ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE

Faculty of Transportation sciences
Department of Air transportation

Organizační modely a metody bezpečnosti v letectví

Organizational Safety Models and Methods in Aviation

Bakalářská práce

Bachelor thesis

Studijní program: B 3710 - LED

Studijní obor: Air Transport

Vedoucí práce: doc. Ing. Andrej Lališ, Ph.D.

Boyue Liu

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ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE
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K621 .... **Ústav letecké dopravy**

ZADÁNÍ BAKALÁŘSKÉ PRÁCE
(PROJEKTU, UMĚLECKÉHO DÍLA, UMĚLECKÉHO VÝKONU)

Jméno a příjmení studenta (včetně titulů):

Boyue Liu

Studijní program (obor/specializace) studenta:

bakalářský – LED – Letecká doprava

Název tématu (česky): **Organizační modely a metody bezpečnosti v letectví**

Název tématu (anglicky): Organizational Safety Models and Methods in Aviation

Zásady pro vypracování

Při zpracování bakalářské práce se řiďte následujícími pokyny:

- Cílem práce je vytvořit přehled existujících modelů a metod bezpečnosti na základě publikovaných odborných výstupů a selektovat takové modely a metody, které jsou vhodné pro řešení otázek organizačních faktorů v letecké bezpečnosti.
- Vypracujte rešerši současného stavu v oblasti organizačních modelů a metod bezpečnosti.
- Proveďte selekci článků vhodných pro následnou analýzu.
- Proveďte analýzu vybraných článků a stanovte modely a metody s největším potenciálem pro využití v letectví pro řešení organizačních faktorů.
- Dosažené výsledky diskutujte a formulujte závěry práce.

Rozsah grafických prací: dle pokynů vedoucího bakalářské práce

Rozsah průvodní zprávy: minimálně 35 stran textu (včetně obrázků, grafů a tabulek, které jsou součástí průvodní zprávy)

Seznam odborné literatury: P. Underwood, P. Waterson. Accident Analysis Models and Methods: Guidance for Safety Professionals, Loughborough University, 2013.

S. Patole. Principles and Practice of Systematic Reviews and Meta-Analysis. Springer International Publishing, 2021

Vedoucí bakalářské práce: **doc. Ing. Andrej Lališ, Ph.D.**

Datum zadání bakalářské práce: **2. října 2021**
(datum prvního zadání této práce, které musí být nejpozději 10 měsíců před datem prvního předpokládaného odevzdání této práce vyplývajícího ze standardní doby studia)

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a) datum prvního předpokládaného odevzdání práce vyplývající ze standardní doby studia a z doporučeného časového plánu studia
b) v případě odkladu odevzdání práce následující datum odevzdání práce vyplývající z doporučeného časového plánu studia

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Potvrzuji převzetí zadání bakalářské práce.

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BACHELOR'S THESIS ASSIGNMENT

(PROJECT, WORK OF ART)

Student's name and surname (including degrees):

Boyue Liu

Study programme (field/specialization) of the student:

bachelor's degree – LED – Air Transport

Theme title (in Czech): **Organizační modely a metody bezpečnosti v letectví**

Theme title (in English): Organizational Safety Models and Methods in Aviation

Guidelines for elaboration

During the elaboration of the bachelor's thesis follow the outline below:

- Thesis goal: Research existing safety models and methods based on research publications and select those applicable for addressing organizational contributory factors in aviation safety.
- Research the current state of the art in the domain of organizational safety models and methods.
- Select publications suitable for subsequent analysis.
- Analyze selected publications and identify models and methods with the greatest potential for utilization in aviation for addressing the organizational factors.
- Discuss the results and formulate conclusions

Rozsah grafických prací:	dle pokynů vedoucího bakalářské práce
Rozsah průvodní zprávy:	minimálně 35 stran textu (včetně obrázků, grafů a tabulek, které jsou součástí průvodní zprávy)
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Abstract

Organizational factors in aviation safety are an essential part of safety management. This paper has studied the Safety Method Database and the methods for analyzing organizational safety methods. In order to analyze the papers which make use of organizational safety methods, this paper has studied and used the PRISMA Flow Diagram, and based on this method, there are 17 papers that have been reviewed in this thesis. According to the review, the Commercial Aviation Safety Survey has been used the most frequently.

Key words: Organizational safety database, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), organizational safety methods, Commercial Aviation Safety Survey

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Statutory Declaration

I hand in for assessment and defense a bachelor thesis, prepared at the end of my studies at the Czech Technical University in Prague, Faculty of Transport.

I herewith formally declare that I have written the submitted bachelor thesis independently. I did not use any outside support except for the quoted literature and other sources mentioned in the paper, accordingly to Methodical instructions on compliance with ethical principles in the preparation of university theses. I am aware that the violation of this regulation will lead to failure of the thesis.

I have no objection against using this thesis in the sense of § 60 Zákona č. 121/2000 Sb., o právu autorském, o právech souvisejících s právem autorským a o změně některých zákonů (autorský zákon).

In Prague on ……………………………

Boyue Liu ……………………………

Signature

List of Abbreviations

ICAO	International Civil Aviation Organization;
JAA	Joint Aviation Authorities;
EASA	European Union Aviation Safety Agency
CADORS	Civil Aviation Daily Occurrence Reporting System
CASS	Commercial Aviation Safety Survey
STEP	Sequentially - Timed Events Plot
AIBN	Accident Investigation Board, Norway
ASAP	Aviation Safety Action Program
SoTeRiA	Socio-Technical Risk Analysis
PRA	Probabilistic Risk Analysis
SMS	Safety Management Systems
DEMATEL	Decision making trial and evaluation laboratory
ANP	Aircraft Noise and Performance
BBN	Bayesian Belief Network
ASAPs	Aviation Safety Action Programs
CCAR	China Civil Aviation Regulations
DS	Design System
DAS	Design Assurance System
HROs	High reliability organization
SMSVP	Safety management systems voluntary program
EEC	Electronic engine control
NLR	Netherlands Aerospace Centre
RCT	Randomized Controlled Trials
QUOROM	Quality of Reporting of Meta-analyses
MES	Multilinear Event Sequencing
ARMS	Aviation Risk Management Solutions
ORA	operational risk assessment
SIRA	Security Issue Risk Assessment
ORM	Operational Risk Management
O&SHA	Operating and Support Hazard Analysis
RCA	Root Cause Analysis
AIBN	Accident Investigation Board, Norway

HFACS	Human Factors Analysis and Classification System
PEAT	Procedural Event Analysis Tool
MEDA	Maintenance Error Decision Aid
REDA	Ramp Error Decision Aid
CPIT	Cabin Procedural Investigation Tool
MOF	Management and Organizational Factors
PSF	Performance Shaping Factor or Human Factors
EF	Environmental Factors
HROs	High reliability organization
SMSVP	Safety management systems voluntary program
MOSE	model of Organizational Safety Effectiveness

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Introduction

As the aviation industry is one of the fastest growing industries and the number of daily operations has steadily increased over the years, the expansion and exploration of organizational safety models and methods for the aviation industry is becoming a pressing issue.

Although aviation is among the safest modes of transportation in the world today, accidents still happen. In order to further reduce accidents and improve safety, proactive approaches must be adopted by the aviation community. Because aviation involves flying in the air, with so much uncertainty and carrying large numbers of passengers, there is an expectation that all its journeys will be safe. However, all modes of transport involve risk, and there is no such thing as total safety.

Safety risk management is the process of taking risks that are already known to exist and reducing them as much as possible by scientific means. And to anticipate which risks may exist and to develop countermeasures to address them accordingly. In developing a safety risk management model, risks can be identified by identifying hazards to aviation equipment, machinery, people or organizations. The consequences of these risks and the severity of accidents are evaluated and assessed.

The goal of the presented bachelor thesis is to review usable methods and models in the selected papers to identify which organizational safety methods have been used the most frequently. Based on this, an overview of organizational safety methods can be created to make it easier for aviation professionals to find and study the relevant topics. The reports have been conducted as systematic research with commentaries provided with the ultimate goal of the research to perform reviewing of chosen articles and to summarize the results or experiments they present.

Though this study does not comprehensively examine all existing methods and models for all kind of situation in organization, but these filtered results and details certainly helped the Aviation origination. Practitioners worked more efficiently and safety, aiming to help user to understand the safety factors development in the aviation industry and enhancing the knowledge of organizational safety models and methods.

In this thesis, the Chapter 1 has introduced the theory of Safety Method database and the application of collecting the Organizational Safety Methods. In Chapter 2, it mainly illustrated the theory of PRISMA flow and how this methodology has been applied to collect the papers which are related to Organizational Safety methods. In Chapter 3, it stated the theory of the methods which have been used in the selected papers and then it comes with the papers with reviewing from Organizational safety methods perspective. In the last chapter, it is the conclusion of this thesis.

Chapter 1

1 Safety Method Database

The Safety Methods Database [1] is the main source of the safety methods and models used in the safety assessment process. The current version 1.2 was issued on November 3rd, 2020, and this database is a living document, which is edited by the Netherlands Aerospace Centre (NLR). These documents mainly contain three parts; they are the overview of safety methods, the statistics, and the references. For the first part, there is a table listing all the safety methods collected since this database was created. From this table, each of the methods provides the following information: method name, format, purpose, year, aim/description, remarks, safety assessment stage, domains, application, and references used. In the second part, there are statistics showing the number of occurrences of elements in the table of safety methods. In the last part, the list of all references that have been used is provided in this document.

