University of Khartoum
Faculty of Engineering
Department of Mechanical Engineering

Evaluation of Technical and Administrative System for Safety Development at Khartoum International Airport

A Thesis Submitted in Fulfillment of the Requirements of the Degree of Ph.D. in Mechanical Engineering

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Dedication

To my beloved daughters, sons, wives, parents, sisters and brothers who gave me all possible time, support, confidence which sustained me for the achievement of this work.

To the researchers and employees in the filed of aviation both the authority and service providers, hopefully, that this modest work will help in integration with other efforts in surmounting the present challenges and anticipating the creation of a developed bright reality.

Ahmed Nour Yousif
Acknowledgment

Praise be to God, the Almighty, who graciously favored me to get over this work and enabled me to accomplish this achievement.

And I would like to convey my sincere thanks and utmost appreciation to my respectable supervisors: Dr. El-amin Abd El-Galil & Dr. El-amin Hussein Mohammed who exerted a considerable effort in guiding me through this research with their resourceful advice and their continuous care and attention in assessment, follow-up and addressing all the difficulties which faced the preparation period and I'm also grateful for their positive contributions which successfully led to the completion of this study in its present form.

Also, I would like to cease this opportunity to extend my thanks and express my acknowledgements to all those who directly or indirectly contributed to the support of this study in the provision of the data, reports, sources and references which this study had relied upon them. My gratitude goes especially to my colleagues in the Civil Aviation Authority, the staff of libraries in the Sudan and Jordan Universities and also the library staff of King Abdul Aziz University in Jeddah.

Lastly, I would like to convey my gratitude to those who contributed to the typing works and all those who sustained me with encouragement, advice and counsel.
المستخلص

يهدف هذا البحث إلى التعرف على الجوانب الفنية والإدارية للسلامة وتقييمها واستقصاء النواص والضعف واستخدام الأساليب والطرق السليمة لتحسين الأداء ومقترح لتشكيل نموذج لنظام إدارة السلامة الفعّال والحديث لمطار الخرطوم الدولي.

تبني البحث المدخل الوصفي - التحليلي، بالإضافة إلى المنهج التجريبي (الأبريقي)، جمعت البيانات من المصادر الأولية والثانوية. شملت المصادر الأولية الاستبانة حيث وزعت على عينة عشوائية شملت 150 موظفاً للهيئة الطيران المدني، بالإضافة إلى موظفي الشركات المختلفة العاملة في مطار الخرطوم الدولي.

أما المصادر الثانوية للبيانات، فقد شملت الكتب والمراجع والتقارير السنوية لهيئة الطيران المدني وتقارير الحوادث والدراسات المختصة بهذا الموضوع عن مسائل السلامة. استخدم اختبار (كاي - تربع) لقياس أهمية ومعامل الارتباط لقياس العلاقة، واستخدمت الحزم الإحصائية للعلوم الاجتماعية (SPSS) لتحليل وتقديم بيانات الحوادث.

توصل البحث إلى أن الظروف الإدارية الحالية تؤثر على بيئة العمل، وعلى عدم كفاية معدات الاتصال والضبط، مما يهدد السلامة. كما وأن ظروفنا مناخية وأخرى تتعلق بالبنية التحتية لمطار الخرطوم الدولي، قد أدت إلى وقوع حوادث الطيران، بجانب أن دور هيئة الطيران المدني تجهد شركات خدمات الطيران، كان محدوداً وضعيفا.

اقترح الدراسة نموذجاً لنظام إدارة السلامة، والذي استوعب أهداف البحث، وغطي الجوانب السلالية والنواص في الوضع الراهن ووحددت مواصفات التكنولوجيا الحديثة وأساليب السلامة، حسب متطلبات المنظمة الدولية للطيران المدني (ICAO) واللوائح الوطنية وأفضل الممارسات في مجال الطيران، وكذلك أوصت الدراسة باستمرار الدراسات المستقبلية لتطوير السلامة.
Abstract

The present study aimed at identifying and assessing the technical and administrative aspects of safety in Khartoum International Airport. It investigates the shortcomings, weaknesses and adoption of appropriate means for improving the performance. It proposes a model for effective and modern Safety Management System for the Airport.

The research adopted the descriptive – analytical approach; in addition to the empirical approach, for the purpose of analysis. The data were collected from primary and secondary sources. The primary sources included a questionnaire involving a random sample of 150 members of the Civil Aviation Authority staff and staff of different companies working at Khartoum International Airport.

The secondary sources of data were books, references, annual reports of the Civil Aviation Authority, accidents reports and relevant studies on topics concerning safety issues. The analytic tools used were the (Chi-square) test for measuring the significance and the coefficient of correlation for measuring relationship. Statistical Package for Social Sciences (SPSS) was used for analysis and evaluation of the accidents data.

The main findings of the study are that, the current administrative conditions affect the working environment. The available communication means and control are not conducive for enhancing safety and there is a weak administrative body. Also, climatic conditions and infrastructure at Khartoum
International Airport are among the causes of aviation accidents; beside the fact that the role of Civil Aviation Authority towards aviation service companies was limited and weak.

The study proposed a model for Safety Management System, which addressed the objectives of the research, covered the negative aspects and shortcomings of the current situation and specified modern techniques in the field of safety, according to the requirements of the International Civil Aviation Origination (ICAO), national regulations and the best practices in the aviation field, concerning safety aspects. The study recommended further studies for safety development.
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<td>Airport Certification Manual</td>
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<td>AEP</td>
<td>Aerodrome Emergency Plan</td>
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<td>AFCAC</td>
<td>African Civil Aviation Commission</td>
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<td>AIP</td>
<td>Aeronautical Information Publication</td>
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<td>ALARP</td>
<td>As Low As Reasonably Practicable</td>
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<td>AOC</td>
<td>Airport Operating Certificate</td>
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<td>ARFF</td>
<td>Aircraft Rescue &amp; Fire Fighting</td>
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<td>CAP</td>
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<td>DASS</td>
<td>Directorate of Aerodromes Safety and Standards</td>
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<td>FAA</td>
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<td>FOD</td>
<td>Foreign Object Damage</td>
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<td>IFATCA</td>
<td>International Federation of Air Traffic Controllers’ Associations</td>
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<td>SM</td>
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<td>SOP</td>
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<td>SPSS</td>
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<td>TOR</td>
<td>Tolerability Of Risk</td>
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<td>U.S.</td>
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<td>USOAP</td>
<td>Universal Safety Oversight Audit Programme (ICAO)</td>
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Chapter One
Introduction

1.1. Background

In recent years, a considerable effort has been devoted to understand how accidents happen in aviation sector. It is generally accepted that most accidents result from human errors. It would be easy to conclude that these human errors indicate carelessness or incompetence on the job, but that would not be accurate. Investigators findings show that the human beings are the last link in a chain that leads to an accident. Accidents will not be prevented by changing people; nevertheless, they will only be stopped by addressing the underlying causes and factors [Transport Canada Civil Aviation, 2001].

In the 1990’s the term “organizational accident” was coined because most of the links in an accident chain are under the control of the organization. Since the greatest threats to aviation safety originate in organizational issues, then to make the system more safe will required action by the organization [Transport Canada Civil Aviation, 2001].

The responsibility for safety and effective safety management is shared among a wide spectrum of organizations and institutions, including: international organizations, State authorities on Civil Aviation, owners and operators, service providers for air navigation services and aerodromes. These responsibilities fall into the following areas [International Civil Aviation Organization (ICAO), 2006]:

- Defining policies and standards affecting safety.
- Allocating resources to sustain risk in management activities.
• Identifying and evaluating safety hazards.

• Taking actions to eliminate hazards or reduce the associated level of risk to what has been decided as being an acceptable level of risk.

• Incorporating technical advances in the design and maintenance of equipment.

• Conducting safety oversight and safety programme evaluation.

• Investigating accidents and serious incidents.

• Adopting the most appropriate and best industrial practices.

• Promoting aviation safety (including the exchange of safety-related information).

• Updating regulations of governing Civil Aviation safety.

Safety Management System (SMS) is a systematic, explicit and comprehensive process for managing safety likewise all management systems which were woven into the fabric of an organization. It becomes part of the culture, the way people do their jobs. A safety management system will provide an organization with the capacity to anticipate and address safety issues before they lead to an incident or accident. A safety management system also provides management with the ability to deal effectively with accidents and near misses so that valuable lessons are applied to improve safety and efficiency. The safety management system approach reduces losses and improves productivity [Transport Canada Civil Aviation, 2001].

1.2. Sudan Civil Aviation Authority

Sudan Civil Aviation Authority (SCAA) was established in 1936 during the British colonial era, as a department under the British administrative
secretary, where its function was limited to issuing overlying and landing permissions. After Independence in 1956, Civil Aviation Department was nationalized and joined the International Civil Aviation Organization (ICAO) in the same year. In 1985 the Civil Aviation Department was changed to an independent authority bearing the name Civil Aviation Authority (CAA) by virtue of a presidential decree. In the year 2005, an independent body named the "Civil Aviation Authority" was attached to the Ministry of Presidential Affairs [Sudan Civil Aviation Authority, 2007].

The main function of the Civil Aviation Authority is to provide services for air transport industry including; security, aircraft safety, regulating air transport and construction and management of airports. Sudan Civil Aviation Authority (SCAA) is committed to its functions according to the Civil Aviation Act 1999. It is also committed to all international regulations issued by ICAO [Sudan Civil Aviation Authority, 2007].

1.2.1. Sudan Civil Aviation Authority Objectives

Sudan Civil Aviation Authority Objectives are described as follows [Sudan Civil Aviation Authority, 2007]:

1. Develop all sorts of aviation services in order to provide the most up to date quality services to boost strategic and commercial air transport activities together with ensuring the safety of Sudanese skies.

2. Represent Sudan in international and regional for active participation in the fields of Civil Aviation and air transport.

3. Develop civil aviation performance, promote local and international air transport and ensure its safety, technical, administrative and economic aspects; so as to serve the national interests of the country.
4. Undertake the studies and researchers for the provision of a complete package of aviation services.

5. Provide high quality equipment in airports and aviation activities to cope with international standards required by the International Civil Aviation Organization (ICAO).

6. Represent Sudan in meetings held by the international, regional or specialized aviation organizations.

**Sudan Civil Aviation Authority Responsibilities**

Sudan Civil Aviation Authority responsibilities fall into the following [Sudan Civil Aviation Authority, 2007]:

2. Provide air traffic services including air inspecting and telecommunication services.

3. Laying down the basic structures of a reliable aeronautical industry and business including issuing licenses, regulation services for passenger, mail and cargo transport.

4. It is responsible for issuance of airworthiness for aircrafts and licenses for pilots, engineers, and airlines.

5. Establishment and management of airports and communication navigation networks in consistence with the ICAO's standards.

**1.2.3. Sudan Civil Aviation Authority Departments:**

The Sudan Civil Aviation Authority consists of a Board of Directors and a Director General whose office comprises the following (Legal Advisors, National Training Institute, Accident Investigation and Prevention Public Relations, Executive Office and a Secretariat). The General Directorates of the
Civil Aviation Authority are described as follows [Sudan Civil Aviation Authority, 2006]:

1. General Directorate for Engineering Affairs.
3. General Directorate for Corporate Planning and Development.
5. General Directorate for Aviation Affairs and Safety.
8. General Directorate for Khartoum International Airport.

Figure (1-1) Explains the Sudan Civil Aviation Authority Organizational Structure.

1.3. Khartoum International Airport

Khartoum airport was established in the wake of the Second World War in 1947. The expansion began in 1956 by constructing the control tower and the aeronautical telecommunication centre. A passenger terminal for international flight was established in the sixties of the last century. A terminal for domestic flights was established, as well as VIP and the presidential lounges. However, there were no dates available in the airport files for the construction of these facilities [Sudan Civil Aviation Authority, 2007].

Khartoum airport is located in the heart of the city of Khartoum; 2.5 km from the city centre at longitude 32E and latitude 15.35N and height 1260 feet above sea level. There is in the airport a paved runway of 2980m length and
Figure 1.1: Sudan Civil Aviation Authority Organizational Structure [Sudan Civil Aviation Authority, 2006]

45m width with runway lighting. It has in addition to five taxiways .The total area of the apron is 10400m² [Sudan Civil Aviation Authority, 2007].

1.4. Research Problem

Khartoum Airport is an international airport and it's considered number one airport in the Sudan in terms of the volume of air traffic and its location in
the capital. However, the current situation lacks the safety implementation for operating the airport due to the following problems:

- Most of the air accidents which occurred in Sudan has caused great casualties and material damage, which necessitate the provision of high levels of safety and precautionary means.
- Lack of coordination between the technical capabilities and human resources management led to deficiency in the achievement of safety objectives.
- Formulation of an adequate model of safety to address the shortcomings in the existing situation.

1.5. Objectives of the Study

1. Assessing and evaluating the technical aspect of safety at Khartoum Airport.
2. Identifying modern technology in the field of safety at the international levels and standards and comparing them with the existing situation at Khartoum Airport.
3. Identifying the shortcomings, weaknesses and adopting the appropriate means for improving the performance.
4. Formulating an advance scientific and practical mechanism for avoidance of incidents, accidents and safety realization.
5. Linking support units for safety inside and outside the airport with the appropriate technologies.
6. Devising modern technical control systems in operations maintenance and supervision levels.
7. Formulating effective and modern safety management system.
8. Determination and provision of minimum level of necessary technique and resource capabilities, as well as identification of alternatives when need arises as safety regards.

9. Formulation of a sustainable strategy and automatic development mechanism to introduce and implement modern technology.

1.6. Hypothesis of the Study

1. The working environment at Khartoum Airport is not suitable for good performance and the current system lacks an effective administrative body.
2. The ineffective administrative body was behind the current negative situation and the unclear definition of the responsibilities.
3. The current ineffective administrative condition affects the training programmes that affect the worker's proficiency in levels of maintenance and operation.
4. The current system lacks of effective administrative body led to aviation accidents in both technical and administrative causes and this in turn, led to the shortcomings in the plans and programs of performance and change.
5. The alternative and choices in dealing with emergencies are ineffective, as a result of insufficient apparatuses of communication and control.
6. Climatic conditions are among the causes which led to aviation accidents, as a result of unsuitable working environment at Khartoum Airport.
7. The infrastructure at Khartoum Airport is insufficient for the best safety achievement.

1.7. Research Methodology

Study adopts the descriptive analytical approach as it was deemed the most suitable one for the study, besides the requirements and standards of the International Civil Aviation Organization (ICAO), the concept of Total Quality
Management (TQM) and the International Standards Organization (ISO) according to the following issues:

- Uses technical Analysis and evaluation available means and potentialities, and studying the modern technologies in safety as well as identifying needs.
- Review administrative aspects level and efficiency of existing system.
- Measure the feasibility of existing system in terms of technical and technological aspect and means of support of the proposed SMS as a new system.

1.8. Sources and Tools of Data Collection

The sources and tools of data collection are as follows:

1. **Primary Sources:**

   Primary sources comprise field works, direct interviews, preparing and analyzing questionnaire results for 150 samples of study population and analyzing of 20 years accidents data.

2. **Secondary Sources:**

   Books, studies, references, research papers, professional and scientific papers in the fields of the study published and unpublished studies and web sites.

1.9. **Study Limitation**

   The scope of the study is confined to the recent conditions of Khartoum Airport in all study topics and time limitation was a period of 21 years from 1988-2008, as data during this period is available.
Chapter Two

Literature Review

2.1. Safety Management System

2.1.1. Introduction

The frequency of incidents and accidents has shown a steady rising and developments, likewise, the air traffic density and numbers of aircrafts movements has shown an increase. The driving force of all the actors in the aviation community is profit related. Safety has had low priority among the service providers, and either the importance is not well understood or utterly neglected. The situation is that safety is so self-evident that is taken for granted and not integrated at all in some instances. It must be understood that increase in capacity and profit will not sell to the traveling public unless safety requirements are satisfied [Svensson, 2002]. Figure (2-1), (2-2) & (2-3) show hull loss accidents, passengers and freight carried in worldwide in sequence.

Safety management system is a process for the management of safety risks that integrates operations and technical systems with financial and human resource management, for all activities related to an air operator or an approved maintenance organization’s certificate. In common with all management systems a safety management system provides for goal setting, planning, and measuring performance. It concerns itself with organizational safety rather than the conventional health and safety at work concerns. A company’s SMS defines how it intends the management of air safety to be conducted as an integral part of the company’s business management activities [Transport Canada Civil Aviation, 2002].

Risk assessment, incursion prevention program, awareness, education and training aid are intended to provide a standardized safety program from “Gate to Gate”
for the aviation community. Action to distribute the training aid will raise the level of awareness among the industry and thus reduce occurrence of accidents. These are the main issues for creating a safety management system [Svensson, 2002].

The organizational structures and activists that make up a safety management system are found throughout an organization, every employee in every department contributes to the safety of the organization. In some departments safety management activity will be more visible than in others, but the system must be integrated into “the way things are done” throughout the establishment. This will be achieved by the implementation and continuing support of a safety program based on a coherent policy that leads to well designed procedures [Transport Canada Civil Aviation, 2002]. The aim of the SMS is to ensure the highest possible operational safety for air traffic and its associated services, under observation of statutory provisions, whereas guaranteed maximum runway safety for aircraft is of prime importance [Association of German Airports, 2002]. Figure (2-4) explains the objectives of the safety management system.

Figure 2.1: Hull Loss Accidents per Million Movements for Western Built Jets, 1994-2003 [Australian Brisbane Airport Corporation, 2006]
Increased operational safety

- Reduction of risks
- Avoidance of safety events
- Minimization of the monetary and operational effects of safety events
- Compliance with safety requirements with regulations, provisions and laws

**Figure 2.2: Passengers Carried on Scheduled Air Services, 1997-2006** [International Civil Aviation Organization Journal, 2007]

**Figure 2.3: Freight Tonnes Carried (millions), 1997-2006** [International Civil Aviation Organization Journal, 2007]

**Figure 2.4: the Objectives of the Safety Management System** [Association of German Airports, 2002]
2.1.2. The Airport as a System

The airport forms an essential part of the air transport system, because it is the physical site at which an auxiliary transfer is made from the air mode to land modes. Therefore, it is the point of interaction of the three major components of the air transport system: the airport, airline, and users. The planning and operation of airports must, if they are to be successful, take into account the interaction of these three major components, or system actors.

For the system to operate well, each of the actors must reach some form of equilibrium with the other two. Failure to do so will result in suboptimal conditions, exemplified by a number of undesirable phenomena that are indicators of inadequate operation. Each can, in a state of unrestrained competition, lead to an eventual decline in scale of operation at the airport facility, as traffic is attracted elsewhere, and in the absence of a competitive option, to depressed demand levels. Such conditions become manifest in a variety of ways [Ashtord et al., 1997]:

- Deficit operations by the airport.
- Deficit operations by the airline at the airport.
- Unsatisfactory working conditions for airline and airport employees.
- Inadequate passenger accommodation.
- Insufficient flight supply.
- Unsafe operations.
- High operational costs to users.
- Inadequate support facilities for airlines.
- High delay levels for airline and passenger.
- Inadequate access facilities.
- Low passenger demand level.
2.1.3. Costs of Accidents and Safety

Safety and profit are not mutually exclusive. Indeed, quality organizations realize that expenditures on the correction of unsafe conditions are an investment towards long-term profitability. Losses cost money. As money is spent on risk reduction measures, costly losses are reduced as shown in Figure (2-5).

However, by spending more and more money on risk reduction, the gains made through reduced losses may not be in proportion to the expenditures. Companies must balance the costs of losses and expenditures on risk reduction measures. Some level of loss may be acceptable from a straight profit and loss point of view; however, few organizations can survive the economic consequences of a major accident. Hence, there is a strong economic case for an effective SMS to manage the risks [International Civil Aviation Organization (ICAO), 2006].

![Figure 2.5: Costs versus Safety](image)

**Figure 2.5: Costs versus Safety [International Civil Aviation Organization (ICAO), 2006]**

Serious aviation incidents, which result in minor damage or injuries, can also cause many of these indirect or uninsured costs. Typical cost factors arising from such incidents can include the following [International Civil Aviation Organization (ICAO), 2006]:

- Flight delays and cancellations.
• At alternate passenger transportation, accommodation, complaints, etc.
• Crew change and positioning.
• Loss of revenue and reputation.
• Aircraft recovery, repair and test flight.
• Incident investigation.

The economic argument is even more salient when one considers the following figures produced by the Boeing aircraft corporation. In 1996, Boeing estimated the average cost in U.S. dollars of the following:

- $500,000 In-flight shutdown.
- $50,000 Flight cancellation.
- $10,000 Flight delay per hour.

The cost of implementing and maintaining a safety management system becomes less significant and well worth the investment when contrasted with the cost of accident [5].

2.1.4. Causes of Accidents

The strongest evidence of a serious breach of a system's safety is an accident. Since safety management aims to reduce the probability and consequences of accidents, an understanding of accident and incident causation is essential to understanding safety management. Because accidents and incidents are closely related, no attempt is made to differentiate accident causation from incident causation [International Civil Aviation Organization (ICAO), 2006].

Figure (2-6) portrays an accident causation model that assists in understanding the interplay of organizational and management factors in accident causation. Various defenses are built into the aviation system to protect against inappropriate performance or poor decisions at all levels of the system. This model shows that while organizational factors, including management decisions, can create latent conditions that could lead to an accident, they also contribute to the system's
defenses [International Civil Aviation Organization (ICAO), 2006].

Research into industrial safety in 1969 indicated that for every 600 reported occurrences with no injury or damage, there were some:

- 30 incidents involving property damage.
- 10 accidents involving serious injuries.
- 1 major or fatal injury.

Figure (2-7) indicates that it is much better to focus investigative efforts on incidents, rather than on serious accidents, due to that recurrent incidents are the direct cause behind serious accidents; and in turn, this leads to the occurrence of fatal accidents [International Civil Aviation Organization (ICAO), 2006].
Human error is cited as being a causal or contributing factor in the majority of aviation occurrences. All too often competent personnel commit errors, although clearly they did not plan to have an accident.

Understanding how normal people commit errors is fundamental to safety management. Only then can effective measures be implemented to minimize the effects of human errors on safety. Figure (2-8) explains contributing factors to human error [International Civil Aviation Organization (ICAO), 2006].

![Diagram of contributing factors to human error]

**Figure 2.8: Contributing Factors to Human Error** [International Civil Aviation Organization (ICAO), 2006].

The acronym ALARP (As low As Reasonably Practicable) is used to describe a risk that had been reduced to a reasonable level. In determining what is reasonably practicable, thus consideration should be given to both the technical feasibility of further reducing the risk and the cost; this could include a cost-benefit study.

Showing that the risk in a system is ALARP means that any further risk reduction is either impracticable or grossly outweighed by the costs. It should, however, be borne in mind that when an individual or society accepts a risk, this does not mean that the risk is eliminated. Some level
of risk remains; however, the individual or society has accepted that the residual risk is sufficiently low that it is outweighed by the benefits. These concepts are illustrated diagrammatically in the Tolerability of Risk (TOR) triangle in Figure (2-9). In this figure, the degree of risk is represented by the width of the triangle [International Civil Aviation Organization (ICAO), 2006].

![Tolerability of Risk (TOR) Triangle](image)

**Figure 2.9: Tolerability of Risk (TOR) Triangle [International Civil Aviation Organization (ICAO), 2006]**

### 2.2. Features of Safety Management System

Every organization, and industry, has its own interpretation of safety management system. From the Civil Aviation perspective there are main features that identify evolving directions and framework which represent the principal. These mean features are [Transport Canada Civil Aviation, 2001]:

- Adopting a data-driven approach to enhancing aviation safety. This includes collecting and making more accessible the type of data that will support a proactive approach to safety.
- Using a risk based approach to resource allocation to support those activities which will achieve the greatest safety benefit.
• Fostering and strengthening partnerships to put into effect the concept that responsibility for safety is shared by the regulator and the aviation community.
• Implementing safety management system in all organization activities.
• Taking account of human and organizational factors in safety management practices.
• Communicating effectively with the aviation local and international community on safety.

When an organization develops a safety management policy and procedures, they have to fit into the organization. Safety management has to be comprehensive. But should not be more complex than the rest of the company's management program. Safety management must be compatible, and preferably, integrated into the overall management scheme. The following list will be helpful to know more about how to make safety management a reality [Transport Canada Civil Aviation, 2001]:

• Senior management commitment.
• Safety policy.
• Safety information.
• Establishing safety as a core value.
• Setting safety goals.
• Hazard identification and risk management.
• Establishing a safety reporting system.
• Safety audit/assessment.
• Accident and incident reporting and investigation.
• Safety orientation and recurrent training.
• Emergency response plan.
• Documentation.
2.2.1. Policy and Principles of SMS

There is no recognized standard in aviation for defining a typical Safety Management System (SMS). So it has been necessary to adapt best practice from other industries in order to provide guidelines for those parts of the aviation industry that wish to implement a formal SMS.

The Policy and Principles (P&Ps) define the components of an organization's SMS. These have been derived from the lessons learned from a wide variety of disastrous accidents where management failures were cited as a significant contributory cause, factors which made the accident more likely to occur. The P&Ps could be considered as a hazard checklist for identifying any potential risks of management failures causing or contributing to an accident; the adoption of an effective formal SMS could be considered as a risk reduction exercise to minimise such failures as far as is reasonably practicable. Safety management systems policy and principles are likely to cover the following statements [United Kingdom Civil Aviation Authority, 2003]:

1. Safety Management Systems Policy Statements

- A statement of intent about maintaining or improving current safety performance.
- A statement of intent to minimise the risks of an accident occurring - probably with the ‘as far as is reasonably practicable’ caveat.
- A statement of intent to implement an effective formal safety management system.
- A statement about individual and management responsibility for safety performance.
- A statement about the priority attributed to flight safety relative to commercial, operational, environmental and working practice pressures.
• A statement about compliance with safety standards and regulatory requirements.
• A statement about ensuring sub-contractors meets company safety standards and requirements.

