



Master's degree thesis

LOG950 Logistics

**Investigating Aspects of Supply Chain Risk
Management-Case Study of Egyptair**

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Acknowledgement and Preface

First of all, I want to thank God who always reply to my prayers and give me the chance to successfully carry out my studies at this advanced level. My thesis is dedicated to all my family, specially to my father and mother who endlessly support me by their prayers, love and advices. This thesis would not have been possible without the motivation from my brother Ahmed and my sister Israa who greatly stand by my side in my weakness times. I would also like to dedicate this thesis to my nephew Ali whose little smile was my source of happiness since he was born. I am thankful to all my friends and fellows who made my stay in Molde very pleasant. I would like to thank specially my best friend Eman, Elakkad, Alaa, Gaber, Chehab Salah and Hesham Mohamed for all the support and help they provided me during the last two years.

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Alaa Abdelsalam

Molde, May 27th, 2014

Abstract

Nowadays companies are facing various critical challenges with regards to supply chain management. One of these critical challenges is risk management with its various sources which can be legal/political, social, operational/technical, natural and economic in nature.

For this purpose and due to the negative impact that supply chain risks have, companies need to develop effective risk management process to mitigate these risks. Companies who heavily rely on effective and efficient supply chain can gain competitive advantage if they manage the risks within their supply chain network. The objective of this paper is to conduct an in-depth research on supply chain risk management approaches. In order to achieve this objective a case study will be conducted on Egyptair Company from the airline industry. The case study data and the conclusions which are drawn from the study are based on qualitative facts that are gathered through interviews. As a conclusion various risk mitigation strategies for most significant risks faced by Egyptair are discussed and analyzed.

Key words: supply chain risk, supply chain risk management

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CHAPTER – 1: INTRODUCTION

1.1 Background

In today's competitive markets, it has been recognized that a number of companies are competing with their competitors through supply chain management which reflects that supply chain excellence is an opportunity to create competitive advantage over companies. One important way to reach excellence in supply chain is to mitigate and handle risks that may obstruct the flow of the whole supply chain.

Globalization and the arising need for more streamlined supply chains have increased risk for companies when acquiring goods and services needed for their operations. Risk is considered as the chance of facing undesired consequences such as damage, loss, or injury. More significantly, risk is defined as the combined probability for an undesired event and the potential damage the event might cause. Zsidisin (2003) argued that it is not essential that the detrimental effects of these undesired consequences be existential to the companies, but typically they cause lost sales, decreased market share and large contractual penalties for the parties affected.

Companies need to have effective risk management process in order to mitigate these risks. Especially companies like Egyptair can gain competitive advantage if they manage the risks within their supply chain network. According to (Artebrant et al 2003, p. 49) supply chain risk management results in identifying the potential areas of risks and the implementation of actions that will mitigate these risks. Companies which have different operational environments use specific tools to handle risks; in some cases the tools that are adapted for managing the operations of the chain are sometimes also appropriate for managing risks. The performance level that the supply chain achieves is determined by the levels of application of these tools as well as the variety of tools.

1.2 Motivation

The early years of the 21st century have evident major supply chain disruptions that have highlighted vulnerabilities for individual companies and for entire industries globally which as a consequence make focus on supply chain risk management important for a firm or organization (Christopher 2005). First of all, supply chain risk management can

lead to cost savings in terms of control over sales- and market-share loss. Further, if something unexpected occurs in the supply chain, an organization can recover faster than its competitors, and thereby achieve competitive advantage. Additionally, identifying disruptions and their costs, can result in cost savings and an increase in utilization of resources.

- In year 1997, Toyota halted production for 20 days after single supplier location burned. Boeing lost \$2.6 Billion due to raw material and part shortages and a 15-day Teamsters (a labor union) strike severely affected the UPS Company.
- In Year 2000, Ericsson lost 400 Million Euro after their supplier's semiconductor plant in New Mexico caught fire. A glitch in Nike's demand planning software caused supply shortages for the popular Air Jordan footwear. As a result, Nike announced a \$100 million sales loss.
- In year 2001, Ford closed 5 plants for several days after all air traffic was suspended after WTC attack. Land Rover laid-off 1,400 workers after one of their key suppliers became insolvent.
- In year 2002, the entire West Coast ports shutdown due to the dockworkers' strike idle manufacturers and incurred high costs while parts were flown in.
- In year 2007, toy maker Mattel repeatedly made the headlines for a recall of toys containing significant amounts of lead in the paint.
- In year 2011 Honda has indicated that supply chain and production issues arising from the recent Japan earthquake and tsunami result in "reduced volume production" at its UK manufacturing division. (*IBM corporation, 2008, p.4*)

The above mentioned examples illustrate that supply chain may not be well prepared for dealing with unanticipated events causing disruption in supply chain networks.

1.3 Thesis Problem

Currently, most of the companies are not aware about the supply chain risks and those who are aware need knowledge to lessen and mitigate these risks. It is, hence, a growing need to develop new generic strategies for managing supply chain risks. Recent disruptions as the 1999 Taiwan earthquake, terrorist attacks such as September 11, 2001,

the 2002 US west coast port strike, Hurricane Katrina in 2005 and most recently the unstable political condition in the Arab area where Egyptair is located, These types of uncertainties, though difficult to control, can be managed through efficient contingency planning.

1.4 Aim and Objective

The purpose of this thesis is to contribute to the knowledge on how to manage risks in the supply chain. The objectives of the study are:

- To identify the various risks in Egyptair
- To rank/prioritize the most important risks in Egyptair
- To investigate the action plan to mitigate significant supply chain risks of Egyptair

The thesis focuses on the following main research questions:

- What are the most significant supply chain risks in Egyptair?
- What strategies Egyptair utilizes to mitigate supply chain risks?