1.1 Overview of Safety Method database

In this Safety Method database, the following information has been provided: Method name, Format, Purpose, Year, Aim/description, Remarks, Safety assessment stage, Domains, Application and References.

1.1.1 Method Name, Aim/Description, Remarks

In the document, the Method Name has been listed with either the full name or abbreviations. As the Safety Method Database [1] is a living document, some of the classification of safety methods could change depending on the new re-classification or requirements setup.

The Aim/Description provides t a summary of each safety method or model. The more detailed and complete description is available in the references part. The Remarks show the changes and development of each model that occurred and the links to related methods.

1.1.2 Format

The Format specifies the general format of the method. There are a total of 11 classes. The details of the Format can be viewed via table 1.1 below:

Table 1.1 Classes of Format [1]

Gen	Generic term or principle or theory, rather than a specific technique
Step	Stepped approach or technique or specific way of working
Tab	Static approach with tabular, checklist or questionnaire support
Stat	Static model or approach with graphical support (e.g. flow charts, trees, graphs)
Dyn	Dynamic model with graphical support, often with mathematical base
Math	Mathematical formalism or expression, with no or limited graphical support
Int	Framework or Integrated method of more than one technique
Dat	Database or data collection tool
Min	Data analysis tool or data mining tool
RTS	Real-time simulation
FTS	Fast-time simulation

1.1.3 Year

The Safety Methods Database [1] also indicates the method's year of development. In this document, 17 out of the 866 methods collected are not available. There were also years' figures estimated or available after they were developed.

The oldest methods are Quality Assurance (2500 BC) and Error Detection and Correction (150 AD), Logic Diagrams (300 AD for 'Porphyrian trees'; the modern Logic Diagram Dates from 1761), Data Mining (1750), Monte Carlo simulation (1777), Wind/Tornado Analysis (1888), Neural networks (1890), Factor analysis (1900), Markov chains (1906) and Pareto charts (1906). The table 1.3 below lists the number of methods developed every 10 years and the percentage of the total number of safety methods.

Table 1.2 The number of safety methods developed [1]

Years	Number	Percentage
2010-2020	27	3 %
2000-2009	148	17 %
1990-1999	289	33 %
1980-1989	177	20 %
1970-1979	106	12 %
1960-1969	44	5 %
1950-1959	25	3 %
1940-1949	11	1 %
1930-1939	4	0 %
1920-1929	5	1 %
1910-1919	3	0 %
1900-1909	3	0 %
1800-1899	2	0 %
Before 1799	5	1 %
Not specified	17	2 %
Total	866	100 %

The earliest establishment of the Safety Method database was in the year of 2004. Initially, there were 520 methods. As time goes by, the Safety Method Database [1] has been extended with plenty of methods from various resources, and some of the existing statistics or methods have been updated as well. In the year 2008, a new classification type was added under “Purpose”, which is called “Organization” techniques. In the year 2016, the re-classification and updating of Format, Purpose and Domain of all methods has taken place. The latest version of the Safety Method database [1] is as of 2020. There are 866 methods, including 177 links or alternative names for methods.

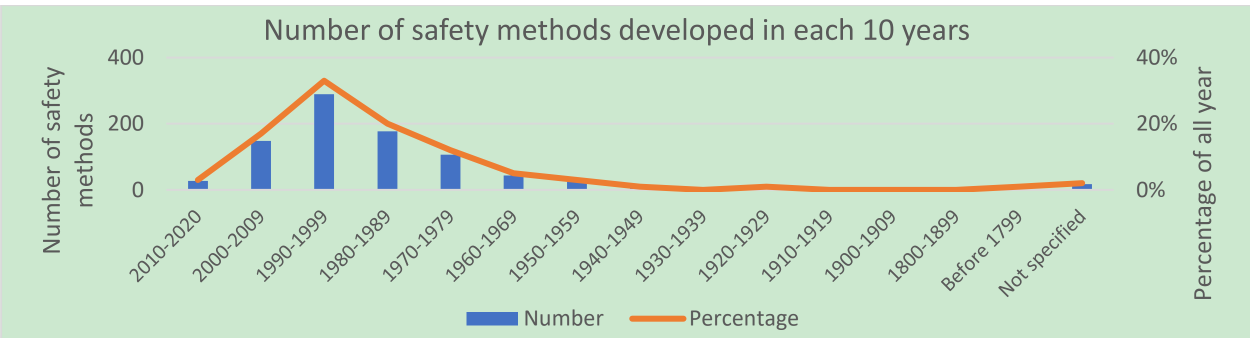


Figure 1 Number of safety methods developed in each 10 years

As this paper aims to look for organizational safety methods, table 1.3 shows the number of safety methods developed during each time interval.

Table 1.3 The number of organizational safety methods developed [1]

Years	Number	Percentage
2010-2020	6	8%
2000-2009	30	38%
1990-1999	22	28%
1980-1989	9	12%
1970-1979	3	4%
1960-1969	2	3%
1950-1959	2	3%
1940-1949	2	3%
1930-1939	1	1%
Before 1799	1	1%

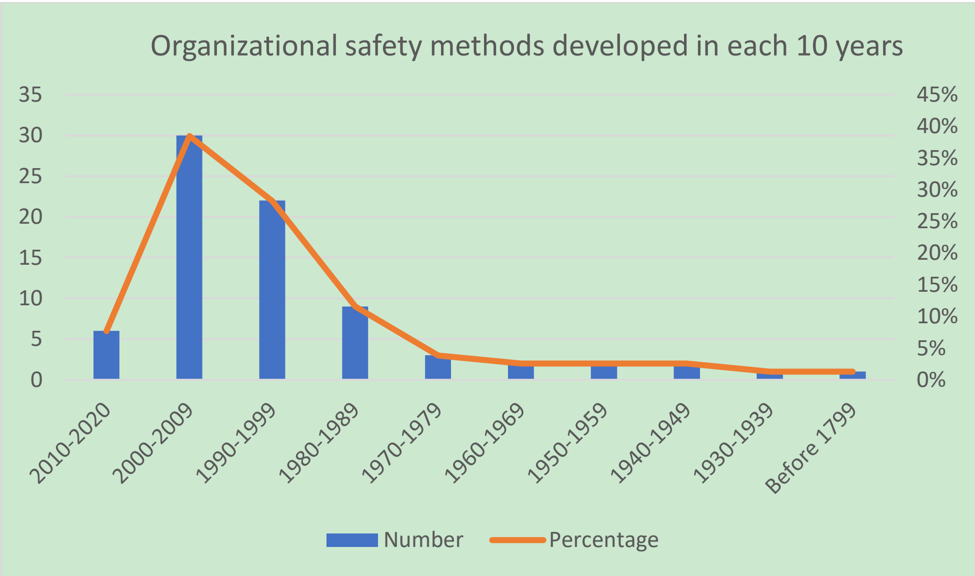


Figure 2 Organizational safety methods developed in each 10 years

1.1.4 Purpose

The information Purpose specifies the primary purpose of the method. In some cases, one method may have multiple purposes. The up-to-date number of purposes is 19, which can be viewed via the below table 1.4:

Table 1.4 Classes in Purpose [1]

Mod	Developing a model (e.g. as input to or as part of analysis)
Par	Parameter value assessment (e.g. human error probabilities, failure frequencies)
HRA	Human Reliability Analysis or Human Error analysis method
HFA	Human Factors Analysis (beyond reliability; e.g. behavior, situation awareness)
Task	Human Task analysis
Trai	Training technique or method to analyze training
Des	Design technique (about making/ensuring a safe design, rather than about analyzing whether the design is safe)
Dec	Decision-making
SwD	Software dependability analysis or Software testing technique
HwD	Hardware dependability analysis (reliability, maintainability, availability, etc)
OpR	Risk analysis of an operation or of a safety-critical scenario
Org	Organization, Safety management, or Safety culture assessment
Dat	Data collection and information sharing
Mit	Mitigation of risk
HzI	Identification of hazards /safety concerns /causes /issues
HzA	Identification and analysis of frequency and/or severity of hazards / safety concerns / causes / issues
Col	Collision risk analysis or Conflict risk analysis, typically between aircraft
Val	Validation, Verification, Bias and uncertainty analysis, Documentation/Tracking, and Oversight/Monitoring
Ret	Retrospective accident or event analysis

1.1.5 Safety Assessment Stage

The Safety Assessment Stage shows the generic safety assessment process. There are 8 stages in this process. The summary distribution of methods can be viewed as in table 1.5 and figure 3 below:

Table 1.5 Stages of generic safety assessment process [1]

Stages of generic safety assessment process	Number	Percentage
Stage 1 (Scope the assessment)	32	4 %
Stage 2 (Learning the nominal operation)	170	20 %
Stage 3 (Identify hazards)	259	30 %
Stage 4 (Combine hazards into risk framework)	216	25 %
Stage 5 (Evaluate risk)	285	33 %
Stage 6 (Identify potential mitigating measures to reduce risk	220	25 %
Stage 7 (Safety monitoring and verification)	119	14 %
Stage 8 (Learning from safety feedback)	150	17 %

