not least section on the page of report is “Actions”. There safety team member can describe actions that needs to be done to resolve the situation. Therefore there is an input field for defining actions it can be edited or deleted any time by pressing on the buttons in the right corner above input field. Under description there is assigning of the task to work on mitigation actions and also shown who it was completed by. It is represented on the Figure 4.19 below.

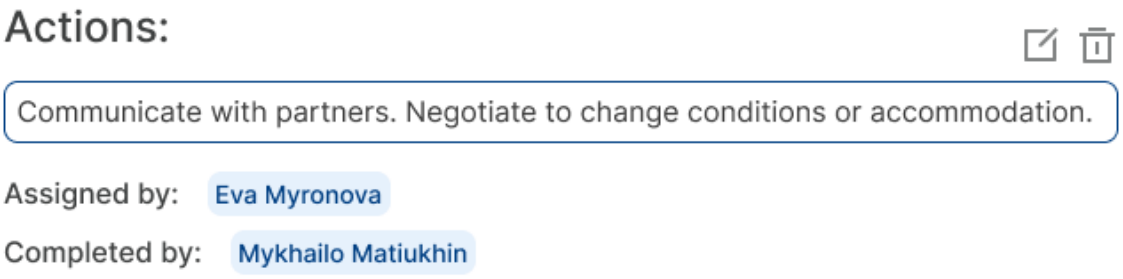


Figure 4.19 – Actions

Lets move to module “Assessments” and examine one of the sections that are accessible there and is shown on the Figure 4.20. Above all we see heading which explains where we at, then there are input field for search through the documents and drop down menu to choose category of assessment and anotherone for specifying period of time for displaying assessments released during that time. Then we see

description of each colomn with round buttons with arrow inside wich means user can press on them and choose parameter to filter by. The first colomn is number. Next colomn is Title of the document than date of uploading. Next colomn shows until when document is valid. Then we have status of the assessment for example “new” which means user didn’t familiarized themselves with that assessment, there also can be such statuses as “active” – user is familiarized and doc is valid, “on review” when there is preparation of new revision or some other which can be added by developers on demand of safety team. “Track” is a button which transfer user to the page where they can track the activity, for example who of the airline employees read the document and when. Then we see actions – “edit”, this button allows to make changes. The last colomn is share button it is easy to share document with anybody even beside the airline with the special settings of access, it is useful for example for external audits or cooperation with another organization to interchange documents. In the end button “Add risk assessment” allows user to upload new document to that section.

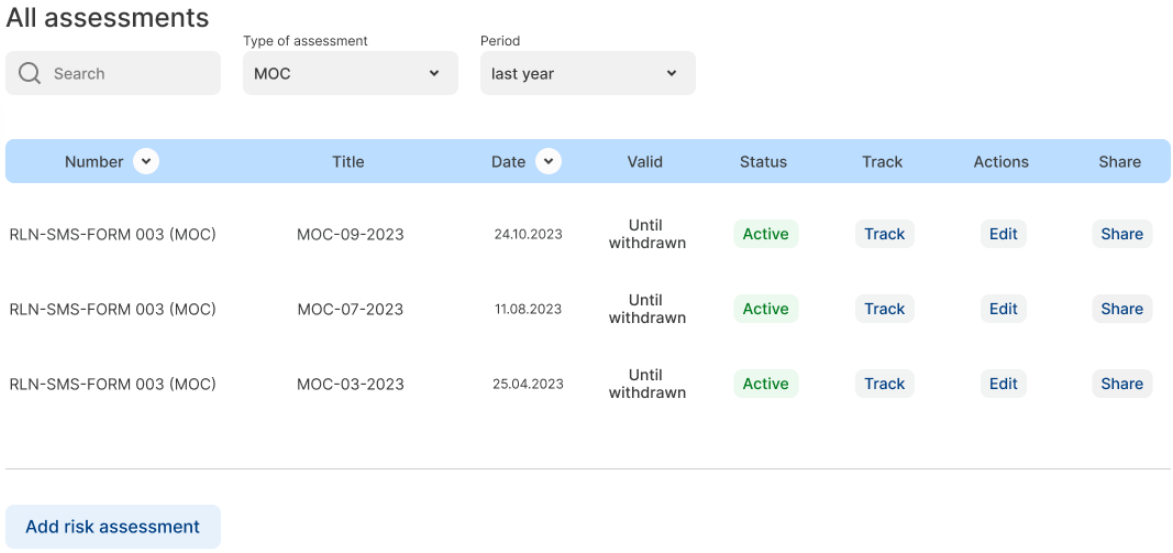


Figure 4.20 – All assessments

On the Figure 4.21 is shown side menu of the page “Assessments”. Under the heading “Risk assessment” there are subdivisions “Assessments” and “Analytics”, little arrow to the left of them shows users that content inside of them can be hidden or disclosed if necessary. “Assessments” contains such structural elements as “All assessments” that will show all the conducted assessments within one screen, “Draft

assessments" – there will be shown assessments that were not finished during previous session, those that are still in development, "Templates" serves to store created templates for assessment, for example airline has specified form for Management of change so such template is created and ready to use placed in this section for easy access. As for "Analytics" there we have SPIs monitoring, so all work concerning safety performance calculations will be placed there. And finally, should be noticed that side menu can be easily hidden in order to extend view of the main information on the screen and disclosed back by clicking on the arrow button in order to switch between sections.