1.5 Thesis Model

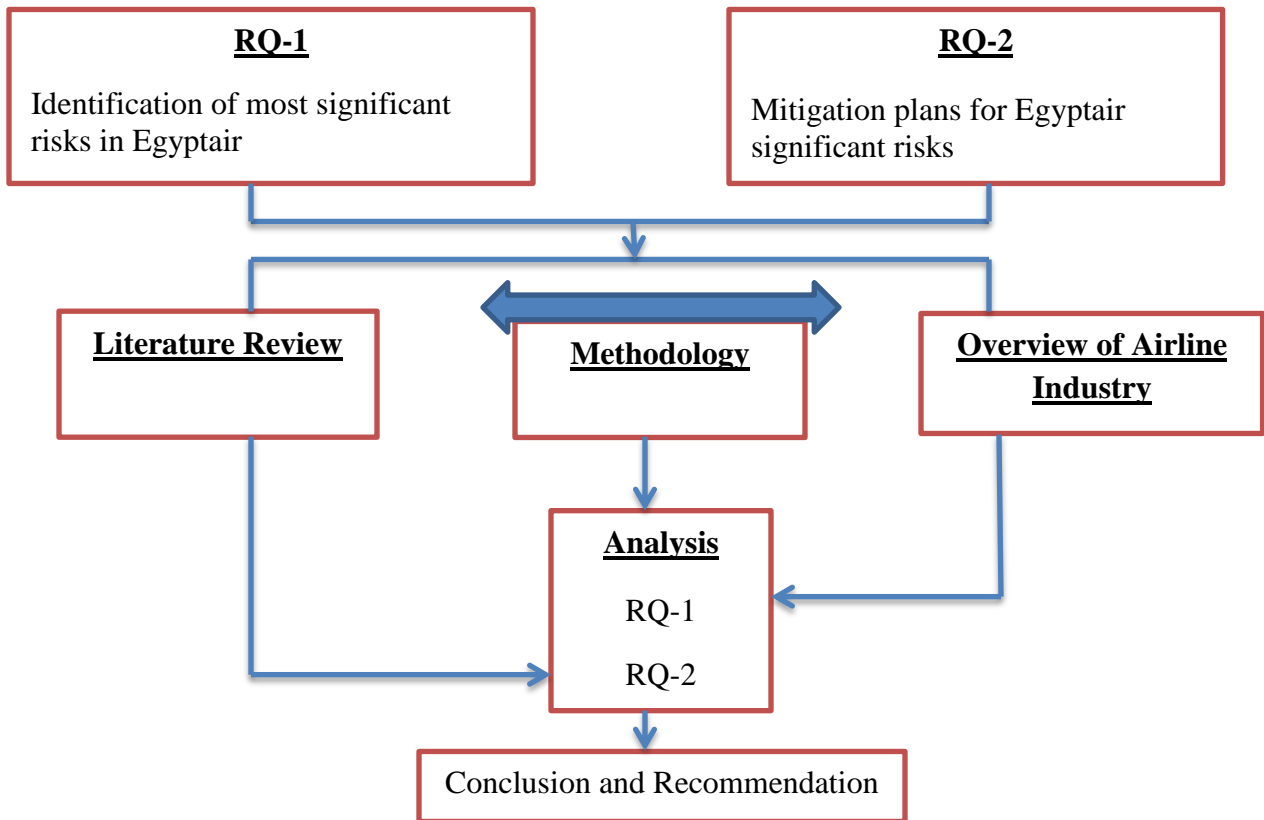


Figure 1: Thesis Model

1.6 Structure of the thesis

- *Chapter One:* Represents the introduction and thesis motivation, identifying the research questions and research model to be applied for analysis.
- *Chapter two:* Represents the research methodology to be used
- *Chapter Three:* Provides an overview on the literature related to risk management with its types, tools and strategies that can be used to mitigate the impact of risks
- *Chapter Four:* Provides an overview about airlines industry
- *Chapter Five:* Is the risk analysis case study within Egyptair, with discussion on major risks that the company faced and the mitigation actions used to handle these risks.
- *Chapter six:* Conclusion, future research recommendations and thesis limitations

CHAPTER – 2: METHODOLOGY

2.1 Exploratory Case study

The methodology of the thesis will be based on case study methodology as defined by Yin (2003). There are two main paths to follow when applying case study research: *exploratory case study* or *explanatory case study*. This thesis will exploit an exploratory case study method. Yin (2003) presents a technical definition for the case study research, illustrating that a case study is as an empirical inquiry that examines within a real life context a contemporary phenomenon, particularly in cases that there is no clear evident for boundaries between phenomenon and context.

2.2 Propositions

The thesis will utilize propositions in order to describe and analyze how Egyptair performs when facing supply chain risks. If these propositions are confirmed, this can lead to reduced Egyptair risks. This is because the propositions are developed in order to reveal if Egyptair is operating according to theory. The propositions deal with aspects of risk management can contribute when suggesting appropriate risk mitigating strategies.

P1: Egyptair operates with a holistic perspective

P2: Egyptair experiences high risks

P3: Egyptair conducts risk assessment

The final proposition about risk assessment is developed to reveal if Egyptair is utilizing risk management strategies.

2.3 Research Design

Research design is a plan on how to conduct the research as it aims to connect empirical data to the research questions, and to the conclusion as mentioned by Yin (1994).

The methodology of **single case study** with holistic design will be applied in this thesis. According to (Yin 1994), the holistic design has both strengths and weaknesses. It is beneficial as it can be a good design when the theory used in the case study is at a general level -as the theory addressed in this thesis- and when no logical subunits can be identified. On the other hand, the weak point with using a holistic design is that the case

study can be conducted at an abstract level and a case study`s nature can shift during the time of study.

2.3.1 Case Study

Case study is a research methodology of a certain occurrence as an event, program, person, social group or an institution/organization (Merriam 1994). (Yin 2003) illustrated five components that are important in the research design for case study.

1. Study questions (who, what, where, how, why)
2. Propositions
3. Unit(s) of analysis
4. The logic linking the data to the propositions
5. Criteria for interpreting findings

Yin (2003) argues that case study method has a unique advantage which is focusing on contemporary and real-life context in situations when a “why” or “how” question is being asked related to contemporary set of events. In addition, Case study method investigates the empirical problem/topic through pre-specified procedures.

2.3.1.1 Study Questions

One of the research questions to be explored is “*where in Egyptair supply chain do the risks occur*”. This investigation potentially answers where the company should focus its risk management. Furthermore, another question to be answered by the case study is “*what processes Egyptair utilize to mitigate its supply chain risks*”.

2.3.1.2 Proposition

According to (Northwestern University 2012) proposition is a sentence that is either true or false. Also, Yin (2003) mentioned that the questions of who, what, where, how and why, are used to help answering the study propositions so, he argues that propositions are the real study when doing qualitative work as. In this thesis the propositions are linked with risk management aspects at Egyptair.

2.3.1.3 Unit of analysis

The unit of analysis covers what actually the case is about, for instance; an individual, organization, an event or an entity. The unit of analysis is also linked to the research questions. Each unit can therefore have different research design and strategy of collecting data. This thesis has *the organization of Egyptair* as unit of analysis and is used to exemplify risks from the Airline industry.