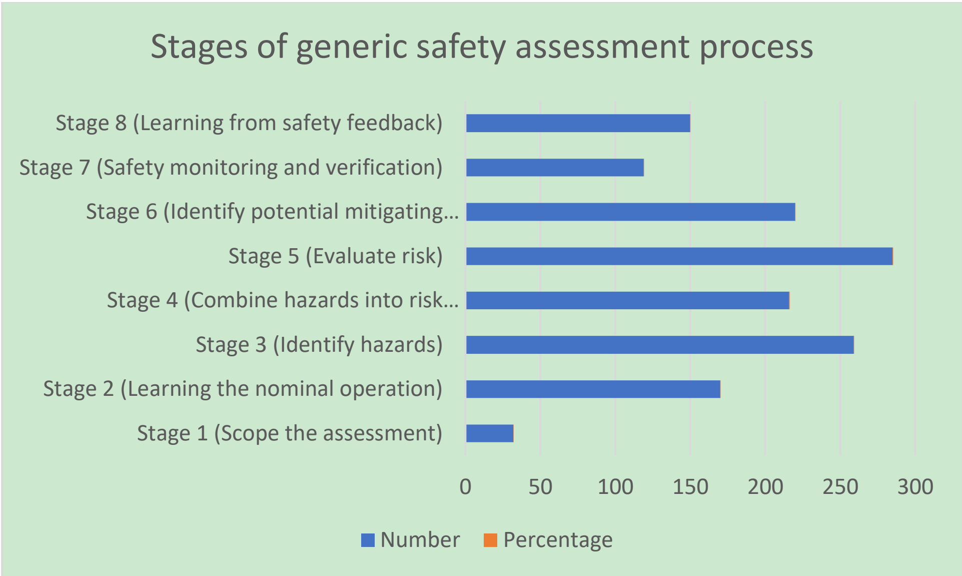


Figure 3 Stages of generic safety assessment process

1.1.6 Domain

The domain means the application of the method that has been used. There are 24 domains existing in this database, but in this paper, it mainly focuses on aviation related domains. The relevant domains have been listed in table 1.6 below:

Table 1.6 Classes in Domain (Activation related) [1]

Aviation	Operation of individual aircraft or aircraft fleets, including pilot and crew factors and airline operations
Airport	Airport operations and airport design
ATM	Air traffic management and air traffic control
Aircraft	Aircraft technical systems and airworthiness issues. Also including rotorcraft such as helicopters.
Avionics	Electronic systems used on aircraft, satellites, and spacecraft, including communication, navigation, cockpit display.

1.1.7 Application

The safety methods aim to assess different aspects. They are applicable to hardware aspects, human aspects, procedures aspects or organization aspects. The number of concept aspects and the percentage of all safety methods database can be viewed via table 1.7 below:

Table 1.7 Concept aspects in Safety Method Database [1]

Concept aspects	Number	Percentage
Hardware	441	51 %
Software	278	32 %
Human	416	48 %
Procedures	267	31 %
Organization	161	17 %

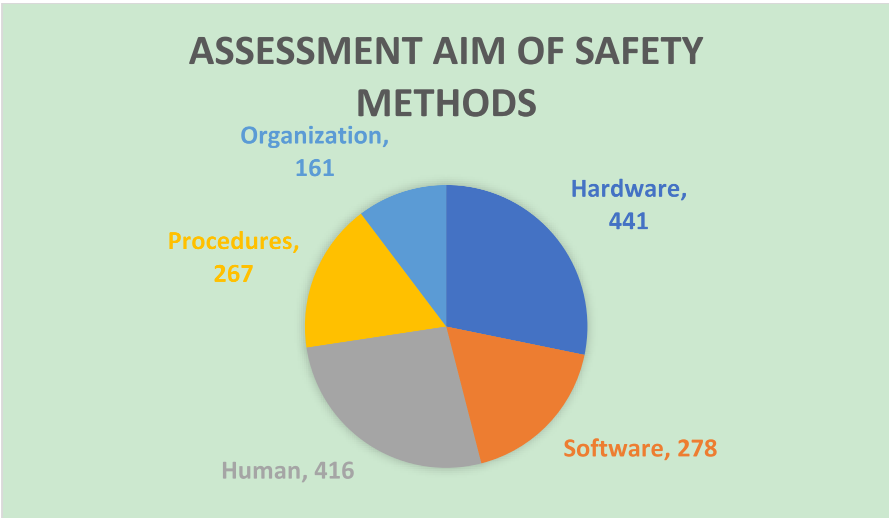


Figure 4 Concept aspects of safety method database

1.1.8 Reference

The main reference used in the Safety Method Database [1] is the Review of SAM techniques [2]. Plenty of other references have been used in the document as well.

1.2 Safety Method Application

According to the published information from ICAO, there are four types of factors: technical factors, human factors, organizational factors, and total system factors. The organizational safety methods will be illustrated step-by-step in this chapter.

1.2.4 Organizational Factors in Safety Management

The concept of an "organizational accident" was introduced in the middle of the 1990s, when there were organizational culture and policies impacting on safety risk controls. This approach enhanced routine safety data collection and analysis using reactive and proactive methodologies, which enabled organizations to monitor known safety risks and detect emerging safety trends. This formed the initial foundation for the establishment of the Safety Management System (SMS).

1.2.5 Procedure to find Organization Safety Method

The safety methods contain different application aspects; thus, the first step is to filter the organizational aspects. In this database, there are 161 methods related to organizational aspects. Afterwards, it is necessary to narrow down the domain of the industry. The domain will be filtered with Aviation, Airport, ATM, Aircraft, and Avionics in this case. In total, there are 79 methods relating to organizational safety methods in the aviation area.

Chapter 2

2 PRISMA Flow Diagram

In this paper, in order to search and filter the organizational safety method papers, the PRISMA method has been used to achieve it step by step.

2.1 Overview of PRISMA

The full description of PRISMA is Preferred Reporting Items for Systematic Reviews and Meta-Analyses. PRISMA is an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses. PRISMA primarily focuses on the reporting of reviews evaluating the effects of interventions but can also be used as a basis for reporting systematic reviews with objectives other than evaluating interventions (e.g., evaluating aetiology, prevalence, diagnosis or prognosis). It is a collection-based set of the most important review and analytical reporting of primary systematic review indicators.

Different people have different PRISMA requirements or uses.From the authors' point of view, PRISMA helps to improve the reporting of systematic reviews and meta-analyses. From a journal peer reviewers' and editors' point of view, the PRISMA may also be useful for critical appraisal of published systematic reviews, although it is not a quality assessment instrument to gauge the quality of a systematic review.

In the past, prior to PRISMA, the Quality of Reporting of Meta-analyses (QUOROM) was addressed as a standard for improving the quality of reporting of meta-analyses of clinical randomized controlled trials (RCTs). Evaluation of reporting was organized into headings and subheadings regarding searches, selection, validity assessment, data abstraction, study characteristics, and quantitative data synthesis. In the year of 2009, the QUOROM was renamed to PRISMA after several conceptual and practical advances in the science of systematic reviews were updated.

The usage of PRISMA has improved the quality of systematic reviews and provided transparency in the selection process of papers in a systematic review.

2.2 PRISMA components

Normally, PRISMA includes the PRISMA checklist and the PRISMA flow diagram. The PRISMA checklist includes 27 items relating to the content of a systematic review and meta-analysis, which include the title, abstract, methods, results, discussion, and funding.

The PRISMA Flow Diagram depicts the flow of information through the different phases of a systematic review. It lays out the number of records identified, included, and excluded, and the reasons for exclusions. Different templates are available depending on the type of review (new or updated) and the sources used to identify studies. The diagrams are classified into four different flows for different data sources.

If the new systematic reviews are needed, there is the basic flow diagram for databases and registers, and also the flow gram via other methods. If the updated systematic reviews are needed, the flow diagram will need to include the sources from previous studies as well.

2.3 PRISMA application

The following content will illustrate how the papers are filtered by using the PRISMA Flow Diagram step by step. The "*PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only"* [1] has been used because this paper is a new study without any previous studies included. Additionally, the data source is only concerning the databases, no registers or other source are added.

2.3.1 Identification Stage

The databases used in this paper are online resources Scopus[2] and Web of Science[3], which can provide access to multiple databases that provide reference and citation data from academic journals, conference proceedings, and other documents in various academic disciplines. According to the purpose of this thesis, the key words in the search fields are "*safety methods"*, "*organizational",* and "*aviation"*. The result that comes after searching through two databases is a total of 585 papers.

[1] https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fprisma-statement.org%2Fdocuments%2FPRISMA_2020_flow_diagram_new_SRs_v1.docx&wdOrigin=BROWSELINK

[2] https://www.scopus.com/standard/marketing.uri

[3] https://www.webofscience.com

The next action is to remove records before moving to the next screening stage. In this step, the initial cleaning of the papers has been done. The papers extracted from the two databases certainly have overlapped results. Thus, after the comparison, the 38 duplicated records have been removed from the result.

2.3.2 Screening Stage

In this step, there are several steps taken to further filter the papers. Firstly, the number of records to be screened is coming from the previous step, which is after the removal of duplicates. Therefore, the records to be screened are the initial paper numbers minus the 38 duplicated numbers, and the final screened number is 548.