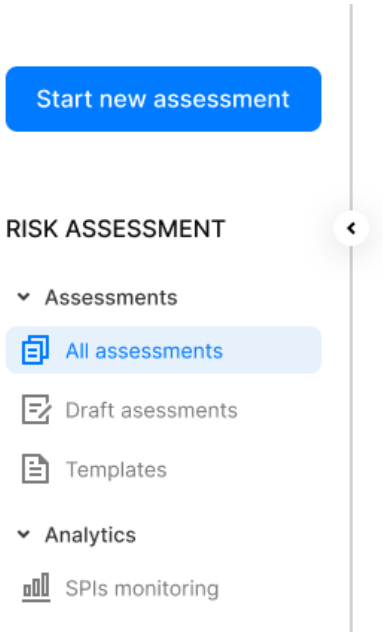


Figure 4.21 – Side menu

Lets examine one of the sections that are accessible there and is shown on the Figure 4.22. Above all we see heading which explains where we at, then there are input field for search through the documents and drop down menu to choose category of document for displaying. Then we see description of each colomn with round buttons with arrow inside wich means user can press on them and choose parameter to filter by. The first colomn is number. There are specific way of numbering the documents and airline will chose its own way to do that. Next colomn is Title of the document than date of uploading. Next colomn shows until when document is valid. Then we have status of the document for example "new" which means user didn't familiarized themselves with that document, there also can be such statuses as "active" – user is

familiarized and doc is valid, “on review” when there is preparation of new revision or some other which can be added by developers on demand of safety team. “Track” is a button which transfer user to the page where they can track the activity, for example who of the airline employees read the document and when. Then we see actions – “edit”, this button allows to make changes. The last colomn is share button it is easy to share document with anybody even beside the airline with the special settings of access, it is useful for example for external audits or cooperation with another organization to interchange documents. After the list of documents there are button “Add policy or statement” which allows to upload new document to that category. Button “Distribution settings” helps to familiarise personnel of airline with documents, then button “Track familiarization” leads to database of employees familiar with document and date when it was done.

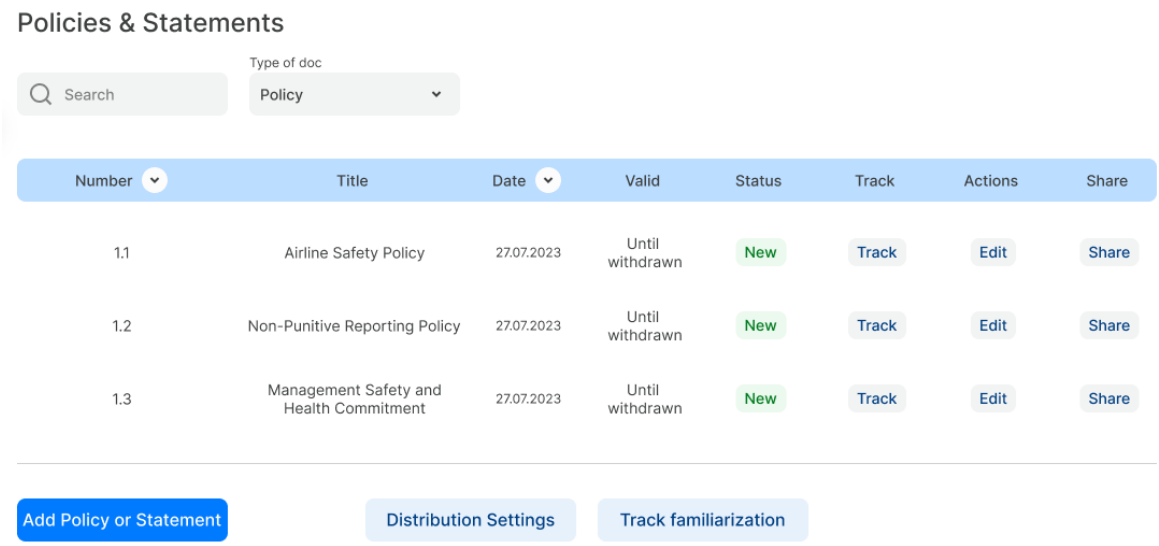


Figure 4.22 – Policies and Statements

On the Figure 4.23 is shown side menu of the page “Documentation”. Under the heading “SMS documents” there are subdivisions “Policies, Manuals, Forms, etc”, “Safety Risk Management and Safety assurance”, “Flight Data Monitoring”, “Safety Review Committee and Safety Action Group”, “Safety Communication and Investigation” and “External safety information”, little arrow to the left of them shows users that content inside of them can be hidden or disclosed if necessary. Each of them

serves as a folder which contains corresponding documents, so user can easily switch between them to find what is needed.

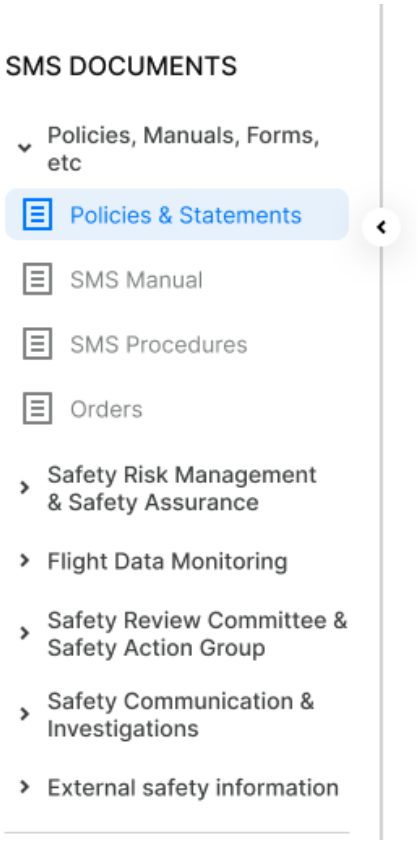


Figure 4.23 – Side menu

CONCLUSIONS TO THE CHAPTER 4

In conclusion, the design and functionality of the web service developed for professional usage underscore the critical need for moderation, conciseness, and user-focused elements. Given the analytical nature of tasks associated with risk estimation, it is imperative to maintain a minimalistic interface that prioritizes functionality over unnecessary graphic elements. This design philosophy aligns with industry best practices observed in comparable systems, where interfaces are crafted to enhance user concentration on their core tasks.