2.3.1.4 The logic linking the data to the propositions

Pattern matching can be used for the aspect of linking the data to propositions by comparing data from two different propositions against each other. It is assumed as a pattern if the two different propositions give the same outcome.

2.3.1.5 Criteria for interpreting findings

This aspect deals with how the investigator interprets the findings from the case study. a researcher can obtain a statistical interpretation from a p-value of .05 if it is a quantitative study, which is a statistical significance level. On the other hand, looking at alternative explanations to the findings can be considered for interpreting findings in a qualitative case study.

2.4 Research Method of Thesis

This research study has been conducted **qualitatively** because this study is based on ground facts, related literature and the experience of concerned personnel of Egyptair, and not based on numerical figures. As Mack et al. (2005) argues that, qualitative methods allow the researcher the flexibility to ask why or how in order to investigate preliminary participant responses. Semi-structured interviews have been conducted for the purpose of data collection from Egyptair which has thus been the basis of the research work and further analysis of significant supply chain risks.

2.5 Data Collection Sources

The research will investigate both primary and secondary data to ensure that most aspects concerning risks and the management of risks are covered in this research. As primary

data will help in collecting real life cases dealing with managing risks and observations at the time of events, while secondary data will help in demonstrating the past actions and historical data about how firms deal with managing risks from scientific point of view.

2.5.1 Primary data

Through semi-structured interviews electronically conducted, observation of the work flow and most important statistical data of assessing risks. Statistical data from business field can also be used to get more knowledge about how risk management help in achieving competitive advantage.

2.5.2 Secondary data

We will use books, journal articles, PhD and Masters Dissertations, government's documents, published information available on the World Wide Web and some other industrial statistics if available.

2.6 Analytical Generalization

It concerns the possibility of generalizing the outcome of this thesis to relate to other airlines. According to Yin (2003) case studies can be seen as experiments in contrast to statistical generalization where results are determined as sampling unit based on empirical data and statistical observations but, this cannot be applied for case studies.

2.7 Validity and reliability

The validity is to determine if the findings of the case study can be generalized which can be performed by use of theory in case of utilizing a qualitative, single-case study. Reliability is to ensure that the result would be like, if an investigator should precede the same steps and case study as the previous investigator. In this thesis, the interviewees are with Egyptair managers to believe the outcome of interviews would be alike. However, since the interviews were in-depth and open-ended, differences in interpretations of results are possible which can be improved by using of structured interviews.

CHAPTER – 3: THEORATICAL FRAMEWORK

3.1 Risk and Uncertainty

In reviewing risk management literature, the first question to be addressed ;what is supply chain risk? The terms ‘uncertainty’ and ‘risk’ have been used interchangeably in operations management literature. In some of the risk categories, such as the forecast risk, where the authors highlight the issues of the bullwhip effect, which arise a debate on whether to consider this as operational uncertainty and could be managed with correctly operating supply chain. According to (Vaagen, H., 2013) “*Uncertainty refers to lack of predictability of outcomes*”; Uncertainties can be categorized into short-term or long term based on the timeframe over which these uncertainties affect the supply chain (Subrahmanyam, Pekny, & Reklaitis, 1994). Short-term uncertainties may include cancelled/rushed orders, day-to-day processing variations, or equipment failure, etc. Long-term uncertainty refers to seasonal demand variations, raw material/final product unit price fluctuations and production rate changes occurring over longer time frames. So the concept risk is often reserved for situations where the negative consequences, their size and their probabilities are well known. If this is not the case, then one talks about uncertainty.

Occurrence of uncertainties that has an impact on the inward flow of the supply chain is usually referred to as **supply risk** (Harland et al., 2003; Tang, 2006a; Zsidisin, 2003). According to Zsidisin (2003) supply risk is “*the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which it outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety*” On the **demand side**, there are many cases of referring demand risk to uncertainties as illustrated by Johnson (2001), for instance, fluctuated demand resulting from the short life cycle of product and rapid changes of customer demand. Demand uncertainty can provide both risk and opportunities, for instance it may lead to incurring extra costs or loss of sales but at the same time may lead to an interest in managing the supply chain based on a long-term forecast.

Apart from supply and demand, uncertainty can be driven by other factors like technology (Chen and Paulraj, 2004). There also exist different viewpoints on uncertainty. According to Lee (2002) demand uncertainty is “*the predictability of the demand*”. Khan and Burnes (2007) compared risk and uncertainty. They conclude that risk is measurable and manageable. On the other hand, uncertainty may not be measurable.

In another set of literature concerning risk, Paulson (2005) identifies risk as “*an event with negative economic consequences*”; also Christopher and Lee (2004) define it broadly as any negative consequence resulting from any external event. In this way risk is a negative outcome after the impact of events. Whereas, Juttner et al. (2003) specifically defined supply chain risk as a “*variation in the distribution of possible supply chain outcomes, their likelihood, and their subjective value*” which indicates that, some authors view risk as the variance of outcome, no matter whether it affects the organization positively or negatively (Spekman and Davis, 2004; Crone, 2006). Zsidisin (2005) provides an encompassed definition of supply chain risk as “*the potential occurrence of an incident or failure to seize opportunities with inbound supply in which its outcomes result in a financial loss for the purchasing firm.*” However it emphasis on the downside, it is a very isolated explanation with a focus on a single company instead of supply system as a whole.

3.2 Recent Trends in Supply Chain that Cause Disruptions

In recent years the composition of the risk portfolio changed for most companies due to new market conditions. The evolving nature of supply chain and transport networks has led to changing risk distributions. The focus on cost optimization with the removal of traditional buffers such as safety stock and excess capacity has highlighted the tension between cost elimination and network robustness. These developments have shifted risk distributions. (Juttner, 2005) identifies the following drivers as causes for the emergence of these new risks.

- Globalization of supply chains
- Reduction of inventory holding

- Centralized distribution
- Reduction of the supplier base
- Outsourcing
- Centralized Production

Globalization leads to an increase in the geographical complexity in the chains, while outsourcing and centralized distribution result in organization and logistical complexity. Simultaneously, companies in a supply chain become more and more dependent on each other when they outsource functions and reduce their supplier base. The concentration on a small number of suppliers or single sourcing may result in a significant increase of supply risks. The breakdown of one supplier may then lead to serious disruptions of the production process of a company. Companies which are unable to react to such problems might even collapse themselves and pass the initial disruption on to the next company in the production process as the breakdown of one company may lead to a damage of partners much further down the supply chain.