2. Typical Safety Management Principles

• Safety management principles define the components or scope of a Safety Management System.
• Published safety accountabilities (where applicable) of managers and key staff appointments.
• Arrangements to conduct internal safety incident investigations and implement remedial action.
• Arrangements for recording and monitoring the overall safety standards of the organization, usually a record of significant safety incidents, if applicable.
• Arrangements to report internally and externally the results of investigations and dissemination of the lessons learned.
• Arrangements to carry out regular safety audits, reviews or surveys within the organization and for ensuring that agreed actions are implemented.
• Arrangements for ensuring staff are adequately trained and competent for the job they are required to do.
• Supervision arrangements for early detection of deviations from intended practices or procedures that degrade safety.
• Arrangements for monitoring any deterioration in performance of safety significant equipment or systems, if applicable.
• Arrangements enabling staff to communicate significant safety concerns
to the appropriate level of management for resolution.

- Arrangements to identify and address potential risks arising from changes in operations, systems, procedures and staff associated with safety significant functions or activities.

2.2.2. Safety Performance Measures

The safety performance of the operation needs to be monitored, proactively and reactively, to ensure that the key safety goals continue to be achieved. Monitoring by audit forms is a key element of this activity and should include both a quantitative and qualitative assessment. The results of all safety performance monitoring should be documented and used as feedback to improve the system.

Performance measurement should be integrally linked to the company stated overall objectives. This requires two things: the development and implementation of a coherent set of safety performance measures; and, a clear linkage between the safety performance measures and the organization's business performance measures. This shows a clear relationship between the company’s safety objectives and the achievement of its organizational and business goals. A simple example is given in the table (2-1).

Table 2.1: Safety Performance Measures [Transport Canada Civil Aviation, 2002]

<table>
<thead>
<tr>
<th>Objective Type</th>
<th>Safety Performance Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Objective: Reduce Costs</td>
<td>Reduction in insurance rates</td>
</tr>
<tr>
<td>Safety Objective: Decrease number and severity of hangar incidents</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total number of events</td>
</tr>
<tr>
<td></td>
<td>Number of damage-only events</td>
</tr>
<tr>
<td></td>
<td>Number of near-miss accidents</td>
</tr>
<tr>
<td></td>
<td>Lessons learned from event analyses</td>
</tr>
<tr>
<td></td>
<td>Number of corrective action plans developed and implemented</td>
</tr>
</tbody>
</table>
2.2.3. System Safety Process

The Management of an aerodrome requires that the organization should assess all aspects of its operation, and changes to it, for safety significance. Safety Assessments should be performed and documented to ensure that due consideration is given to the safety of all parts of the system. The Safety Assessment should be conducted to ensure that the management of any hazards is commensurate with the risk involved and the safety objectives that have been identified.

The System Safety discipline is defined as the application of special technical and managerial skills to the systematic, forward-looking identification and control of hazards throughout the life cycle of a project, program, or activity. The primary objective of System Safety is accident prevention. Proactively identifying, assessing, and eliminating or controlling safety-related hazards, to acceptable levels, can achieve accident prevention. A hazard is a condition, event, or circumstance that could lead to or contribute to an unplanned or undesired event. Risk is an expression of the impact of an undesired event in terms of event severity and event likelihood. Throughout this process, hazards are identified, risks analyzed, assessed, prioritized, and results documented for decision-making. The continuous loop process provides for validation of decisions and evaluation for desired results and/or the need for further action [Federal Aviation Administration, 2004]. The System Safety process steps, are depicted graphically in the figure (2-10).

A systematic approach to process improvement requires proactively searching for opportunities to improve the process at every step, not simply identifying deficiencies after an undesired event. Risk Management has been defined as the process by which Risk Assessment results are integrated with political, social, economic, and engineering considerations for decisions about
Figure (2-10) System Safety Process [Federal Aviation Administration, 2004]

need/methods for risk reduction. The system safety process steps described as the following [Federal Aviation Administration, 2004]:

1- Define Objectives

The first step in the System Safety process is to define the objectives of the system under review. These objectives are typically documented in business plans and operating specifications.

2- System Description

A description of the interactions among people, procedures, tools, materials, equipment, facilities, software, and the environment. This also includes descriptions of data available.

3- Hazard Identification: Identify Hazards & Consequences

Potential hazards may be identified from a number of internal and external sources. Generally, hazards are initially listed on a Preliminary Hazard List, then
grouped by functional equivalence for analysis. Prior to risk analysis you must also include the consequence (undesired event) resulting from the hazard scenarios. Hazard scenarios may address the following: who, what where, when, why and how. This provides an intermediate product that expresses the condition and the consequences that will be used during risk analysis.

4- Risk Analysis: Analyze Hazards and Identify Risks

Risk analysis is the process whereby hazards are characterized for their likelihood and severity. Risk analysis looks at hazards to determine what can happen through, either a qualitative or quantitative analysis. The inability to quantify and/or the lack of historical data on a particular hazard do not exclude the hazard from the need for analysis. Some type of a Risk Assessment Matrix is normally used to determine the level of risk.

5- Risk Assessment Consolidate & Prioritize Risk

Risk assessment is generally defined as the process of combining the impacts of risk elements discovered in risk analysis and comparing them against some acceptability criteria. Risk assessment can include the consolidation of risks into risk sets that can be jointly mitigated, combined, and then used in decision making.

6- Decision Making: Develop Action Plans

This step begins with the receipt of a prioritized risk list. Review the list to determine how to address each risk, beginning with the highest prioritized risk. The four options that may be chosen for a risk are transfer, eliminate, accept, or mitigate. Generally, design engineering follows the “safety order of precedence”: 1) design for minimum risk, 2) incorporate safety devices, 3) provide warning devices, or 4) develop procedures and training. This may result in alternative action plans.
7- Validations and Control: Evaluate Results of Action Plan for Further Action

Validation and control begins with the results of scheduled analyses on the effectiveness of actions taken (this will include identification of data to be collected and identification of triggering events if possible; then developing a plan to review the data collected) and the current status of each prioritized risk. If the residual risk is acceptable, then documentation is required to reflect the modification to the system, and the rationale for accepting the residual risk. If it is unacceptable, an alternate action plan may be needed, or a modification to the system/process may be necessary.

8- Modify System/Process (if Needed)

If the status of a risk should change or the mitigating action does not produce the intended effect, a determination must be made as to why. It may be that the wrong hazard was being addressed, or the system/process needs to be modified. In either case, one would then re-enter the system safety process at the hazard identification step.

2.3. Creating Positive Safety Culture

2.3.1. Supportive Culture

The commitment of a company’s top management those who direct and control the organization at the highest level towards safety, safety practices and safety oversight will determine how business is conducted from a safety standpoint. The safety culture of the company underpins the entire safety achievement of the company and is crucial to its success. The ideal safety culture is one that is supportive of the staff and systems of work, recognizes that errors will be made and blaming some of the staff for those errors will not resolve the problems.
Therefore, the supportive culture will encourage open reporting, seek to learn from its failures and be just in dealing with those involved. Punitive action must not follow automatically from the open acknowledgement of human error. However, it must be made clear that indemnity will not be guaranteed where there has been gross negligence. The front line defence is that operating staff must not accept unsafe behaviour from their peers. Figure (2-11) shows the components of safety culture.

![Components of Safety Culture](image)

**Figure 2.11: Components of Safety Culture [Global Aviation Information Network (GAIN), 2004]**

### 2.3.2. Learning from Unsafe Acts

A Just Culture supports learning from unsafe acts. The first goal of any manager is to improve safety and production. Any event related to safety, especially human or organizational errors must be first considered as an opportunity to improve operations through experience feedback and lessons learnt. Failures and ‘incidents’ are considered by organizations with good safety cultures as lessons which can be used to avoid more serious events to attain his goal of learning from errors it is imperative to maintain a continuous recording of those errors and to subject them to study. Hence there is a strong drive to ensure that all
incidents and accidents should be reported and investigated to discover the root causes, and that timely feedback is given on the findings and remedial actions, both to the work groups involved and to others in the organization or industry who might experience the same problem. This ‘horizontal’ communication is particularly important.

2.3.3. Benefits of Just Culture

A “Just Culture” refers to a way of safety thinking that promotes a questioning attitude, is resistant to complacency, is committed to excellence, and fosters both personal accountability and corporate self-regulation in safety matters. A “Just” safety culture, then, is both attitudinal as well as structural, relating to both individuals and organizations. Personal attitudes and corporate style can enable or facilitate the unsafe acts and conditions that are the precursors to accidents and incidents. It requires not only actively identifying safety issues, but responding with appropriate action.

The benefits that can be gained from the creation of a Just Culture in an organization include measurable effects such as increased event reports and corrective actions taken, as well as intangible organizational and managerial benefits:

- A Just Culture can lead to not only increased event reporting, particularly of previously unreported events, but also the identification of trends that will provide opportunities to address latent safety problems.
- It has been estimated that for each major accident involving fatalities, there are as many as several hundred unreported incidents that, if properly investigated, might have identified an underlying problem in time to prevent the accident.
- A lack of reported events is not indicative of a safe operation, and likewise, an increase in reported events is not indicative of a decrease in safety. Event
reporting illuminates potential safety concerns, and any increase in such reporting should be seen as a healthy safety indicator.

- It can be expected that a Just Culture will enhance the organization’s effectiveness by defining job performance expectations, establishing clear guidelines for the consequences of deviance from procedures, and promoting the continuous review of policies and procedures.

- Just Culture can allow an organization to be better able to determine whether violations are occurring infrequently or if deviation from established procedures has become normalized among its front-line employees and supervisors.

- Outdated or ineffective management structures can be manifested in many ways, as by operational inefficiencies, lost opportunities, or safety lapses. While Just Culture is primarily implemented by a safety motive, it is recognized “that the same factors which are creating accidents are creating production losses as well as quality and cost problems.

2.4. Strategic Management

2.4.1. Strategic Management Elements

Strategic management can be defined as that set of managerial decisions and actions that determines the long-run performance of a corporation, also can be defined as the art and science of formulating, implementing, and evaluating cross-functional decisions that enable an organization to achieve its objectives.

Strategic management is one of the significant reasons that it can make a difference in how well an organization performs. Studies of the factors that contribute to organizational performance have shown a positive relationship between strategic planning and performance. Strategic management consists of four basic elements [Shams Eldein, 2004]:

29
1- Environmental scanning.
2- Strategy formulation.
3- Strategy implementation
4- Evaluation and control

1- Environmental Scanning

Before the organization can begin strategy formulation, it must scan the external environment to identify possible opportunities and threats and its internal environment for strengths and weaknesses.

Environmental scanning is a tool to identify signals of change in the external environment in order to gain lead time to respond or to adapt to these signals. It is a critical component of an effective strategic planning system. Environmental scanning is the monitoring, evaluating, and disseminating of information from the external and internal environments to key people within the corporation. Its purpose is to identify strategic factors—those external and internal elements that will determine the future of the corporation.

2- Strategy Formulation

Strategy formulation includes developing a strategic vision, mission, identifying an organization's external opportunities and threats determining internal strengths and weaknesses, establishing long-term objectives, generating alternative strategies, and choosing particular strategies to pursue Strategy-formulation.

Issues include deciding what new businesses to enter, what businesses to abandon how to allocate resources, whether to expand operations or diversify, whether to enter international markets, whether to merge or form a joint venture, and how to avoid a hostile takeover.

Since no organization has unlimited resources, strategists must decide which alternative strategies will benefit the firm most. Strategy-formulation decisions
commit an organization to specific products markets, resources, and technologies over an extended period of time Strategies.

3- **Strategy Implementation**

Strategy implementation requires a firm to establish annual objectives, devise policies, motivate employees, and allocate resources, so that formulated strategies can be executed, strategy implementation includes developing a strategy-supportive culture, creating an effective organizational structure, redirecting marketing effort, preparing budgets, developing and utilizing information systems, and linking employee compensation to organizational performance.

Strategy implementation is often called the action stage of strategic management. Implementing means mobilizing employees and managers to put formulated strategies into action. Often considered to be the most difficult stage in strategic management, strategy implementation requires personal discipline, commitment, and sacrifice. Successful strategy implementation hinges upon managers' ability to motivate employees, which is more an art than science. Strategies formulated but not implemented serve no useful.

4- **Evaluation and control**

Control and Strategy evaluation is the final stage in strategic management, some considers it a part of strategy implementation stage, while others considers it separate stage. Managers desperately need to know when particular strategies are not working well and strategy evaluation. All strategies are subject to future modification because external and internal factors are constantly changing. Strategy evaluation is needed because success today is no guarantee for success tomorrow. Success always creates new and different problems. Figure (2-12) below explains the Strategic Management Process.
Figure (2-12) the Strategic Management Process [Shams Eldein, 2004]
2.4.2. Analysis of Organizational Resources and Capabilities

Two critical steps in the strategic management process are analysis of the organization and analysis of its environment. They may be approached by a technique known as SWOT analysis: the internal analysis of organizational Strengths and Weaknesses as well as the external analysis of environmental Opportunities and Threats.

SWOT analysis begins with a systematic evaluation of the organization's resources and capabilities. A major goal is to identify core competencies in the form of special strengths that the organization has or does exceptionally well in comparison with competitors. They are capabilities that by virtue of being rare, costly to imitate, and no substitutable become viable sources of competitive advantage.

Core competencies may be found in special knowledge or expertise, superior technologies, efficient manufacturing technologies, or unique product distribution systems, among many other possibilities. But always, with the notion of strategy itself, they must be viewed relative to the competition. Simply put, organizations need core competencies that do important things better than the competition and that are very difficult for competitors to duplicate.

The goal in strategy formulation is to create strategies that leverage core competencies for competitive advantage by building upon organizational strengths and minimizing the impact of weaknesses [Schermerhorn, 2004]. Figure (2-13) explain SWOT analysis of strengths, weaknesses, opportunities, and threats.
Figure (2 -13) the SWOT Analysis: Strengths, Weaknesses, Opportunities and Threats [Schermerhorn, 2004]
2.4.3. Strategic Vision and Mission

Strategic vision is future forecasting has much greater direction-setting and strategy-making value. There's an ever-present managerial imperative to look beyond today and think strategically about the impact of new technologies on the horizon: how customer needs and expectations are changing, what it will take to overtake or outrun competitors, which promising market opportunities ought to be aggressively pursued, and all the other external and internal factors that of an organization’s for being existence in society, drive what the company needs to be doing to prepare for the future.

The roles of a mission statement is to give the organization its own special identity, business emphasis, and path for development from other similarly situated companies, the mission statement speaks to what a company is doing today and the scope of its purpose and a declaration.

The importance of a mission statement to effective strategic management is well documented in the literature and is needed before alternative strategies can be formulated and implemented. A mission statement reveals the long-term vision of an organization in terms of what it wants to be and whom it wants to serve and developing a business mission compels strategists to think about the nature and scope of present operations and to assess the potential attractiveness of future markets and activities [Shams Eldein, 2004].

2.4.4. Strategic Management and Performance

Strategic management typically focuses on analyzing the problems and opportunities faced by people in top management. Many empirical studies have been conducted to measure the relationship between strategic management and the performance of enterprises. The majority of these studies reported a positive relationship; there is strong reason to associate effective performance with good
strategic management process. This positive relationship is attributed to many factors as follows [Ali, 2005]:

- Enterprises are working in changing environment; due to this fact planning becomes more difficult. Strategic management allows a firm’s top executives to anticipate change and provide direction and control for the enterprise.
- Most people perform better if they know what is expected of them and where the enterprise is going, this can also help reduce conflict. Effective strategic management points the way for the employees to follow.
- Strategic management is one way to systematize the most important of business decisions.
- Strategic management helps educate managers to become better decision-makers. It helps managers examine the basic problems of an enterprise.
- Strategic management helps improve corporate communication, the coordination of individual projects, the allocation of resources, and short-range planning.
- Strategic management provides an enterprise with consistency of action. A sound strategic management process helps ensure that all organizational parts are working toward the same objectives and purposes.

2.5. Hazards and Risks of Airport Operations

2.5.1. Hazard Identification and Risk Management

A hazard is a condition with the potential of causing injury to personnel, damage to equipment or structures, loss of material, or reduction of the ability to perform a prescribed function. Risk is the chance of injury or loss. This concept includes both the likelihood of a loss and the magnitude.
Risk management is a proactive activity that looks at the risks associated with identified hazards and assists in selecting actions to maintain an appropriate level of safety when faced with these hazards. Once hazards have been identified, either through occurrence/hazard reporting, or a safety assessment the risk management process begins. Risk management is an evaluation of the potential for injury or loss due to a hazard and the management of that probability. Risk management comprises three essential elements: hazard identification, risk assessment and risk mitigation. The concepts of risk management have equal application in decision-making in flight operations, air traffic control, maintenance, airport management and State administration.

Hazard identification and risk management should be put in high consideration in the following circumstances:

- during implementation of the safety management system and then at regular intervals;
- when major operational changes are planned;
- if the organization is undergoing rapid change, such as growth and expansion, offering new services, cutting back on existing service, or introducing new equipment or procedures; and
- When key personnel change.
- Systematically identify Possible Hazards to aircraft.
- Evaluate the seriousness of the consequences of the hazard occurring.
- Consider the chances of it happening.
- Determine whether the consequent risk is acceptable.

2.5.2. Risk Assessment

The risk assessment methodology for the Airport described as follows:

- Identifying and defining the system being reviewed.
• Identifying hazards from operation of the runway system to give both a current and a future risk profile.
• Identifying consequences arising from the hazard.
• Identifying the likelihood of these consequences happening in their entirety.
• Carrying out an analysis and assessment of the risk issues identified taking note of mitigation measures that are in place. The three risk regions can be summarized as follows: Figure (2-14) explains the Risk Categories [Australian Brisbane Airport Corporation, 2006]:
  • Region 1: Risk unacceptable Risk is so high that it is not acceptable unless extraordinary circumstances apply. Risk reduction must be undertaken.
  • Region 2: Risk tolerable if ALARP Risk reduction measures must be implemented where reasonably practicable. That is unless further risk reduction is clearly not possible or the cost is disproportionate to the improvement gained.
  • Region 3: Risk broadly acceptable Risks must be managed to ensure that they remain at this level and, if practicable, continually reduced. In principle, the ALARP concept extends to this region as well. Reasonably practicable’ is a difficult phrase: both its words require judgments to be made. Informal day to day interpretation of what is reasonably practicable is the adoption of accepted best practice in safety for an activity. If a more formal analysis is considered necessary, cost benefit analysis is being increasingly used; risk reduction is considered practicable if and only if it is possible to find appropriate risk reduction measures where the cost of these is proportionate to the improvement gained in terms of risk.
2.5.3. Occurrence and Hazard Reporting

Every event is an opportunity to learn valuable safety lessons. The lessons will only be understood, however, if the occurrence is analyzed so that all employees, including management, understand not only what happened, but also why it happened. This involves looking beyond the event and investigating the contributing factors, the organizational and human factors within the organization that played a role in the event. To achieve this, the company should maintain procedures for the internal reporting and recording of occurrences, hazards and other safety related issues. The collection of timely, appropriate and accurate data will allow the company to react to information received, and apply the necessary corrective action to prevent a recurrence of the event. An operator’s safety reporting system should encompass the following fundamental elements:

- Systems for reporting hazards, events or safety concerns
- Systems for analyzing data, safety reports and any other safety related information.
- Methods for the collection, storage and distribution of data.
- Corrective action and risk reduction strategies.
- On-going monitoring.
- Confirmation of the effectiveness of corrective action.

2.5.4. Operational and Construction Hazards

Dangerous goods management during the construction and general operations can arise due to the following:

- Security issues during construction and operation.
- Dangerous goods management during the operational stages including any additional on site refueling storage.
- Assessment of fire risks measures for treatment of hazardous material spills.
- The risk of uncovering dangerous material during sand extraction.
- Modification of existing emergency plans, procedures and relationships with disaster control organizations including command and control; and
- Access points to the Airport for accidents and/or retrievals during the construction and operational stage, including alternative access in the event of gridlock during construction.

2.5.5. Bird Strike

Another significant issue to consider with airport operation is ‘bird strike’ where birds collide with aeroplanes in normal flight or adjacent to airports. While bird strikes must be reported, they have a very low probability of causing significant aircraft accidents since modern aircraft and aircraft engines are designed to minimise the resultant consequences. However, there is a need of
redesign and precautions to ensure full protection that bird will not enter the engines.

Control of bird species will be an important issue during reclamation and construction works. This issue is addressed in the Environmental Management Framework. Overall, provided the application of best practice techniques for the management of bird hazards on and around Airport continues, the risk from aircraft crash incidents as a result of bird strikes with the operation should be considered as low as reasonably practicable and thus broadly acceptable. A number of staff dedicated to bird control techniques. These may include methods such as [Australian Brisbane Airport Corporation, 2006]:

- Monitoring of bird activity by Airport Operations Officers, particularly during the three hours after sunrise which have been identified as the ones with highest bird activity.
- Reducing the amount of water lying on the Airport grounds to avoid attracting birds etc.
- Maintaining the grass at a length which deters birds;
- Minimizing available food.
- Harassing birds using:
  - Vehicle lights and horns.
  - Cracker shot; and/or
  - Live shotgun rounds.

2.5.6. Mitigation Measures

The following existing risk mitigation measures already must be in place for Airport operation with the current runway configuration will remain in place [Australian Brisbane Airport Corporation, 2006].

- Highly regulated air traffic environment in and out of the Airport.
• Highly regulated aircraft inspection and maintenance protocols for operations.
• Highly regulated pilot licensing regimes for operations.
• Existing security and related control systems.
• Existing emergency planning regimes.
• Existing management systems for managing the storage and handling of dangerous goods and hazardous substances. These systems will be updated for the operation of the runway situation.

2.6. Total Quality Management

2.6.1. Need for TQM

Total Quality Management, (TQM), can be defined as 'the process of integration of all activities, functions and processes within an Organization in order to achieve continuous improvement in cost, quality, function and delivery of goods and services for customer satisfaction'. Goal of TQM is customer satisfaction, by means of continuous improvement. TQM occurs when an entire organizational culture becomes focused on quality and customer satisfaction through an integrated system of processes, tools, techniques and training.

TQM is a basic strategy for this performance excellence. TQM is not merely a system of quality management; it is a strategy that is designed to seek improvement in business performance by focusing on customers, empowering people, restructuring processes and leading the organization by vision and purpose. TQM is the outcome of the collective actions and efforts of all members within and outside the organization, who have a stake in the company's well-being and performance [Mandal, 2005].

TQM: "Doing the Right Thing, Right the First Time, All the Time; always striving for Improvement & always satisfying the Customers. It emphasizes
team activity, brings pride in performance to all levels of the organization, develops more informed and supportive managers and supervisors, and so leads to an improved climate in the workplace. It offers lower costs and improved productivity, leading to greater effectiveness, long-term competitive advantage, and improved job prospects [PAL Management Solutions, 2005].

2.6.2. TQM Principles

The principles governing the TQM system are [Tricker, 2005]:

1- ‘Customer Focused’ approach to all activities and processes in the organization. This approach ensures that all are concerned with the customers’ needs and their efforts should be directed towards winning customer satisfaction.

2- Strategic Planning and Leadership for achieving the customer focused quality targets in all activities and processes. Leadership should lead to strong ‘customer orientation’ in the organization and be willing to make long-term commitments to its customers, employees, vendors, stockholders and to society.

3- Restructuring of Vertical Processes To ‘cross-functional’ horizontal processes where clear view of customer needs can be established in each of these processes. This is the new approach to change the work culture of teamwork and making everyone in the process responsible for the quality.

4- Creating A Culture of Working Through ‘internal customer’ system, where each stage in the process and each person in the process can be linked as customers to each other in the chain of activities for production and delivery of goods and services.

5- Continuous Improvement of all Processes and Activities, leading to total customer satisfaction and competitive advantage. This is a critical measure for TQM, for performance excellence continued thinking and working for improvements becomes a part of corporate life.
6- Training and development of people: TQM believes that people are at the core of every process and activities of the organization. People should be trained and developed for understanding the process of TQM, the values and vision systems and tools of TQM and, above all, understanding customer needs.

7- Empowerment and Teamwork of People: This is to provide people with the opportunity to learn, apply and practice their skills, creativity and knowledge. Sufficiently empowered by management to facilitate immediate response to customer needs, to eliminate bureaucracy and delay in decision-making, which otherwise adversely affects customer service.

2.6.3. Quality Management System Approach

Customers require products and/or services that continually meet their needs and expectations and in order to be profitable, an organization must be able to offer them so that it can continually achieve customer satisfaction and satisfy its customers’ requirements.

As well as providing a framework for providing customer satisfaction, a QMS also provides confidence (to the organization and to its customers) that the organization is capable of providing products and services that consistently fulfill requirements. This is achieved by [Mandal, 2005]:

- Determining the needs and expectations of the customer.
- Establishing the quality policy and quality objectives of the organization.
- Determining the processes and responsibilities necessary to attain the quality objectives.
- Establishing measures for the effectiveness of each process towards attaining the quality objectives.
- Applying the measures to determine the current effectiveness of each process.
• Means of preventing non-conformities and eliminating their causes.
• Looking for opportunities to improve the effectiveness and efficiency of processes.
• Determining and prioritizing those improvements which can provide optimum results.
• Planning the strategies, processes and resources to deliver the identified improvements.
• Implementing the plan.
• Monitoring the effects of the improvements.
• Assessing the results against the expected outcomes.
• Reviewing the improvement activities to determine appropriate follow-up actions.