Secondly, the reason to further exclude the papers needs to be defined. Due to the keyword's setup, the content of aviation will be included into outcome and the papers with safety related topics not only in aviation area but also including other topics or areas are extracted as well. For example, the paper "*Strategic Management in Public Organizations: Profiling the Public Entrepreneur as Strategist" has* been extracted from Scopus database and there is no such paper duplicated existing in Web of Science database. This paper contains the keywords of aviation, safety method and organization. However, the core of that paper is to discussion the strategic management and public entrepreneur. Another reason to remove certain papers in this step is that the paper content is not directly discussing the required topics and points but having some content closely. For example, the paper *"Airport environmental impacts: A simplified method for their assessment"*. It mentioned the content within the aviation area however, it more highlighted on environmental impacts such as air pollution, aircraft noise. Apparently that paper cannot fulfill the requirement of the screening. In this step, totally 225 records have been excluded and it remains 323 records to be retrieved.

Thirdly, in order to review the selected papers, it is necessary to make sure all the papers are accessible. Among these 323 papers, there are 38 reports that cannot be retrieved successfully. As both the Scopus and Web of Science databases provide online resources, it is possible that the database only has the paper title, abstract, author, and citations available. In order to read the details of the paper, the author needs to share the paper, either for free or for a certain fee. As a result, it creates a barrier because the authors of the selected papers may be unable to be contacted. After deducting the unavailable reports, there are 285 papers in total to be taken for further analysis.

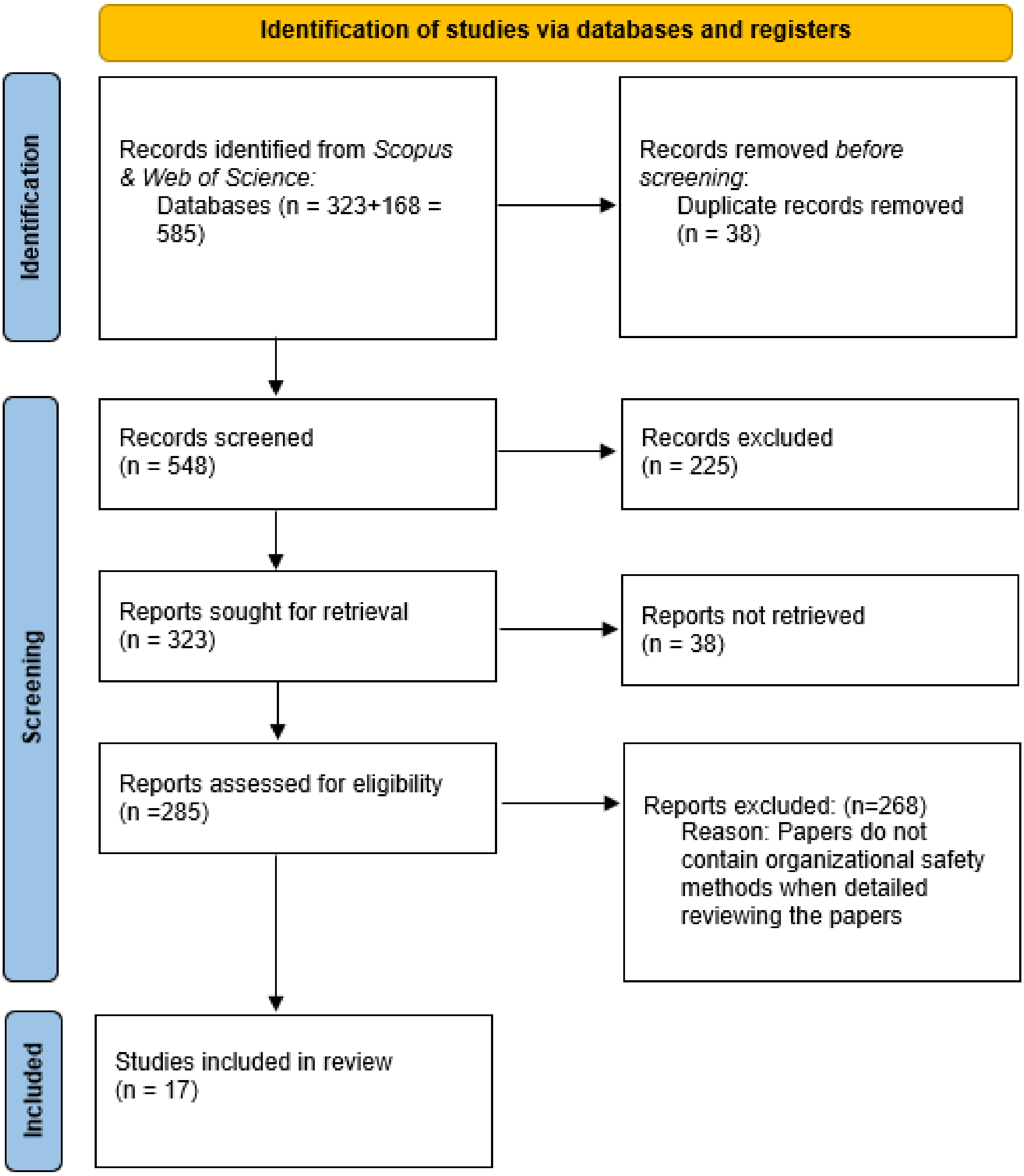
In the last step of the screening stage, it performs another exclusion of papers. A detailed check of the remaining paper is needed in this step. The paper which is discussing the safety methods, if it is not related to organizational factors, such as human factors or technical factors, it will have been removed from this step. Some of the papers do not distinctly state if the analysis of safety methods is related to organizational factors, so they have been removed as well. There are 268 papers in total that do not perfectly meet the requirement and have been removed from the results.

2.3.3 Included Stage

The last step of the PRISMA Flow diagram shows the final result, which is to be included in the further review process. The reports which can be accessed but excluded in the final step of screening are 16 and it means these 16 papers will be subjected to a detailed analysis of their organizational safety methods.

The entire process has been displayed with the PRISMA Flow Diagram on the next page Picture 1.

Picture 1: PRISMA Flow Diagram for selecting Organizational Safety Methods in Aviation



Chapter 3

3 Review of selected papers

In this part, the organizational safety methods that have been used in the selected papers will be introduced with theoretical explanations. Next, this session will continue with the review of the 16 selected papers for the topic of organizational safety factors in the aviation industry, which are filtered by using the PRISMA method.

3.1 Organizational Safety Methods application

This section will mention several organizational safety methods in a theoretical way, which were used in the selected papers.

3.1.1 Organizational Learning

This method has been used in the paper *"Free lessons" in aviation safety.*

This method is a more generic term or principle or theory, than a specific technique. The purpose of this method is to do data collection and information sharing, mitigate risk and eventually for organization, Safety management, or Safety culture assessment. Organizational learning is a process of detecting and correcting errors. Organizations learn through individuals acting as agents for them: The individuals' learning activities, in turn, are facilitated or inhibited by an ecological system of factors that may be called an organizational learning system.

3.1.2 Civil Aviation Daily Occurrence Reporting System (CADORS)

This method has been used in the paper *"Free lessons" in aviation safety.*

This method is mainly used as a database or data collection tool. It is used to collect timely information concerning operational occurrences and it is used in the early identification of potential aviation hazards and system deficiencies. CADORS captures a wide scope of safety related events including ATC operating irregularities; communication, navigation, surveillance, and other air traffic systems failures; controlled airspace violations; etc. Included in the collection are occurrences related to aircraft, aerodromes, security (e.g., bomb threats, strike actions) and the environment (e.g., fuel spills).

3.1.3 Commercial Aviation Safety Survey (CASS)

This method has been used in the paper "*Aviation safety and maintenance under major organizational changes, investigating non-existing accidents."*

This method has been developed since 2003 as a static approach with tabular, checklist or questionnaire support. The purpose is for Organization, Safety management, or Safety culture assessment. The CASS questionnaire-based survey was designed to measure five organizational indicators of safety culture within an airline: Organizational Commitment to Safety; Managerial Involvement in Safety; Employee Empowerment; Accountability System; Reporting System. CASS exists in two versions: one for flight operations personnel (pilots, chief pilots, and operations management); and one for aviation maintenance personnel (technicians, inspectors, lead technicians, supervisors, and maintenance management).

3.1.4 Sequentially - Timed Events Plot (STEP)

This method has been used in the paper "*Aviation safety and maintenance under major organizational changes, investigating non-existing accidents.*"

This is a static model or approach with graphical support. The purpose of this method is to do risk analysis of an operation or of a safety-critical scenario, or to do retrospective accident or event analysis. This method is used to define systems; analyze system operations to discover, assess, and find problems; find and assess options to eliminate or control problems; monitor future performance; and invest. This method was developed in 1987. In accident investigation, a sequential time line of events may give critical insight into documenting and determining the causes of an accident. Multilinear Event Sequencing (MES) is a refinement of STEP. It is used for complex events with many actors and when the time sequence is important.

3.1.5 Aviation Safety Action Program (ASAP)

This method has been used in the paper "*Aviation Safety Plans: Content and Training.*"

The main purpose of this method is to work as a data collection tool. ASAP promotes voluntary reporting of safety issues and events that come to the attention of airline employees, including pilots, flight attendants, and repair stations. It includes enforcement-related incentives to encourage employees to voluntarily report safety issues, even though the issues may involve an alleged violation of Title 14 of the FAA Code of Federal Regulations (14 CFR). ASAP safety data, much of which would otherwise be unobtainable, is used to develop corrective actions for identified safety concerns, and to educate the appropriate parties to prevent a reoccurrence of the same type of safety event.