Drawing inspiration from successful models beyond the aviation sector, the examination of Atlassian products, highlights the effectiveness of a discreet, user-friendly, and intuitively understandable design. Incorporating such design principles into the web service enhances user experience and fosters a results-driven work environment.

The chapter also emphasizes the indispensability of guidelines for service users in ensuring a well-organized, productive, and risk-averse workplace. The multifaceted benefits of guidelines encompass clarity and consistency in task execution, increased efficiency, streamlined onboarding processes, risk mitigation, quality assurance, and compliance with legal and regulatory standards. Furthermore, guidelines contribute to a consistent user experience, promote adaptability, and empower users to confidently contribute to the organization's success.

Addressing a specific drawback identified through surveys and interviews, the importance of user-friendly guidelines within the developed system becomes evident. This underscores the pivotal role of comprehensive guidelines in bridging the gap between system functionality and user proficiency. By breaking down user tasks and offering step-by-step instructions, this part of the thesis aims to empower users and ensure a seamless and productive interaction with the designed service. Through these efforts, the web service not only becomes a tool for risk assessment but also a user-friendly environment that promotes efficiency, accuracy, and a proactive approach to safety management.

5. LABOUR PRECAUTION AND ENVIRONMENTAL PROTECTION

One of the best ways to safeguard your company's most valuable asset is to implement a safety and health program for your employees. Even for a brief period of time, losing employees due to disease or accident can have a big financial impact on you, the affected employees, and their families. Additionally, it can harm reputation, productivity, turnover, and workplace morale.

Programs for safety and health encourage a pro-active approach to "finding and fixing" hazards at work before they can result in disease or injury. Management and employees work together to identify and resolve problems before they arise, as opposed to responding to an incident. This kind of cooperation fosters communication, increases trust, and frequently results in other business improvements. [3]

It is a good practice to compare certain systems and approaches of different States in order to upgrade and improve processes all over the world. So when it comes to safety at working places it is quite good example to learn about. That is why this chapter is focusing on US way of dealing with the challenge of providing safe environment for employees.

The field of occupational safety, health, and environment (OSHE) is concerned with the welfare, health, and safety of people at work. It is also known as workplace health and safety (WHS) or occupational health and safety (OHS). [2] The intention is the main distinction between OSHE systems and aviation safety management. Employers are legally required in many states to provide for the health and safety of their workforce. By promoting a safe and healthy workplace, OSHE programs aim to help employers fulfill their ethical and legal responsibilities.

Compound hazards that affect both OSHE and aviation safety at the same time can pose safety risks that can be addressed by different (parallel) risk mitigation procedures aimed at addressing the consequences of OSHE and aviation separately. As an alternative, compound hazards may be addressed by an integrated aviation and OSHE risk mitigation system. A lightning strike on an airplane at an airport transit gate is an illustration of a compound hazard. An OSHE inspector may classify this hazard as a "workplace hazard" (ground personnel/workplace safety). It is also regarded by an

aviation safety inspector as an aviation hazard that poses a risk to passenger safety as well as to aircraft damage. Given that they are not always the same, it is crucial to take into account the implications of such compound hazards for both aviation safety and OSHE. Preventive controls for OSHE and the implications for aviation safety may have different goals and points of emphasis.

Here is the overview of guidelines that were developed by Occupational Safety and Health Administration. OSHA is part of the United States Department of Labor.

The suggested practices place a strong emphasis on managing workplace health and safety in a proactive manner. Conventional methods are frequently reactive, meaning that they are implemented only in response to a worker's illness or injury, the publication of a new standard or regulation, or the discovery of an issue by an outside inspection that requires correction. It is far more effective to identify and address hazards before they result in illness or injury. By doing this, worker illnesses and injuries are prevented, saving money both directly and indirectly, and a positive work environment is fostered.

The foundation of the advised practices is the idea of continuous improvement. The first step is usually the hardest on any journey. Starting with a simple program and expanding from there is the plan. You can assist your workplace in moving toward greater levels of safety and health over time by first concentrating on reaching modest goals, keeping an eye on performance, and analyzing results.

The advantages of putting these suggested practices into practice

The primary objective of a safety and health program, as well as the pain and financial hardship these occurrences can cause for employees, their families, and their employers, is to prevent workplace illnesses, injuries, and deaths. This is something that conscientious employers understand. Employers might discover additional advantages from putting these suggested practices into practice. The following have been connected to the cooperative environment between employers and employees as well as the reaffirmed or strengthened commitment to safety and health:

a) Enhancements to the quality of the process, product, and service.

b) Enhanced morale at work.

c) Better hiring and retention of staff.

d) A more positive reputation and image (among suppliers, customers, and the community). [3]

Core elements of the safety and health program recommended practices:

a) **Management leadership**. Top management sets program expectations and responsibilities and demonstrates its commitment to ongoing safety and health improvement. It also communicates this commitment to employees. Managers at all levels set safety and health goals and objectives, provide sufficient resources and support for the program, and lead by example. They also make safety and health a core organizational value.

b) **Worker participation.** Every facet of the program is carried out by workers and their representatives, including goal-setting, hazard identification and reporting, incident investigation, and progress monitoring. Workers are encouraged to communicate openly with management and to report safety and health concerns without fear of retaliation. All workers, including contractors and temporary workers, understand their roles and responsibilities under the program and what they need to do to effectively carry them out.

c) **Hazard identification & assessment**. Processes are implemented to continuously assess risks and identify workplace hazards. Risks to health and safety from regular, irregular, and emergency situations are recognized and evaluated. To find new hazards, periodic inspections and reassessments are conducted after an initial evaluation of the risks, exposures, and control measures already in place. The aim of any investigation is to find the underlying causes of any incidents. The control of identified hazards is ranked.

d) **Hazard prevention & control**. To identify and choose strategies for getting rid of, preventing, or controlling workplace hazards, employers and employees collaborate. A hierarchy is used to choose controls: engineering solutions are used first, then safe work practices, administrative controls, and personal protective equipment (PPE). A strategy is created to guarantee that controls are

put into place, that there is temporary protection, that progress is monitored, and that the efficacy of the controls is confirmed.