Any organization that adopts the above approach will create confidence in the capability of its processes and the reliability of its products. It will also provide a basis for continual improvement and can lead to increased customer satisfaction.

2.6.4. Performance Measures in TQM Practice

TQM is a process that is guided by vision and directed towards accomplishing strategic goals, which must be achieved for superior performance and growth. These goals should relate to critical areas like customer satisfaction, cost leadership, employee satisfaction, new product launching, environment management, shareholders value addition etc. Goals must have clear performance measures. To achieve the goals, TQM practice may strategically resort to identifying ‘critical success factors’ and ‘key business processes’. The former is related to factors that must be internally built into the work culture of the organization to facilitate performance, and the latter are processes through
which the goals and objectives are to be accomplished. TQM practice should identify and define these factors and process objectives before venturing into restructuring key processes into” horizontal team based organization [Mandal, 2005].

Action for TQM refers to activities and processes for accomplishment of objectives. This accomplishment or actualization of TQM objectives in an organization is the cornerstone of success of all efforts towards total quality management. For actualization of TQM, areas to act and address are:

- Setting up of appropriate business strategy and strategic plans, including identification of key success factors.
- Designing and engineering of ‘key business processes’.
- Setting up of organization for TQM implementation, monitoring and review.
- Integration of key business processes with ‘TQM process categories’.
- Planning on approaches i.e. how the organization will address the requirements of TQM principles.
- Planning on deployment of approaches i.e. the extent of coverage in practice.
- Measurement and analysis of results, and
- Actions for continuous

Figure (2-15) shows the steps for determination of performance measures. Basically, TQM is a customer-focused process, geared towards the satisfaction of the customers' expectations and needs. This in turn requires the determination of the specific targets which should be measured and by whom they will be measured, besides fixing the manner and method of their analysis and interpretation. It is also equally important to make efforts to continually
upgrade the processes by redesign and benchmarking in order to achieve improved and innovative products for customer delight.

Figure 2.15: the Steps for Determination of Performance Measures
[Mandal, 2005]

2.6.5. TQM Road Map

TQM road map is a tool which helps in systematic approach. As a road map of a country or state needs a starting place and a destination, the TQM road map requires basic information about the present status of company- this is
analogous to the starting point in the country road map. The end result or the destination is the goal of the company that has to be achieved within the given time period. Introduction of TQM in an organization requires meticulous plan. Thus, the road map of TQM essentially consists of the following factors [Suganthi & Anand, 2005]:

- Understand the current status, where you stand.
- Decide the destination, where you want to be.
- Take stock of the available resources and recoup the needed resources, what is needed—manpower, money, machines, etc.
- Locate the constraints, if any problem areas.
- Finalize the methodology to be adopted and tools to be used, How to do—technology.
- Devise a training plan for the personnel involved.
- Prepare the time schedule for the whole exercise.
- Formulate an appropriate monitoring system—auditing.
- Celebrate the success by rewarding the contributors—Reward, Recognition.

2.7. Human Resource Management

2.7.1. Human Resource Management Contribution

Human resource management is a relatively new functional area in many organizations. These units were usually called personnel departments and were headed by personnel managers. The original personnel function is now more commonly called human recourse management and generally its activities much more respect and significance in organization than was case in earlier times.

Human resource management deals with a variety of complex and strategic issues. The basic tasks and functions of human resource managers today include adopting a strategic perspective, understanding their
environmental context staffing the organization, enhancing motivation and performance of employees, conducting the ongoing management of the existing workforce, and meeting other challenges. An integrated human resource management system, supported by an electronic information system, typifies the human resource function in most companies today.

Human resource management generally has four basic goals to pursue. These goals are facilitating organizational competitiveness, enhancing productivity and quality, complying with legal and social obligations, and promoting individual growth and development.

Today’s human resource managers must become more and more professional in both their training and their orientation toward their work various career paths are also available for people wanting to work in the human resource function. Regardless of approach or career path, however, human resource manager need a broad and thorough knowledge of all aspects of the organization if they are to make meaningful contributions [Denisi & Ricky, 2001].

2.7.2. Organizational Human Resource Management

The management of people takes place in, or in relation to, some organization and co-ordination of their activities. This produces synergy: working together to produce a result that is greater than the sum of the individual parts. That co-ordination spreads beyond the employees of the business along the supply chain, or value chain, to include suppliers and customers. The processes of organization are concerned with communication and information. One of the main instruments in organization is planning requirements before working out how those requirements can be met, and one of the main methods of co-ordination is organization structure and culture.

The structure describes the bare bones of the various working relationships between the people in the business, while the culture is a collection
of values and attitudes that the people of the business have in common to energize them and get them working effectively together [Torrington et al., 2002].

2.7.3. Human Resource Planning Process

The human resource management process is the process of attracting, developing, and maintaining a quality workforce, and planning process of analyzing staffing needs and identifying actions to satisfy these needs over time. The purpose of human resource planning is to make sure the organization always has people with the right abilities available to do the required work. A complex legal environment influences human resource management, giving special attention to equal employment opportunity [Schermerhorn, 2004]. Figure (2-16) explains the steps in the strategic human resource planning process.

![Figure 2.16: the Steps in the Strategic Human Resource Planning Process](image-url)

**Figure 2.16: the Steps in the Strategic Human Resource Planning Process**

[Schermerhorn, 2004]
2.7.4. Human and Strategic Management Criteria

The organization carefully must develop a written mission statement to ensure unanimity of purpose within the organization and provide a basis or standard for allocating organizational resources. Organization must specify purposes and the translation of these purposes into objectives in such a way that cost, time, and performance parameters can be assessed [Shams Eldein, 2004].

The human resource management should process in plan attracting, developing and maintaining a quality workforce. Human resource planning includes analyzing staff needs and identifying actions to satisfy these needs over time. It must always have people with the right abilities available to do the required work. Helpful criteria for attract and develop quality employees as follow [Schermunderhorn, 2004]:

- Recruitment should attract qualified job candidates involved in realistic job with accurate information on the job and organization.
- Performance management systems focus on the establishment of work standards and the assessment of results through performance appraisal.
- Career planning systematically matches individual career goals and capabilities with opportunities for their fulfilment.
- Whenever employees must be replaced over time because of promotions, transfers, retirements, and terminations, the goal should be to treat everyone fairly while ensuring that jobs are filled with the best personnel available.
- Compensation and benefits packages must be continually updated so that the organization maintains a competitive position in external labour markets. Where labour unions exist, labour-management relationships should be positively approached and handled with all due consideration of applicable laws.
2.8. Balanced Scorecards

2.8.1. Balanced Scorecard Concept

Balanced Scorecard (BSC) is a performance management program that puts strategy at the center of the process. At the highest conceptual level, the Balance Scorecard is a framework that helps organization translates strategy into operational objectives that drive both behavior and performance. The Balanced Scorecard translates your mission and strategy into tangible objectives and measures. To focus teams and individuals on strategic priorities The Balanced Scorecard IS a tool and framework with a Goals of Strategic Measures. Companies use the Balanced Scorecard for these reasons [PAL Management Solutions, 2005]:

- Clarify the vision throughout the organization.
- Gain consensus and ownership by the executive team.
- Provide a framework to align the organization.
- Provide structure for multiple initiatives.
- Drive the capital and resource allocation process.
- Integrate the strategic management process across the organization.

2.8.2. Balanced Scorecard Principles
2.8.3. Balanced Scorecard Evaluation and Measurements Objectives

- Management uses strategic measures to test the organization's progress in achieving strategic objectives.
- Accountability for BSC implementation must be clear.
- Measures function as a tool to drive desired behavior.
- Measures give individuals direction in what they need to accomplish for the organization's strategy.
- Strategic measures show the relationship between strategic and objectives as a constant test upon the validity of strategy.
- Leadership and groups for making the BSC operational e.g. missing measures, communications, reporting.
- The Leadership Team must set and accept responsibility for such major activities.
- Monitoring the Balanced Scorecard through: initiatives, measures, targets, projects, and reporting to the leadership team on the status.
- Responsibility forecasting the BSC through the organization and management of change.

2.8.4. Balanced Scorecard Key Performance Indicators

Balanced Scorecard start from defining strategic objectives, and then define the activities that will support the achievement of such objectives, and then define the responsible person for this activity, whom will be reporting, about the level of achievement that activity has reached. For that purpose key Performance Indicators (KPIs) are needed for measuring the performance of the activities. These measures will provide feedback to management about who good strategic objectives are achieved [PAL Management Solutions, 2005]. The
The main objectives of KPIs as follows: (Figure (2-17) explains Balanced Scorecard loop)

- Provide benchmarking against which business or project's performance can be measured or evaluated.
- Used to provide information about a unit or process.
- Provide a solid input for decision making.
- Used to provide information about a unit or process for decision making.

![Figure 2.17: Balanced Scorecard Loop](PAL Management Solutions, 2005)

2.9. Maintenance and Operation Safety Working Conditions

The aerodrome certification process includes approval/acceptance of an aerodrome manual that outlines the aerodrome’s safety management system (SMS). Although the potential for a catastrophic accident during aircraft operations on the ground exists, the likelihood of a minor accident while the aircraft is on the ground, particularly during a turnaround, is high. Each year, aircraft operators incur significant financial losses associated with accidents during ground operations. Accidents and incidents occurring in flight are generally well reported and investigated. However, ground accidents do not
always receive the same level of attention. Minor accidents and incidents may not be reported to the aerodrome management by the operators and service providers based at the aerodrome. These minor accidents and incidents may be a breeding ground for more serious accidents. Understanding the conditions that create hazards to safety at aerodromes is vital to effective safety management.

Safety at aerodromes requires much the same approach to safety management as that required for safe flight operations. The concentration of many different activities at aerodromes creates unique circumstances with significant accident potential. Given the complexity of the aerodrome environment, a systematic approach to safety is required in order to coordinate the various activities for the safe delivery of services. Safety Management System provides such a coherent approach, in so doing, the safety philosophy and the supporting policies are developed, operating procedures are coordinated and implemented, and day-to-day operational practices are systematically monitored. In short, the SMS helps create an aerodrome safety culture conducive to safe operations. Appendix (A) shows a typical aircraft maintenance working conditions.

Effective operation of the SMS for maintenance builds upon risk-based decision-making, a concept that has long been integral to maintenance practices. For example, maintenance cycles are built upon probabilities that systems and components would not fail for the period of the cycle. Components are often replaced because they are “time expired”, even though they may remain functionally serviceable. Based on knowledge and experience, risks of unexpected failure are reduced to acceptable levels. Some of the principal tools for operating the SMS for maintenance function include [International Civil Aviation Organization (ICAO), 2006]:

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• Clearly defined and enforced SOPs.
• Risk-based resource allocations.
• Hazard and incident reporting systems.
• Flight data analysis programmes.
• Trend monitoring and safety analyses (including cost-benefit analyses).
• Competent investigation of maintenance-related occurrences.
• Training in safety management.
• Communication and feedback systems (including information exchange and safety promotion).

2.10. Mechanisms and Features of SMS

2.10.1. Senior Management Commitment

Senior management commitment will not lead to positive action unless that commitment is expressed as direction. Senior management must develop and communicate safety policy that allocates responsibilities and holds people countable for meeting safety performance goals. The organization is required by regulation to meet defined standards in the formulation and documentation of safety related policy. The relevant regulation should be consulted to make sure that required standards are met. Safety Policy should include, at a minimum:

• Clear declaration of commitment and objectives.
• Means for setting safety goals and regular review of safety performance.
• Clear statements of responsibility applying to every department or functional area in the organization.
• Clearly stated accountabilities converging at the top of the organization.
• Means for ensuring compliance with regulations.
• Means for ensuring adequate safety management knowledge and skills at all levels.
• Compatibility or integration with other management systems.

2.10.2. Non Punitive Disciplinary Policies

The company should strive to develop a non-punitive, disciplinary policy as part of its safety management system. Employees are more likely to report events and cooperate in an investigation when some level of immunity from disciplinary action is offered. When considering the application of a non-punitive disciplinary policy, the company might want to consider whether the event involved wilful intent on the part of the individual involved and the attendant circumstances.

2.10.3. Training

In order for employees to comply with all safety requirements, they need the appropriate information, skills and training. To effectively accomplish this, the company should make clear the training requirements for each area of work within the company. The type of training to be offered is already mandated via regulation for certain positions in the company.

This includes initial, recurrent and update training requirements and, where required, training specific to the operation of the safety management system. These regulations will provide a good starting point to identify what training is required. It is recommended that a training file be developed for each employee, including management, to assist in identifying and tracking employee training requirements.

2.10.4. Corrective Action Plan

Once a safety event report has been investigated and analysed, or a hazard identified, a safety report outlining the occurrence, and if available, the results of
a hazard assessment, should be given to the appropriate director for determination of corrective or preventative action.

The functional director should develop a corrective action plan, a plan submitted in response to findings, outlining how the company proposes to correct the deficiencies documented in the findings. Depending on the findings the plan might include short-term and long-term corrective actions.

2.10.5. Roles and Responsibilities

An organization should document and define the roles and responsibilities of all personnel in the safety management system. Furthermore, a statement should be made to ensure that everyone has a responsibility for safety. This includes a commitment on the part of top management to be accountable for safety within the company.

The dedication and involvement of top management towards safety and safety practices should be clearly visible. It is important that senior management is seen to provide a strong and active leadership role in the safety management system. This includes a commitment to provide the resources necessary to attain the strategic safety objectives established by the organization.

2.10.6. Emergency Response Plan

An emergency response plan outlines in writing what should be done after an accident happens, and who is responsible for each action. When the plan is adopted, relevant staff should be briefed on the plan and their responsibilities. Appropriate staff should receive training in emergency response procedures. The plan should be readily available and a copy should be at the work station of the person who normally answers the company telephone as this is likely to be the first person notified of an occurrence. The plan issues can be described as follows:
• Relevant and useful to people on duty at the time of an accident;
• Inclusive of checklists and emergency contact details;
• Updated when contact details change; and
• Exercised to ensure the adequacy of the plan and the readiness of the people who must make it work.

2.10.7. Pro-Active Safety Assessment

For a safety management system to transition from a reactive to a proactive, it must actively seek out potential safety hazards and evaluate the associated risks. This can be achieved through a safety assessment. A safety assessment allows for the identification of potential hazards and then applies risk management techniques to effectively manage the hazard. A certificate holder’s safety assessment system should encompass the following basic elements:

• Systems for identifying potential hazards
• Risk management techniques
• On-going monitoring/quality assurance.

2.10.8. Report Investigation and Analysis

Every event should be investigated. The extent of the investigation will depend on the actual and potential consequences of the occurrence or hazard. This can be determined through a risk assessment. Reports that demonstrate a high potential should be investigated in greater depth than those with low potential. The investigative process should be comprehensive and should attempt to address the factors that contributed to the event, rather than simply focusing on the event itself - the active failure. Active failures are the actions that took place immediately prior to the event and have a direct impact on the safety of the system because of the immediacy of their adverse effects. They are
not, however, the root cause of the event; as such, applying corrective actions to these issues may not address the real cause of the problem.

A more detailed analysis is required to establish the organizational factors that contributed to the error. The investigator, or team of investigators must be technically competent and either possess or have access to background information, so the facts and events are interpreted accurately. The investigator should have the confidence of the staff and the investigation process should be a search to understand how the mishap happened, not a hunt for someone to blame.

2.10.9. Documentation

Up to date documentation is essential if the company is to operate in a safe and efficient manner in accordance with current aviation safety regulations, standards and exemptions. For this reason an operator’s Safety Management System must address the four following documentary requirements:

- The identification of applicable aviation safety regulations
- Consolidated documentation describing the systems for each component of the safety management system.
- The implementation of changes to company documentation required by changes to aviation safety regulations, standards and exemptions.
- The maintenance of current, applicable and effective documentation.

2.10.10. Safety Office

There is no regulatory requirement to have a safety office. It is recognized, however, that the company may choose to employ a safety officer as a consultative or administrative body. The safety office may provide data directly to the accountable executive regarding major safety issues identified by the system.
The safety office serves as a focal point for safety-related activities, acts as a repository for safety reports and information, and provides expertise on safety management to line managers. A safety office fulfils a variety of corporate safety functions. Some of the more common functions include the following:

- Setting safety policy, defining responsibilities and accountabilities for safety.
- Establishing an effective corporate SMS for resource allocations in support of safety initiatives.
- Assessing identified risks and organizing emergency response planning.
- Selecting the most appropriate risk mitigation measures for those risks deemed unacceptable.
- Data analysis programmes; incident reporting systems and occurrence investigations.
- Safety studies; trend monitoring and coordinating safety committees.
- Sustaining awareness and understanding of the organization’s safety management processes across all operational areas.
- Disseminating safety lessons and providing training on safety management methods.
- Exchanging safety information with external agencies and similar operations.
- Conducting safety survey and providing guidance on safety oversight.
- Reporting on safety to meet the requirements and participating in accident and incident investigations.

2.10.11. Safety Manager

In most small and medium sized companies it is expected that the Flight Safety and Quality tasks will have many common points and there
can be no objection to the combination of the roles in one staff member. This ‘safety manager’ must have a direct reporting line, on safety matters, to the accountable manager. It is important that this person has the respect of the staff from the shop floor up to the senior management, yet is able to be objective in the fulfilment of safety Management task.

The safety manager (SM) should possess operational management experience and an adequate technical background to understand the systems that support operations. Operational skills alone will not be sufficient. The SM must have a good understanding of safety management principles that has been acquired through formal training and practical experience. SM requires strength in several areas to complement his professional expertise may include the following:

- A broad knowledge of aviation and the organization’s functions and activities.
- Human being skills (such as tact, diplomacy, objectivity and fairness).
- Analytical and problem-solving skills.
- Project management skills.
- Oral and written communication skills.

2.10.12. Safety Committee

The use of a safety committee in larger, more complex organizations can provide benefits for the organization. Safety committees provide a forum for discussing safety related issues from a cross-functional perspective and may lead to the inclusion of issues that look at safety from a broader viewpoint. Conventional safety at work concerns is a good example of this. Frequently, safety issues are not limited to one specific area and require inputs and expertise from a variety of different fields.
Safety committee can provide a forum for discussing safety-related issues from different perspectives to enable management to cooperate in promoting and developing measures to ensure the safety. Safety committee also ensures the active involvement of the senior management of the organization for assessing safety performance from a system perspective. The role of the safety committee may include the following:

- Act as a source of expertise and advice on safety matters to senior management.
- Review the progress on identified hazards and actions taken following accidents and incidents.
- Study of accidents and notified diseases and trends
- Examine safety audit reports.
- Consider reports and factual information provided by Government departments, ICAO, other states' CAA’s, consultants, and other appropriate sources.
- Monitor the effectiveness of the safety content of personnel training
- Keep under review the adequacy of personal protective equipment and its method of control.
- Monitor the performance of the different directorates and contractors in meeting airport standards.
- Review at regular internals the airport's Safety Policy and the organization and arrangements in force to implement them and advise the Director responsible for Safety of their adequacy.
- Determine annually the need for corrective actions arising from the results of safety audits, reviews, and surveys.
- Determine collectively the time scales for the corrective action.
• Ensure that senior management continually maintains the priority afforded to safety.
• Look for deviations from intended safety requirements.


A safety management manual provides management with a key instrument for communicating the organization’s approach to safety to the whole organization. The manual should document all aspects of the SMS, including the safety policy, safety procedures, and individual safety accountabilities. The safety management manual should be a living document, reflecting the status of the SMS.

The SM will likely be responsible for the development of the safety management manual. The manual should be written so that it reflects the intent and processes of the SMS. Thus, a significant change to the SMS will require an update of the safety management manual. The safety management manual should be kept as short and concise as possible. Any information that changes regularly should be put into appendices. This includes, for example, names of personnel assigned specific safety responsibilities. The safety management manual should include the following:

• Document control procedures.
• Scope of the SMS.
• Safety policy.
• Safety accountabilities.
• Hazard identification schemes.
• Safety performance monitoring.
• Safety assessment.
• Safety auditing;
• Safety promotion.
• Safety organizational structure.

2.11. Proposed Model for Airport Certification Manual (ACM)

The purpose of this order is to provide guidance to assist airport operators in the development of an acceptable Airport Certification Manual. The model manual in this order fulfills ICAO requirements and best practice. For all civil airport operators who are required to certify the airport. The main issues for proposed model for Airport Certification Manual are described as follows [Jordanian Civil Aviation Authority, 2008]:

1. Related Reading Material.
2. Airport Familiarization.
3. General Information.
4. Maintenance of the ACM.
5. Airport Safety Management System.
7. Personnel Requirements.
8. Safety Areas.
10. Maintenance of Safety Areas.
11. Aircraft Rescue and Fire Fighting.
1. Related Reading Material

Additional information is found in the following publications:


2. Airport Familiarization

Operator Identification:  
Airport Operator:  
Mailing Address:

P.O Box:  
Area Code:  
Fax:  
Tel:  
E – Mail:

Location of the airport:  
operating air carriers:  
The aircraft types:

3. General Information

Airport dimensions and related information (general information), including the following:

- Runway true bearing designation number, length, width, displaced threshold location, slope, surface type, type of runway, and for a precision approach runway the existence of an obstacle free zone.

- Length, width and surface type of the strip, runway end safety areas, and stop ways.

- Length, width, and surface type of taxiways (the ground used by the aircraft before and after flying).

- Apron surface type and aircraft stands.

- Clearway length and ground profile.
Visual aids for approach procedures, visual approach lighting type, and visual approach slope indicator system.


Airport Director is responsible for the maintenance of the ACM as required by SCAA as follows:

- Maintain the ACM current at all times. The Airport Director is responsible for maintaining the currency of the ACM.
- Maintain the official copy of the ACM at the Airport Director's Office.
- Furnish a CAA approved and current copy of the ACM to the personnel directly responsible for implementation of the ACM.
- Make the official copy of the ACM available for inspection by the CAA.
- Provide the CAA with one complete and current copy of the ACM.
- Airport Director is responsible for the amending the ACM.

5. Airport Safety Management System

A Safety Management System will be established at airport to ensure compliance with all safety requirements and to achieve continuous improvement in safety performance. The essential features of the airport SMS are:

- Safety policy must be applicable on the process of safety management and its relation to the operational and maintenance process;
- Structure or organization of the SMS including staffing and assignment of individual and group responsibilities safety issues;
• SMS strategy and planning such as setting safety performance targets, allocating priority for implementing safety initiatives and providing a framework for controlling the risks to a level as low as reasonably practicable keeping always in view the requirements of the Standard and Recommended Practices in Annex 14, Volume I to the Convention on International Civil Aviation and the national regulations, standards, rules or orders;

• SMS implementation including facilities, methods and procedures for the effective communication of safety messages and enforcement of safety requirements;

• System for the implementation of, and action on, critical safety areas which require a higher level of safety management integrity (Safety Measures Program);

• Measures for safety promotion, accident prevention and system for risk control involving analysis and handling of accident, incidents, complaints, defects, faults, discrepancies and failures, and continuing safety monitoring;

• Internal safety audit and review system detailing the systems and programs for quality control on safety;

• System for the documentation of all safety related airport facilities as well as airport operational and maintenance records including information on the design and construction of aircraft pavements and aerodrome lighting. The system should enable easy retrieval of records including charts;
• Staff training and competency including review and evaluation of the adequacy of training provided to staff on safety related duties and of the certification system for testing their competency; and

• Incorporation of safety related clauses in the contracts for work at the airport.

6. Safety Requirements

• A pre-work meeting will be held with all related parties to give them a briefing on the work intended to be done and ensure that nothing will affect the safe operations of flights.

• NOTAMs will be disseminated through the airport NOTAM system (Airport Condition Reporting) and will include all declared distances.

• All safety requirements specified in "the work in progress plan" will be strictly adhered to.

• All unserviceable areas will be marked in accordance with SCAA requirements.

• The ground operations staff will check that any equipment which affects landing and takeoff of aircrafts is removed before the runway is opened.

• The ground operations staff will check to see if all required permits have been issued for works on the movement area and then check that all underground services in the area of work are located and marked before or at the commencement of work to reduce the risk of damage to all infrastructure services.

• The ground operations staff will ensure that all personnel are aware of the location of runway and taxiway lights and other vital services and
markings so that they will not be damaged by vehicles and equipment. The ground operations staff will also ensure that routes of access to the work sites are clearly marked. Flashing lights may be used for night marking.

- The ground operations staff will ensure that adequate parking space is allocated for workers and employees responsible for accomplishing the work required in addition to all needed vehicle equipment.

- A distance of at least 50 meters will be between the runway edge and any parked vehicle at the side of the strip.

7. Personnel Requirements

- Airport will maintain sufficient qualified, competent, and certified personnel to comply with the requirements of this Airport Certification Manual.

- Personnel are subject to recurrent competency training covering airport topography, traffic rules and traffic procedures in the airport movement area and airport radio-communications system, training as will as operation& maintenance field.

- Marshallers (persons who direct the traffic in the taxiways and apron) are subject to recurrent tests for qualification covering rules and regulations governing aircraft movement and positioning, airport operational procedures, airport topography, radio-communications, docking handling, and air passenger bridges.

- Airport safety Unit inspectors are familiar with the airport facilities, regulations and the airport certification manual requirements concerning the self inspection program.
8. Safety Areas

Safety area dimensions conform to ICAO standards and recommended practices contained in Annex 14, Vol. 1. A map is included to depict the conditions and locations of areas safety must be attachment. Safety area conditions are maintained as follows:

- Each safety area is cleared and graded, and will be maintained free of potentially hazardous ruts, humps, depressions, ditches or other surface variations.
- Each safety area is drained by grading and storm sewers to prevent water accumulation.
- Each safety area is capable under dry conditions of supporting aircraft rescue and firefighting equipment and the occasional passage of aircraft without causing major damage. In wet conditions it is also able to support snow removal equipment. Manhole or duct access covers are constructed from steel of sufficient thickness and strength to support equipment and aircraft.
- No objects are located in any safety area, except for objects that need to be located in the safety areas because of their function. The objects currently located in the safety areas because of their function are constructed on frangible mounted structures of the lowest practicable height and are maintained so the frangible point is no higher than 7.5 cm above grade. Any future objects that will be located in the safety areas because of their function will be constructed on frangible mounted structures.
- Safety areas will conform to dimensions acceptable to the Director General of Civil Aviation if any runways or taxiways are constructed, reconstructed, or extended.