3.3 Classification of Supply Chain Risks

Before any kind of preventive /corrective actions are taken, supply chain risks and uncertainties are to be concertized and classified. Increasing awareness and concretization of uncertainty that affect a particular decision problem are the first steps in handling uncertainty in a correct way. Risk classification relates to how an organization defines the risks it faces. However while firms may have a coherent system for classifying risks that meets their own requirements, such systems are unlikely to be identical between firms. Each system represents a risk “language” bespoke to the firm, with firms using different terminology for the same risks, or the same terminology for completely different risks. The different risk languages used by firms in their day to day work can cause confusion when different firms come together to discuss risk.

Significant differences can exist between how different organizations classify risks. Moreover, further confusion is possible when we drill down to sub categories. For instance one organization may class failure of a project as Operational Risk, while another may class it as Strategy Risk. Identifying where similar risks exist within the organization can be done using a formalized risk classification system which also enables

the organization to distribute responsibilities among organization's members for setting strategy for management of related or similar risks. Also, appropriate risk classification will help in better identifying the risk appetite, risk capacity and total risk exposure in relation to each risk, group of similar risks or generic type of risk.

Risk may be generated as a result of risk 'drivers' that are either internal or external to the company. The external drivers are the risk areas that are most commonly thought of by managers. Kahneman and Tversky (1982) applies a classification method where external uncertainty is referred to uncertainty outside of the decision maker's control and, hence, 'unmanageable'. As opposed to external uncertainty, internal uncertainty is arising from lack of knowledge and ignorance. The risks of unpredictable demand, unreliable supply, and the effects of external shocks in the business, social and climatic environment are all the areas that are considered to be uncertainties that cannot be controlled by the decision maker.

3.3.1 External Supply Chain Risk:

External risks facing supply chains result from environmental factors that can have an effect on supply chain both directly and indirectly. They can be due to political reasons, economic, technological or geographical (Kleindorfer & Saad, 2005). Supplier failure, supplier quality problems, oil crisis, malfunction of IT system, accident (e.g. fire), and natural disaster can be considered as criteria for classifying external supply chain risks.

3.3.2 Internal Supply Chain Risks:

Problems in organizational boundaries such as faults of machines or problems related to information technology can cause supply chain internal risks (Rice & Caniato, 2003). For instance, machine breakdowns, import or export restrictions, transportation failure, delivery chain disruptions, increasing customs duty, change in customer demand, technological change.

Gustav Hamilton (1996) introduced "The circle of risks" as a comprehensive view of all risks which can threaten an organization, who within an organization that is responsible for managing which type of risk, and it illustrates the relations between risks, actions and responsibilities. The circle of risks is divided in two natural halves; the right half which

includes operational, static, risks within production where the risk with most impact is discounting in the production flow. Most of the work the risk manager is conducting is represented on this right half. The left half includes dynamic risks found outside the production such as inflation, new laws and terrorism, and this half is included in the circle of risks to offer a comprehensive view of the risk situation of the organization.

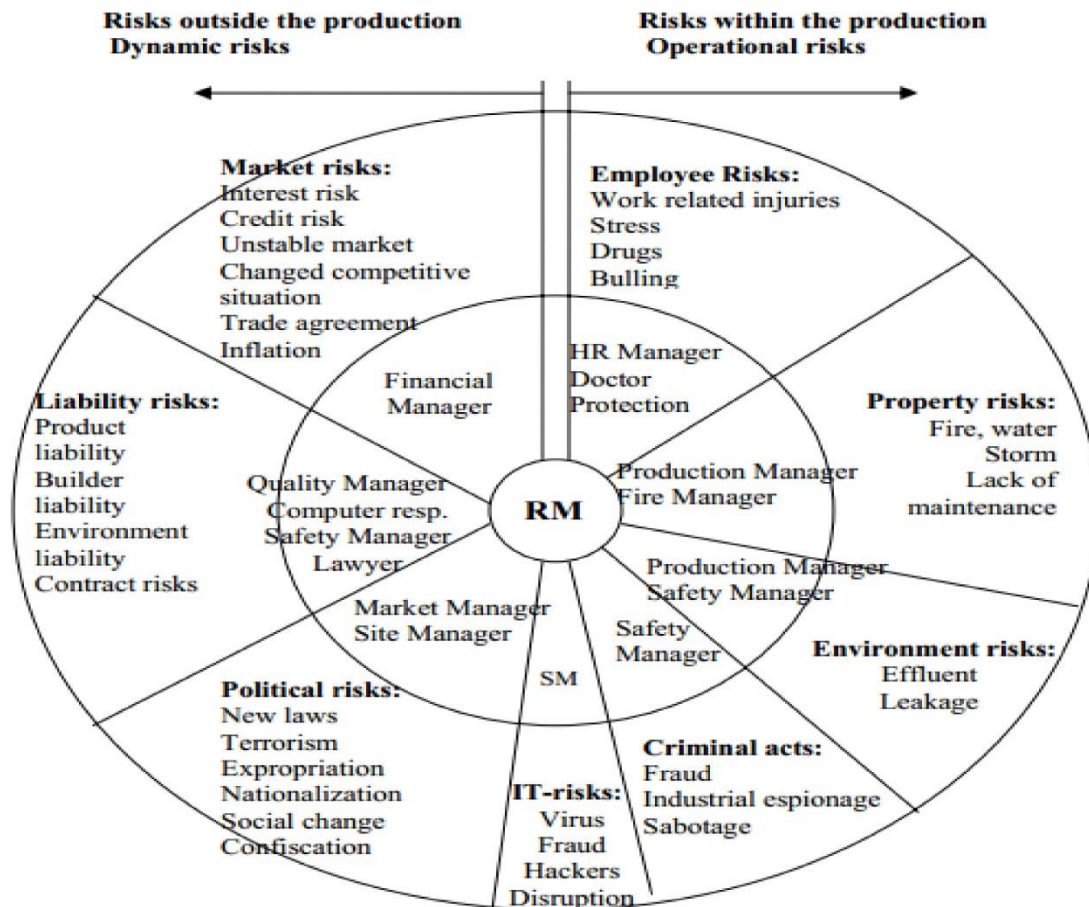


Figure 2: The circle of risk

Source: Hamilton G., (1996)

Risks within the production

Employee risks: include such as working injuries, problems related to stress and drugs and bullying among colleagues. A company with inferior working environment produces discomfort and working injuries which results in an increased absence and unwanted employee turnover. This creates disturbance in production which can result in poor quality. Long-term this is a major threat to the organization.