e) **Education & training.** All workers are trained to understand how the program works and how to carry out the responsibilities assigned to them under the program. Employers, managers, and supervisors receive training on safety concepts and their responsibility for protecting workers' rights and responding to workers' reports and concerns.

f) **Program evaluation & improvement**. Control measures are assessed for efficacy on a regular basis. Procedures are set up to track program effectiveness, confirm program execution, and pinpoint program weaknesses and areas for development. The program and overall performance in terms of safety and health are improved by taking the necessary steps.

g) **Communication and coordination for host employers, contractors, and staffing agencies**. All employees will receive the same degree of safety and health protection from host employers, contractors, and staffing agencies. Communicate with host employers, contractors, and staffing agencies about the risks that are already at the workplace and those that contract workers may bring about. Prior to starting work, host employers, contractors, and staffing agencies coordinate on work planning and scheduling to identify and resolve any conflicts that could affect safety or health.

Lets consider all of the elements separately.

Management leadership. The resources, vision, and leadership required to put in place a successful safety and health program are provided by management. In order to practice management leadership, company owners, managers, and supervisors must:

a) Make employee health and safety a top priority within the company.
b) Have a strong commitment to removing risks, safeguarding employees, and enhancing occupational health and safety on a constant basis.
c) Assign adequate resources for the safety and health program's implementation and upkeep.

d) Clearly show and explain to coworkers and others their commitment to safety and health.
e) Model behavior for others by their own deeds.

A well-articulated written policy facilitates the communication of the organization's core values, which include customer satisfaction, product or service quality, productivity, profitability, and safety and health. Management sets expectations for managers, supervisors, employees, and the program as a whole by defining clear goals and objectives. The main focus of the goals and objectives should be on particular steps that will enhance worker health and safety. Management supplies the tools required to carry out the safety and health program, pursue program objectives, and fix program flaws as they arise. The program's management takes the lead by defining roles and duties and creating a welcoming atmosphere that promotes dialogue about health and safety.

Worker participation. Any safety and health program needs the active participation of employees and their representatives in order to be effective. Employees stand to gain the most from a successful program and the most to lose from its failure. Additionally, they frequently have the most knowledge about any risks related to their line of work. Programs that are successful make use of this knowledge base. Participation of workers in the creation, management, assessment, and enhancement of the safety and health program is referred to as worker involvement. Everyone who works at a site should be involved, including employees of temporary staffing companies, contractors, and subcontractors.

Each worker in an effective safety and health program:

a) are urged to take part in the program, feel free to offer suggestions, and disclose any health or safety issues.
b) Have access to the data they require in order to engage with the program successfully.
c) Get the chance to take part in every stage of the planning and execution of the program.

d) Do not face reprisals for speaking up about health and safety issues, reporting diseases, accidents, or dangers, taking part in the program, or advocating for their rights to health and safety.

By promoting program participation, management shows employees that it values their opinions on matters pertaining to safety and health. Employees are frequently in the best position to spot program flaws as well as safety and health issues, such as newly emerging workplace dangers, hazardous situations, near misses, and actual incidents. Through promoting reporting and expeditiously addressing all reports, employers can resolve issues prior to harm or illness. Establishing trust and assisting organizations in making better safety and health decisions are two benefits of providing workers with pertinent safety and health information. Incorporating worker input throughout the entire program design and implementation process enhances the program's sustainability over time, fosters a sense of program ownership among employees, and helps identify the existence and causes of workplace hazards. Employees must believe that their opinions are valued, that their voices will be heard, and that they have access to reporting tools in order to engage in the program in a meaningful way.

Hazard identification and assessment

A primary contributing factor to incidents, diseases, and injuries at work is the inability to detect or identify potential risks that may have been foreseen. A proactive, continuous process to identify and evaluate such hazards is an essential component of any successful safety and health program. To recognize and evaluate risks, employers and employees should:

a) Gather and examine data regarding the risks that are either already present or likely to exist in the workplace.
b) Perform routine and initial workplace inspections to find any new or recurring hazards.
c) Examine illnesses, injuries, incidents, and near misses/close calls to identify underlying hazards, their causes, and inadequacies in safety and health programs.

d) Combine comparable events and find patterns in the reported risks, diseases, and injuries.
e) Examine potential risks related to emergency or non-routine situations.
f) Analyze possible dangers associated with emergency or unusual circumstances.

Employers and employees may already have access to information about workplace hazards from both internal and external sources. When workstations and procedures change, tools or equipment wear down, maintenance is neglected, or housekeeping standards deteriorate, hazards may eventually be introduced. Making time to periodically check the workplace for hazards can aid in identifying flaws so that they can be fixed before an incident happens. It is usually more difficult to identify health risks that employees are exposed to than physical safety risks. For instance, gases and vapors frequently have no smell, are invisible, and may not immediately cause harm to one's health. Biological hazards (infectious diseases), physical hazards (noise, radiation, heat, etc.), and ergonomic risk factors (heavy lifting, repetitive motions, vibration) are examples of health hazards. Chemical hazards include solvents, adhesives, paints, toxic dusts, etc. Examining employee medical records—which have been suitably redacted to protect patient and employee privacy—can be helpful in determining potential health risks related to job exposures. Events that occur at work, such as illnesses, injuries, near misses, and reports of other issues, make it evident where risks are. By carefully looking into reports and incidents, you can find risks that could endanger people in the future. Finding the primary cause of an issue or incident—of which there are frequently several—must always be the goal of an investigation in order to stop similar incidents from happening in the future. There are risks associated with emergencies that must be acknowledged and comprehended. Potential risks can also arise from nonroutine or infrequent tasks, such as maintenance and startup/shutdown operations. It is necessary to create plans and procedures for safely and appropriately handling risks related to both routine and foreseeable emergency scenarios. The following stage entails evaluating and comprehending the risks that have been identified as well as the kinds of incidents that may arise from worker

exposure to those risks. Using this data, temporary controls can be created and hazards can be ranked for long-term control.