- Vegetation should be cut at all time.

9. Inspection Procedures of Safety Areas

- Daily inspections of the safety areas are done by ground operations personnel and an inspection report should be made.

- If any unsatisfactory condition is found an airport condition report form will be filled and delivered to the Civil Engineering Department.

- All inspection records are kept and made available to safety inspectors upon request.

10. Maintenance of Safety Areas

- Preventive maintenance program established at the airport to maintain facilities in condition which does not impair the safety of aircraft operations.

- Corrective action will be initiated by Civil Engineering staff as soon as practical when any unsatisfactory condition is found in the safety areas.

- If the airport operator determines that an uncorrected condition in a safety area is unsafe for aircraft operations, that portion of the airport will be closed to aircraft operation until the unsafe condition is corrected.

- The Airport Maintenance including preventive and corrective maintenance shall be executed through nominated contractors.
11. Aircraft Rescue and Fire Fighting

Aircraft Rescue and Fire Fighting (ARFF) equipment complies with (ICAO Category). ARFF vehicles conform to standards set in Guidance Specifications for Water Foam Aircraft Rescue and Firefighting Vehicles. ARFF Standby Procedures and Response Capability as follows:

- ARFF will respond to each emergency during periods of air carrier operations.
- ARFF will demonstrate compliance with the response requirements when requested.
- The response time required will achieve the following performance:
  a. Within 2 minutes from the time of alarm and the time when the first responding vehicle(s) reach any point of the operational runway(s) and discharge 50% of the total vehicle discharge rate.
  b. Within 3 minutes from the time of alarm, all remaining vehicles will reach the location and shall deliver the amount of distinguishing agent specified.
- Sufficient ARFF personnel will be available during all air carrier operations to operate the vehicles, meet the response time, and meet the minimum agent discharge rates required.
- Procedures and equipment are established and maintained for alerting ARFF personnel by the Airport crash alarm which will be tested daily at every 0800, 1600, and 2100 and shall consist of continuous 83 seconds blasts activated by the Airport Tower or Fire Control Center to any existing or impending emergency requiring their assistance.
• Fire fighters authorized for ARFF duty will be at standby alert at the airport fire station with the ARFF vehicle at least 15 minutes prior to scheduled arrivals and until 15 minutes after departure. If departure is scheduled at a later time the standby alert will be discontinued until 15 minutes before the scheduled boarding time.

12. Airport Emergency Plan

An Airport Emergency Plan (AEP), meeting the standards must be developed and is included in Appendix. The (AEP) is distributed to all concerned departments and agencies. All airport personnel having duties and responsibilities under the (AEP) are properly trained and familiar with their assignments. Annual Review of the AEP as follows:

• A review of the (AEP) is conducted at least every 12 months to ensure that the (AEP) is current and all parties with whom the plan is coordinated are familiar with their responsibilities.

• All of the agencies involved in the AEP are invited to participate in an annual review meeting at the airport.

• Tri-Annual Full-Scale Exercise of the AEP

• A full-scale exercise of the AEP will be conducted every two years.

• The full-scale exercise will involve, to the extent practicable, all mutual aid participants and a reasonable amount of emergency equipment.

• The purpose of the exercise will be to test the effectiveness of the AEP through a response of the airport and its mutual aid to an
aircraft accident at the airport, and to familiarize emergency personnel with their responsibilities in the plan.

13. Apron Safety Management

Apron safety management is the responsibility of Ground Safety personnel. Safety precautions as follows:

- No person shall walk, stand, drive a vehicle, park a vehicle or aircraft, or cause an obstruction on the movement area of the airport except in accordance with permission given:
  - By the airport operator, and
  - When applicable, by the appropriate air traffic control unit or flight service station.

- No person shall go to an aircraft on an active movement area at night unless the aircraft displays operating wingtip, tail and anti-collision lights, or is illuminated by lights mounted on the towing vehicle and directed at the aircraft being towed.

- No person shall park or otherwise leave an aircraft on an active maneuvering area at night unless the aircraft displays operating wingtip, tail and anti-collision lights or illuminated by lanterns suspended from the wingtips, tail and nose of the aircraft.

- No person shall operate a vehicle at night or during the hours of restricted visibility unless it is equipped with suitable lighting.

- Knowingly remove, deface, extinguish or interfere with a marker, marking, light or signal that is used for the purpose of air navigation, except in accordance with permission given:
a. By the airport operator, and

b. Where applicable, by the appropriate control unit or flight service station.

c. On the airside

d. On an aircraft loading bridge or on a gallery or balcony that is contiguous to or that overhangs an apron

e. In an area where smoking, or the presence of an open flame, is likely to create a fire hazard that could endanger persons or property.

f. Smoking is permitted only in specified locations in an enclosed building/shelter where such smoking will not create a fire hazard

• At, or on the vicinity of the airport, knowingly display a marker, marking, sign, light or signal that is likely to be hazardous to aviation safety by causing a glare or confusion with, or preventing clear visual perception of, a marker, marking, sign, light or signal that is required for the airport operations.

• No person will leave a vehicle unattended where it may create a hazard.

• Vehicles and personnel will not approach aircraft until propellers and engines have stopped revolving.

• Opening the passenger doors and the disembarking of passengers from aircraft will not take place before propellers and engines have stopped revolving.

• Propellers will not be stopped or slowed down by hand.

• All personnel working on the airside will wear high visibility clothing.
• All personnel working in the vicinity of aircraft with engines running will wear ear defenders.

• Wheel chocks are to be placed before any aircraft engine start-up.

• Smoking, or display of an open flame, is prohibited:

• All traffic on the airside will at all times comply with any lawful order, signal, or direction from any authorized airport authority representative. Where such traffic is controlled by traffic lights, signs, mechanical or electrical signal, or pavement marking; such signals and marking will be obeyed unless instructed by an authorized airport personnel to do otherwise.

• None of the following will be allowed when operating a vehicle on the airport:
  a. Operating the vehicle in a careless or negligent manner and without due caution
  b. Operating in a manner which endangers unreasonably persons or property Disregard of the right and safety of others
  c. Speeding
  d. Driving under the influence of intoxicating liquor or narcotic

• The Airport operator will remove from any area of the airport any vehicle which is disabled, abandoned, parked in violation of these rules and regulations, or which presents an operational problem to any other area at the airport. The Airport operator may store vehicles, at the owner’s or operator’s expense, without liability for damage which may result in the course of removing, towing, or storing of the vehicle.
• Coupling devices holding small baggage type trailers together will have positive-locking and release mechanism through manual action only for any combination of vehicle.

• All ground support vehicles will display lights from one-half hour after sunset to one-half hour before sunrise, and at all other times when there is insufficient light to render persons, vehicles, and property clearly at a distance of 150 meters, except when such vehicles are parking in areas designated by the airport operator for such purposes.

• Windscreens, windshields, and windows of any vehicle or mobile equipment working on the airport will be free of cracks, blisters, discoloration or obstructions to vision of the operator of the vehicle.

• The use or placing of posters, stickers, signs or other objects on the windscreen, windshield or rear windows of any vehicle other than those authorized by the airport operator is prohibited.

• The vision of the operator of an automotive vehicle or any mobile equipment will not be obstructed by an extended superstructure or load.

• No motorized vehicle will be operated on the airside unless the following is maintained:
  a. The driver is duly authorized to operate such vehicle and is licensed by the license authority to operate on a public highway or roadway.
  b. The vehicle is registered in accordance with the provisions of the law or, in the case of specialized vehicles, by the airport operator.

• Fire extinguisher equipment will not be tampered with at any time or used for any purpose other than fire fighting or fire prevention.
• Vehicle speed limits are set as follows:
  
  10 km/hr approximately to aircraft.
  20 km/hr at night and bad visibility.
  25 km/hr in daytime.
  40 km/hr elsewhere.

14. Safety Audit

Audit is necessary to confirm that the processes and results of that system actually achieve their intents, having implemented a system to manage safety within the airport. Several elements are assessed during a safety audit:

• Surveillance of compliance with requirements.

• The Audit Team will ascertain that the appropriate regulations of ICAO, SCAA, and safety standards have been identified and implemented.

• Areas & Degree of Risk and their effective management.

• In order to ensure that an organisation’s activities continue to be adequately safe operation. Procedures and processes with safety significance must be periodically reviewed in order to ensure that they continue to meet airport safety objectives.

• The competence and performance of those responsible for safety.

• The Audit Team will seek to confirm that the competence of key personnel remains adequate. For this, it will also examine procedures and specifically training programme for assuring the safety culture. Tables (2-2), (2-3) and (2-4) respectively, used for continuous surveillance, periodic evaluation and special inspection checklist to ensure safety in the aircraft movement area.
Table 2.2: Continuous Surveillance Checklist [Jordanian Civil Aviation Authority, 2008]

<table>
<thead>
<tr>
<th>FACILITIES</th>
<th>CONDITIONS</th>
<th>✓</th>
<th>X</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground</td>
<td>Rules / Procedures followed</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuelling</td>
<td>Fire / Explosion Hazards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>Ground / No smoking</td>
<td></td>
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<tr>
<td></td>
<td>Auto Shut off system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water &amp; Humidity</td>
<td>Surface conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Safety plan</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Runway Incursions</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Runway &amp; Taxiway use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Protection</td>
<td>Unauthorized Persons</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Unauthorized Vehicles</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Gates Clear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife Hazards</td>
<td>Birds</td>
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<td></td>
<td>Animals</td>
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<tr>
<td>Miscellaneous</td>
<td>Pedestrians in movement area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passenger load / unload</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Debris in movement area</td>
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<td></td>
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</tbody>
</table>
Table 2.3: Periodic Condition Evaluation Checklist [Jordanian Civil Aviation Authority, 2008]

<table>
<thead>
<tr>
<th>DATE: __________</th>
<th>DAY: ________________</th>
<th>√ Satisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME: __________</td>
<td>INSPECTOR: __________</td>
<td>X Unsatisfactory</td>
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</table>

<table>
<thead>
<tr>
<th>FACILITIES</th>
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<th>X</th>
<th>REMARKS</th>
</tr>
</thead>
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<tr>
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<td>Rubber Depositing</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Polishing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Markings &amp; Signs</td>
<td>Visible / Standard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lighting</td>
<td>Power Generator Check</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Circuit Resistance Test</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Aim / Adjustment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Aids</td>
<td>REILs/ PAPI/ Aiming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstructions</td>
<td>Surveyed Trees / Structures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Check Overhead Power Lines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuelling</td>
<td>Physical Facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>Mobile Fuelers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fire Extinguishers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fuel Marking / Labeling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grounding Clips</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft Rescue</td>
<td>Response Times</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and Firefighting</td>
<td>Live Fire Drills</td>
<td></td>
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</tr>
</tbody>
</table>
### Table 2.4: Special Inspection Checklist [Jordanian Civil Aviation Authority, 2008]

<table>
<thead>
<tr>
<th>FACILITIES</th>
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<th>√</th>
<th>X</th>
<th>REMARKS</th>
</tr>
</thead>
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<td>Ponding / Edge Dams</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polishing</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Safety Areas</td>
<td>Drainage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reopening Runways</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Reopening Taxiways</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marking &amp; Signs</td>
<td>Visible after rain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard after construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water and Humidity</td>
<td>Surface conditions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Snow bank Clearance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lights &amp; signs obscured</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>FOD</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Braking action reports</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Barricades</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Construction lights</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Equipment parking</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
2.12. Previous Studies

2.12.1. Quality and Strategic Studies

2.12.1.1. Foreign Studies

Thompson et al., (1995) explained that senior executives commonly ponder such questions as “What might give us continued competitive advantage?” and “What new products should be made or markets should enter and how?” These questions go to the heart of a firm's strategic vision, the shared understanding of what the firm should be and how it must change. This presents a framework to answer such questions critically and creatively. Knowing the answers constitutes the difference between muddling through and managing with confidence and foresight. The framework has four steps:

- Generate broad scenarios of possible futures that your firm may encounter.
- Conduct a competitive analysis of the industry and its strategic segments.
- Analyze your company's and your competition's core capabilities.
- Develop a strategic vision and identify your strategic options.

Al-Quran, (2002) developed a model of TQM in the administrative units at Jordanian universities. The major findings of the study were as follows:

- The possible degree of application of the TQM elements generally was moderate.
- The technique of "Building Team" became the highest, with a moderate degree, while the technique of administration by recording results was the lowest, with a moderate degree.
The findings revealed that the shortage of qualified trained staff in quality improvement was the greatest obstacle to the application of TQM in the administrative units of Jordanian universities.

Zawati, (2005) tackled the Balanced Score-Card (BSC) in the Jordanian public sector, in this research; the focus is on the importance of implementing the BSC concept in the public sector organizations. The researcher has modified the original BSC model to define first the needed strategies to achieve the organization vision. The definition of strategies based upon the analysis of environment of the organization in order to be able to adapt to the keep-changing surroundings.

JPS faces difficulties in measuring its performance systematically and in managing all the activities carried out to pursue its key strategies and objectives.

Al-Seker, (2006) designed a model for total quality management (TQM) in Saudi Arabia universities the results showed: sample items showed a great desire to implement the proposed in conformity with creating the appropriate environment for total quality management implementation.

Al-Kamim, (2003) evaluated the TQM in Yemen the main findings of the study are: There is a positive relation between TQM with all its elements (total and individual) and all the study domains (domestic and foreign sales, costs, profitability, market share, competitive advantage' and the export ability). The application TQM system improves the performance level of the company. The best results of applying TQM are represented in market share, competitive advantage, export ability, respectively, followed by foreign' sales, profitability, local sales, where as negative or no-significant results were noted in one domain only (costs).

Otaibe, (2006) proposed a model for total quality management at Kuwait university finally the researcher comes up to the following recommendations:
• Publicizing TQM culture and increasing its presence among top level management, through conferences, discussions and workshops, to inform all of Kuwait University employees about what is TQM, and encourage them to discuss its expected obstacles.

• Providing training programs for university employees in TQM techniques to help in understanding the conditions for its success.

2.12.1.2. Local Studies

Abu Ganaya, (2002) proved that the success of any organization depends greatly on implantation of strategic management approach. Adopting the strategic management process has a significant impact on an organization financial success, and becomes the critical factor in a company’s survival and growth. The result of One-way Anova test showed that the level of knowledge with strategic management have an influence on the success of the organizations.

Mohammed, (2006) covered the cost of quality control and it's measurement at Sudanese industrial enterprise the results confirmed to the study concluded that:

- Quality control measurement leads to continuous improving product and minimizing cost.
- The higher quality leads to increase the share of competitive market.
- A traditional measure doesn’t realize the effective level of quality progress.

Ali, (2005) examined the strategic management in Sudan the study shows that the performance of the enterprise under consideration varied according to their practice of strategic management. The enterprise which practiced strategic management properly was able to perform better than the others; and thus
enterprises experienced the poorest practice consequently its performance were the worst.

2.12.2. General Aviation Studies

Al-Sheikh, (2005) dealt with the air transportation enterprise in Sudan. The research focuses on conducting a comprehensive assessment of the air transport industry in Sudan, in the period 1985 through 2003. Studying air traffic indicators and financial ones, comparing them with global and regional indicators. The indicators for Sudan airports and Sudan Airways performance are found to be poor. The study findings include:

- The implementation of a policy of open skies leads to shortage in infrastructure capacity.
- Unorganized competition leads to monopoly and hikes in costs of air transport services.
- Non-proportionate alliances lead to hegemony by the mightier party over the weaker.

Mohammed, (2007) treated the strategic management in Sudan Civil Aviation Authority. This study aimed at the elucidation of the concepts of strategic management. Furthermore it clarified the importance of the strategic planning and its role in enabling the organizations to achieve their objectives successfully as required. This study reflects the importance of planning in finding out the needs of the organization in different fields. It is known that human resources and financial funds are rare, and limited so they should be utilized to the optimum by planning.

Planning focuses on the future: what is to be accomplished and how and when. In essence, the planning function includes those managerial activities that determine objectives for the future and the appropriate means for achieving those objectives.
Mohammed, (2003) addressed the airports operation and air navigation on economical Principles the study results and conclusion as follows:

- Balance between cost and services depends on global measurements and financial profit, and surrounding environmental factors in transport such as; social, political and economical.
- Perfect model deal with a significant relation between airports operation and air navigation according to economical principles.
- Research results and recommendations dealt with the importance of developing the finance, training, management and laws in order to simplify and create a conducive environment of work and the basic of economic principle.

Adam, (2007) broached the optimum utilization of Sudan air space this study is focused for the planning and the usage of human resource and generous financial support to speed up the development of air traffic control center to accommodate for the whole region and serve the international air transport demand.

Otrakji, and Khashab, (2001) prepared mission report evaluation of the Sudan Civil Aviation structure and Khartoum international airport the main conclusion and findings of the report as follows:

- The general directorates were further divided into directorates then into sections but without any explanation of their specific function, other than that what could be construed from their title.
- There were no job descriptions mandates or duties of the senior personnel in charge of the general directorates and the subordinate directorates.
• The mandate and authority of Director General remained however mainly the financial and administrative areas with no clear references to his authority in technical, operational, aviation safety and security area.
• The 1999 law like its predecessor, did not contain, any organizational structure for CAA below the level of the Director General.
• No coordination seems to have been effected to avoid duplication of duties and overlapping of responsibilities units. Thus has result in a situation divisions claim responsibility for the same duties and where certain confusion prevails.
• The CAA offices remain therefore dispersed in various rented buildings in town and in the airport.

2.12.3. Safety Aviation Studies

O'Hare, (1999) considered that the human performance in general aviation the training is an activity designed to prepare people for performance. Effective performance in many skills is based on the ability to recognize situations on the basis of subtle cues and distinctions. In aviation there needs to be a greater emphasis on analyzing expert performance and task structure to identify these critical constraints. The results can form the basis to enhance the ability of the novice to pay attention to the critical cues and constraints which govern action in a wide variety of circumstances.

Sudan Civil Aviation Authority, (1999) studied and analyzed the repeated aviation accidents in Sudan the aviation accidents in Sudan started to upset the public, responsible and workers in aviation field. By having a look at the global fatal accidents review of the period 1980-1996, it is found that the African average of accident is massive and there is accident in every 75,000 departures. With reference to statistics about Sudan in the period from 1988 to 1997 and
according to 80,000 departures a year, Sudan's accidents represent 50 accidents in every million flight and Sudan is the second large country where accidents take place in Africa.

Sudanese Aviation Industry Development Organization (SAIDO), (2008) helped a seminar on aircraft Accidents the main conclusion and findings as following:

- Africa's aircraft accidents rate is the highest in the world. (World Airnews, May 2000).
- The Africa has accounted for 13% of the world's accidents, between 1987 and 1996.
- Sudan topped the list with an average of 41 accidents per million departures.
- It listed the latent reasons for making mistakes include:
  - Inadequate selection, training, facilities, equipment and resources.
  - Poor communication, planning, inspection, oversight, motivation and management problems.

Federal Aviation Administration, (2006) introduced the benefits of SMS are essentially a quality management approach to Ling risk. It also provides the organizational framework to support a sound safety culture. General aviation operators, a SMS can form the core of the company’s safety efforts. For certificated operators such as airlines, air taxi operators, and aviation training organizations, may also serve as an efficient means of interfacing with certificate oversight offices. The SMS provides the company’s management with a detailed roadmap for monitoring safety related processes. Development and implementation of a SMS can give the aviation service provider’s
management a structured set of tools to meet their legal responsibilities but they can also provide significant business benefits.

Air Accident Investigation Central Directorate: SCAA, (2007), explained that the sole objective of the investigation of an accident or incident under the Regulation shall be the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion or liability. An investigation shall include:

- Gathering, recording and analysis of all available information on the accident or incident.
- If appropriate, the issuance of safety recommendations.
- If possible, the determination of the causes.
- In the case of an accident, the completion of the Final Report.

Abd Elhadi, (2006) prepared implementation of Aerodrome Regulations and Safety Management system in Sudan the objective of mission was to assess the resources, facilities and services available in Sudan Aerodromes, to evaluate the procedures, working methods used to its operation, particularly those related to implementation of certification of aerodrome and safety management systems requirements, in compliance with Annex 14 Volume I provisions, as well as other relevant ICAO specifications. The main discussion and findings as follows:

- National regulations specific to aerodromes are not yet developed and completed.
- No entity was established within CAA implementation of airdrome certification regulations.
- All Aerodromes in Sudan are owned and operated by the government.
• No regulatory framework was established for the implementation of the certification of aerodromes in Sudan and no established criteria certification of aerodromes in accordance with Annex 14.
• Non-implementation of the certification of aerodromes is due mainly to a lack of regulatory framework, experience, availability of qualified and trained aerodrome inspectors.
• Competence and skills of the aerodrome engineers and inspectors are not regularly evaluated. No licensing system for the aerodrome personnel is in place.
• Risk assessments are not conducted to support the application of a non-conformance or non adherence to ICAO SARPs at existing aerodromes.

International Civil Aviation Organization (ICAO), (2005-2006) approved the expansion of the existing (USOAP) in April 2005 along with other safety related aviation activities, under a comprehensive systems approach including Aerodromes. ICAO recognizes the need for States to exercise effective safety oversight of their aviation industries. Audit results analyzed and reported within main eight critical elements described as follows:

**Critical Element 1: Primary Aviation Legislation**
The provision of a comprehensive and effective aviation law consistent with the environment and complexity of the states aviation activity, and compliant with the requirements contained in the convention on international Civil Aviation.

**Critical Element 2: Specific Operating Regulations**

The provision of adequate regulation to address, at a minimum, national requirements emanating from the primary aviation legislation and providing for standardized operational procedures, equipment and infrastructures, in conformance with the ICAO standards and recommended practices (SARPs).
Critical Element 3: State Civil Aviation System and Safety Oversight Function

The establishment of Civil Aviation authority (CAA) and/or other relevant authorities or government agencies, headed by a chief executive officer, supported by the appropriate and adequate technical and non-technical safety and provided with adequate financial resources.

Critical Element 4: Technical Personnel Qualification and Training

The establishment of minimum requirements for knowledge and experience of the technical personnel performing safety oversight function and the provision of appropriate training to maintain and enhance their competence at the desired level.

Critical Element 5: Technical Guidance, Tools and the Provision of Safety Critical Information

The provision of technical guidance including processes, procedures facilities, equipment and safety critical information, as applicable, to the technical personnel to enable them to perform their safety oversight function in accordance with established requirements.

Critical Element 6: Licensing Certification, Authorization and/or Approval Obligations

The implementation of processes and procedures to ensure that personnel and organizations performing an aviation activity meet the established requirements.

Critical Element 7: Surveillance Obligation

The implementation of processes, such as inspections and audits, to proactively ensure that aviation license, certificate, authorization and/or approval holders continue to meet the established requirements and safety required by the state.
Critical Element 8: Resolution of Safety Concerns

The implementation of processes and procedures to resolve identified deficiencies impacting aviation safety. Table (2-5) shows the comparison between Sudan, Canada, Germany, Gambia, Malaysia, Panama, Thailand and Czech Republic for lack of effective implementation of ICAO, USOAP audits results within two years 2005-2006.

Table 2.5: Critical Elements of a Safety Lack of Effective Implementation (%)
[International Civil Aviation Organization (ICAO), 2005-2006]

<table>
<thead>
<tr>
<th>State</th>
<th>Critical element 1</th>
<th>Critical element 2</th>
<th>Critical element 3</th>
<th>Critical element 4</th>
<th>Critical element 5</th>
<th>Critical element 6</th>
<th>Critical element 7</th>
<th>Critical element 8</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudan</td>
<td>13.64</td>
<td>27.21</td>
<td>52.48</td>
<td>87.50</td>
<td>40.41</td>
<td>49.48</td>
<td>65.79</td>
<td>65.91</td>
<td>50.26</td>
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<tr>
<td>Canada</td>
<td>3.70</td>
<td>5.14</td>
<td>1.58</td>
<td>5.81</td>
<td>4.44</td>
<td>7.65</td>
<td>1.10</td>
<td>7.65</td>
<td>4.62</td>
</tr>
<tr>
<td>Germany</td>
<td>29.63</td>
<td>10.29</td>
<td>17.18</td>
<td>11.62</td>
<td>26.67</td>
<td>8.09</td>
<td>15.85</td>
<td>7.55</td>
<td>15.80</td>
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<tr>
<td>Gambia</td>
<td>0.00</td>
<td>16.78</td>
<td>21.50</td>
<td>8.75</td>
<td>27.02</td>
<td>27.44</td>
<td>28.17</td>
<td>18.60</td>
<td>18.64</td>
</tr>
<tr>
<td>Malaysia</td>
<td>7.41</td>
<td>18.29</td>
<td>24.22</td>
<td>31.40</td>
<td>26.67</td>
<td>5.58</td>
<td>14.29</td>
<td>30.19</td>
<td>19.74</td>
</tr>
<tr>
<td>Panama</td>
<td>20.00</td>
<td>13.91</td>
<td>18.81</td>
<td>13.75</td>
<td>14.74</td>
<td>9.41</td>
<td>18.29</td>
<td>13.64</td>
<td>15.31</td>
</tr>
<tr>
<td>Thailand</td>
<td>25.93</td>
<td>20.00</td>
<td>18.76</td>
<td>22.67</td>
<td>16.67</td>
<td>14.04</td>
<td>17.58</td>
<td>20.75</td>
<td>19.54</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>7.50</td>
<td>9.72</td>
<td>21.43</td>
<td>27.18</td>
<td>18.32</td>
<td>10.74</td>
<td>18.95</td>
<td>15.63</td>
<td>16.18</td>
</tr>
</tbody>
</table>

2.13. Comments on the Previous Studies

This study is similar to the previous studies, in the importance of the analysis of the current situation, and the determination of the points of strengths and to work for their maximization. Likewise, the acknowledgement of the weak points; and to work for their treatment by many techniques. This is done through adopting the strategic management approach and the introduction of the Total Quality Management policy; in addition to caring for the human cadre and it is training. Thus, this study was different from the previous studies in the following:-

- There were no similar scientific and academic studies which handled the topic of the study; practically or fully, despite the importance of the study;
and that the registered advanced figures and situations vis-a-vis many other states, in the increase of aircrafts accidents, rather progressively; and the negative and destructive results that followed.