Property risks: represent damage which can be caused by fire, water, storms and inadequate maintenance. For a long time the most dreaded risk has been fire. Lately though, new technological advances have released new forces which cannot be controlled, hence fire is no longer feared as before. Still however, the damage from fires every year is a big problem.

Environmental risks: include pollutions and leakages. The environmental problems are getting more and more difficult to survey since the sources of origin are diffuse and hard to localize.

Criminal acts: represent sabotage, industrial espionage, theft and fraud. During the last decade there has been a significant shift from outside criminal acts to inside operations. Today the employees in a company are responsible for most of the economic crimes in the organizations. Some ways to prevent this are clear routines and running internal records.

Risks Outside the Production

Market risks: the risk that as a result of market movements, covers inflation, trade agreements, changed terms of competition, risks with currency and so forth. Financial transactions have become a considerable risk lately. Speculation with currency has led to most big companies having some form of finance policy to limit the associated risks.

Liability risks: among others include responsibility of environment and product and also risks with contracts. Product liability means that a company has a liability to pay damage when their product has caused injury to another property or person.. To avoid risks associated with product liability it is important to have a quality securing system in the company which results in products and services fulfilling the quality expected by the customer.

Political risks: represent new laws, terrorism, nationalization and social revolution etc. Countries with political instability are more than others affected by alterations that can change the conditions of the economic life overnight. Hence it means great political risks to own companies situated in.

IT risks: Risks concerning IT are covered in both halves since they can occur both within and outside the production. It is important to put static and dynamic risks in relation to each other to get a meaningful judgment of the company's risk environment and to be able to act rational. It is essential for every company to chart their own circle of risks to fully grasp the risk environment which is specific for each organization. There are some risks which are not represented in the circle of risks like for example the human factor and loss of built up confidence.

This literature is not limited for specific industry it mainly focuses on supply chain risk in general.

3.4 Supply Chain Risk Management

According to Tachankova (2002), risk is an inherent part of any business. Risks covered all the activities of the organizations so management of any business focuses on coping these risks at all levels. Companies have been aware of the need for risk management and contingency planning for some considerable time and there exist a wide body of literature from such diverse fields as economics, finance, strategic management, and international management. Due to increasing market competition that require higher customer satisfaction and lower cost, most supply chains became more complex and consequently more vulnerable to disruptions than they were before. Supply chain disruptions can have effect either inside or outside a supply chain. Moreover, external factors such as natural hazard, global outsourcing, and shorter product life cycle have heightened the exposure of supply chains to risks. Kouvelis et al. (2006) view Supply chain risk management in terms of managing the uncertainty of costs, demand and supply. Carter and Rogers (2008) define SCRM as “the ability of a firm to understand and manage its economic, environmental, and social risks in the supply chain” which could be achieved by the adoption of contingency planning and having a resilient and agile supply chains.

The essence of SCRM is to make decisions that optimally align organizational processes and decisions to exploit opportunities while simultaneously minimizing risk. As Wagner and Bode (2008) point out, the financial default of a supplier and an earthquake that destroys production capacity are situations with completely different attributes and therefore has different effects on the supply chain. Therefore, SCRM needs to look at

understanding and reducing vulnerability to the supply chain as a whole, rather than at a focal firm level. As supply chains become longer and parts of larger networks of demand and supply nodes and interacting logistics nodes and modes, they become more liable to the negative attributes of systems, complexity, flexibility, sensitivity, reliability and vulnerability (Meister 1991) .

There are also other approaches to risk management in supply chains. Rice and Caniato (2003) define resilience of supply chain as “*the ability of an organization to react to an unexpected disruption and maintain operations after the event*”. Christopher and Peck (2004) define resilience as “*the ability of a system to return to its original state or move to a new, more desirable state after being disturbed*”. According to Peck (2006), resilience brings the concept of an organization’s “ability to absorb or mitigate the impact of the disturbance”.

According to Juttner, Peck and Christopher (2003) , SCRM aims to “*identify the potential sources of risk and implement appropriate actions to avoid or contain supply chain vulnerability*”. Norrman and Lindroth (2002, p. 7) mention that risks and uncertainties that are the cause of or has an impact on logistics related activities or resources in the supply chain w needs the collaboration of SCRM partners to apply risk management process tools. Whereas, Paulsson (2007, p. 169) illustrated that supply chain risk management main objectives are:

- “*To maintain the supply and continuous availability of a product;*
- *To increase the supply chain’s ability*
- *To cope with disruptions in the supply chain of products if necessary;*
- *To avoid possible domino effects throughout the chain;*
- *and to make the supply chain more resilient to disruptions”*

A firm’s risk to a disruptive event can be viewed as a combination of the likelihood of a disruption and its potential severity. Thus Sheffi (2005) introduce a metric that encompasses these two dimensions; the disruptive probability and consequences of events, which may also, facilitates the firm to identify their risks. The vertical axis is the probability of the disruptive event and the horizontal axis represent the magnitude of the

consequences. Thus, each of the four quadrants has a specific meaning. Risk is highest when both the likelihood and the impact are high. Similarly, low-consequence events represent the lowest levels of risk. High-probability/low-impact events are part of the scope of daily management operations, due to the relatively small random variations in demand, unexpected low productivity, quality problems, absenteeism, or other such relatively common events that are part of the “cost of doing business”. On the other hand low probability/high-impact events, call for planning and a response that is outside the realm of daily activity.