Hazard prevention and control. Effective controls reduce or eliminate risks to employees' safety and health, shield them from workplace dangers, and assist employers in providing a safe and healthy work environment for their employees. Employers can prevent and control the hazards mentioned in the previous section with the aid of the procedures outlined in this section.

In order to effectively manage and avoid risks, employers ought to:

a) Involve employees, as they frequently possess the best knowledge of the circumstances that give rise to hazards and the solutions for managing them. Utilizing a "hierarchy of controls," identify and assess available options for hazard control.
b) Select and apply controls in accordance with a hazard control plan, which should serve as a guide during this process. Create plans with safety precautions for employees in case of emergencies or unexpected activities.
c) Assess the efficacy of current controls to ascertain whether they are still protective or if other controls might be more effective. Examine whether new technologies have the potential to be less expensive, more dependable, or more protective.

Employers can explore various options for managing identified hazards with the assistance of a plethora of information available. Workers' opinions on the viability and efficacy of various control options must be sought before choosing any.

The controls that employers choose should be the most practical, efficient, and long-lasting. How the chosen controls will be put into practice is outlined in a hazard control plan. A good plan will take care of major risks first. The ultimate objective is to guarantee efficient long-term control of hazards, even though interim controls might be required. Monitoring the control plan's completion is crucial, as is periodically confirming that controls are still in place. Provisions for safeguarding employees during unexpected events and non-routine operations should be included in the hazard control plan. Fires, explosions, chemical spills, hazardous material releases,

unscheduled equipment shutdowns, infrequent maintenance activities, natural and weather disasters, workplace violence, terrorist or criminal attacks, disease outbreaks (like the pandemic influenza), or medical emergencies are a few examples, depending on the workplace. Tasks that employees don't typically perform, or nonroutine tasks, should be handled with extra caution. Measures for preventing and controlling hazards should be identified and then put into action in accordance with the hazard control plan. Employers should monitor the implementation of controls, inspect and assess controls after they are installed, and carry out routine preventive maintenance procedures in order to guarantee that controls are and stay effective.

Education and training. Training and education are crucial instruments for educating managers and employees about workplace risks and safety procedures so they can operate more productively and safely. Nonetheless, managers and employees can also play a part in the development and execution of the safety and health program by gaining a deeper understanding of it through education and training.

Employers, managers, supervisors, and employees can benefit from education and training by getting:

a) The information and abilities required to carry out their jobs safely and prevent the creation of risks that could endanger others or themselves.
b) Knowledge of potential risks at work and how to recognize, report, and mitigate them.
c) Specialized training if the risks associated with their work are particular.

Depending on the roles that are assigned within the program, more training might be required. For instance, in order to guarantee that they can carry out their responsibilities of offering guidance, leadership, and resources for the safety and health program, employers, managers, and supervisors might require specialized training. Employees designated for particular roles within the program (such as members of the incident investigation team) might require training to guarantee their active involvement in those responsibilities.

The structure, plans, and procedures of the program must be understood by managers, supervisors, and employees alike. Knowing this guarantees that everyone

can take part completely in creating, executing, and refining the program. Supervisors, managers, and employers are accountable for the safety of their employees; however, they are not always well-versed in safety-related concepts and procedures. They could gain from specialized training that enables them to carry out their program leadership responsibilities.

Program evaluation and improvement

A safety and health program should be assessed as soon as it is created to make sure it is being carried out as intended. After that, companies should take a step back and evaluate what is and is not working in the program, as well as whether it is on track to meet its objectives, at least once a year. Employers, managers, and supervisors should collaborate with employees to implement any necessary changes to the program whenever these assessments reveal areas for improvement. They should also keep an eye on the program's overall performance. It will be easier to promote continuous improvement if monitoring and evaluation results are shared among coworkers and successes are acknowledged.

Establishing indicators to track performance and advancement is the first stage in the monitoring process. The next step is to set up and adhere to protocols for gathering, reviewing, and analyzing performance data by employers, managers, supervisors, and employees. It is advisable to use both leading and lagging indicators. Generally speaking, lagging indicators monitor worker exposures and injuries after they have already happened. Leading indicators monitor program implementation effectiveness and show proactive measures taken to avert illnesses or injuries before they arise. Employers must assess the program at the beginning and at least once a year to make sure it is working as planned, effectively managing hazards that have been identified, and moving the company closer to its set safety and health goals and objectives. The breadth, complexity, and maturity of the program; the kinds of hazards it must control; and changes in OSHA standards will all influence the scope and frequency of program evaluations. Employers must act quickly to address any issues that are found in any area of the safety and health program, working with managers, workers, and supervisors to ensure that the problem is fixed and doesn't happen again.

Communication and coordination for host employers, contractors, and staffing agencies

In the modern economy, a growing number of employees are dispatched by staffing firms to particular "host" workplaces where they are managed and directed by the host employer. Examples include temporary staffing needs filled by seasonal workers like delivery drivers and warehouse workers, as well as office and production workers who might be assigned to both short- and long-term projects. In these circumstances, it's critical that the host employer and the staffing agency coordinate and communicate in order to give and preserve a safe work environment for their employees.

In scenarios involving multiple employers as well as temporary workers, safety is improved when employers set up systems to effectively coordinate and communicate in order to provide equal protection for all employees against risks. Among these mechanisms are steps to guarantee that every worker present (as well as their delegates) can take part in averting illnesses and injuries. If these actions are not taken, safety programs may be compromised. Employee engagement and participation may suffer as a result of inconsistent safety policies, which may also lead to workers doubting the validity of safety and health initiatives.