- The collection of information and full reports about the topic of the study, for a continuous period of more than the past 20 years in the period 1988-2008; and knowing the nature of the conditions which proceeded this period, from several sources each confirm the other. The classification of these data and their analysis, in an exact form, is attained by the use of the modern statistical techniques, such as SPSS / Excel.

- The study conducted many comparisons; for local, regional and international experiences. It clearly defined the nature of the problems and their classifications. At the same time; it proposed an integrated and comprehensive (SMS), for the treatment of these problems and the mechanism for the continuous self-development.

2.14. The Perspective and Guidelines of the Study

2.14.1. Basic Guidelines Process

- Eliminate non value adding steps.
- Provide the shortest possible route requirements.
- Possible to track progress of the transaction.
- Eliminate "black holes".
- Develop vision, mission.
- Determine high level safety requirements.
- Conduct strength / weaknesses / opportunity / threat (SWOT) Analysis.
- Identify core competencies.
- Identify major business processes.
- Develop the process map.
• Conduct detailed safety requirements analysis.
• Categorize/ prioritize process improvement projects.
• Establish safety project of the organization.
• Develop project plan.

2.14.2. Evaluation and Follow-up Action
• Specifying the company’s SMS standards.
• Allocating adequate resources to the SMS.
• Ensuring the standards are known and accepted by all staff.
• Ensuring there is a system in place to that deviation from the standards are recognized and reported.
• Hazard and occurrences are reported in a timely manner.
• All staff are encouraged to report hazard, occurrences and safety concerns.
• Procedures are in place to track significant events, and detect unexplained increases in safety related events.
• There are processes to regularly review the effectiveness of the company reporting and notification system.
• Compliance with ICAO Annex 14 Volume SARPs.
• Provision and maintenance of facilities and services.
• Responsibilities being clearly defined.
• All staff consistently achieves the standards.

2.14.3. Establishing Safety Management System
• A safety management plan
• Clear authorities, responsibilities and accountabilities for safety at all levels within the organization.
• Occurrence and Hazard reporting.
• Data collection procedures.
• Incident analysis.
• Hazard identification and risk management.
• Documentation.
• Change operational procedures to minimize the hazard.
• Involve all staff in safety.
• Develop a positive safety culture.
• Maintain commitment.
• Assess progress.
• Prevention of accidents.
• Aerodrome safety.
• Reduction/elimination of deficiencies.
• Aerodrome safety management system.
• CAA aerodrome safety oversight.
• ICAO USOAP aerodromes audit.
• Prepare aerodrome manual.
• Possess an Aerodrome Certification.
• Benchmarking for Best Practices
• Implement safety management system.
Chapter Three

Air Transport and Aviation Accidents in Sudan

3.1. Development of Air Transport in Sudan’s Airport

The country obligation to prepare the airports and air navigation services and its responsibility towards them. The air-transport sector is characterized by several features from the other economic sectors; distinction in air navigations services, natural monopoly and the large amount of money required by the sector [Mohammed, 2003].

The traffic of air transport has developed in different airports of Sudan, and the number of the airports have been rebuilt become nine international airports and eight domestic airports, to enable the international and domestic air transport to develop and connect all parts of Sudan with the international and regional surroundings. Figures (3-1) and (3-2) show the distribution and locations of airports, and the routes of air traffic in Sudan.

The international and regional relationships have been strengthened with several agreements, for instance; ICAO, AFCAC (African Civil Aviation Commission), Arab Civil Aviation Organization and bilateral relations with different countries and companies.

The development includes all the fields in Civil Aviation; and it is positively reflected on the growth of air traffic in all airports of Sudan. With the rapid increase, and more than forty international and domestic companies are working in the field of passengers transport and despite the sanctions imposed on Sudan, the number of flights for some airports were 500 aircrafts flights and the number of passengers in Khartoum airport reached more than two million passengers a year and the number of aircraft's movement is more than 60,000 aircrafts per year [Sudan Civil Aviation Authority, 1988-2008].
Figure 3.1: Distribution and locations of Airports in Sudan [Sudan Civil Aviation Authority, 2007]
Figure 3.2: Air Traffic Routes in Sudan (Upper) [Sudan Civil Aviation Authority, 2007]
Table (3-1), Figures (3-3), (3-4) & (3-5) and the graphics (3-6), (3-7) & (3-8) show the size of development and increase of air traffic is evident out in all Sudan Airports performance, during the period (1991-2008). It is worth mentioning here that these situations in the period (1991 – 2008) do not include any data for the year 2005. Therefore, it was excluded, due to the lack of accurate documentation in the civil aviation sources.

Moreover, Sudan is situated in the area of air traffic from north of Africa and Europe to the middle and South of Africa where the over flying reach more than 27,000 flights a year and the fees of over flying services are more than 30% of Civil Aviation Authorities earnings [Al-Sheikh, 2005].

Table 3.1: Air Traffic Movement in Sudan Airports, 1991-2008 [Sudan Civil Aviation Authority, 1988-2008]

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Years</th>
<th>Aircraft flights</th>
<th>Passengers</th>
<th>Freight (Tones)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1991</td>
<td>13330</td>
<td>675860</td>
<td>30928</td>
</tr>
<tr>
<td>2</td>
<td>1992</td>
<td>18868</td>
<td>691681</td>
<td>96958</td>
</tr>
<tr>
<td>3</td>
<td>1993</td>
<td>16478</td>
<td>720687</td>
<td>59020</td>
</tr>
<tr>
<td>4</td>
<td>1994</td>
<td>19376</td>
<td>761276</td>
<td>72733</td>
</tr>
<tr>
<td>5</td>
<td>1995</td>
<td>18940</td>
<td>774623</td>
<td>51675</td>
</tr>
<tr>
<td>6</td>
<td>1996</td>
<td>15482</td>
<td>716315</td>
<td>52322</td>
</tr>
<tr>
<td>7</td>
<td>1997</td>
<td>15742</td>
<td>719606</td>
<td>75935</td>
</tr>
<tr>
<td>8</td>
<td>1998</td>
<td>24614</td>
<td>808202</td>
<td>122243</td>
</tr>
<tr>
<td>9</td>
<td>1999</td>
<td>36756</td>
<td>939209</td>
<td>120455</td>
</tr>
<tr>
<td>10</td>
<td>2000</td>
<td>39066</td>
<td>1015545</td>
<td>121406</td>
</tr>
<tr>
<td>11</td>
<td>2001</td>
<td>36132</td>
<td>1093363</td>
<td>165108</td>
</tr>
<tr>
<td>12</td>
<td>2002</td>
<td>38098</td>
<td>1204790</td>
<td>168318</td>
</tr>
<tr>
<td>13</td>
<td>2003</td>
<td>39648</td>
<td>1291940</td>
<td>126456</td>
</tr>
<tr>
<td>14</td>
<td>2004</td>
<td>52562</td>
<td>1334061</td>
<td>162511</td>
</tr>
<tr>
<td>15</td>
<td>2006</td>
<td>106340</td>
<td>1969295</td>
<td>155463</td>
</tr>
<tr>
<td>16</td>
<td>2007</td>
<td>100338</td>
<td>1992302</td>
<td>89545</td>
</tr>
<tr>
<td>17</td>
<td>2008</td>
<td>106656</td>
<td>2015005</td>
<td>85300</td>
</tr>
</tbody>
</table>
Figure 3-3: Aircraft Movement, 1991-2008

Figure 3.4: Passengers Movement, 1991-2008
Years

**Figure 3.5: Freight (Tones) Movement, 1991-2008**

\[ y = 2E^{-103}e^{0.1234x} \]

\[ R^2 = 0.8937 \]

Years

**Figure 3.6: Aircraft Regression Curve and Correlation Coefficient, 1991-2008 [Sudan Civil Aviation Authority, 1988-2008]**
Figure 3.7: Passengers Regression Curve and Correlation Coefficient, 1991-2008 [Sudan Civil Aviation Authority, 1988-2008]

Figure 3.8: Freight Regression Curve and Correlation Coefficient, 1991-2008 [Sudan Civil Aviation Authority, 1988-2008]
3.2. Conditions and Increase of Aviation Accidents

There are no registered observations, information and reports about the nature and details of aviation accidents that occurred before the year 1979. For more than 40 years, which had succeeded the establishment of the Civil Aviation Authority in 1936, there was slow increase in air traffic in terms of the type and numbers of the aircrafts working during this period in the Sudan.

The period from 1979 to 1987 witnessed increasing in number of occurrences where their total number in this period amounted to 134 occurrences. The number of victims was 98 and the injured was 6. The details of these occurrences are not available, for lack of documentation.

Table (3-2) shows the accidents in this period and table (3-3) shows some data about the nature of fatal accidents. But the accidents developed widely during the period from 1988 to 2008 because of the increase in the size of air traffic and there are data about the circumstances and conditions of these accidents, where the number of accidents during this period reached 288; classified in fatal, serious, minor accidents and serious incident.

Table (3-4) and Figure (3-9) show the occurrences in this period. The results show that there is a clear difference in number of accidents from one year to the other, where it found that the least number of accidents is 3 in the year 1998, while it found that the highest number is 32 accidents in the year 2003 with a percentage of 11% of the total accidents. The mean number of accidents is 14 per a year, it is a large value. This means that there is spread of accidents which affect the work safety in aviation field.
Table 3.2: Total Number of Accidents, 1979-1987

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Years</th>
<th>Number of Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1979</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>1980</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>1981</td>
<td>27</td>
</tr>
<tr>
<td>4</td>
<td>1982</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>1983</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>1984</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>1985</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>1986</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>1987</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total of Accidents</td>
</tr>
</tbody>
</table>

Source: Sudan Civil Aviation Authority, 1988-2008.

Table 3.3: Fatal Accidents, 1979-1987

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Date</th>
<th>A/C Type</th>
<th>A/C Registration</th>
<th>Number of Causalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>June 1979</td>
<td>PA-28</td>
<td>ST-AFE</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>September 1979</td>
<td>PA-32r</td>
<td>ST-AHJ</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>November 1979</td>
<td>DC-3</td>
<td>ST-AHH</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>February 1980</td>
<td>F-27</td>
<td>ST-AAS</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>November 1981</td>
<td>STR-T34</td>
<td>OE-EVP</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>April 1983</td>
<td>RS-148</td>
<td>EE-ADIH</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>September 1984</td>
<td>C-188</td>
<td>OH-CIX</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>November 1984</td>
<td>PZL-106</td>
<td>SP-ZBA</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>December 1984</td>
<td>C-188</td>
<td>N2071J</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>August 1986</td>
<td>F-27</td>
<td>ST-ADY</td>
<td>63</td>
</tr>
<tr>
<td>11</td>
<td>May 1987</td>
<td>C-404</td>
<td>ST-AIJ</td>
<td>11</td>
</tr>
</tbody>
</table>

Source: Sudan Civil Aviation Authority, 1988-2008.
Table 3.4: the Number of Accidents, 1988-2008

<table>
<thead>
<tr>
<th>Numbers</th>
<th>Year</th>
<th>Number of Accidents</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1988</td>
<td>22</td>
<td>7.6%</td>
</tr>
<tr>
<td>2</td>
<td>1989</td>
<td>19</td>
<td>6.6%</td>
</tr>
<tr>
<td>3</td>
<td>1990</td>
<td>19</td>
<td>6.6%</td>
</tr>
<tr>
<td>4</td>
<td>1991</td>
<td>14</td>
<td>4.9%</td>
</tr>
<tr>
<td>5</td>
<td>1993</td>
<td>18</td>
<td>6.3%</td>
</tr>
<tr>
<td>6</td>
<td>1994</td>
<td>14</td>
<td>4.9%</td>
</tr>
<tr>
<td>7</td>
<td>1995</td>
<td>13</td>
<td>4.5%</td>
</tr>
<tr>
<td>8</td>
<td>1996</td>
<td>6</td>
<td>2.1%</td>
</tr>
<tr>
<td>9</td>
<td>1997</td>
<td>6</td>
<td>2.1%</td>
</tr>
<tr>
<td>10</td>
<td>1998</td>
<td>3</td>
<td>1.0%</td>
</tr>
<tr>
<td>11</td>
<td>1999</td>
<td>6</td>
<td>2.1%</td>
</tr>
<tr>
<td>12</td>
<td>2000</td>
<td>8</td>
<td>2.8%</td>
</tr>
<tr>
<td>13</td>
<td>2001</td>
<td>9</td>
<td>3.1%</td>
</tr>
<tr>
<td>14</td>
<td>2002</td>
<td>15</td>
<td>5.2%</td>
</tr>
<tr>
<td>15</td>
<td>2003</td>
<td>32</td>
<td>11.1%</td>
</tr>
<tr>
<td>16</td>
<td>2004</td>
<td>8</td>
<td>2.8%</td>
</tr>
<tr>
<td>17</td>
<td>2005</td>
<td>22</td>
<td>7.6%</td>
</tr>
<tr>
<td>18</td>
<td>2006</td>
<td>17</td>
<td>5.9%</td>
</tr>
<tr>
<td>19</td>
<td>2007</td>
<td>17</td>
<td>5.9%</td>
</tr>
<tr>
<td>20</td>
<td>2008</td>
<td>20</td>
<td>6.9%</td>
</tr>
<tr>
<td><strong>Total of Accidents</strong></td>
<td><strong>288</strong></td>
<td></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Source: Sudan Civil Aviation Authority, 1988-2008.

Figure 3.9: The Number of Accidents, 1988-2008
3.3. Summary of Accidents for the Last Twenty Years 1988-2008

Summary of the accidents for the last twenty years 1988-2008 during which the increasing frequency of such accidents could be attributed to similar circumstances and causes.

There are no studies and evaluation in the previous situations and the lessons learned from them. The information and data are available and a great value in conducting analysis and evaluation to determine the real reasons that leads to the occurrence of these accidents.

The summary explains the locations of these accidents, their reasons and the size of loss, by taking into considerations the fact that most of these accidents occurred on landing or take off that means these accidents occurred inside or around the airports, and amounted to 288 accidents.

The period did not include the accidents occurred in 1992, because there is no data during this year involved in documents of Civil Aviation; means that there is shortage of data and reports, and incompletion of investigation in some of them or authorize out side parties to the investigation process, that amounted to 5% of the total number of accidents during the period.

The available data is adequate for analysis and evaluation process, and the period is essential for the nature of the previous accumulation and current situations and the possibility of evaluation according to these data and possibility of changing the situation to new situations based on requirements of this important period.

3.4. The Study Methodology and Analysis of Accidents

3.4.1. Sample and Population of the Research

The population of the research includes Civil Aviation Authority staff and different aviation service companies working in Khartoum Airport. The sample
for this study is the managers at top, middle and direct supervisor's levels. Stratified simple random sampling is used to select the sample.

A questionnaire of 150 Samples is used to collect the relevant data of the study, and it represents 30% of the population. Appendixes (B)&(C) show the questionnaire and referees names (those who revise and approved the final shape of the questionnaire) respectively. This sample is considered sufficient to represent the individuals of the study population, as the pervious studies indicated that the sample is selected with average not less than 10% of the original population of the study [Elnour, 2005].

3.4.2. Cause and Effect Analysis (Fish Bone)

Cause and effect analysis is used as a useful technique for helping to examine the underlying causes. It helps to see patterns and relationships among potential causes, a more specific definition of the problem; it stimulates further brainstorming and clarification of the problem. Figure (3-10) shows the cause and effect diagram.

![Figure 3-10: Cause and Effect Diagram](image)

3.4.3. Statistical Analysis

This study adopted a descriptive analytical approach of the sake of capturing the relationship between the different variable. The statistical package for social sciences (SPSS) and excel interactive spread sheets had been used for descriptive statistics, cross tabulation, frequency distribution, Chi-square tests
and statistical confidences. The findings show how confidently it can be
generalize for a large population from a selected sample of that population.

3.4.4. Chi-squared Test

Chi-square test is used to compare between observed frequencies of
categories; and expected frequencies. The Chi-squared test (Chi is pronounced
‘ki’, and written as \( \chi^2 \)) allowing hypothesis testing for categorical data. Chi-
square value measures the probability of getting a value of a minimum given
size to determine whether it is significant.

The value of chi-square is calculated using the following formula:[Bashier, 2003]

\[
\chi^2 = \sum \frac{(O - E)^2}{E}
\]

Where \( \chi^2 \) is chi-square

- O is Observed frequency for the corresponding cell.
- E is expected frequency for the corresponding cell.

To measure the Chi-square value, it is needed to know probability of
getting a Chi-square value of a minimum given size to determine whether it is
significant.

The probability depends on the degrees of freedom of the table from
which chi-square value is derived.

Mathematically, degrees of freedom (df) is expressed as follows:

\[
df = (r - 1) (c - 1)
\]

where: r is the number of row, c is the number of
column [Elfaki, 2006].

3.4.5. Correlation

The relationship between two aspects is called correlation. The correlation
can be linear or non linear. The used measurement which measures the
correction degree is known as correlation coefficients and represented with R and its value ranging between -1 to 1.

The simple linear correlation coefficient is contend with assuming that there is a linear relationship only between two of the variances, bearing in mind that, having small value (close to the zero) for this coefficient, does not mean that there is no relationship between the two variances, there can be a second class relationship called non linear correlation [Bashier, 2003].

3.4.6. Testing of Hypothesis

The Chi-square had been used to test hypothesis and explain the relationship between variables. Chi-square tested the hypothesis whether two or more samples that are different enough in some characteristics or aspects of their behavior to generalize from our samples that the populations samples are drawn. They are also different in their behavior. Probability Level of Significance is the probability that a subject with a positive test result really has the value < ($\alpha = 0.01$). Where $\alpha$ is a value of error equal to 1%.

3.4.7. Questionnaire Reliability

Reliability data used Alpha Cronbach's to be sure of unit co-ordination and they are free of random mistakes that affect the measurement. It's been realized that the questionnaire is defined with high reliability and Alpha Cronbach's coefficient reliability, reached 71% and it's very good level of reliability. Appendix (D) shows the reliability results.

3.5. Study Difficulties

- Civil Aviation departments suffered from weaknesses in data saving and documenting.
• It is not easy for the researcher to obtain all the needed material due to the wide scope of the study and the existence of the necessary data in a considerably scattered and varied source locations.

• The paucity of previous literature and studies relevant to the topics of the present study.
Chapter Four
Results and Analysis

4.1. Accidents Classification Criteria

The accidents have been classified during the indicated period (1988-2008) in order to get acquaintance with the causes and circumstances which led to their occurrences and to know the nature of such accidents in terms of the place and time of their occurrences, size of damage, in addition to the other administrative, technical causes and natural conditions. The classification includes the following:

- Distribution of accidents during every month, so as to know in which month the aviation accidents had increased. The results proved that some accidents occurred as a result of sandstorm, thunderstorm and bird strike. The accidents showed an increase in the rainy season in the months of August, September and October.
- The classification of accidents according to the property damage and human causalities, aircrafts and assets damage is classified as: fatal, serious and minor damage.
- Location of accidents to know the required precautions of work suitable and required for research and rescue. It was found that most of the accidents occurred in or around airports.
- The classification of accidents according to their causes whether it is technical, administrative or natural.
- The classification according to the circumstances of accidents; while landing, take off, on ground or cruising.
- The casualties of victims according to killed or injured persons in each accident.


Figure (4-1) shows the monthly distribution of aviation accidents during the period 1988-2008. The results of the accidents distribution indicate that there is an obvious variation in the number of accidents from month to the other, where it found
that the least accidents occurred in April with 12 accidents, while it found the highest number of accidents occurred in October with 41. It found that accidents were increased during the period of August, September and October, and that is due to natural conditions in rainy season and the accidents occurred as a result of the wind, rain, low visibility and birds strike.

![Number of Accidents versus Months, 1988-2008](image)

**Figure 4.1: Number of Accidents versus Months, 1988-2008**

### 4.3. Damage Type of Accidents 1988-2008

Figure (4-2) shows the type of accidents damage occurred during the period 1988-2008. It is noticed that most of the minor accidents and serious incidents are not registered, because of the lack of concern and attention; and these occurrences don’t represent obligations and responsibilities to any body, and their registration represents the first defense line to ensure their non-repetition and thus not causing serious accidents.
4.3.1. Fatal Damage of Accidents

Figure (4-3) shows the distribution of fatal accidents damage during the period 1988-2008. There is a variance between the numbers of accidents in each year; it includes the accidents which occurred during the operations of spray in agricultural projects, and it has been noticed that the crash of aircrafts increased during the period from 1988-93 in five successive years with a noticeable rapid increase in year 2005 and 2008. Where terrible accidents occurred and the number of victims increased

4.3.2. Serious Damage of Accidents

*Remarks:* 17 accidents have not been evaluated, due to insufficient data and they represent 6% of the total.
Figure (4.4) shows the distribution of serious accidents damage during the period 1988 – 2008. It indicates that the accidents during the period from 1988 – 1995 are above the mean and the year 2003 witnessed the highest average of serious accidents, as a result of unaddressed causes.

Figure 4.4: Serious Damage of Accidents 1988-2008

4.3.3. Minor Damage of Accident, 1988-2008

Figure (4-5) shows the distribution of minor accidents damage during the period 1988-2008. The number of occurrences of minor accidents and serious incidents does not find the consideration and exact record for all the occurrences, which took place, and their registration can contribute to avoid the occurrences of serious accidents and that may occur, and most of accidents occurred in 2007 and 2008.
4.4. Location of Accidents 1988-2008

Figure (4-6) shows the distribution of accidents location during the period 1988-2008. Most of the accidents took place with a percentage of 81% in or around airports; precautions and effective emergency plan should be done and activated to reduce the occurrences or the effects of accidents in airports.

![Pie chart showing the distribution of accidents location during the period 1988-2008.]

**Figure 4.6: Location of Accidents 1988-2008**

4.4.1. Accidents Occurred in Khartoum Airport

Figure (4-7) shows the distribution Accidents Occurred in Khartoum Airport during the period 1988-2008. The average of occurrences took place in Khartoum Airport during the period 1988-2008; reached 101 with a percentage of 36% of the total accidents, which occurred in Sudan during this period reaching the highest average. This means that any efforts made in Khartoum Airport should contribute towards the reduction of accidents in Sudan.

![Bar chart showing the number of accidents occurred in Khartoum Airport 1988-2008.]

**Figure 4.7: Accidents Occurred in Khartoum Airport 1988-2008**
4.4.2. Accidents Occurred in all Sudan's Airports except Khartoum Airport

Figure (4-8) shows the distribution of accidents occurred in all Sudan's Airports except Khartoum Airport during the period 1988-2008. The number of accidents for all Sudan's airports except Khartoum Airport during this period amounted to 127 accidents with a percentage of 45%, noting that the number of accidents during the period 1989-1994 is above the mean number and there are no recorded accidents in year 2004. However, the year 2003 witnessed the highest average of accidents where it reached to 16 accidents.

Figure 4.8: Accidents Occurred in all Sudan's Airports except Khartoum Airport

4.4.3. Accidents Occurred in Other Locations

Figure (4-9) shows the distribution of accidents occurred in other locations during the period 1988-2008. The total occurrences took place out of airports amounted to 55 representing 19% of the total accidents in which the operations of search and rescue are carried out by the authorities in the locations of accidents under the supervision and participation of units of search and rescue in the Civil Aviation Authority in case of fatal accidents.

Figure 4.9: The Distribution of Accidents Occurred in Other locations 1988-2008.

Figure (4-10) shows the distribution of accidents causes during the period 1988-2008. The majority of the accidents which occurred due to technical reasons were 55%, the administrative aspect was 29% and the natural aspects such as wind, rain and work environmental conditions represent 16% of the total accidents (266), which occurred during the period 1988-2008.

Figure 4.10: Causes of Accidents 1988-2008

4.5.1. Accidents Occurred due to Technical Causes 1988-2008

Figure (4-11) shows the distribution of accidents which occurred as result of technical causes during the period 1988-2008. The total accidents occurred due to technical causes were 145, which represent 55% of the total accidents. The period 1988-1994 witnessed an increase in the accidents, and the two years 2003 and 2005 witnessed the highest increase of accidents for technical causes.

Figure 4.11: Accidents Occurred due to Technical Causes 1988-2008
4.5.2. Accidents Occurred Due to Administrative Causes 1988-2008

Figure (4-12) shows the distribution of accidents occurred as result of administrative causes during the period 1988-2008. The total accidents occurred as a result of administrative faults include the Civil Aviation Authorities and the companies' errors and violations amounted to 78 represents 29% of total accidents. The period 2006-2008 witnessed an increase above the mean number of accidents, while the year 2003 witnessed the highest average of accidents. Most of these accidents occurred on the ground due to the overlapping of authorities, unclear assignment of responsibilities, violations and weak inspections and observations.