3.1.6 Socio-Technical Risk Analysis (SoTeRiA)

This method has been used in paper *"Incorporating organizational factors into probabilistic risk assessment of complex socio-technical systems: Principles and theoretical foundations."*

This method is the framework or integrated method of more than one technique. The purpose of this method is to conduct a risk analysis of an operation or of a safety-critical scenario. SoTeRiA is a probabilistic risk assessment framework aiming to evaluate the effects of organizational factors on accidents and incidents. The Fault tree and Event Sequence Diagram are used to determine the probability of an undesired event and subsequently the risk. Risk values are then fed into System Dynamics (SD) that updates the value/status of risk influencing factors at various levels and calculates the corresponding probabilities. These probabilities are fed into a Bayesian Belief Network to calculate leaf node probabilities of the Fault tree. SoTeRiA is at an academic level, though it has been applied to a test case (addressing airline maintenance system risk) in order to demonstrate its feasibility and add value.

3.1.7 Aviation Risk Management Solutions (ARMS)

The ICAO Executive Body has developed new Safety Management System (SMS) standards for various aviation organizations, including airlines, maintenance organizations, ATC services, and airports. Risk assessment has a central role in safety management systems. Risk assessment is a very challenging task for many reasons. The old methods were characterized by a high degree of subjectivity and other difficulties. An industry working group, ARMS (Aviation Risk Management Solutions), was established in 2007 to develop a new and better method for operational risk assessment (ORA). The primary target group for this methodology is the airlines, but it will be fully applicable to other aviation organizations as well. The working group is mainly made up of safety practitioners from the airlines. This should ensure that the proposed methodology is applicable to the actual environment of the airline or other aviation organization.

ARMS defines an overall process for operational risk assessment. This begins with an incident risk classification (ERC), which is the first review of the urgency of the incident and the need for further investigation. This step also attaches a risk value to each incident - this is necessary to create safety statistics that reflect the risk. The next step is data analysis to identify current safety issues. A detailed risk assessment of these security issues is then carried out through a Security Issue Risk Assessment (SIRA). The whole process ensures that any necessary safety actions are identified, creates a register for following up on risks and actions, and provides a safety performance monitoring function. SIRA can also be used to carry out safety assessments, which is a requirement of “change management”.

3.1.8 Aviation Safety Reporting System (ASRS)

ASRS is a decision support system designed to predict the impact of new safety technologies or interventions on aviation accident rates.

The ASRS receives, processes, and analyses voluntarily submitted incident reports from pilots, air traffic controllers, and others. Reports submitted to ASRS describe both unsafe occurrences and hazardous situations. ASRS's particular concern is the quality of human performance in the aviation system. Individuals involved in aviation operations (pilots, crew members, ground personnel, etc.) can submit reports to the ASRS when they are involved in or observe a situation that they believe has compromised safety. These reports are voluntary and submitted at the discretion of the individual.

3.1.9 Operational Risk Management (ORM)

This method is mainly a decision-making tool to identify operational risk and benefits and determine the best courses of action for any given situation. The ORM process comprises six steps. 1) Using a Task analysis as input, identify Hazards and their causes; 2) Assess the Risk; 3) Identify and analyze Risk Control Measures and prioritize those risk controls that will reduce the risk to an acceptable level; 4) Make Control Decisions; 5) Implement Risk Controls, by making the implementation directive clear, establishing accountability, and getting approval, commitment and support at the appropriate management level; 6) Supervise and Review, and establish a feedback system.

In contrast to an Operating and Support Hazard Analysis (O&SHA), which is performed during development, an ORM is performed during operational use.

3.1.10 Root Cause Analysis (RCA)

This method mainly focuses on the causal factors to accident or near-miss incidents. The technique goes beyond the direct causes to identify fundamental reasons for the fault or failure; it asks why things happen, instead of treating the symptoms. It is a systematic process of gathering and ordering all relevant data about counter-quality within an organization; then identifying the internal causes that have generated or allowed the problem; then analyzing for decision-makers the comparative benefits and cost- effectiveness of all available prevention options.

To accomplish this, the analysis methodology provides visibility of all causes, an understanding of the nature of the causal systems they form, a way to measure and compare the causal systems, an understanding of the principles that govern those causal systems, and visibility of all internal opportunities for the organization to control the systems.

3.2 Review of selected papers

In this part, the 17 selected papers will be reviewed and identify the organizational safety methods applied.

3.2.1 “Free lessons” in aviation safety

The Safety Methods Organizational Learning, Civil Aviation Daily Occurrence Reporting System (CADORS) have been used in this paper.

The paper [3] started with the introduction of a good tradition within the aviation industry, that is good at learning from aviation accidents. Every country, government, institution, and airline contributes a lot of effort to ensure aviation accidents have been deeply investigated, either for technical or human failings. The investigation could take months or years to complete. By nature of the detailed and thorough investigation, the accident results and recommendations made by investigators are little to no challenge. The entire aviation industry generally accepts and adopts the accidents’ conclusions and recommendations.
The accident rate has been reduced based on the work and support from the entire industry and related organizations. However, in the meantime, when accidents happen less, the opportunities for investigating and learning from accidents have decreased as well. In other words, this success could reduce the perceived potential of incidents and make people less likely to learn from them.

Thus, in this paper, a way to overcome this problem is mentioned, which mainly contains three points. The first point is about the organization. The organization has the duty to treat incident reporting as an opportunity to see how the system broke down to allow something to happen. The second point is to share the knowledge and experience gained from incidents and their investigation. The sharing must be done both throughout the organization and across the industry. And organizations and industries must demonstrate how they are learning from knowledge sharing and responding to recurring incidents. The third point is to avoid individual blame. The system and people’s failures have to be accepted.

These three points help to build a healthy safety culture that addresses the key aspects of reporting, justice, flexibility, and learning. This safety culture needs to constantly work against to pressure of minimizing incidents and allow them to be accepted as lessons on how the system fails. When the organization can improve such a safety culture, welcome the incident reports and actively learn from them, in the long term, it will become a self-improving circle.

3.2.2 Aviation safety and maintenance under major organizational changes, investigating non-existing accidents

This paper [4] uses the Commercial Aviation Safety Survey (CASS) and Sequentially-Timed Events Plot (STEP) as methods to analyze the impact of organizational changes on aviation maintenance and safety.

The object of this paper is to discuss whether current organizational changes have a direct impact on aviation maintenance and safety and if so, how to measure them. The actual example in this paper is from the Norwegian aviation industry. The Accident Investigation Board, Norway (AIBN) is responsible for the investigating the Norwegian aviation organizational safety changes between 2000 and 2004. During this period, several major changes occurred at the same time in the organizations of the regulators, the airports, the navigation providers, and the operators. What’s more, some other developments were also taking places, such as deregulation, liberation, privatization, cost reductions, and the growth of low-cost carriers.

In order to evaluate the changes and safety impact, the first step is to collect the information. The information could come from an external international or national framework such as political, regulatory changes or other studies; the company data which contains the trend in safety indicators or aircraft utilization, questionnaire and interviews; the organizational changes which happen in assessment and management of change, management of maintenance program, safety and quality reporting and training. Based on the collected information, the second step is to identify the safety issues. In order to better measure the outcome, the indicators were classified into groups as external-internal audits, competence training and level of experience, maintenance, and financial investments. The indicators can work as a navigation aid in the safe space. Practically speaking, the indicators in the Air Safety Report, Ground Occurrence Report, or Flight Occurrence Report which refer to accidents and incidents are always have a few opportunities to get, but they need to make more effort to investigate and learn. However, some other indicators which exist in the Flight Report, Technical Report, Hold Item List, and Minimum Equipment List has a lot more opportunities. For example, they provide an early warning to the organization of the health of the aircraft, but it takes a little effort to investigate and learn. The questionnaire was also prepared to collect the inadequacies during ongoing changes. The topics are related to personal data, safety culture, management of safety, changes within the company, and positive or negative impact on safety.

In the paper, the method STEP is used to show as an example of how the international aviation organizations' training recommendations change had an impact on the operators' training procedures and practices. Among the international organizations, parts of the ICAO recommendations have been transferred to the JAA, then the JAA published the JAR - 66, and the EASA had the publication regarding the establishment of EASA. In the national regulator level, the AVINOR and LT were established as separated organizations. At the operators' level, operators adjusted to follow new requirements regarding technician certificates (JAR 66). It has been confirmed that changes in the regulations have a direct impact in the organization and management activities of the airline.

In the end, the conclusion of this paper is that when it is concerning the method, it is not possible to investigate whether organizational changes affect safety from just one perspective. The method cannot identify all safety impacts related to organizational changes, but it helps to identify safety issues and improves safety in maintenance activities.

3.2.3 Aviation Safety Plans: Content and Training

This paper [5] has mentioned Organizational Learning and Aviation Safety Action Program (ASAP) for safety culture objectives.

Each airline company has the safety programs which are created based on the specific requirements of an organization's operational needs. This paper addresses the content and training of safety cultures and the organizational aspects of safety plans.

The breakdown of system maturity has been set up into three levels to define organizational safety maturity. The first is proactive, which means airlines have a strong safety culture and can use systematic techniques to identify and manage risk. The second is compliant, which means airlines use regulations, standards, accident reports, or codes from other airlines. The last one is reactive, which means airlines only react until they have their own accidents. This classification helps to motivate and achieve safe actions.

Each airline has its own organizational culture to define the values, beliefs, symbols and behaviors, and the safety culture is a subset of the organization's culture. The key predictors of safety performance are ranked as following factors, effective communication, good organizational learning, organizational focus and, financial health. These factors are not fit all situations so some of the main techniques include observations, interviews, document reviews, policy and procedure reviews, focus groups, employee surveys and retention studies into organizational safety programs and safety culture.