Every host employer creates and puts into effect a protocol to guarantee that information regarding on-site hazards and the controls in place to mitigate them is shared. As a result, every employee on the property is aware of the risks present at work as well as the techniques and policies required to limit exposure to them. Coordinating on work planning, scheduling, and resolving program differences amongst host employers, contractors, and staffing agencies helps to identify and resolve any issues or conflicts that may affect safety or health. [3]

GENERAL CONCLUSIONS

This thesis has attempted to break down the complex layers of the Safety Management System (SMS) in the vast field of aviation, where accuracy, teamwork, and safety are interwoven. The thesis establishes a foundation for comprehending the complexities of safety regulation and risk management through a thorough examination of the aviation industry, from its complex functional subsystems to the vital importance of striking a balance between safety and production and profitability.

One key element in guaranteeing operational safety in the aviation industry is the Safety Management System. The SMS is an indication of the industry's dedication to proactive risk mitigation, having its roots in an awareness of the interdependence of participants and the possible ramifications of even small mistakes. It is a dynamic framework that changes in response to lessons learned from previous disasters, completing the gaps left by tragedies to strengthen the sector against potential threats in the future.

Going deep into the principles, the thesis emphasizes the contradiction between security and safety, stressing how crucial it is to discern between unintentional consequences and deliberate disruptions. Theoretical foundations are provided by the SHELL Model, James Reason's "Swiss-Cheese" Model, and Scott A. Snook's theory of practical drift to comprehend how human factors affect safety performance and how dynamic system behavior is in real-world scenarios.

One recurring theme is the delicate balance that dance organizations must maintain to remain financially viable while adhering to strict safety standards: production, profitability, and safety risks. Acknowledging the dynamic nature of the aviation system and the need for constant attention to hazard identification, assessment, mitigation, and risk acceptance, safety risk management (SRM) emerges as a continuous process.

The diploma project delves deeply into the risk assessment processes, which are crucial in the ever-changing aviation safety landscape. In the complex world of Safety Management Systems (SMS), it is critical to systematically identify, assess, and mitigate potential hazards. Risk assessment's proactive approach serves as a sentinel,

protecting aviation operations' safety and integrity from unanticipated vulnerabilities. This methodical procedure covers a wide range of topics, including environmental variables, technological interfaces, and human factors. As this study has shown, the advancement and improvement of risk assessment techniques provide an early warning system against the constantly changing difficulties that the aviation sector faces Through the adoption of an ongoing cycle of hazard identification, risk assessment, and mitigation tactics, aviation industry organizations can establish a robust safety culture that guarantees the continual balance between operational effectiveness and uncompromised safety.

The use of Safety Performance Indicators (SPIs) highlights the need for a sophisticated strategy that integrates various metrics to obtain a comprehensive understanding of safety performance. SPIs offer a quantitative or qualitative yardstick to evaluate safety targets. The incorporation of taxonomies and definitions serves as a stimulant for efficient safety data processing, cultivating a shared vocabulary and enabling information sharing among aviation professionals.

As the thesis concludes with a thorough analysis of SMS documentation, it is clear that this handbook functions as an organizational knowledge base as well as a guide for internal administration, offering a record of past choices, actions, and presumptions made in the quest for improved safety performance.

In keeping with the main goal, the thesis examined the features and constraints of the software solutions that are currently in use. The result of this investigation was the creation of an interface design solution, a workable illustration made specifically to automate the risk assessment procedure inside an airline's complex workflows.

As the thesis comes to an end, it is clear that the complex investigation and design considerations are not just theoretical but also real-world initiatives meant to improve the effectiveness and safety of airline operations. This interface design solution, which provides a preview of the automation of risk assessment in the aviation sector, is a monument to the dedication to connecting theoretical understanding with practical breakthroughs.