![Figure 4.12: Accidents Occurred Due to Administrative Causes 1988-2008](image)

4.5.3. Accidents Occurred due to Natural Causes, 1988-2008

Figure (4-13) shows the distribution of accidents occurred as result of natural causes during the period 1988-2008. The total accidents occurred as result of natural causes amounted to 43 which represents 16% of the total accidents, and they include the conditions of wind, rain, storm and low visibility conditions. Most of them occurred due to weakness of precaution and infective emergency plan. To remedy this situation, there is an urgent need for some measures, in order to overcome the natural conditions and circumstances.

Figure (4-14) shows the distribution of accidents circumstances during the period 1988-2008. 40% of accidents occurred on landing, 18% on Take off, ground accidents represented 22% of the accidents, cruising accidents amounted to 20.6%. Totally 79.4% of the accidents occurred on landing, take off and on ground in locations in or around airports, while only 20.6% on cruising.


Figure (4-15) shows the distribution of accidents circumstances during landing in the period 1988-2008. The total accidents occurred during landing amounted to 101 with a percentage of 40% of total accidents, the highest average of landing accidents occurred in the year 2003, while the year 1998 hasn’t witnessed any accidents and the period 1988-1994 witnessed an increase above the mean.
4.6.2. The Circumstances of Accidents during take off 1988-2008

Figure (4-16) shows the distribution of accidents circumstances during take off in the period 1988-2008. The total accidents occurred during the Take off amounted to 45 with a percentage of 18%, as a result of overload, technical faults, crash and collision with other bodies. The period 1988-1995 witnessed an increase above the mean.

4.6.3. Circumstances of Accidents on Ground 1988-2008

Figure (4-17) shows the distribution of accidents circumstances on ground in the period 1988-2008. The total accidents on the ground amounted to 55 with a percentage of 22% and most of them are considered as faults in the operation and low visibility, the year 2003 witnessed increasing of accidents in comparison to the other years. Most of these accidents occurred due to managerial and operational faults.
shortcomings in the part of Civil Aviation Authority, the airlines and aviation companies' services.


Figure (4-18) shows the distribution of accidents conditions during cruising in the period 1988-2008. Total accidents occurred during cruising was 52 with a percentage of 21% of total accidents; the year 1988 witnessed an increase in comparison to the other years. Most of accidents occurred as a result of technical problems due to collision with other bodies or shortage of fuel.


Figure (4-19) shows the distribution of human casualties, during the period 1988-2008. The total number of Casualties of Accidents includes both passengers and
crew members during the period amounted to 383 killed and injured persons, the year 2003 witnessed large number of casualties. The worst accidents of the aircraft B737, which belongs to Sudan Airways in the year 2003, in which 116 persons were killed in Port Sudan Airport, with only one child survived and the accident of the aircraft A310 which belongs to Sudan Airways occurred in 2008, where 30 persons were killed and 20 were injured.

![Pie chart showing killed and injured persons from 1988 to 2008.](image)

**Figure 4.19: Human Causalities of Accidents 1988-2008**

### 4.7.1. Killed Persons due to Accidents

Figure (4-20) shows the distribution of killed persons during the period 1988-2008. The total number of persons killed during the period amounted to 337. The years 1996, 2003 and 2008 witnessed large numbers of casualties.

![Bar chart showing number of killed persons from 1988 to 2008.](image)

**Figure 4.20: Killed Persons due to Accidents 1988-2008**

### 4.7.2. The Injured Persons due to Accidents 1988-2008

Figure (4-21) shows the distribution of injured victims of accidents during the period 1988-2008. The total number of injured persons during the period amounted to 46, the
year 2008 witnessed large numbers of the injured persons. There is no exact record on the number of the injured persons.

4.8. Questionnaire Analysis and Results

A questionnaire of 150 Samples is used to collect the relevant data of the study, and it represents 30% of the population. Intentional simple random sampling is used to select the sample. The population includes Civil Aviation Authority staff and different aviation service companies working in Khartoum Airport. The sample for this study is selected from the managers at the top, middle and direct supervisor's levels.

4.8.1. The Kind of the Sample

Figure (4-22) shows the aviation kind of the sample. The analysis results indicate that 75% of the sample is workers in the Civil Aviation Authority and 25% from other Civil Aviation companies. Most of the sample has been surveyed are working in the Civil Aviation Authority and that due to their responsibility and obligation for safety in airports.
4.8.2. The Gender Type

Figure (4-23) shows the Type of Gender. The number males are 136 with a percentage of 91% against 14 females with a percentage of 9% and that because the numbers of female employed is very few in comparison to men. Most of them occupy low job levels.

![Figure 4.23: The Type of Gender](image)

4.8.3. The Sample Field of Work

Figure (4-24) shows the sample field of work. 50% of the samples are managers, and 37% are working in operation field, and most are responsible for the critical situation solution, while 13% are working in the field of maintenance.

![Figure 4.24: The Sample Field of Work](image)

4.8.4. The Sample Years of Experience

Figure (4-25) shows the sample years of experience. 55% of he sample are experts, having more than 20 years experience, the most competent to evaluate the situation for their acquired and accumulated knowledge, while 35% are with 10-20 years of experience in aviation and 10% with 5-10 years experience.
4.8.5. The Degree of Responsibility of the Sample

Figure (4-26) shows the degree of responsibility of the sample. The sample includes 13% top management, 39% middle and executive staff and 48% the direct supervising responsible staff.

4.8.6. The Questionnaire Components:

The Questionnaire composed of two parts described as follows:

**Part one:** Considers the basic data of the sample members to get acquaintance with their nature and capabilities. The data comprises aviation kind/gender type/work sphere/experience level and degree of responsibility.

**Part two:** Consists of (18) phrases covering the objectives of the study. The questionnaire phrases formulated in accordance with the axes of the hypotheses using 5 (Recatres) model: Strongly agree/Agree/I don't know/Disagree/ or Strongly disagree

4.8.7. The Questionnaire Classifications:

The questionnaire phrases can be summarized in five axes explained in the following:
The first axis: The main causes of aviation accidents are due to weak coordination, bad execution or weak planning.

The second axis: The main factors of aviation accidents are due to technical reasons related to problems in maintenance, technical reasons related to problems in operation or technical reasons related to both technical and administrative reasons.

The third axis: Weakness of the administrative body led to the occurrence of ground accidents, the unclear definition of responsibilities and duties, the insufficiency of the responsibilities imposed by Aviation Authority on Aviation Service companies or the plans and programs of performance and change are not good.

The forth axis: Considers the work environment and reality which comprises: work conditions, infrastructures, training level or the extent of availability of communication and control equipment.

The fifth axis: It tackles with the climatic conditions and the level of dealing with emergencies.

4.8.8. The Questionnaire Statements Results

Table (4-1) and Figure (4-27) show the questionnaire results of the statements. The issues questionnaire statements results which have more agreement and emphasis include the following items:

The main factor in aviation accidents is: technical causes related to maintenance problems.

- The current negative aspects are the result of not clearly defining responsibility and duties.
- Training programmes are not sufficient.
- Plans and programmes of performance and changes are not good.

There is disagreement with the fact that the main cause of aviation accidents is due to the lack of qualification and experience of workers.
For the rest of the issues, there is widely agreement on the statements given in the questionnaire.

Table 4-1: The Questionnaire Statements Results:

<table>
<thead>
<tr>
<th>No</th>
<th>The Statements</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>I don’t Know</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The main cause of aviation accidents is: weak co-ordination</td>
<td>38 (25.3%)</td>
<td>58 (38.7%)</td>
<td>6 (4.0%)</td>
<td>45 (30.0%)</td>
<td>3 (2.0%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>The main cause of aviation accidents is: bad execution</td>
<td>31 (20.6%)</td>
<td>59 (39.3%)</td>
<td>7 (4.7%)</td>
<td>49 (32.7%)</td>
<td>4 (2.7%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>3</td>
<td>The main factor of aviation accidents is: weak planning</td>
<td>39 (26.0%)</td>
<td>55 (36.7%)</td>
<td>6 (4.0%)</td>
<td>44 (29.3%)</td>
<td>6 (4.0%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>4</td>
<td>The main cause of aviation accidents is: technical reasons relating to problems in maintenance</td>
<td>71 (47.3%)</td>
<td>49 (32.7%)</td>
<td>3 (2.0%)</td>
<td>23 (15.3%)</td>
<td>4 (2.7%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>5</td>
<td>The main cause of aviation accidents is: technical reasons relating to problems in operation</td>
<td>38 (25.3%)</td>
<td>68 (45.3%)</td>
<td>1 (0.8%)</td>
<td>38 (25.3%)</td>
<td>5 (3.3%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>6</td>
<td>The main factor in aviation accidents is both technical and administrative reasons</td>
<td>47 (31.2%)</td>
<td>66 (44.0%)</td>
<td>3 (2.0%)</td>
<td>33 (22.0%)</td>
<td>1 (0.8%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>7</td>
<td>The main cause of ground accidents is due to the weak authoritative body</td>
<td>37 (24.7%)</td>
<td>40 (26.6%)</td>
<td>3 (2.0%)</td>
<td>54 (36.0%)</td>
<td>16 (11.7%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>8</td>
<td>The current system lack an effective administrative body</td>
<td>70 (47.8%)</td>
<td>44 (29.3%)</td>
<td>2 (1.3%)</td>
<td>26 (17.3%)</td>
<td>8 (5.3%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>9</td>
<td>The current negative aspects are the result of unclear definition of responsibilities and duties</td>
<td>62 (41.3%)</td>
<td>61 (40.7%)</td>
<td>4 (2.7%)</td>
<td>18 (12.0%)</td>
<td>5 (3.3%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>No</td>
<td>The Statements</td>
<td>Strongly agree</td>
<td>Agree</td>
<td>I don’t Know</td>
<td>Disagree</td>
<td>Strongly Disagree</td>
<td>Total</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>-------</td>
<td>--------------</td>
<td>----------</td>
<td>-------------------</td>
<td>-------</td>
</tr>
<tr>
<td>10</td>
<td>The responsibilities of Civil Aviation Authority imposed on aviation service</td>
<td>53</td>
<td>43</td>
<td>1</td>
<td>45</td>
<td>8</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>companies are not sufficient</td>
<td>35.3%</td>
<td>28.6%</td>
<td>0.8%</td>
<td>30.0%</td>
<td>5.3%</td>
<td>100%</td>
</tr>
<tr>
<td>11</td>
<td>The working environment at Khartoum Air Port is not suitable for good</td>
<td>59</td>
<td>59</td>
<td>2</td>
<td>26</td>
<td>4</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>performance</td>
<td>39.3%</td>
<td>39.3%</td>
<td>1.3%</td>
<td>17.3%</td>
<td>2.8%</td>
<td>100%</td>
</tr>
<tr>
<td>12</td>
<td>The infrastructure at Khartoum Air Port is not sufficient for achieving the</td>
<td>46</td>
<td>59</td>
<td>2</td>
<td>37</td>
<td>6</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>best of safety</td>
<td>30.7%</td>
<td>39.3%</td>
<td>1.3%</td>
<td>24.7%</td>
<td>4.0%</td>
<td>100%</td>
</tr>
<tr>
<td>13</td>
<td>The main cause of aviation accidents is due to the lack of qualification and</td>
<td>27</td>
<td>44</td>
<td>2</td>
<td>60</td>
<td>17</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>experience of workers</td>
<td>18.0%</td>
<td>29.3%</td>
<td>1.3%</td>
<td>40.1%</td>
<td>11.3%</td>
<td>100%</td>
</tr>
<tr>
<td>14</td>
<td>Training programmes are insufficient</td>
<td>76</td>
<td>52</td>
<td>5</td>
<td>15</td>
<td>2</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.7%</td>
<td>34.7%</td>
<td>3.3%</td>
<td>10.0%</td>
<td>1.3%</td>
<td>100%</td>
</tr>
<tr>
<td>15</td>
<td>Plans and programmes of performs and changes are not good</td>
<td>63</td>
<td>64</td>
<td>4</td>
<td>16</td>
<td>3</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>42.0%</td>
<td>42.7%</td>
<td>2.7%</td>
<td>10.6%</td>
<td>2.0%</td>
<td>100%</td>
</tr>
<tr>
<td>16</td>
<td>There is no sufficient equipment of communication and control</td>
<td>49</td>
<td>53</td>
<td>5</td>
<td>31</td>
<td>12</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32.7%</td>
<td>35.3%</td>
<td>3.3%</td>
<td>20.7%</td>
<td>8.0%</td>
<td>100%</td>
</tr>
<tr>
<td>17</td>
<td>There are no alternatives and choices in dealing with emergencies</td>
<td>46</td>
<td>63</td>
<td>7</td>
<td>29</td>
<td>5</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30.7%</td>
<td>42.0%</td>
<td>4.7%</td>
<td>19.3%</td>
<td>3.3%</td>
<td>100%</td>
</tr>
<tr>
<td>18</td>
<td>Climate conditions are the main cause of aviation accidents</td>
<td>48</td>
<td>54</td>
<td>0</td>
<td>37</td>
<td>11</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32.0%</td>
<td>36.0%</td>
<td>0.0%</td>
<td>24.7%</td>
<td>7.3%</td>
<td>100%</td>
</tr>
</tbody>
</table>
4.9. Discussion and Validity of Hypotheses

4.9.1. The First Hypothesis

The working environment at Khartoum Airport is not suitable for good performance and the current system lacks an effective administrative body.

Chi-square test has been used to know the relationship between the variables of the study by using; Pearson, Spearman and Chi-square tests. Table (4-2) shows the hypothesis relationships and validity.

Table 4.2: First Hypothesis Variables Relations and Results

<table>
<thead>
<tr>
<th>Number of Relation</th>
<th>Variables</th>
<th>Pearson chi-square Calculated</th>
<th>Pearson chi-square tabulated</th>
<th>Spearman correlation</th>
<th>Significance</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The current system lacks an effective administrative body and The working environment is not suitable for good performance</td>
<td>43.364</td>
<td>26.3</td>
<td>0.334</td>
<td>0.000</td>
<td>Statistical Significance</td>
</tr>
<tr>
<td>2</td>
<td>The current system lacks effective administrative body There is no sufficient equipment of communication and control</td>
<td>40.703</td>
<td>26.3</td>
<td>0.248</td>
<td>0.001</td>
<td>Statistical Significance</td>
</tr>
</tbody>
</table>
From the table (4.2) results, the value of tabulated Chi-square is less than the value of the calculated chi-square for each variables relationship, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at ($\alpha = 0.01$).

In the first relationship, there was a relationship with statistical significance between the current administrative condition in the Civil Aviation Authority and the working environment in Khartoum Airport attributed to that the current condition affects the working environment.

In the second relationship, there is statistical significance between the current system's lacks of an effective administrative body and there is no sufficient equipment of communication and control due to the current system's lack of an effective administrative body affects there is no sufficient equipment of communication and control system.

**Findings:**

- The current administrative conditions, affects the working environment.
- There is no sufficient communication equipment and control system to establish a satisfactory and sufficient safety requirement.

**4.9.2. The Second Hypothesis**

The ineffective administrative body led to the current negative aspects and not clearly the defining the responsibilities. Table (4-3) shows the hypothesis relationships and validity.
Table 4.3: the Second Hypothesis Variables Relationships and Results

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson's chi-square</th>
<th>Spearman's correlation</th>
<th>Significance</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Calculated</td>
<td>Tabulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>The main cause of ground accidents is due to the weak administrative body</td>
<td>40.808</td>
<td>26.3</td>
<td>0.404</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Responsibilities of Civil Aviation Authority imposed on aviation service companies are not sufficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The main cause of ground accidents is the ineffective administrative body</td>
<td>56.896</td>
<td>26.3</td>
<td>0.350</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>The current negative aspects are the result of not clearly defining the responsibilities and duties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>The responsibilities of Civil Aviation Authority imposed on aviation service companies are insufficient</td>
<td>66.00</td>
<td>26.3</td>
<td>0.320</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>The current negative aspects are the result of not clearly defining the responsibilities and duties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the table (4-3) results, the value of tabulated Chi-square is less than the value of the calculated chi-square for each variables relationship, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at ($\alpha = 0.01$).

In the first relation, there was a relationship of statistical significance between the main cause of ground accidents due to the weak authority body and responsibilities of Civil Aviation Authority imposed on aviation service companies are un-sufficient. This means that the weak administrative body caused the ground accidents and it also led to an unclear definition of responsibilities towards Aviations Services Companies.

In the second relation, there was a relationship of statistical significance between the weak administrative body and the current negative aspects as a result of not clearly defining the responsibilities and duties due to the weak administrative body affects clearly the negative aspects.

In the third relationship, there was a statistical significance relationship between the responsibilities of Civil Aviation Authority imposed on aviation service companies which insufficient; and the current negative aspects which result of not clearly defining
Findings:

- The weak administrative body was the main cause of ground accidents.
- Ground accidents were a result of the current negative aspects.
- The role of Civil Aviation Authority towards aviation service companies was limited and weak.

4.9.3. The Third Hypothesis

The current ineffective administrative condition affects the training programmes that affect the worker's proficiency in levels of maintenance and operation. Table (4-4) shows the hypothesis relationships and validity.

<table>
<thead>
<tr>
<th>Number of relationship</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Spearman correlation</th>
<th>Significance</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Calculated</td>
<td>Tabulated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>The current system lacks of an effective administrative body</td>
<td>72.123</td>
<td>26.3</td>
<td>0.394</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>The current training programmes insufficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the table (4.4) results, the value of tabulated Chi-square is less than the value of the calculated chi-square, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at ($\alpha = 0.01$).

In this relationship there was a statistical significance relationship between the current condition, lack of an effective administrative body and the training programmes are insufficient. This means that current ineffective administrative
condition affects the training programmes. This in turn, affects the workers' proficiency in levels of maintenance and operation.

**Finding:**

The current administrative conditions affected the levels of maintenance and operation, because of the poor training programmes and employees' proficiency.

**4.9.4. The Fourth Hypothesis**

The current system lack of effective administrative body led to aviation accidents in both technical and administrative causes and thus plans and programmes of performs and changes are not good. Table (4-5) shows the hypothesis relationships and validity.

**Table 4.5: the Fourth Hypothesis Variables Relationships and Results**

<table>
<thead>
<tr>
<th>Number of relationships</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Spearman correlation</th>
<th>Significance</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The current system lacks an effective administrative body</td>
<td></td>
<td></td>
<td></td>
<td>Statistical Significance</td>
</tr>
<tr>
<td></td>
<td>The main factor in aviation accidents is both technical and administrative</td>
<td>33.743</td>
<td>26.3</td>
<td>0.173</td>
<td>0.006</td>
</tr>
<tr>
<td>1</td>
<td>The current system lacks an effective administrative body</td>
<td></td>
<td></td>
<td></td>
<td>Statistical Significance</td>
</tr>
<tr>
<td></td>
<td>Plans and programmes of performance and changes are not good</td>
<td>39.58</td>
<td>26.3</td>
<td>0.263</td>
<td>0.001</td>
</tr>
</tbody>
</table>
From the table (4.5) results, the value of tabulated Chi-square is less than the value of the calculated chi-square for each variables relationship, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at ($\alpha = 0.01$).

In the first relationship, there was a statistical significance relationship between the current system which lacks of an effective administrative body; and the main factor in aviation accidents is both technical and administrative causes. This means that current system lacks of an effective administrative body; and the main factor in aviation accidents, is both technical and administrative. This means that current system lacks of an effective administrative body. This leads to the occurrence of aviation accidents.

In the second relationship, there was a statistical significance between the current system which lacks of an effective administrative body; and the plans and programmes of performance and changes are not good. This means that current system lack of an effective administrative body; leads in turn, to the weak plans and programmes of performance and changes.

**Findings:**

- The lack of effective administrative body led to the increase of number of accidents, as a result of both technical and administrative problems.
- The lack of effective administrative body led to weakness in plans and programmes of performance and changes.

**4.9.5. The Fifth Hypothesis**

The alternative and choices in dealing with emergencies are ineffective, as a result of insufficient equipment of communication and control. Table (4-6) shows the hypothesis variables relationships and results.
Table 4.6: the fifth Hypothesis Variables Relationships and Results

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Spearman correlation</th>
<th>Significance</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There is no alternative and choices in dealing with emergencies</td>
<td>44.695</td>
<td>32.0</td>
<td>0.174</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>There is no sufficient equipment of communication and control</td>
<td></td>
<td></td>
<td></td>
<td>Statistical Significance</td>
</tr>
</tbody>
</table>

From the table (4.6) results, the value of tabulated Chi-square is less than the value of the calculated chi-square, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at \( \alpha = 0.01 \).

In this relationship there was a statistical significance between there is no alternative and choices in dealing with emergencies and that there is no sufficient equipment of communication and control. This means that lack of equipment lead to the lack of dealing with emergencies effectively.

**Finding:**

The negative administrative and technical role led to the insufficient equipment of communication and control which in turn affected dealing with emergencies.

4.9.6. The Sixth Hypothesis

Climatic conditions lead to aviation accidents as a result of unsuitable working environment at Khartoum Airport. Table (4-7) shows the hypothesis variables relationships and results.
Table 4-7: the Sixth Hypothesis Variables Relationships and Results

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Significance</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Calculated</td>
<td>Tabulated</td>
<td>Statistical Significance</td>
</tr>
<tr>
<td>1</td>
<td>Climate conditions are the one of the main cause of aviation accidents</td>
<td>28.933</td>
<td>9.49</td>
<td>0.000</td>
</tr>
</tbody>
</table>

From the table (4-7) results, the value of tabulated Chi-square is less than the value of the calculated chi-square, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at (α = 0.01).

In this relationship there was a difference with statistical significance between the opinions of the subjects over the Hypothesis variables attributed to the climatic conditions are the one of the main cause of aviation accidents.

**Finding:**

Climatic conditions were among the main causes of aviation accidents.

4.9.7. The Seventh Hypothesis

The infrastructure at Khartoum Airport is insufficient for achieving the best safety. Table (4-8) shows the hypothesis variables relationships and results

Table 4.8: the Seventh Hypothesis Variables Relationships and Results

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Sig.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Calculated</td>
<td>Tabulated</td>
<td>Statistical Significance</td>
</tr>
<tr>
<td>1</td>
<td>The infrastructure at Khartoum Airport is insufficient for achieving the best safety</td>
<td>83.53</td>
<td>9.49</td>
<td>0.000</td>
</tr>
</tbody>
</table>

From the table (4-8) results, the value of tabulated Chi-square is less than the value of the calculated chi-square, hence the null hypothesis (H0) is rejected and the
alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at (\(\alpha = 0.01\)).

In this relationship there were differences with a statistical significance between the opinions of the subjects about the variables of the Hypothesis attributed, in favour of those who agree with that the infrastructure at Khartoum Airport is not sufficient for achieving the best safety.

**Finding:**

The infrastructure at Khartoum airport was not sufficient for achieving the best level of safety.

**4.10. The Variables Relationship of Accidents, 1988-2008**


From the table (4.9) results, the value of calculated Chi-square is less than the value of the tabulated chi-square, hence the null hypothesis (H0) is accepted. The significance level of tabulated chi-square is taken at (\(\alpha = 0.01\)).

In this relationship there were no differences with a statistical significance between the type of damage and the Cause of accidents. Figure (4-28) shows that 12.7% of the fatal accidents occurred by the cause of technical problems, while it found 3.9% by the cause of administrative problems and 3.5% refers to the environment. It found for serious accidents, 37.5% for technical cause and 20.8% administrative and 10% for environment. In minor accidents, it found that 4.6% occurred as a result of administrative problems and 4.2% technical and 2.7% for environment.
Table 4.9: The Chi-square Tests Results of the Damage and Causes of Accidents 1988 - 2008

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson chi-square Calculated</th>
<th>Tabulated</th>
<th>Sig.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Causes of accidents: Technical, Administrative or Environmental</td>
<td>6.806</td>
<td>9.49</td>
<td>0.146</td>
<td>Not Statistically Significance</td>
</tr>
<tr>
<td></td>
<td>Types of damages: Fatal, Serious or Minor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.28: The Relationships between Damage and Causes of Accidents 1988-2008

4.10.2. The Relationships between the Damage and Circumstances of Accidents 1988-2008

From the table (4-10) results, the value of tabulated Chi-square is less than the value of the calculated chi-square, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at ($\alpha = 0.01$).

In this relationship there is a difference with a statistical significance between the type of damage and the circumstances of accidents. Figure (4-29) shows that 7.6% of fatal accidents occurred on landing and 29.5% of serious accidents on landing and 4% of minor accidents on landing. This means that most of the accidents occur on
landing and then on ground and after in cruising. It conclude that most of the problems due to technical causes. Other causes of accidents are administrative in the second level and then the natural causes. This means that the organizing plans of performs must be done according to these priorities and important findings obtained.

**Table 4.10: The Chi-square Tests Results of the Damage and Circumstances of Accidents 1988 - 2008**

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Sig.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Types of damages: Fatal, Serious or Minor</td>
<td>20.357</td>
<td>12.6</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Circumstances of accidents: Landing, Takeoff, Ground or Cruise</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Figure 4.29: The Relationships between the Damage and Circumstances of Accidents 1988-2008](image-url)

From the table (4-11) results, the value of tabulated Chi-square is less than the value of the calculated chi-square, hence the null hypothesis (H0) is rejected and the alternatives hypothesis (H1) is accepted. The significance level of tabulated chi-square is taken at \( \alpha = 0.01 \).

In this relationship there were differences with a statistical significance between the circumstances and causes of accidents. Figure (4-30) results shows that most of the accidents due to technical causes: landing due to technical with average of 26.5% in landing, 11.4% in take off and 14% while cruising. This means that most of the problems due to technical occurred in the condition of landing and in take off.