Based on the elements of good safety culture, the management team of airlines should also create and perpetuate the safety culture. They can set standards and expectations and provide the resources to meet the safety culture, develop and enforce a standard protocol that emphasizes safety, and set up a meaningful incentive program that rewards safety behavior. In the meanwhile, the management team needs to make sure to have a realistic perception of the risk entailed in the organization's operations.

To a detailed degree, this paper has introduced an organization scorecard for safety programs and culture, which highly concerns the safety culture. The rank is from 1 to 10 depending on the achievement of safety programs. For example, the safety programs do not support safety goals will be scored as 1. The company actively solicits and encourages input from aircraft manufacturers' product-support groups will be scored as 10. Besides it, there is also a scorecard that focus on the management and staff attitude towards safety. The rank is also from 1 to 10. For example, when there is little evidence of a safety culture in either management or in individuals within the organization, it will be ranked as 1. When the safety culture is well embedded and obvious in all it does, it will be ranked as 10. These records strongly show the correlation between safety and organizational culture and the training of the organizational program. In the end, the Aviation Safety Action Program is introduced. This program can provide the supplements for normal regulatory structure. The airlines, pilot union and CAA personnel will cooperate to know the weakness in safety related procedures. It helps to offer a potentially highly effective process for increasing safety.

3.2.4 Incorporating organizational factors into probabilistic risk assessment of complex socio-technical systems: Principles and theoretical foundations

The Socio-Technical Risk Analysis (SoTeRiA) has been used in this paper [6].

Probabilistic Risk Analysis (PRA) is rapidly becoming the method of choice for many public and private sector organizations to assess and manage safety risks of complex technological systems and processes. PRA is used to identify potential accident scenarios, estimate their likelihoods and consequences, and improve system safety and operation. However, the current generation of PRA does not include an explicit representation of the possible impacts of organization and management on the safety performance of systems and personnel. There are some technical challenges in developing a predictive model of organizational safety performance. Based on these requirements, a well-accepted model of organizational influences could be developed and validated.

In this paper, a set of general principles for developing organizational safety frameworks has been proposed. They are safety risk, multi-dimensional performance objective, safety performance and deviation, multi-level framing, depth of causality and level of detail, model generality, basic unit of analysis, factor level and nature, factor selection, link nature, structure and level, dynamic characteristics, measurement techniques, modeling techniques.

With these proposed principles, the realization of modeling principles has been performed and developed. This is the Socio-Technical Risk Analysis (SoTeRiA) framework. The framework has been implemented in the aviation industry and particularly for airline maintenance systems.

3.2.5 Key Factors to Achieve Maturity in Safety Management Under a Safety Management System (SMS)

In order to improve the overall operational safety record of the aviation industry by using a better method of safety management, the International Civil Aviation Organization (ICAO) and Federal Aviation Administration (FAA) have agreed to improve the System Safety approach.

This paper [7] mentioned that the Safety Management System (SMS) is the most effective way to improve safety in any aviation organization. The SMS can ensure the aviation organization is organized, structured and documented. The SMS is made up of 4 components and 12 elements. The safety management needs to constantly verify the organization, the workplace, the people and the defenses.

When there is enough data collected during the operation, the incidents, accidents, and other condition that increases the risk in the operation, the organizations need to monitor and measure the performance to improve the safety which can be verified. With this process, there are 2 different types of indicators used in this paper, which are leading and lagging. Leading indicator means the process which is to increase the number of hazard reports received by the organization, and the findings from internal audits that needs to be closed. A lagging indicator means the process that to be decreased such as the number of incidents, the number of serious incidents or the number of ramp damage incidents. We can monitor the organizational processes, improve workplace conditions, contain active failures, identify latent conditions and reinforce defense so as to ensure the leading and lagging indicators are measured.

The aviation organization's safety management system has already reached to initial level of maturity, only when we can clearly show how both types of indicators are improving. It means all elements of the safety management system are influencing daily operations. The key part of the safety management system is based on tangible support from top management. Another key factor is the yearly assessment of how the safety management system is working compared with the theoretically designed. The third factor is about the change management process, whether it is effectively implemented to quickly act once there are new hazards appearing.

The last key factor is to use effective tools such as Root Cause Analysis, the Human Factors Analysis and Classification System (HFACS). There are also some other tools developed by Boeing, such as Procedural Event Analysis Tool (PEAT), Maintenance Error Decision Aid (MEDA), Ramp Error Decision Aid (REDA), and Cabin Procedural Investigation Tool (CPIT). These tools can help organizations solve or mitigate safety hazards effectively.

3.2.6 Perils and Profits: A Reexamination of the Link Between Profitability and Safety in U.S. Aviation

This paper has mentioned Aviation Risk Management Solutions (ARMS) and Operational Risk Management (ORM).

This paper [8] starts with an example that FAA gave the fine to Southwest Airlines, in response to the revelation that dozens of jets without performing required maintenance inspections. This occurred during a certain period of financial difficulties for US airlines and eventually it shows the connections between airline profitability and aviation safety. From some research and study, the profit – safety link could drive partially by behavioral factors, and it will impact organizational risk-taking. In another word, the decision is strongly impacted by financial targets and goals. This paper reviews the extant literature of profit – safety link and risk taking of organizations.

In the second part of this paper, it introduced the theory and hypotheses for the profitability – safety link and the behavioral theory of the Firm and Organizational Risk Taking and Risk Taking and Organizational Safety. It deeply stated the historical development of these theories and analyzed the relationship between profitability and risk taking. From the theoretical part, this paper included the sample and data, dependent variables, independent variables, and control variables. With these parameters, this paper has performed the analysis and got the results.

In the last part, this paper has discussed and get a certain conclusion. It mentions that commercial aviation is most incomprehensibly safe. This finding shows the relation between organizational theory and management methods when dealing with the risky operations in the aviation industry. In this paper, it also presented the limitations. The first is the analysis may not be precise. Second, the result of this study cannot be strictly generalized outside of the US airline industry. Third, the reported results for airline incidents may be influenced by under-reporting.

3.2.7 Knowledge brokering for transference to the pilot's safety behavior

The Commercial Aviation Safety Survey (CASS), questionnaire and statistical evaluation methods have been used in this paper.

This paper [9] started with the topics of an organization's operations and management for learning and innovation. The organization should be able to learn from old knowledge and create new knowledge to overcome various difficulties when facing the challenges. In the airline management area, transport safety is the most important topic. In the safety literature of the aviation industry, the relationship between organizational culture and safety culture and safety behavior has been deeply discussed.

In the second part of this paper, it started with the introduction of conceptual background and hypothesis then followed with the Method used in this paper. In the fourth part, it shows the empirical results and analysis. In this part, it stated the perceptions of five factors between short and long work experiences for the sampled airline. It listed five tables for comparison of views on the airline's safety mission statement of pilots with short and long work experience with this airline. The statement includes the safety mission, organizational identification, organizational culture, safety culture and safety behavior. In the end, the paper used the Pearson correlation coefficients between these factors and found that all were positively and significantly related to each other.

In the final conclusion, the result of this paper was performed on a survey presented three important findings. First, the paper showed that organizational factors have been measured is correlated with plenty of practical and theatrical variables. Second, from the Pearson correlation analysis, the five factors were highly correlated to each other.

What's more, this paper has also provided an overview of the crew's perceptions of how safety has been managed in the aviation industry. Based on the survey, we know that organizations in the various sectors of the airlines industry can do better job to manage safety.

3.2.8 Evaluation of the Influence of Organizational Factors in the Effective Implementation of Safety Management Systems (SMS) in the United Arab Emirates (UAE)

At present, the level of development of technology has been increased, typically for building an aircraft, the complexity and type of operation involving aircraft have also diversified. The risk behind is also going up so that improving air safety has always been a top priority for air transport. It is confirmed that with the rise in the use of air transport, there are also higher accident rates. With the forecasted rise in global aviation activity, there is concern that traditionally reactive methods of reducing risks to an acceptable level may not be sufficient, then the probability of increasing accident rates will get higher. The traditional reaction methods may not be an acceptable level to reduce risk, but they increased the probability of accident rates. Thus, when there are newly developed techniques used in the air transport industry, it is crucial for operators and regulators to ensure the alignment of technique newly developed and safety knowledge gained in the past. The approach that is being implemented in the air transport industry is the Safety Management Systems (SMS).

One of the most important factors used in this system is called organizational safety factor. It can be categorized into four levels: organizational level factors, safety management factors, work group factors, and individual level factors. Furthermore, there is a central role with three concepts to explain the organizational role in safety, they are safety management, safety climate and safety culture. According to relevance, the two major organizational processes are adopted, which are safety management and organizational culture. Under each process, there are hazard identification, risk management, safety culture and safety climate.

In this paper [10], it is mentioned that the root cause of accidents is composed of many interrelated factors within an organization, and the management of these latent organizational factors has become important. The major safety factors are communication, documentation, equipment, incident investigation and analysis, safety policy, rules and regulations, safety committee, safety culture, safety risk management, training and competency, work practice. More specifically, this paper finds that the twelve elements listed under ICAO’s Framework meet the characteristics to be considered as the organizational factors to be studied in the effective implementation of SMS.