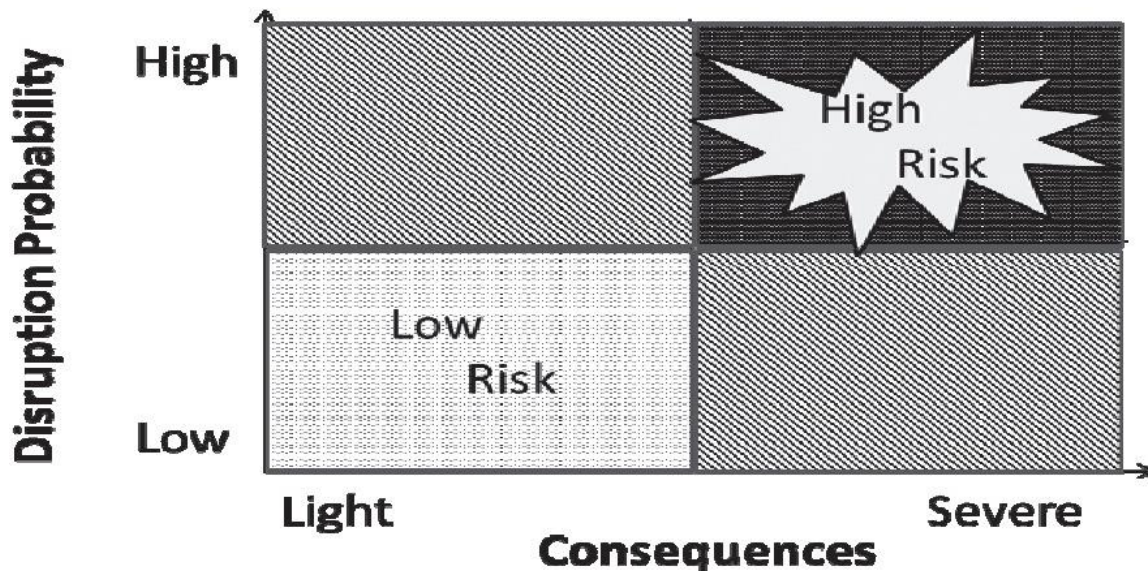


Figure 3: probability Consequence Matrix

Source: Sheffi (2005)

Ericsson revised their SCRM after a fire incident affected their operations, which now consists of a feedback-loop of risk identification, risk assessment, risk treatment and risk monitoring (Norrman and Jansson, 2004). In addition, Ericsson implement a new approach which includes contingency planning and incident handling in parallel to the basic loop.

3.4.1 Supply Chain Risk Management Framework

According to Lin & Zhang (2008) the basic supply chain risk management process and analyzing tool consists on risk identification, assessment, evaluation, planning and controlling. Lin & Zhang (2008); Brindley (2004) argues that risk analysis involved risk

identification, assessment and evaluation. The purpose of risk analysis is to design/define actions/strategies to handle risk: mitigate, reduce, eliminate or consciously accept it.. Risk control is the implementation of tailored risk mitigation tactics in the essence that risk analysis and its controlling leads to risk mitigation. Manuj and Menzer (2008) believe that especially in case of global supply chain, managing risk should comprise at least risk identification, risk evaluation and risk mitigation processes. The International Organization for Standardization (ISO) has developed a framework known as ISO 31000 that is concerned with risk management. This frame work can be used as a standardization base to develop risk management towards supply chains. It also correlates with the risk management approach of Christopher (2005), Manuj and Mentzer (2008), Zsidisin, G. and B. Ritchie (2009). This thesis will be based on this framework for risk management in supply chains. The supply chain risk management process consists of five steps as shown in the following table.

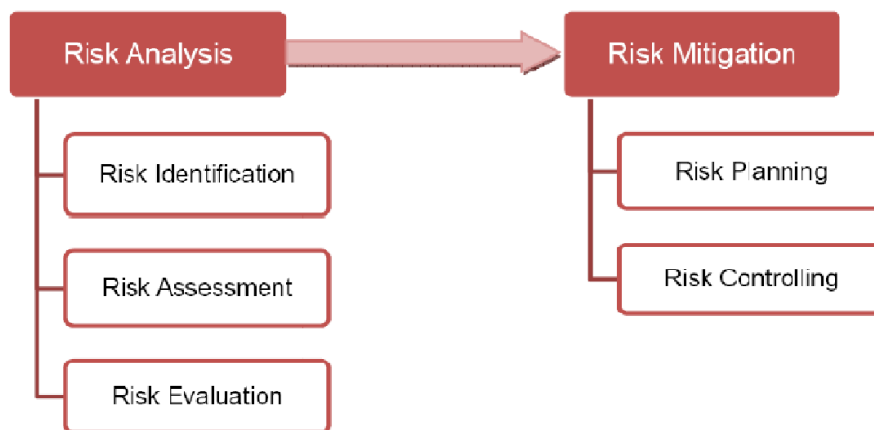


Figure 4: Supply Chain Risk Management FrameWork

Source: Lin & Zhang (2008)

Simon, Hillson and Newland (1997) suggest that techniques undertaking these two stages can be separated into three general groups, even if there is a wide variety to choose from:

1. Qualitative techniques (identify, describe, analyse and understand risks)
2. Quantitative techniques (model risk in order to quantify its effect)
3. Control techniques (respond to identified risk in order to minimise risk exposure)

3.4.1.1 Risk Identification

It is the first step which helps to develop a common understanding of the future uncertainties surrounding the supply chain, thus recognizing the potential risks in order to manage these scenarios effectively. According to Lin & Zhang (2008, p. 2), “*risk identification aims to discover possible risk sources and potential risk events. Risk identification is the comprehensive approach which involves theoretical knowledge, empirical experience, information and appropriate tools. Risk checklist, Supply Chain Operations Reference Model (SCOR), event tree, cause-and effect tree, and fault tree are all useful tools for risk identification*”.

Effective risk identification requires investigating different organizational activities in every direction and at every level also this should be done in a continuous basis to reveal new risks in case of internal and external changes in the environment. Greene and Trieschmann (1984) argues that it becomes extremely difficult to manage or to mitigate risks in case if managers are not able to identify all possible risks and sources of risks which can harm the organization, in this case organization will not plan for mitigation actions for those risks that remained unidentified and the result may be unexpected, Dickson and Hastings (1989). Managers should not focus only on what can be insured or mitigated but they should be proactive in risk identification. To be able to identify risks some basic questions should be asked:

- “*How can the organizational resources be threatened?*”
- “*What adverse effect can prevent the organization from achieving its goals?*”
- “*What favorable possibility can be revealed?*” Tchankova (2002, p. 291)

Risk identification could be carried through:

- Checklists
- Brain storming sessions
- Issues logs
- Behavioral models
- Diagramming techniques
- Flowcharting project and process models
- Regular meetings

3.4.1.2 Risk Assessment

The second step is the risk assessment, which refers to the assignment of probabilities to risk bearing events in the system and identifying the consequences of these risk events defined in the first step. For the assessment of the identified and analyzed risks, Company's own experiences, other companies' performance results or forecasting analysis can be utilized also; companies should make estimations about likelihood of occurrence and the impact of these risks on the performance of company.

Lin & Zhang (2008, p. 2) defines risk assessment as, “*risk assessment follows to study the characters of every single risk and estimate its happening possibility, emerging time, and consequences*”. According to Salvador et al (2006) risk assessment quantifies the results of identified risks.