Table 4.11: The Chi-square Tests Results of the Circumstances and Causes of Accidents 1988 - 2008

<table>
<thead>
<tr>
<th>Number of Relationship</th>
<th>Variables</th>
<th>Pearson chi-square</th>
<th>Sig.</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Causes of Accidents: Technical, Administrative or Natural.</td>
<td>72.071</td>
<td>12.6</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Circumstances of accidents: Landing, Takeoff, Ground or Cruise</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.30: The Relationships between Circumstances and Causes of Accidents 1988-2008
4.11. The Causes of Accidents

As a result of the wide survey and analysis of this study and some of accidents investigation findings, evaluation of accidents data collection, safety reports and recommendations the repetition of accidents were occurred due to the following causes:

- Absence of surveillance and application of recommendations issued by some of the boards of investigation, to know the causes and the best direction of solutions.

- The weak infrastructure of air transport industry in Sudan such as, landings, navigation and control devices, laboratories and training centre.

- The weakness of deficiencies in training, system and programs are not complete and advanced courses for air and ground are non-existing. So they cannot cope with the rapid developments in this field; and especially in the field of aviation simulation.

- Pressure on Civil Aviation Authority and the rapid increase in the air traffic in the country. This had lead to weakness in applying the rules and their requirements. Also; the successive change of administration in short periods, led to weakness of surveillance and inspection plans.

- There are no information surrounding the aircraft, in some cases, during the operations or in the completion of tasks.

- There is no consistence among members of cockpit management, in some occurred accidents.

- The economic sanctions imposed on Sudan and its effects, due to the following:
  - Import of the devices and equipment to develop the infrastructure, so that cost of rehabilitation is expensive.
  - Provide the spare parts of aircrafts in the suitable time.
  - Maintenance of aircrafts abroad.
- No exchange of information, periodicals and technologies with the international institutions. Such as: ICAO, JAA, and FAA.
- Exchange of technologies with other counterparts abroad.
  • Introduction of Russian aircrafts with Russian pilots, engineers and navigators in Sudan and the difficulty of communication.
  • The aircrafts fleet in some companies is obsolete in addition to the lack of spare-parts, test equipments and guidance materials.
  • More than 90% of the accidents occurred because of human faults, and they are above the common global average, which are 80% and that because of lack of training.
  • The administrative errors have been along subordinate causes for accident, so they can not be overlooked.
  • Some accidents occurred due to the bad climate and low visibility. This indicated that, the role of weather conditions can not be ignored, in a large country with changing weather conditions, like Sudan, also with poor weather forecast.
  • Concern of the owners of private aviation for earnings only and the subjection of the pilots to their pressure to violate the overloads of aircrafts.
  • The ineffective exchange of communication between the working bodies in the field of aviation in the country such as; Air Force, Civil Aviation Authority and working companies, to coordinate between themselves, in relationship to the air safety such as; validity of airports, meteorology, training, search, and the lessons learned from accidents occurrences, is not existent.
  • There is no specialized institute to qualify and train persons as: the pilots, engineers and traffic controllers in Sudan, which led some of the wealthy people to study abroad on their own private expenses.
• The requirements of works such as, offices, furniture and equipment in most companies are not adequate for the work in the aviation field; that requires accurate and organized companies.

• The instability and the unsatisfactory financial credit of employees was behind the losing many experienced staff either by immigration or leaving the work.

• The working companies in Sudan are tiny. This makes the departments on these companies impose number of jobs and tasks to one person led to inconsistence in the performance of duty.

• The companies are not informed or do not understand the results of accidents that occurred and recommendations of investigation these accidents.

• There are disorders in some airports and a lot of errors and violations may be occurred in sometimes.

• Some of the airports are very bad; despite the heavy air traffic in these airports. This causes a lot of incidents and accidents.

4.12. Road Map for Enhancing Safety

The study classified the real causes behind the occurrence of defects in the safety system within the present situation. This was made through analysis and evaluation of the incidents and accidents recorded during the period of (1988 - 2008). Furthermore, study provided a road map to address the negatives which led to this reality. This road map comprises the following:

• Approving the strategic management methodology and the concept of the total quality management for all the civil aviation activities, for enhancing safety environment and thus achieve Civil Aviation objectives.

• The SCAA must regulates and establish a disciplinary and enforcement policy that promotes SMS implemented from a day-to-day involvement in all activities. The day-to-day issues must be discovered, analyzed and corrected internally.
The SMS must develop a safety culture that promotes open reporting, through non-punitive disciplinary policies and continual improvement through, proactive safety assessments and quality assurance.

The Safety Management System philosophy requires that responsibility and accountability for safety be retained within the management structure of the organization.

Safety Management system must remain at the forefront of methods by which the organization can make aviation, already the safest, and move beyond the traditional reactionary systems to predict areas of exposure.

Imposition of strict enforcement and effectuation of the law and its exigencies in order to ensure the full compliance with the safety requirements implementation.

Revival of the role of Civil Aviation Authority and exercise of its observative and inspection role on aviation companies and their employees.

Revision of the requirements of offering sanctions on aviation companies and apply these requirements upon which these sanctions are imposed.

Diffusion and dissemination of the culture in the field of safety.

Formation of a committee for air safety including the specialized departments in: Civil Aviation Authority, and aviation companies, meteorology and civil defence. The tasks of this committee are observation, supervision and protection.

Maximization of the training in all fields of safety and to up-raise the proficiency and efficiency.

Obligation of the companies that buy or rent aircrafts to have their documents and guidance material in English or Arabic language.

Establishment of principles for the maintenance of registered aircrafts in Sudan, and to obligate all the companies and institutions that own or rent aircrafts for work in Sudan and to lay down the necessary conditions to check that the required
maintenance is done for these aircrafts and their devices by qualified engineers and technicians.

- Improvement of the work environment for employees in this field by paying good salaries and under good working conditions.

- Renewal and up-dating of the navigation control equipment and communication devices, and to introduce the radars, improve the airports, fire-fighting, search and rescue equipment.

- Development of the investigation unit of aircraft accidents and separate it from the operation department and provide it with specialized staff knowledge in all aspects of investigation and empower them with authority to perform their work, regarding their reports and exchange information of the previous investigations.

- The general Civil Aviation Authority should ensure that there is an operation manual and maintenance schedule for the companies, as a must, to provide the certificate of A.O.C.

- Promotion of the procedures of medical check for the aircraft crew, by a medical committee specialized in aviation medicine.

- The general Civil Aviation Authority and its various departments should increase the field visitations and inspections of aviation companies to up-raise the degree of air safety.

- Hold periodical conference and meetings for air safety to discuss the principles between the companies and employees in this field, such as: Civil Aviation Authority, Air Force, private companies and governmental companies.

- Obligation of all the governmental companies to respect the rules and laws that govern the work in the field of aviation industry. Which their work in the commercial field of passengers and goods transportation.

- Revision of the barriers and buildings around the airports and remove what is not convenient to safety.
• Removal of the paradox between different departments such as: airports engineering, traffic control and airside administration.
• Up-dating of the communication and navigation devices in the airports.
• Recruit qualified technical cadres and train them in civil aviation. Organize courses and grand opportunities for qualified employees to attend seminars and courses according to the field of work.
• Giving the employees a chance in experienced in foreign countries, and attend seminars and conference related to safety held every year in different countries to develop the performance and technical skills.
• Establishment of a national institute specialized in aviation with clear formulated academic training curriculum for the training and qualification of pilots, engineers, air-traffic controller and other relevant functions to aviation.
• Obligation of the aircrafts’ validity to stop the prolongation of aircrafts’ validity to short terms.
• Improvement of the provincial airports and provide them with the necessary equipment to receive aircrafts and provide them with qualified cadres staff in different safety concern such as; airports officer, air transport, air traffic controller, meteorology, security and civil defence.
• The general Civil Aviation Authority should check that airport departments have modernized with an emergency plan for different situations in airports and how to coordinate with other parties to give the necessary assistance.
• Introduction of a system of confidential reports by pilots about the faults that lead to accidents and give them legal protection, to do this role and analyze the reports and issue suitable instructions to prevent the repetition of these faults.
• Making sure that all employees in the field of aviation are endowed with good morals and conduct with equal the sensitivity of the job and the requirements of safety.
• Giving consideration to the reports of safety oversight and impose the requirements on aviation companies.

• The safe and organized management depends widely on the technical competence of the employees, and therefore the specialized departments should be provided with qualified employees who are able to achieve the technical obligations and required performance.

• There should be good working conditions and salaries must be according to qualifications, technical knowledge and experience and equal to work conditions and salaries of air investor’s employees which their activities under go to their supervision and inspection.

• The Civil Aviation Authorities should have a clear system of regulations and rules for the maintenance of positive surveillance and guidance and they should commit the holders of Air Carrier Certificate (AOC) to abide with such regulations.

• The main legislation of aviation (Civil Aviation Law) is the effective key for safety surveillance from the government side, and there should be powers given to the employees based on strong legal document and issued from the highest legislative level in the country.

• The process of aircraft registration can be in itself one of the aviation safety issues, that imposes many obligations on the country under an agreement related directly to aviation safety; and thereby the country has to make sure that:

  • Certification of aviation validity fulfills the minimal limit of essentially prescribed decided principles.
  • Guaranteeing the continuation of the aircraft validity.
  • Checking that the individuals who carry out the maintenance have the necessary experience, knowledge and skills that is required to perform the job.
  • Issuance of the certificate of maintenance and operation.
• Checking that the cockpit management has the experience, knowledge and requirements of skills to drive an aircraft with safety.

• Making sure that the aircraft and operation employees are continuing to satisfy the conditions required for insurance of the certificate and sanctions.

• Taking the covenant procedures in the suitable time to correct the faults found out in relation to the aircraft’s maintenance and operation.
Chapter Five
A Proposed Model for a Typical Safety Management System

5.1. Introduction

A safety management system will provide an organization with the capacity to anticipate and address safety issues before they lead to an incident or accident. A safety management system also provides management with the ability to deal effectively with accidents and near misses so that valuable lessons are applied to improve safety and efficiency. The safety management system approach reduces losses and improves productivity.

Safety is established as a Core Value not accomplished solely by the owner, Chief Executive Officer, or any other individual in an organization. Safety involves everyone. A positive safety culture is invaluable in encouraging the kind of behaviour that will enhance safety. Positively re-enforcing safety conscious action sends the message that management cares about safety.

The best way to establish safety as a core value is to make safety an integral part of the management plan. This is done by setting safety goals and holding managers and employees accountable for achieving those goals. The basic safety process is accomplished in five steps:

1. A safety issue or concern is raised, a hazard is identified, or an incident or accident happens.
2. The concern or event is reported or brought to the attention of management.
3. The event, hazard, or issue is analyzed to determine its cause or source.
4. Corrective action, control or mitigation is developed and implemented.
5. The corrective action is evaluated to make sure it is effective. If the safety issue is resolved, the action can be documented and the safety enhancement
maintained. If the problem or issue is not resolved, it should be re-analyzed until it is resolved.

5.2. Gap Analysis and Safety Plan

A gap analysis is conducted to the organization’s existing systems compared to the SMS requirements; and best practice proposed to be implemented, the requirements of the results of the gap analysis develop a safety plan that clearly demonstrates how the organization will implement their SMS. The safety plan will include milestones for critical items such as dates for development and submission of policies and procedures, training of staff and review. These milestone dates are important, as principal inspectors will use them to plan their implementation responsibilities and commitments.

The company must develop a Safety Management Systems Assessment Guide, which will assist the organization in conducting their gap analysis. This guide lists all the SMS components and elements and includes criteria linked to the appropriate regulation or standard. The SMS Assessment Guide will be appended to the Inspection & Audit Manual, and will form the basis of company's on going SMS evaluations Appendix (E) shows Area of responsibility in the SMS.

A comprehensive SMS framework and gap analysis forms are included in Appendices (F) and (G) in sequence. Each gap analysis question is designed for a “yes” or “no” response. If you respond with a “yes” answer indicating that the organization already meets the criteria for that particular SMS component or element. A “No” answer indicates that a gap exists between the stated criteria and the organization’s policies, procedures or processes. If the response is “yes”, the next column of the gap analysis form can be used to indicate where, in company documentation, the requirement is addressed. If the response is “no”, the same column can be used to indicate how and/or where the policy, procedure or process will be further developed to bring the organization into compliance with the requirement.
Appendix (H) provides a safety plan example with suggested headings to assist the organization in the development of their plan [Transport Canada Civil Aviation, 2005].

The Safety Plan should present and define safety responsibility, procedures for management and operators engaged in the design, installation and maintenance of a system with its components for the duration of its technical and operational life. Safety Management involves hazard identification and closing any gaps in the defences of the system. Effective SMS is build upon the defining, cornerstones namely as: A comprehensive corporate approach to effective safety organizational tools to deliver safety standards and a formal system for safety oversight. The Safety Plan should at least present statements concerning:

- Scope and purpose of the Safety Plan.
- Policies and strategies along with the methods for analysis and assessment and in which way this is going to be disseminated throughout the organization to create a safety culture.
- Organizational entities and staff with defined safety responsibilities to oversee the procedures and take action at detection of variations.
- Description of the relationship between the National Aviation Safety Authority and the Aerodrome.
- Description of the established safety procedures.
- Measures for training and information both internally and externally.
- How the organization's safety plan will apply through the life cycle of a system.
- Assurance of the competency of the staff with regard to design, installation.
- Maintenance of a system with its components.
- Analysis and assessment of hazardous and potentially hazardous events to eliminate or minimise reoccurrence of risks.
- Monitoring and analysis of operation and maintenance for systems.
• Initiation of modifications to systems with internal approval.

5.3. Systems to Achieve Safety Oversight

Safety oversight is fundamental to the safety management process. A principal of safety management policies, principles and procedures requires an organization to critically review its existing operations, proposed. Operational changes and additions or replacements, for their safety significance. This is achieved through two principal means: Figure (5-1) shows safety oversight process flow [Transport Canada Civil Aviation, 2002].

- Reactive - Occurrence/hazard reporting, and;
- Proactive - Safety assessments.

![Figure 5.1: Safety Oversight Process Flow](Transport Canada Civil Aviation, 2002)

For the most part these are two distinct elements in the safety management system: one is reactive, the other proactive. The basic difference is the method of discovery: the reactive process responds to events that have already occurred, whilst the proactive method actively seeks to identify potential hazards through an analysis of
the everyday activities of the company. The exception to this rule occurs when a potential hazard has been reported through the company’s safety reporting program, with respect to the following considerations:

- **Conducting Internal Safety Incident Investigations and Implementing Remedial Actions.** The company must ensure that their staff are aware of the internal safety-related investigation procedure. The subject and findings of the investigation should be disseminated to all staff affected.

- **Effective use of Safety Data for Performance Analysis.** The company should be able to show the method of operation of any safety data capture programmes and the results of factual investigations which arise therefore. The response of executive management should ensure the effective use of safety data monitoring to address company safety issues and provide advice accordingly.

- **Arrangements for ongoing Safety Promotion.** The company should have clearly defined arrangements to ensure that the work achieved by the Safety Manager and Committees, as well as line management, is transmitted to all those involved in the relevant activities.

- **Periodic Review of the Safety Management System.** The effectiveness of the SMS in addressing safety-related findings and in the achievement of continuous safety improvement must be monitored. This should be achieved by periodic management review overseen.

- **Line Manager’s Monitoring.** The practices used by operational and engineering staff and all others involved in safety sensitive areas of aviation are key to the achievement of safety. Compliance with procedures is often assumed but not invariably achieved. Whether through line or route checks, or compliance monitoring in line with standards, it is essential that managers and supervisors know how each safety critical task is actually achieved.
5.4. Establishing Safety Reporting System

Aviation is a dynamic industry and conditions are constantly changing. To alert management that something has changed, or a new hazard is emerging, organizations need input from all levels. Employees must have a way to report hazards and safety concerns as they become aware of them and every employee must know how to report their concerns. When an employee reports a concern or hazard, the report should be acknowledged and analyzed. Acting on reported safety concerns will build employees’ confidence in the system. If, however, a reporting system is not maintained and attended to, people will quickly stop using it. Not all safety concerns require a special reporting system. Some should be made on existing paperwork, such as reports or logs. Other hazards might not fit well into existing reporting systems. It is fairly easy to create a form or process.

The report must be analyzed to determine whether there is a real threat to safety and if so, what needs to be done. When the issue requires action, that information must go to the person who has the authority to take the action. This preserves the accountability of the safety management system. The credibility of the system is preserved when the outcome is fed back to the reporter. If it is decided that no action is appropriate, that information, and the causes for that decision should be fed back to the reporter. What really matters is that all staff knows how to report safety concerns and that their reports are acknowledged, analyzed, and resolved in a timely manner.

The management and the specialist departments require information in order to make decisions and provide resources. Management should have access to, and be able to use, safety information. That is why a suitable reporting system must be established for the systematic collection, analysis and distribution of safety data. Reporting comprises:

- Definition of safety objectives and analysis of progress.
• Documentation of accidents and incidents, including the results of internal/external investigations and corrective actions that have been initiated.
• Statistical reports showing developments and trends.
• Results of safety reviews and recommendations for corrective actions.
• Documentation of safety-related events, training courses and measures.
• All reservations concerning safety, along with their assessment and resultant adjustments.
• Analysis of developments and findings.
• All activities relating to the identification of risks, risk assessment and corrective actions that have been initiated.
• Statistical surveys on accidents and incidents.
• Results of all investigations into accidents and incidents, and corrective actions that have been initiated.
• All safety reports received, including analysis of and response to them.
• All SMS safety recommendations as well as initiated measures.
• Results of internal safety audits and assessments.
• Formation of an Airport Safety Committee.
• Publication of a safety bulletin.
• Training measures.
• Safety campaigns.
• Informational meetings.
• Provision of safety information via databases or intranet.
• Establishment of an airport-wide reporting system to give an account of accidents, incidents and safety reservations.
• Participation in safety conferences and collaboration in national and international committees.
• Co-operation with research and scientific institutions.
Provision of technical journals and texts on laws.

The organization will be required by regulation to institute a reporting system. A system that employees do not trust or use will not fulfil the requirements of the regulation. Any safety concern should be reported, but here are some real life examples [Transport Canada Civil Aviation, 2001]:

- High workload during passenger boarding, Unruly passengers.
- Poor communication between operational areas.
- Crews rushing through checks.
- Inadequate checklists, tool or equipment control.
- Feeling fatigued on certain schedules.
- NOTAMS not being passed to crew.
- In-flight turbulence, difficulty obtaining parts.
- Unsafe ground movements, poor communication within maintenance.
- Lack of emergency equipment, procedures, training.
- Emergency exit paths blocked, Poorly designed task cards.
- Vehicles left in fire lanes or other unauthorized area.
- Confusing signs, poor lighting.
- Dispatching overloaded aircraft, failing to maintain operational control.

5.5. Establishment of a Safety Management System

The establishment of a SMS at aerodromes means systematic integration and networking of safety measures for the day-to-day operations of airlines and airside service providers, taking into account human and technical factors. Rules on accident prevention and reduction of risks must be created on the basis of experience and research into the causes of accidents and/or incidents, and applied throughout the company. The employees of the companies involved in airport operations must identify with the rules of the SMS.
The basis of any SMS is airport-wide rules and policies relating to the avoidance of accidents and incidents. Safety rules and policies are based, on the one hand, on the risks identified by the company, and on the other, on the analysis of causal and assisting factors in previous accidents and incidents. The rules must be clear and understandable.

Documentation and monitoring of the company’s rules and policies are an integral component of the SMS. They are the proof and, at the same time, means of communication of the existence and scope of the existing body of rules. Figures (5-2) and (5-3) show in sequence a typical structure of aerodrome safety directorate and Safety Management System Flow Process.

![Organizational Structure of A typical Directorate of Aerodrome Safety and Standards](image)

Figure 5.2: Organizational Structure of A typical Directorate of Aerodrome Safety and Standards [International Civil Aviation Organization (ICAO), 2001]
Figure 5.3: Safety Management System Flow Process [Association of German Airports, 2002]
The following points must be taken into account when establishing a Safety Management System:

- Top management must support the establishment of a SMS and the necessity of respecting and further developing the system must be communicated to the company. Company should adapt their SMS to already existing management systems.
- The airport company should name one or more persons who are responsible for introducing, establishing, implementing and further developing the SMS. The SMS should have an across-the-board organisational structure, unhindered by organisational boundaries of existing areas of responsibility.
- Tried-and-tested procedures form the foundation for establishment of the SMS. The obligation to collaborate in the airport’s SMS must be contractually regulated.
- Effective safety management requires a systems approach to the development of safety policies, procedures and practices to allow the organization to achieve its safety objectives. Similar to other management functions, safety management requires planning, organizing, communicating and providing direction. Safety management integrate diverse activities into a coherent whole, follow-up will be required to evaluate and validate the appropriateness and effectiveness of the organization’s safety management practices, thereby closing the safety loop.
- There are several ways of meeting the organization’s needs for safety management. There is on single model that “fits all”. Size, complexity and the type of operation, as well as the corporate safety culture and operating environment, will influence the structure most suited for individual organizations and their unique circumstances.
• This focuses on the factors to be considered in establishing the SMS. The degree of formality and rigidity in the SMS should be a reflection of the organization’s needs, rather than blind adherence to doctrine. It is important that the size and complexity of the SMS be appropriate for the organization.

• Before the organization can implement an effective SMS, it needs to possess an aspect of safety culture to the success of the SMS. Having staff who are competent for the jobs they are performing is a fundamental prerequisite for safety Competency requirements and, where appropriate, requirements should be stated in the job description for each safety-related position. These requirements should be reflected in the recruitment requirements and internal training for these positions.

• Effective safety management requires more than establishing an appropriate organizational structure and promulgating rules and procedures to be followed. It requires a genuine commitment to safety on the part of senior management. The attitudes, decisions and methods of operation at the policy-making level demonstrate the priority given to safety. The initial indication of corporate commitment to safety is in the organization’s stated safety policy and objective and whether staffs believes that concern for safety might, on occasion, override production objectives.

• Key indicator of management’s commitment to safety is the adequacy of resource allocations. Establishing an appropriate management structure, assigning responsibilities and accountabilities, and allocating appropriate resources must be consistent with the organization’s stated safety objectives. Sufficient experienced staff, relevant and timely training, and funding for the necessary equipment and facilities are fundamental to creating a working environment in which everyone takes safety seriously.
• In successful safety cultures, there are clear reporting lines, clearly defined duties and well understood procedures. Personnel fully understand their responsibilities and know what to report, to whom and when. The senior management usually undertakes the same level; the revision of both the financial and the safety performance of the organization.

5.6. Aerodrome Audit and Certification

The state needs to enact basic legislation that will provide for the development and setting out Civil Aviation Authority regulations, including aerodrome regulation, consistent with their adoption of the Annexes. It retains its overseeing responsibility and ensures that the operator complies with the relevant ICAO SARPs and applicable nation regulations. Certification of aerodromes objectives [International Civil Aviation Organization (ICAO), 2001]

• Prevention of accidents.
• Aerodrome safety.
• Reduction/elimination of deficiencies.
• Aerodrome safety management system.
• CAA aerodrome safety oversight and certification.
• ICAO USOAP aerodromes audit.
• Compliance with ICAO Annex 14 Volume I SARPs.
• Provision and maintenance of facilities and services.
• Prepare aerodrome manual.
• Possess an Aerodrome Certification.
• Implement safety management systems.

The state should establish a criteria for the mandatory certification of all categories of airports, the requirements of the certification should ensure the safety of operations such as those related to the movement area and the visual aids. These requirements comprise the following:
The certification procedure.

The duties and responsibilities of aerodrome operators.

Safety audits, inspections and testing.

The imposition of sanctions for contravention of failure to comply with any of the provisions of the regulations.

Safety audits are one of the principal methods for fulfilling the safety performance monitoring functions. They are a core activity of any safety management system (SMS). Safety audits may be performed by an external audit authority, such as the State regulatory authority, or they may be carried out internally as part of the SMS. Safety audits are used to ensure that:

- Safety audits should be conducted regularly, following a cycle that ensures each functional area is audited as a part of the organization’s plan for evaluating overall safety performance.
- Safety audits should entail a periodic detailed review of the safety performance, procedures and practices of each unit or section with safety responsibilities.
- Safety audits should go beyond just checking compliance with regulatory requirements and conformance with the organization’s standards, should assess whether the procedures in use are appropriate.
- The structure of the SMS is sound in terms of appropriate levels of staff; compliance with approved procedures and instructions; and a satisfactory level of competency and training to operate equipment and facilities and to maintain their levels of performance;
- Equipment performance is adequate for the safety levels of the service provided; effective arrangements exist for promoting safety, monitoring safety performance and processing safety issues; and adequate arrangements exist to handle foreseeable emergencies.
5.7. Safety Assessments

Safety management provides the means by which organizations can control the processes that could lead to hazardous events, in order to ensure that the risk of harm or damage is limited to an acceptable level. Much of this activity focuses on hazards as they are identified through such processes and activities as the investigation of safety occurrences, incident reporting systems and safety oversight programmes. Safety assessments provide another proactive mechanism for identifying potential hazards and finding ways to control the risks associated with them. A safety assessment should be undertaken prior to the implementation of any major change potentially affecting the safety of operations in order to demonstrate that the change meets an acceptable level of safety. For example, when major changes involving operating procedures, equipment acquisition or configuration, organizational working relationships, etc. are planned, a safety assessment may be warranted. The scope of a safety assessment must be wide enough to cover all aspects of the system that may be affected by the change, either directly or indirectly, and should include human, equipment, and procedural elements [International Civil Aviation Organization (ICAO), 2006].

If the result of an assessment is that the system under review does not satisfy the safety assessment criteria, it will be necessary to find some means of modifying the system in order to reduce the risk. This process is called risk mitigation. The development of mitigation measures becomes an integral part of the assessment process. The adequacy of proposed mitigation measures should be tested by re-evaluating what the risk would be with the mitigation measures in place.