Appendix A

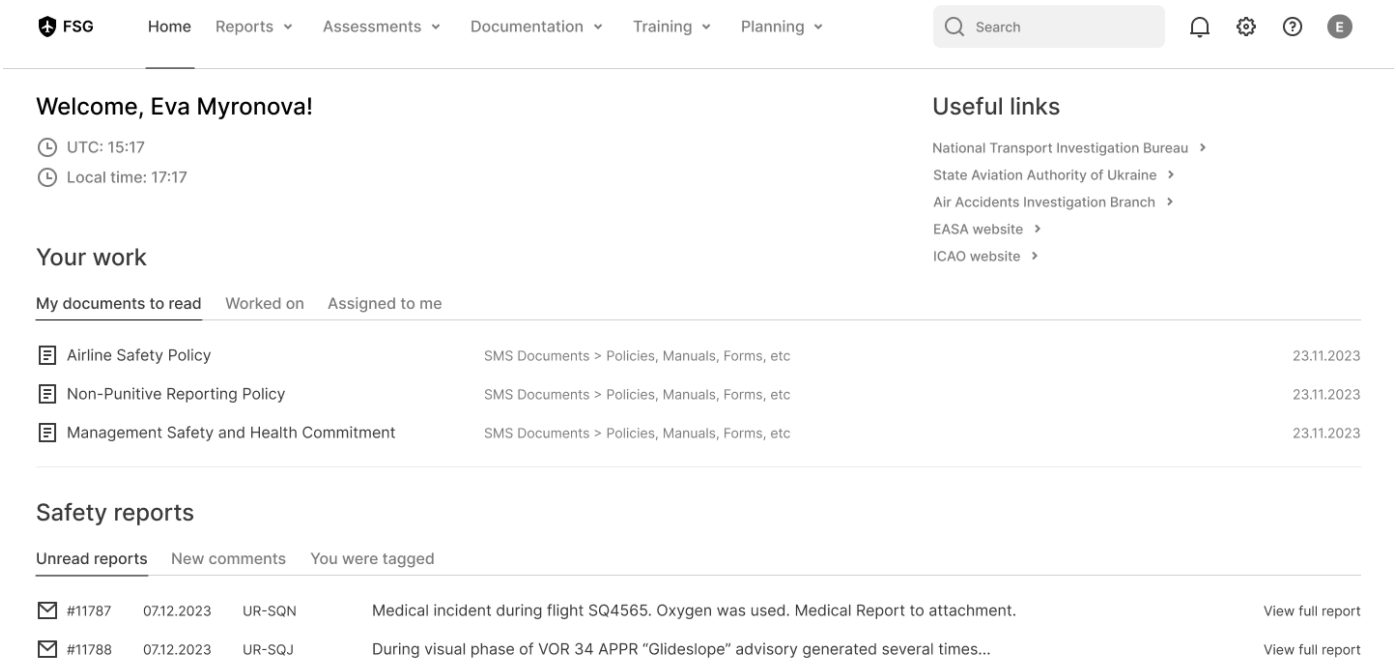


Figure 1 – Prototype of the Home page

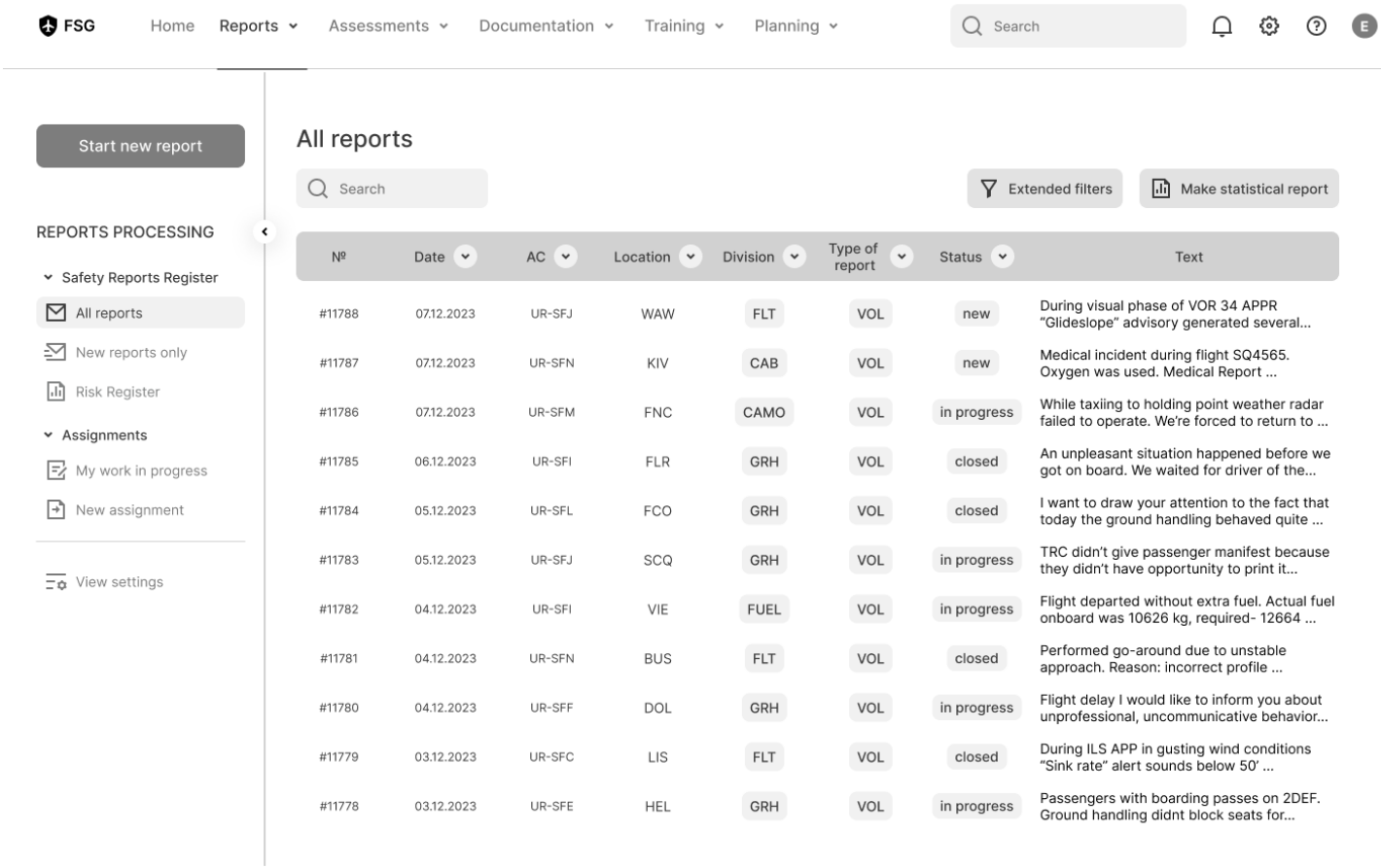


Figure 2– Prototype of the Reports page

Appendix B