Risk assessment done through qualitative and quantitative methods; qualitative method is to examine the impact of risk events through the application of a logical reasoning process while quantitative method requires numerical values for both impact and likelihood using data from a variety of sources, the quality of the analysis depends on the accuracy and completeness of the numerical values and the validity of the models used

Artebrant et al (2003) discusses the following risk assessment qualitative methods:

- The What-If Method: This method is quite simple one but requires imagination to analyze the result of possible deviation from a normal situation. This is done through investigating questions with employees about various risk areas.
- The One-Day Analysis: In this method first, risks are analyzed and prioritized then prioritized risks are examined by measuring insurance policies and current

actions against those risks. This can be done through the cooperation of managing director and staff, heads of production, risk manager. Insurance company and municipal rescue service representative are also invited to participate.

- **The Jonsson Analysis:** This method of analysis review distribution, probability, and consequences of risks. A scale is graded to inspect the level of risk after analyzing the consequences and probability of risks. The probability factor multiplied by impact factor is termed as level of risk. For example if there is a medium probability and high consequences ($2 \times 3 = 6$) the risk level will be catastrophic means must be dealt immediately. There are three approaches to find the probability of events, Waters (2007):

- **Knowledge** about the situation that helps in calculating a theoretical or a priori probability although it is difficult to do calculations that cover all circumstances, as the real circumstances are complicated
- **Historical data** that will determine how often an event occurred in the past which can be used in estimating the probability of occurrence in the future. Conditions might change over time and therefore influence the probability of the event so it is important to realize these conditions.
- **People opinion** about the probability of an event. The advantage of this method is that data will be always available although this method is not very reliable since the objectivity of people might be very low.

	Probability	Consequences		Level of risk
1	Low Seldom occurring	Little Low cost, damage or loss	1-2	Acceptable Can be allowed and should be dealt with
2	Medium Neither often nor seldom occurring	Medium More cost, more damage or loss	3-4	Unacceptable Not allowed and shall be dealt with
3	High Often occurring	Big Cost which can not be carried	5-6	Catastrophic Inexcusable, must be dealt with immediately

Figure 5: Grading table- Jacsson Analysis

Source: Artebrant et al (2003)

- Delphi-Technique: Competent people from other firm and experts are gathered to examine risks and brainstorm and within the company. Risk conditions are then selected by the group. This method affects the decisions of the host company regarding risk management making use of the human evaluations of important exposures, which may possibly.(Mehmood et al.2010)
- Check Lists: Measure the established security level which will result in developing a control tool by asking questions regarding risks, vulnerabilities and damage exposure. In the analysis, the results of all the questions asked by inquiry are comparable. On the other hand this method has some disadvantage, that the question forms of this technique does not provide the damage cost in numeric terms, and involves overlook of essential problems. (Mehmood et al.2010)
- Bowtie method: The Bowtie method is used to analyze and demonstrate causal relationships in high risk scenarios. A Bowtie diagram gives a visual summary of all accident scenarios that could exist around a certain Hazard. Second, by identifying control measures the Bowtie display what a company does to control those scenarios. The diagram is shaped like a bow-tie, creating a clear differentiation between proactive and reactive risk management.

Quantitative risk assessment methods are as follows:

- Risk Modeling: Developing quantitative models can be helpful when trying to examine the consequences of risk events. The models may be as simple as a spread sheet budget or as complex as a mathematical representation of a product, process, or project in all of its details. Simple or complex, models give the opportunity to examine the outcomes of risk events when viewed according to different assumptions. Also there is an underlying risk in the assumptions. Frequently the assumptions do not reflect reality and have the potential to increase risks as such.
- Expected value analysis: Mathematical expectation helps in computing the expected value of an event associated with the event and their probabilities

$$\text{Expected value} = \text{expected gains} - \text{expected losses}$$

- Benefit –Cost ratio analysis: This method of risk assessment enables decision makers to explore how benefits vary under different conditions. If benefit/cost =1 this indicates a break even situation where no profit or losses are presented, if benefit/cost > 1 this presented a profit, while benefit/cost < 1 this represents loss. Benefit-cost ratios are valuable when carried out properly but sometimes there are some pitfalls associated with computing these ratios for example; losing sight of the absolute size of benefits and costs, not assessing when payback occurs, and measuring the wrong stuff.
- Expected Damage Cost Analysis: This method provides numeric figures about potential risk damage and vulnerability factors. The result of this method is directly choosing the security measures which optimize the costs of these risks.

Option Theory

Both qualitative and quantitative techniques have advantages and disadvantages. Most companies begin with qualitative assessments and develop quantitative capabilities over time as their decision-making needs dictate. The following table shows a comparison between the advantages and disadvantages of both methods

Table 1: Comparison between Qualitative and Quantitative techniques

	Advantages	Disadvantages
Qualitative	<ul style="list-style-type: none"> -Is relatively quick and easy -Provides rich information beyond financial impact and likelihood such as vulnerability, speed of onset, and non-financial impacts such as health and safety and reputation -Is easily understood by a large number of employees who may not be trained in sophisticated quantification techniques 	<ul style="list-style-type: none"> -Gives limited differentiation between levels of risk (i.e. very high, high, medium, and low) -Is imprecise – risk events that plot within the same risk level can represent substantially different amounts of risk -Cannot numerically aggregate or address risk interactions and correlations -Provides limited ability to perform cost-benefit analysis
Quantitative	<ul style="list-style-type: none"> -Allows numerical aggregation taking into account risk interactions when using an “at risk” measure such as Cash Flow at Risk -Permits cost-benefit analysis of risk response options -Enables risk-based capital allocation to business activities with optimal risk-return -Helps compute capital requirement to maintain solvency under extreme conditions 	<ul style="list-style-type: none"> -Can be time-consuming and costly, especially at first during model development -Must choose units of measure such as dollars and annual frequency which may result in qualitative impacts being overlooked -Use of numbers may imply greater precision than the uncertainty of inputs warrants -Assumptions may not be apparent

Source: Mack et al (2005)

3.4.1.3 Risk Evaluation

According to Lin & Zhang (2008), the objective of risk evaluation is to prioritize/rank the risks on the basis of risk level and chances of occurrence before and after risk mitigation planning tactics will be adopted and this is as a result of evaluating the risks in the whole supply chain with. *“Risk prioritization is a continuous process that is accomplished throughout the life-cycle of a system. Effective risk prioritization depends on planning; early identification and analyses of risks; continuous monitoring and reassessment; communication, documentation, and coordination”*. Risks which are identified during the

identification process of the company are ranked according to the risk prioritization for mitigation. The following factors should be considered for risks prioritization:

- Risk occurring probability,
- Risk consequence,
- And cost and resources to mitigate risks.