Once a safety assessment is completed, it should be signed-off by the responsible manager, indicating that the manager is satisfied that the assessment has been properly performed and that the level of risk is acceptable. For the manager to be able to make an informed decision concerning this, the safety assessment must be well documented. The documentation should be retained to provide a record of the basis on
which the acceptance decision was made. The implementation of a safety assessment programme requires the organization to [International Civil Aviation Organization (ICAO), 2006]:

- Identify requirements as to when safety assessments must be performed.
- Develop procedures for performing safety assessments.
- Develop organizational risk classification criteria for identified hazards.
- Develop acceptance criteria for safety assessments.
- Develop documentation requirements and processes for retaining and disseminating safety information acquired through the assessments.

Figure (5-4) illustrates the safety assessment process diagrammatically, and shows the possible need to perform a number of cycles of the process until a satisfactory method of risk mitigation is found. These are described in seven steps for safety assessment as follows [International Civil Aviation Organization (ICAO), 2006]:

**Step 1:** Development (or procurement) of a complete description of the system to be evaluated and of the environment in which the system is to be operated.

**Step 2:** Identification of hazards.

**Step 3:** Estimation of the severity of the consequences of a hazard occurring.

**Step 4:** Estimation of the likelihood of a hazard occurring.

**Step 5:** Evaluation of risk.

**Step 6:** Mitigation of risk.

**Step 7:** Development of safety assessment documentation.
Describe the system to be assessed

Describe the operational environment

Identify hazards

Identify consequences

Make estimate of risk

Is risk acceptable?

Yes

Identify risk mitigation measures

Make new estimate of risk

Is risk acceptable?

Yes

Is risk tolerable?

Yes

Document decision and proceed to next stage of development or implementation

No

Is risk ALARP?

Yes

No

Abandon or revise original project objectives

No
Chapter Six

Conclusion and Recommendations

6-1 Conclusion

The study explained that the accidents of the last twenty years, during 1988-2008, had witnessed rapid increase for causes and circumstances of a broad similar nature. However, there were no studies and evaluation in the previous situations and the lessons learned from them. The study indicated the locations of these accidents their causes, conditions and the magnitude of damage, by taking into consideration the fact that most of these accidents occurred on landing and taking off, that means these accidents occurred inside or around the airports, which amounted to (288) accidents.

The study findings were adequate and essential for the nature of the previous accumulation and current situations and the possibility of change according to these findings to create a new situation based on requirements of these important results. The main study findings were as follows:

- The current administrative conditions affect the working environment.
- There were no sufficient equipments of communication and control for the establishment of safety situations.
- The weak administrative body was the main cause of ground accidents.
- Ground accidents were a result of the negative aspects in the current system.
- The role of Civil Aviation Authority towards aviation service companies was limited and weak.
- Lack of effective administrative body led to the increase of the number of accidents, due to both technical and administrative problems.
The lack of effective administrative body led to the weakness in plans and programmes of performance and changes.

The negative administrative and technical role led to the insufficient equipments of communication and control which in turn affected dealing with emergencies.

Climatic conditions were among the main causes of aviation accidents.

The infrastructure at Khartoum airport was not sufficient for achieving the best level of safety.

Also the study provided a comprehensive vision concerning the nature and components of the proposed Safety Management System. Furthermore, this proposed SMS answered and satisfied all the objectives of the study especially the identification and assessment of technical aspects of safety, identification of shortcomings and their rectification and lastly the identification of modern technology in the field of safety and modern technical control in operations and maintenance.

6-2 Recommendations for Further Future Studies

- The encouragement of the civil aviation studies in the field of improving performance and the promotion of the administrative and technical aspects, for modernizing and coping with modern and recent techniques.
- A study about the development and modernization of the navigation services for enhancing air safety.
- A study about the causes and remedies of repeated faults and violations in the runway (runway incursion) and aircraft movement area.
- A study to develop an adequate methods and models to human factor in safety assessments and when introduced a new technologies.
References


International Civil Aviation Organization (ICAO), "Final Reports on Safety Oversight Audit of the Civil Aviation System in States: Sudan, Canada, Germany, Gambia, Malaysia, Panama, Thailand and Czech Republic ", Canada, 2005-2006.


o PAL Management Solutions, "Managing Strategies with the BSC", Sudan, 2005.


• www.afatca.org.com
• www.asi.com
• www.caa.co.uk.com
• www.google.com.
• www.iata.com
• www.iata-org/traning
• www.icao.com
• www.iqa.org usa institute of quality assurance
• www.naif arab university for security sciences.com
• www.rh.com.
• www.university arabs book.com
Appendix (A) Aircraft Maintenance Working Conditions

Listed below are some of the typical issues impacting on the working conditions under which aircraft maintenance is carried out [International Civil Aviation Organization (ICAO), 2006]:

a) Organizational Issues:
   • Time pressures to sustain on-time departures and around-the-clock operations;
   • Ageing aircraft requiring intensive inspections for fatigue, corrosion, overall condition, etc.;
   • New technologies requiring new tools, new work procedures, costly retraining, etc.;
   • “Fix-it” focus to stay on schedule (e.g. replacing broken parts without determination as to why they failed perhaps due to poor design or incorrect assembly);
   • Airline expansions and mergers (e.g. combining maintenance departments with different work practices and safety cultures);
   • Outsourcing of services to subcontractors (e.g. for heavy maintenance and overhaul);
   • Unwitting introduction of (lower cost, substandard) bogus parts, etc.; and
   • licensing for different aircraft, aircraft generations, types and manufacturers;

b) Work Site Conditions:
   • Aircraft designs that are not user-friendly from a maintenance perspective (for example, cramped access to components and inappropriate height off the ground).
   • Control of aircraft configurations (which are continually subject
to modifications) versus standardization of maintenance tasks and procedures.

- Availability (and accessibility) of spares, tools, documentation, etc.
- Requirements for having ready access to voluminous technical information, and the need for maintaining detailed work records.
- Variable environmental factors (for example, conditions on the ramp versus in the technical workshop versus on the hangar floor).
- Unique operating conditions created by concurrent activities and inclement weather on the ramp.

Shortcomings in the provision of timely, accurate, understandable discrepancy reports by flight crews.
# الجزء الثاني

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- **جودة** : نوع الطيارة يجب أن تعمل على التشغيل للصحة
- ** seri **: عدد السنوات بين 5-10 سنة
- ** kisht **: عالية تنفيذية إشرافية
- ** kif ***: 2 ديوان
- ** yeghef **: متميزة
- **yeghef** : (شعبة) الأجهزة
- **Juji 20-10** : دي 10-5
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الإعداد: المهندس أحمد نور يوسف
إشراف: د. الأمين عبد الجليل & د. الأمين حسين
Appendix (C)

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<td>35490 د. القانون</td>
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Appendix (D) Reliability:

<table>
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<tr>
<th>Cronbach's Alpha</th>
<th>Cronbach's Alpha Based on Standardized Items</th>
<th>N of Items</th>
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<tr>
<td>.710</td>
<td>.709</td>
<td>18</td>
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**Item-Total Statistics**

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<tr>
<th>Item Description</th>
<th>Cronbach's Alpha if Item Deleted</th>
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<tr>
<td>The main cause of aviation accidents is: weak co-ordination</td>
<td>.700</td>
</tr>
<tr>
<td>The main cause of aviation accidents is bad execution</td>
<td>.717</td>
</tr>
<tr>
<td>The main factor in aviation accidents is: weak planning</td>
<td>.689</td>
</tr>
<tr>
<td>The main cause of aviation accidents is: technical reasons relating to problems in</td>
<td>.728</td>
</tr>
<tr>
<td>Transportation</td>
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<tr>
<td>The main cause of aviation accidents is: technical reason relating to problems of</td>
<td>.707</td>
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<tr>
<td>Operations</td>
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<tr>
<td>The main factor in aviation accidents is both technical and administrative reasons</td>
<td>.712</td>
</tr>
<tr>
<td>The main cause of landing accidents is: the weak authoritative body</td>
<td>.685</td>
</tr>
<tr>
<td>The current system lack an effective administrative body</td>
<td>.669</td>
</tr>
<tr>
<td>The current negative aspects are the result of not clearly defining responsibility and accountability</td>
<td>.677</td>
</tr>
<tr>
<td>The responsibilities of civil aviation imposed on aviation service companies are not clearly defined</td>
<td>.681</td>
</tr>
<tr>
<td>The working environment at Khartoum Air Port is not suitable for good performance</td>
<td>.694</td>
</tr>
<tr>
<td>The infrastructure at Khartoum Air Port is not sufficient for achieving the best of services</td>
<td>.710</td>
</tr>
<tr>
<td>The main cause of aviation accidents is due to the lack of qualification and experience</td>
<td>.700</td>
</tr>
<tr>
<td>Training programmes are not sufficient</td>
<td>.672</td>
</tr>
<tr>
<td>Plans and programmes of performs and changes are not good</td>
<td>.690</td>
</tr>
<tr>
<td>There is not sufficient apparatus of communication and control</td>
<td>.674</td>
</tr>
<tr>
<td>There are no alternatives and choices in dealing with emergencies</td>
<td>.705</td>
</tr>
<tr>
<td>Climate conditions are the main cause of aviation accidents</td>
<td>.741</td>
</tr>
<tr>
<td>Elements of SMS Categories (Checklist)</td>
<td>Description</td>
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<td>---------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Airport user regulations</td>
<td>Regulations and policies</td>
</tr>
</tbody>
</table>
| Aerodrome reporting                    | Procedures for:  
  a) reporting on changes to aerodrome information in the AIP  
  b) requesting a NOTAM publication |
| Access to the aerodrome movement area   | Procedures for regulating access to the aerodrome’s airside for persons, aircraft, equipment, animals or other parties/objects |
| Aerodrome emergency plan               | Plans and regulations for handling emergencies at the aerodrome and in its vicinity |
| Rescue and fire-fighting               | Facilities, equipment, staff and procedures for complying with rescue and fire-fighting requirements |
| Inspection of the aerodrome movement and obstacle limitation surface by the aerodrome operator | Procedures for conducting inspections of all movement and open surfaces within the aerodrome area |
| Visual aids and aerodrome electrical systems | Procedures for examining and maintenance of lighting/navigation lights (incl. obstruction lights), signs, markings and the aerodrome’s electrical systems |
| Maintenance of the movement area       | Facilities and procedures for maintenance of the movement areas |
| Winter services                       | Facilities, equipment and procedures for conducting winter services on movement areas and for aircraft de-icing |
## Continue-Appendix Table (E) Area of Responsibility in the SMS [Association of German Airports, 2002]

<table>
<thead>
<tr>
<th>Elements of SMS Categories (Checklist)</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Aerodrome works – Safety</td>
<td>Procedures to ensure safety in the execution of construction and maintenance work on and in the vicinity of movement areas</td>
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<tr>
<td>Apron management</td>
<td>Procedures for apron traffic management</td>
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<tr>
<td>Apron safety management</td>
<td>Procedures for ensuring apron safety</td>
</tr>
<tr>
<td>Airside vehicle control</td>
<td>Procedures for controlling vehicles, driving permits and the observance of traffic regulations on movement areas and roads used for operations</td>
</tr>
<tr>
<td>Wildlife hazard management</td>
<td>Procedures for averting risks to air traffic from the presence of animals (birds and mammals) in the vicinity of the aerodrome</td>
</tr>
<tr>
<td>Obstacle control</td>
<td>Monitoring of the adherence to obstacle limitation surfaces in the area of the aerodrome and in its vicinity</td>
</tr>
<tr>
<td>Removal of disabled aircraft</td>
<td>Procedures for recovering aircraft that cannot move on or next to movement areas</td>
</tr>
<tr>
<td>Handling of hazardous materials</td>
<td>Procedures for secure handling and storage of hazardous substances at the aerodrome</td>
</tr>
<tr>
<td>Low-visibility operations</td>
<td>Operational procedures in the event of restricted visibility / CAT 2/3 procedures</td>
</tr>
<tr>
<td>Protection of sites for radar and navigational aids</td>
<td>Procedures and precautions for ensuring the working order of radar and navigation systems at locations in the aerodrome area</td>
</tr>
</tbody>
</table>
| Safety management                     | a. Safety policy of the company  
b. SMS rules and affected persons/ procedures  
c. Names and telephone numbers of the persons responsible for the company’s SMS |
<table>
<thead>
<tr>
<th>Component</th>
<th>Element</th>
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<tr>
<td>Safety Management System</td>
<td>Compliance Document, Gap Analysais, Project Plan</td>
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<td>1. Safety Management Plan</td>
<td>1.1 Safety Policy</td>
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<td>1.2 Non-Punitive Reporting Policy</td>
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<td>1.3 Roles, Responsibilities &amp; Employee Involvement</td>
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<td>1.4 Communication</td>
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<td></td>
<td>1.5 Safety Planning, Objectives and Goals</td>
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<td></td>
<td>1.6 Performance Measurement</td>
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<td>1.7 Management Review</td>
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<td>2. Document Management</td>
<td>2.1 Identification and Maintenance of Applicable Regulations</td>
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<td>2.2 SMS Documentation</td>
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<td>2.3 Records Management</td>
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<tr>
<td>3. Risk Management</td>
<td>3.1 Reactive Processes</td>
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<td>3.2 Proactive Processes</td>
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<td>3.3 Investigation and Analysis</td>
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<td>3.4 Risk Management</td>
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<tr>
<td>4. Training</td>
<td>4.1 Training, Awareness and Competence</td>
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<tr>
<td>5. Quality Assurance</td>
<td>5.1 Operational Quality Assurance</td>
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Appendix (G) Gap Analysis Form [Transport Canada Civil Aviation, 2005]

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<thead>
<tr>
<th>Safety Management System Requirements</th>
<th>Response (Yes/No)</th>
<th>If yes, state where the requirement is addressed, If no, record SMS processes that need further development</th>
</tr>
</thead>
</table>

**Component 1, Safety Management Plan - Element 1.1, Safety Policy**

Is a safety management system with defined components established, maintained and adhered to?  
Is the safety management system appropriate to the size and complexity of the Organization?  
Is there a safety policy in place?  
Has the organization based its safety management system on the safety policy?  
Is the safety policy approved by the accountable executive?  
Is the safety policy promoted by the accountable executive?  
Is the safety policy reviewed periodically?  
Is the safety policy communicated to all employees with the intent that they are made aware of their individual safety obligations?

**Component 1, Safety Management Plan - Element 1.2, Non-Punitive Safety Reporting**

Is there a policy in place that provides immunity from disciplinary action for employees that report safety deficiencies, hazards or occurrences?

**Component 1, Safety Management Plan - Element 1.3, Roles & Responsibilities**

Has an accountable executive been appointed with responsibility for ensuring that the safety management system is properly implemented and performing to requirements in all areas of the organization?
**Continue -Appendix (G) Gap Analysis Form**

[Transport Canada Civil Aviation, 2005]

<table>
<thead>
<tr>
<th>Safety Management System Requirements</th>
<th>Response (Yes/No)</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Does the accountable executive have control of the financial and human resources required for the proper execution of his/her SMS responsibilities?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has a qualified person been appointed to manage the operation of the SMS?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the person managing the operation of the SMS fulfill the required job functions and responsibilities?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are the safety authorities, responsibilities and accountabilities of personnel at all levels of the organization defined and documented?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do all personnel understand their authorities, responsibilities and accountabilities in regards to all safety management processes, decisions and actions?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Component 1, Safety Management Plan - Element 1.4, Communication**

<p>| Are there communication processes in place within the organization that permit the safety management system to function effectively? |                   |
| Are there communication processes in place within the organization that permit the safety management system to function effectively? |                   |
| Are communication processes (written, meetings, electronic, etc.) commensurate with the size and scope of the organization? |                   |</p>
<table>
<thead>
<tr>
<th>Component 1, Safety Management Plan - Element 1.5, Safety Planning, Objectives &amp; Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have safety objectives been established?</td>
</tr>
<tr>
<td>Is there a formal process to develop a coherent set of safety</td>
</tr>
<tr>
<td>goals necessary to achieve overall safety objectives?</td>
</tr>
<tr>
<td>Are safety objectives and goals publicized and distributed?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component 1, Safety Management Plan - Element 1.6, Performance Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there a formal process to develop and maintain a set of performance</td>
</tr>
<tr>
<td>parameters to be measured?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component 1, Safety Management Plan - Element 1.7, Management Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are regular and periodic, planned reviews of company safety performance</td>
</tr>
<tr>
<td>and achievement including an examination of the company’s Safety Management</td>
</tr>
<tr>
<td>System conducted to ensure its continuing suitability, adequacy and</td>
</tr>
<tr>
<td>effectiveness?</td>
</tr>
<tr>
<td>Is there a process to evaluate the effectiveness of corrective actions?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component 2, Documentation - Element 2.1, Identification &amp; Maintenance of Applicable Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has a documented procedure been established and maintained for identifying applicable regulatory</td>
</tr>
<tr>
<td>requirements?</td>
</tr>
</tbody>
</table>
## Appendix (G) Gap Analysis Form [Transport Canada Civil Aviation, 2005]

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<tr>
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<th>Response (Yes/No)</th>
<th>If yes, state where the requirement is addressed, If no, record SMS processes that need further development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are Regulations, Standards and Exemptions periodically reviewed to ensure that the most current information is available?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Component 2, Documentation - Element 2.2, SMS Documentation**

<table>
<thead>
<tr>
<th><strong>Component 2, Documentation - Element 2.2, SMS Documentation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there consolidated documentation that describes the safety management system and the interrelationship between all of its elements?</td>
</tr>
<tr>
<td>Does this information reside or is it incorporated by reference into approved documentation, such as Company Operations Manual, Maintenance Control/ Policy Manual, Airport Operations Manual, as applicable, and where these approved documents are not required by regulation, the organization includes the information in a separate, controlled document?</td>
</tr>
</tbody>
</table>

**Component 2, Documentation - Element 2.3, Records Management**

<table>
<thead>
<tr>
<th><strong>Component 2, Documentation - Element 2.3, Records Management</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the organization have a records system that ensures the generation and retention of all records necessary to document and support operational requirements, and is in accordance with applicable regulatory requirements?</td>
</tr>
<tr>
<td>Does the system provide the control processes necessary to ensure appropriate identification, legibility, storage, protection, archiving, retrieval, retention time, and disposition of records?</td>
</tr>
<tr>
<td>Safety Management System Requirements</td>
</tr>
<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td><strong>Component 3, Safety Oversight - Element, 3.1, Reactive Processes</strong></td>
</tr>
<tr>
<td>Does the organization have a reactive process or system that provides for the capture of internal information including incidents, accidents and other data relevant to SMS?</td>
</tr>
<tr>
<td>Is the reactive reporting process simple, accessible and commensurate with the size of the organization?</td>
</tr>
<tr>
<td>Are reactive reports reviewed at the appropriate level of management?</td>
</tr>
<tr>
<td>Is there a feedback process notify contributors that their reports have been received and to share the results of the analysis?</td>
</tr>
<tr>
<td>Is there a process in place to monitor and analyze trends?</td>
</tr>
<tr>
<td>Are corrective and preventive actions generated in response to event analysis?</td>
</tr>
<tr>
<td><strong>Component 3, Safety Oversight - Element, 3.2, Proactive Processes</strong></td>
</tr>
<tr>
<td>Does the organization have a process or system that provides for the capture of internal information including hazard identification, occurrences and other data relevant to SMS?</td>
</tr>
<tr>
<td>Is the proactive reporting process simple, accessible and commensurate with the size of the organization?</td>
</tr>
<tr>
<td>Are proactive reports reviewed at the appropriate level of management?</td>
</tr>
</tbody>
</table>
Continue- Appendix (G) Gap Analysis Form [Transport Canada Civil Aviation, 2005]

<table>
<thead>
<tr>
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<th>Response (Yes/No)</th>
<th>If yes, state where the requirement is addressed, If no, record SMS processes that need further development</th>
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</thead>
<tbody>
<tr>
<td>Is there a feedback process to notify contributors that their reports have been received and to share the results of the analysis?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there a process in place to monitor and analyze trends?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has the organization planned self-evaluation processes, such as regularly scheduled reviews, evaluations, surveys, operational audits, assessments, etc.?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are corrective and preventive actions generated in response to hazard analysis?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a process in place for analyzing changes to operations or key personnel for hazards?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Component 3, Safety Oversight - Element, 3.3, Investigation & Analysis

| Are there procedures in place for the conduct of investigations? |                  |                                                                                                             |
| Do measures exist that ensure all reported occurrences and deficiencies are investigated? |                  |                                                                                                             |
| Is there a process to ensure that occurrences and deficiencies reported are analyzed to identify contributing and root causes? |                  |                                                                                                             |
| Are corrective and preventative actions generated in response to event investigation and analysis? |                  |                                                                                                             |

Component 3, Safety Oversight - Element, 3.4, Risk Management

<p>| Is there a structured process for the assessment of risk associated with identified hazards, expressed in terms of severity, level of exposure and probability of occurrence? |                  |                                                                                                             |</p>
<table>
<thead>
<tr>
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<th>If yes, state where the requirement is addressed, If no, record SMS processes that need further development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are there criteria for evaluating risk and the tolerable level of risk the organization is willing to accept?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the organization have risk control strategies that include corrective/ preventive action plans to prevent recurrence of reported occurrences and deficiencies?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the organization have a process for evaluating the effectiveness of the corrective/preventive measures that have been developed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are corrective/ preventive actions, including timelines, documented?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Component 4, Training - Element 4.1, Training, Awareness & Competence**

| Is there a documented process to identify training requirements so that personnel are competent to perform their duties? | | |
| Is there a validation process that measures the effectiveness of training? | | |
| Does the training include initial, recurrent and update training, as applicable? | | |
| Is the organization’s safety management training incorporated into indoctrination training upon employment? | | |
| Does the training include human and organizational factors? | | |
| Is there emergency preparedness and response training for affected personnel? | | |
## Component 5, Quality Assurance - Element 5.1, Operational Quality Assurance

<table>
<thead>
<tr>
<th>Question</th>
<th>Response (Yes/No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is a quality assurance system established and maintained and is under the management of an appropriate person?</td>
<td></td>
</tr>
<tr>
<td>Does the organization conduct reviews and audits of its processes, its procedures, analyses, inspections and training?</td>
<td></td>
</tr>
<tr>
<td>Does the organization have a system to monitor for completeness, the internal reporting process and the corrective action completion?</td>
<td></td>
</tr>
<tr>
<td>Is there an operationally independent audit function with the authority required to carry out an effective internal evaluation program?</td>
<td></td>
</tr>
<tr>
<td>Does the quality assurance system cover all functions defined within the certificate(s)?</td>
<td></td>
</tr>
<tr>
<td>Are there defined audit scope, criteria, frequency and methods?</td>
<td></td>
</tr>
<tr>
<td>Are there selection/training process to ensure the objectivity and competence of auditors as well as the impartiality of the audit process?</td>
<td></td>
</tr>
<tr>
<td>Is there a procedure for reporting audit results and maintaining records?</td>
<td></td>
</tr>
<tr>
<td>Is there a procedure outlining requirements for timely corrective and preventive action in response to audit results?</td>
<td></td>
</tr>
<tr>
<td>Is there a procedure to record verification of action(s) taken and the reporting of verification results?</td>
<td></td>
</tr>
</tbody>
</table>
## Continue - Appendix (G) Gap Analysis Form [Transport Canada Civil Aviation, 2005]

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</thead>
<tbody>
<tr>
<td>Does the organization perform periodic Management reviews of safety critical functions and relevant safety or quality issues that arise from the internal evaluation program?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Component 6, Emergency Preparedness - Element 6.1, Emergency Preparedness & Response

<p>| Does the organization have an emergency preparedness procedure, appropriate to the size, nature and complexity of the organization? |                  |
| Have the Emergency preparedness procedures been documented, implemented and assigned to a responsible manager? |                  |
| Have the emergency preparedness procedures been periodically reviewed as a part of the management review and after key personnel or organizational change? |                  |
| Does the organization have a process to distribute the ERP procedures and to communicate the content to all personnel? |                  |
| Has the organization conducted drills and exercises with all key personnel at intervals defined in the approved control manual? |                  |</p>
<table>
<thead>
<tr>
<th>Component or Element (identified by the gap analysis)</th>
<th>Regulatory Reference</th>
<th>Due Date</th>
<th>Project Manager</th>
<th>Project Status Update recommended</th>
<th>Description of Required Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and document a safety policy that is appropriate to the size and complexity of the organization</td>
<td>Add applicable reference</td>
<td>Select a due date that will coincide with the terms of the Exemption</td>
<td>As assigned</td>
<td>Select a status update that is mid way to the due date</td>
<td>- develop appropriate safety policy text- amend applicable company documents -communicate policy to staff</td>
</tr>
<tr>
<td>Ensure that the safety policy states the organization’s intentions, management principles and commitment to continuous improvement</td>
<td>“”</td>
<td>“”</td>
<td>As assigned</td>
<td>“”</td>
<td>- develop appropriate safety policy amend applicable company documents -communicate policy to staff</td>
</tr>
<tr>
<td>Safety policy approved by the accountable executive</td>
<td>“”</td>
<td>“”</td>
<td>As assigned</td>
<td>“”</td>
<td>-accountable executive to endorse safety policy in applicable company documents</td>
</tr>
<tr>
<td>Ensure the safety policy is promoted by the accountable executive</td>
<td>“”</td>
<td>“”</td>
<td>As assigned</td>
<td>“”</td>
<td>- establish methods for accountable executive to promote the safety policy- amend applicable documents</td>
</tr>
<tr>
<td>Develop periodic review of safety policy</td>
<td>“”</td>
<td>“”</td>
<td>As assigned</td>
<td>“”</td>
<td>- develop procedures for periodic review - amend applicable documents</td>
</tr>
</tbody>
</table>