The paper has used Aircraft Noise and Performance (ANP) analysis and Decision Making Trial and Evaluation Laboratory (DEMATEL) process, which identified four factors as the core functions for effective implementation of SMS in the UAE, which are hazard identification, risk management, change management, and coordination of emergency.

The findings can help individuals holding decision making positions in airlines in the UAE, the air transport organizations, and the regulatory body in the UAE. The air transport organizations can design efficient and effective safety strategies that will help them attain an 'acceptable level of safety' with minimal cost and maximum utilization of resources.

3.2.9 General model analysis of aeronautical accidents involving human and organizational factors

This paper [11] presents the development of a general model of accident analysis according to the principal factors which can impact aeronautical accidents. Besides technical and human performance in aviation safety, the concept of organizational accidents has been developed since the 1990s. This is due to the limitation of traditional approaches for accident models which cannot explain the cause of accidents in complex systems developed in the last half of the twentieth century. For example, the Bayesian Belief Network (BBN) method is one of the newly introduced methods in order to have a more accurate analysis of physical phenomena, human and organizational factors.

In this paper, it brings up a general model to analyze aircraft accidents considering the factors which contribute to the pilot's performance. There are totally four factors that can influence the pilot's performance. The first factor is the Management and Organizational Factors (MOF) which refers to organizational factors which the pilot serves. The second factor is the Performance Shaping Factor or Human Factors (PSF) which refers to the human pilot's performance factors. The third factor is the Environmental Factors (EF) which refers to the climatic factors (weather). The last factor is the Required Abilities (RA) which refers to the skills needed for the pilot to develop the relevant tasks to the flight phase. It is considered that the MOF can directly influence the PSF, which means before the pilot performed the tasks, the pilot has the MOF established earlier as MOF is related to their home institution. The PSF and EF factor groups are distinguished by the capability to change the status during flight. Besides, there is an airport infrastructure factor that only concerns the accidents happening during the departing or landing phases.

The development of a general model of aircraft accident analysis is important to better understand an event and the chain of factors that are associated with it. This proposed general model analysis of aeronautical accidents can be applied to any accidents.

3.2.10 System dynamics modeling of the safety evolution of blended-wing-body subscale demonstrator flight testing

This paper has used the Socio-Technical Risk Analysis (SoTeRiA) as a safety method analysis.

The subscale demonstration plays an important role in the research method for investigating the characteristics of a new conceptual aircraft configuration design. However, there are many demonstrator mishaps due to complex interactions among technological uncertainty, low reliable system components, human factors, flight environments, and organizational deficiencies. In the aviation industry, accident cannot be blamed on a single mechanical failure. The involved factors are rather at all levels of the socio-technical system and further upstream in an organization.

In this paper [12], it reviews the system dynamics in the field of system safety. The basic modeling elements of system dynamics modeling are the reinforcing loop, the balancing loop, and the delay. During the case study session, the safety records of three blended-wing-body (BWB) have been taken during flight testing. The unsafe factors are found during the testing.

Based on that case study, the general organizational safety behavior called ‘‘get out of ‘‘fly-fix-fly” predicament” has been identified. This behavior always exists when the research teams or institutions have little prior knowledge. With more post-hoc analysis and learning, the teams' safety experience will be increased, and fly-fix-fly mindset will get lower. When the safety control approach is initialized, a clear safety commitment in the team begins to set up.

Afterward the paper explained how the implemented systematic safety control strategy reduced the accident rate but with a delayed safety benefit. It can be treated that the technical, organizational, and human dimensions are integrated for the dynamic behaviors of a socio-technical system.

3.2.11 The art of measuring nothing: The paradox of measuring safety in a changing civil aviation industry using traditional safety metrics

In this paper [13], measuring of safety as an outcome variable within the ultra-safe civil aviation during organizational change is a difficult task. The traditional safety metrics to measure incidents and accidents did not reflect the negative effects of change that were being observed within the organization at the individual and unit levels. These observations confirmed that no changes in traditional safety metrics were detected. And it brings the confusion that safety was

unaffected by the change processes, at least not in the short run.
Specifically speaking, in the aviation industry, when there is an accident occurring, the measurement indicator shows the things are not safe, but when nothing happens, or there is nothing to pay attention to we do not know if this is due to safety processes were properly running, or due to good fortune. Based on the questionnaire and statistical analysis, it shows that there is a general lack of studies to address the relationship between organizational change and safety outcomes, particularly in the high-risk organizations, which are business oriented. Based on the decision-making process, the high-risk organizations are also business oriented. However, the relationships between organizational change and safety outcomes are lacking in studying.

In this paper, it is mentioned that the traditional safety metrics for measuring safety in civil aviation industry cannot fully capture the true safety state of an evolving organization. Instead, a more accurate approach to measure safety in a complex system is proposed. Thus, the Safety Management System has been used to monitor safety in an organizational culture. The three phases proactive, interactive and reactive measures are integrated in safety management model.

Using a combination of approaches in an integrated model provides a much better evaluation by which organizational leaders can make better informed choices in business management in high-risk industries that are also ultra-safe.

3.2.12 Study on the Organizational Factors in Civil Aviation Safety

The Commercial Aviation Safety Survey (CASS) has been used in this paper.
This paper [14] brings an opinion which is the organization factors have become key factors for civil aviation enterprises to improve safety. The accident rate can be expected to decline substantially only by finding out the potential errors and working out aviation safety programs on the organizational level.

Based on the relative studies, there are 16 organizational factors that affects civil aviation safety and they have been divided into 4 aspects. They are resource management, process management, organizational climate and organizational supervision. In order to collect samples and do testing, the questionnaires have been prepared for organizational factors and safety status. Totally there are 19 indicators for measurement.

Based on the results of the questionnaire, five conclusions have been drawn. The first conclusion is that not all four aspects of organizational factors are interrelated with each other. The Resource Management is not interrelated with Organizational Climate and Organizational Supervision. Besides, Organizational Supervision has a low correlation with the other two factors.

The second conclusion is that Resource Management has significant and positive effect on Safety Status. Personnel education & training has the most significant effect on Resource Management.

The third conclusion is that Process Management has significant and positive effect on Safety Status. The Process Management contains Information service & management, Site management, Operation plan and Procedures & documents.

The fourth conclusion is that Organizational Climate has significant and positive effect on Safety Status. Organizational Climate is mainly decided by Organizational culture and Organizational policies. Meanwhile, Organizational goals have some effect on it.

The last conclusion is that Organizational Supervision has significant and positive effects on Safety Status. The Risk management is the most important aspect of Organizational Supervision. Supervision management and Intensity of supervision are less important.

3.2.13 A Review of the Current State of Aviation Safety Action Programs in Maintenance Organizations

In this paper [15], it mentions the Aviation Safety Action Programs (ASAPs) were designed to encourage air carrier and repair station employees to report errors or conditions for the safety of flights voluntarily. This program has been starting to work since 1998.

In order to better understand the current state of the ASAP programs, the questionnaire has been prepared to ask four aspects of an ASAP program which are background and structure, current operations, outcomes, and specific examples of common safety threatening behaviors. Based on the outcomes, it concludes that successful ASAP programs tend to have strong and consistent support from senior management so as to make sure the disciplinary policy can be overcome. The impact of ASAP investigations could be classified into three categories, they are task-level, organization-level, or industry-level. There are several ways to measure the effectiveness of ASAP programs. It is better to emphasize on the actual changes as a result of ASAP investigation rather than only the amount of reports.

3.2.14 Difference Analysis between Safety Management System and Airworthiness Management System in Civil Aircraft Design and Manufacture Organization

This paper has mentioned about Operational Risk Management (ORM) and Aviation Risk Management Solutions (ARMS) as safety methods.

In China, there are the China Civil Aviation Regulations (CCAR) and airworthiness management systems to make sure the safety and airworthiness of civil aircraft before entering the aviation market. Specifically, there are Design System (DS) and Design Assurance System (DAS) for aircraft manufacture, defect information report system, unsafe condition correction and continuous improvement programs. Recently, the safety management system (SMS) has been implemented by International Civil Aviation Organization (ICAO). It highlights the importance of safety management in a proactive way. In addition, it focuses on accident prevention and safety planning, and collects the risk information. China's aviation industry also started to use a safety management system in order to facet the rapid development of the aviation industry and civil aviation safety operations. However, it is not easy to define the relevant regulations and plans to improve the core idea of SMS. The gap between current airworthiness management system and safety management system is still existing.

Recommended by ICAO, the Reason Model is used to study the internal relationships between accidents and organizational defects. The Reason model is built based on the accident, which cannot only have the chain reaction of an event itself, but also exist in a defected organization. When there are multiple levels of organizational defects occurring at the same time, an unsafe event will happen. Thus, it requires the SMS to continuously develop the organizational management.

In order to do a risk assessment for SMS, the risk analysis matrix method can be used to measure it. The risk of severe matrix has been created for risk assessment. It collects the event information, prepares matrix form and makes relevant decisions. The matrix is divided to the frame of acceptable, which means no need to take further measures; acceptable after remission, which means the risk can be tolerated, but the precondition is that risk is decreasing as much as possible; unacceptable, which means the current state of working must be stopped until the risk has been decreased to a tolerable level.

After the theoretical introduction, this paper [16] performed the comparative analysis between current airworthiness management system and SMS and the difference analysis between DAS, QS and SMS. The conclusion is that there is no essential difference between airworthiness management system and SMS. The current DAS and QS are feasible for aircraft type design and manufacturing organization to establish SMS.