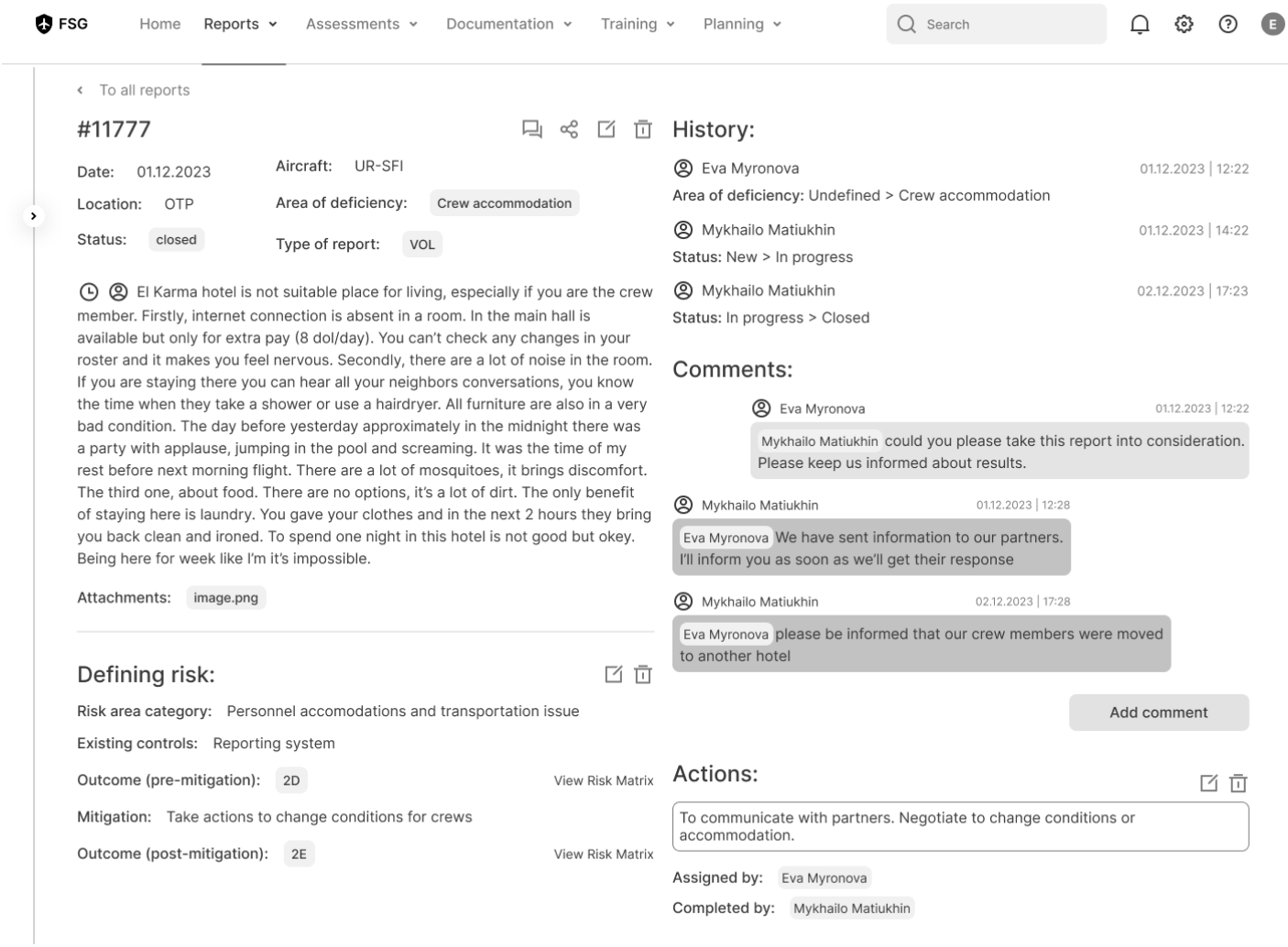


Figure 1– Prototype of the Report page

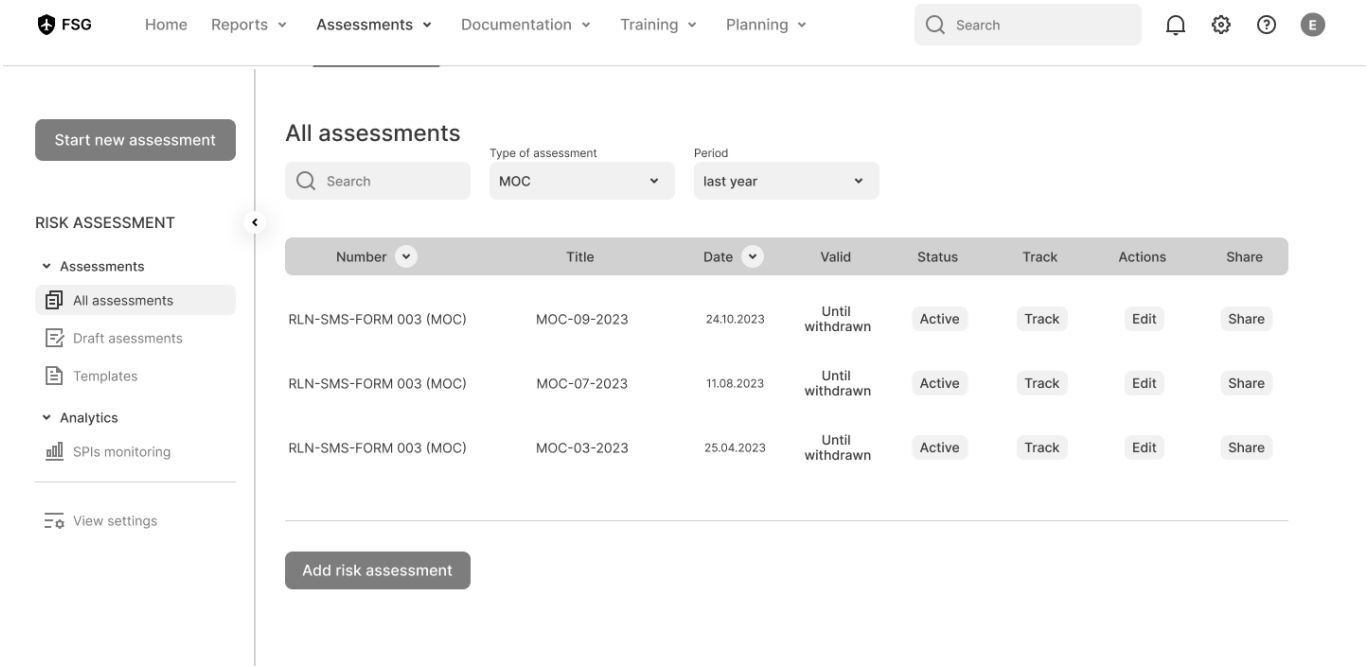


Figure 2– Prototype of the Assessments page

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