3.2.15 A Mindful Governance model for ultra-safe organizations

This paper has mentioned about the Aviation Safety Reporting System (ASRS) this safety method.

This paper [17] started with the definition of mindful organizing, which is the key to integrating the concept to fix the organizational accident. It is treated that the information and knowledge are always shared and informed throughout the organization. However, the mindful organizing construct has never been used as a practical and effective method approach for complex ultra-safe systems. Thus, in this paper, it mentions that Mindful Governance could be enhanced and supported by some simple applications.

As mindful organizing enables individuals to interact with others in the organization, the understanding of the situation that individuals have encountered should be shared. The mindful organizing exists when it is collectively enacted, which means the mindful organizing must be adapted to current conditions rather than relying on predefined organizational structures.

In the organizational hierarchy, the mindful organizing contains the top administrators, middle managers and front-line employees. This includes the resources from the top managers to the overall organization, who can put in place to support safety management and improvements. The mindful organizing needs to cooperate across the organizational levels. The top managers create the organizational mindfulness and middle managers go to synchronize across levels and translate it into mindful organizing actions for the front-line employees.

In this paper, it has a case study about the airline ground operations, analysis of operational audits and management of safety information. With the actual case, the set of principles has been brought out. With these principles, the issues which are studied in both cases, can be supported. Next, this paper used multiple case study methods to support the application. The first is in the case study for the ATC organization, and the second case study is the airline ground operations.

In the conclusion part, it summarized a concept that if people are provided with information and support connected with their actions, this created a way to solve the issue they meet. The rule can be used at all levels of the system and across all the systems that will generate the risks.

3.2.16 Assessing the relationship between organizational management factors and a resilient safety culture in a collegiate aviation program with Safety Management Systems (SMS)

This paper used the Commercial Aviation Safety Survey (CASS) and Questionnaire to analyze the organizational safety related topic.

As the technology has increased rapidly, the requirement of accepting levels of safety in the aviation industry should also be implemented in order to meet the organizational safety culture. The organizational safety culture is normally classified into three groups, psychological aspect, the behavioral aspect, and the situational aspect. The situational aspect of a safety culture also relates to policies, procedures, and organizational management system. The resilient safety culture is based on three factors, which are psychological or cognitive capabilities, behavioral capabilities and managerial or contextual capabilities. With this, the safety professional can better identify the vulnerabilities in the organization safety culture framework and work for improvements.

In order to analyze the relationship between organizational management factors (Principles, Policy, Procedures and Practices) and resilient safety, the theories that have been used in this paper are as follows: High reliability organizations (HROs) and resilient safety culture; safety management systems voluntary program (SMSVP); resilient safety culture perceptions and SMS impact

This paper [18] also prepared the questionnaire to help the research deeper. Based on the questionnaire and the mathematical correlation calculation for management factors, the result shows that a resilient safety culture is strongly influenced by the policies, procedures, and principles within an organization.

3.2.17 Measuring safety climate in aviation: A review and recommendations for the future

This paper used questionnaire, Commercial Aviation Safety Survey (CASS) and Aviation Safety Action Program (ASAP) as the organizational safety methods.

In the past, the organizations have accessed the safety performance based on "lagging indicators". The lagging indicators show when a desired safety outcome has failed or has not been achieved. However, as the safety has been improved in the aviation industry, some lagging indicators cannot be part of the factors to measure safety performance. And in the High Reliability Organizations (HROs), the number of accidents occurring has been lower. Given these facts, the HROs have started to examine the "leading indicators" of safety to improve safety performance even further.

The safety climate is one of the most commonly used leading indicators of safety in non-aviation HROs. The safety climate is a "snapshot" of the current manifestation of the safety culture in the organization. In this paper [19], the safety culture and safety climate are two different items with different concepts. The general consensus is that culture represents the more stable and consistent features of organizations. Safety culture reflects fundamental values, norms, assumptions and expectations. However, the safety climate is thought to represent a more visible culture, at a particular moment in time.

The purpose of this paper is therefore to identify whether there is evidence of construct (the extent to which the questionnaire measures what it is intended to measure) and discriminate (the ability of the tool to differentiate between organizations or personnel with different levels of safety performance) validity of the questionnaires used. Additionally, this paper will make recommendations for what to be done to improve the validity of safety climate assessments in the aviation industry.

In the next chapter, this paper has introduced the database for searching the literature. They are PsycINFO, Google Scholar, Medline, and Defense Technical Information Center. The keywords for the computerized search of the literature were: ‘‘aviation’’ with ‘‘safety climate’’, or ‘‘safety culture’’.

Then, by using the safety method questionnaire, several groups are classified to be taken survey. They are commercial pilots, cabin staff, ground handlers, aviation maintainers, air traffic controllers, combined aviation occupational groups, and US Naval aviators and maintainers. For commercial pilots, the questionnaire is designed based on previous safety climate research, input from aviation safety experts and the content of airline flight operations. The survey to cabin staff for these themes: management commitment towards safety, cabin work environment, rule compliance, crewmember involvement and participation, accident investigation, and injury incidence. For ground handlers, the questionnaire is designed based on the servicing of an aircraft while it is on the ground at an airport. The questionnaire for aviation maintainers is based on factor analysis. For air traffic controllers, the survey is designed based on the literature review and input from subject matter experts on the final items to be included. For the combined aviation occupational groups, the questionnaire has found that pilots believed luck and safety to be the most important factors in aviation safety, and employers were not perceived to be placing much importance on safety management systems and safety culture. For the US Naval Aviation, the questionnaires were based upon a conceptual model of Organizational Safety Effectiveness (MOSE) that identified five major areas relevant to organizations in managing risk and developing a climate to reduce accidents in HROs.

In total, all of the questionnaires reviewed consisted of safety climate factors that are in agreement with the broader literature on safety climate in HROs. And the result shows the relationship between safety climate and other measures of safety performance is not strong.

Chapter 4

4 Discussion

Based on the result from PRISMA method, 17 of selected paper have been reviewed from the previous chapter. There are some organizational safety methods have been used or multiple used, here in this paper, below 9 methods have been stated.
The methods have been used are Organizational Learning, Civil Aviation Daily Occurrence Reporting System (CADORS), Commercial Aviation Safety Survey (CASS), Sequentially Timed Events Plot (STEP), Aviation Safety Action Program (ASAP), Socio-Technical Risk Analysis (SoTeRiA), Aviation Safety Reporting System (ASRS), Operational Risk Management (ORM), Aviation Risk Management Solutions (ARMS).

The frequency of using these methods have been listed in this in the table 1.8 below:

Table 1.8 Organizational safety methods used in selected papers

Organizational Safety Methods	Frequency of usage
Organizational Learning	2
Civil Aviation Daily Occurrence Reporting System (CADORS)	1
Commercial Aviation Safety Survey (CASS)	5
Sequentially - Timed Events Plot (STEP)	1
Aviation Safety Action Program (ASAP)	3
Socio-Technical Risk Analysis (SoTeRiA)	1
Aviation safety Reporting system	1
Operational Risk Management	2
Aviation Risk Management Solutions (ARMS)	2

Based on the frequency of usage, it shows that the method Commercial Aviation Safety Survey has been used the most frequently. The Aviation Safety Action Program has been used three times in the selected papers. The reason using the Commercial Aviation Safety Survey is that to investigate the impact on the organizational level of safety management would normally need to collect the information from organizations or different individuals. With more information collected, it will help the analysis of the organizational safety. In another word, it confirms that the organizational safety management should learn from the safety feedback.

Due to limited papers have been selected in this thesis, there are not many organizational safety methods have been used here. The reason can relate to the safety methods development stages, after the technical and human factors, people stated to realize the importance of organizational safety management in aviation industry. As the safety methods database is a living document, all the methods are always under implementing as time goes by. Therefore, majority of organizational safety methods dated back to last century have not been used very often in the paper, instead, the Commercial Aviation safety Survey which was developed since 2003 was used the most here.

Conclusion

As aviation safety management is becoming more and more popular topic now, it is very important to understand the related safety methods to improve the safety management operations in the aviation industry. As it is already known, the safety method has developed through technical factors, human factors, organizational factors, and systematic factors. Therefore, studying organizational safety methods is helpful and necessary for all the relevant individuals and institutions.

This paper has started with the studying of the organizational safety methods which are extracted from the safety method database. From this database, this paper clearly shows how the organizational factors have been searched out and studied.

In order to properly find out the papers from online resources which have discussed the organizational safety methods in the aviation area, the best way to achieve it is to use the PRISMA Flow diagram. Following the standard flow, it is possible to screen and exclude the irreverent papers step by step.

The keywords in the database Scopus and Web of Science which are used for searching are "safety methods", "organizational", and "aviation". After finishing all steps in PRISMA Flow diagram, there are 17 papers including the necessary information and have been reviewed in this paper. And all of these 17 papers have been reviewed and analyzed which safety methods have been applied.

In this paper, there are half of the organizational safety methods have been repeatedly used to help to analyze the organizational factors in the aviation area. Such as Commercial Aviation Safety Survey, and Aviation Safety Action Program. Based on the fact of organizational safety management, the survey or questionnaire is helpful for collecting data from organizations or different individuals. Therefore, the Commercial Aviation Safety Survey methods have occurred in this paper the most frequently. Based on this, it concludes that the Commercial Aviation Safety Survey could be one of the most useful methods for organizational safety method analysis in the aviation industry.

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