One method of doing a risk evaluation is to prioritize risks by likelihood and consequences which (Cox, 2008) referred to as risk matrix method. (Cox, 2008) discuss the different usages for risk matrix method in risk management practices such as business risk management, airport safety, highway construction project risk management, and in the assessment of potential risks to building ranging from terrorist attacks to hurricanes. *“Risk matrices provide a clear framework for systematic review of individual risks and portfolios of risks; convenient documentation for the rationale of risk rankings and priority setting; relatively simple appearing inputs and outputs, often with attractively colored grids”* (Cox ,2008, pp. 498).

In the risk matrix table, numerous categories of severity/impact/consequences are on vertical axis and categories of probability/ likelihood/frequency are along horizontal axis. In addition, in each cell, each row column pair can indicate urgency, priority, management actions and level of risk. The benefit of this table matrix is that it mainly focuses on minimizing the maximum loss from misclassified risks, prioritizing the risks and distinguishing qualitatively between least urgent and most urgent risks in many applications. It can be used as a guide for resource allocation both in national and international standards and is considered much better than purely random decision making, Cox (2008).

The following figure indicates an example of standard 5×5 risk matrix for risk assessment and rating/prioritization. The red, yellow, and green cells show high, medium, and low risk levels respectively on the basis of likelihood ratings on the horizontal axis and impact on vertical axis ranging from very insignificant to catastrophic. Hazards receiving higher risk require higher priority for treatment and mitigation.

Severity \ Likelihood	Rare (1)	Unlikely (2)	Possible (3)	Likely (4)	Almost Certain (5)
Catastrophic (A)	Medium	Medium	High	High	High
Major (B)	Medium	Medium	Medium	High	High
Moderate (C)	Low	Medium	Medium	Medium	High
Minor (D)	Low	Medium	Medium	Medium	Medium
Insignificant (E)	Low	Low	Low	Medium	Medium

Figure 6: Rix Rating Matrix

According to Vose (2008) rating matrix has the following advantages as explained below:

- No environment limitation
- Easy to operate.
- Flexible, as the range of value can be set depending on different products and the size of project.
- Provides the level and degree of each single risk in the project
- A quick way to visualize a signal risk

The disadvantage of this method can be estimated as there is no way to choose from two risks having same qualitative rating which can lead to fifty percent error probability. Cox (2008) argues that there would be no guarantee that risks that receive higher risk ranking in a risk matrix are in fact greater than risks that receive lower rankings if some consequence with sufficiently large variances are selected randomly.

3.4.1.4 Risk Mitigation

The risk mitigation actions are to act directly on the pre-identified risks in order to reduce either the occurrence probability or the degree of severity of its consequences. If supply chain has more flexible strategies then it can act as advantage to mitigate the disruption risks. It is important for the organization to have insight in the different risk mitigation options before choosing an appropriate option for the different risks. Risk avoidance, risk transfer, risk reduction and creating flexibility to adapt changes (risk acceptance) are the risk mitigation options that are mentioned by almost all of authors who wrote in this subject which can be applied individually or in combination.

Risk avoidance: Avoiding risk is to eliminate the type of event that could trigger the risk to reduce the probability of occurrence (Kersten et al., 2007). Risk avoidance does not mandate that the action be canceled; rather it may suggest that the plan should be adjusted to eliminate the sources of problems. Kersten et al., 2006 argues that the most effective way to avoid risks is to eliminate the causes of incidents pro-actively and the transparency in the supply chain network, because otherwise organizations would not be able to recognize the risk sources in time. Supply chain risk avoidance can be related to products, geographical markets and or supplier and customer organizations (Jüttner et al., 2003).

Risk transfer: Transferring risk only includes moving the risk away from the organization; on to another organization it does not mean solving or eliminating the risk. The most common is transfer by insurance. Risk can be transferred to insurance companies or to supply chain partners. (Waters, 2007) mention that when the risk is too high for one organization to accept, an insurance company can pool the risks and share the costs. According to Kersten et al. (2007) elucidates that *“the transfer strategy is suitable when a potential damage is materially and the continuance of the firm is not affected.”*

Risk reduction: Risk reduction can be realized by reducing the probability and/or the consequences of the risk. First lessen the likelihood that a risk event will arise. Second, lessen the negative impacts resulting from untoward risk events. According to Waters (2007) organizations can reduce the probability of risk by avoiding operations where the

risk might occur; this assumes some of the characteristics of risk avoidance. The difference is that in risk avoidance the source of the problem entirely is eliminated by refusing to carry out work that is risky or that may require replanning a work effort to eliminate risk source. While risk reduction, is the action of tempering these risks with a view of reducing the probability of their occurrence or their impact. Mullai (2009) mentions that by reducing the frequency of causes and eliminating some causes result in reducing the probability of risk.

Risk acceptance: It means accepting the impact and consequences the risk has on the organization (Waters, 2007). In contrast to the other risk mitigation options, sometimes organizations might have to accept, or even ignore the risk, due to the costs of avoiding, reducing or transferring the risk or due to lack of good risk management. For example the organization has to accept the possible risks that are related to specific supplier in the case that there is only one supplier for a specific material, and no substitutes. The most common way to handle risks in the case of risk acceptance is to establish contingency plans to deal with disruptive events, and create flexibility to adapt when changes occur. This can be done in the case of knowing that a particular event can occur but the details about the occurrence and its consequences are still unknown. Whereas, in the case of the unknown of both the risk event and its consequences, companies do what is called crisis management.

Selection Aspects:

Different aspects are realized when choosing the suitable risk mitigation option as: the risk portfolio, the organizational supply chain network and the overall competitive strategy of the supply chain (Kersten et al., 2007). Mullai (2009) mentions that the decision making process is influenced by a variety and complexity of choices, some of which are the environment in which it is made, multiple and often conflicting objectives, different risk perspectives, the uncertainty and the sensitivity of decisions. As a consequence to be able to choose the appropriate risk mitigation strategy, decision makers need to have reliable and accurate information as lack of accurate information is obviously a source of uncertainty. A very important aspect in choosing a risk mitigation strategy is the financial aspect. According to Committee Draft of ISO 31000 (2007)

“selecting the most appropriate risk treatment option involves balancing the costs and effort of implementation against the benefits derived” but *“legal and regulatory requirements and social responsibility override financial cost benefit analysis”*. The opinion of the stakeholders is also considered a very important aspect. Choosing for a certain strategy will influence the whole supply chain and therefore the members of the supply chain. In this way different supply chain members should consult in determining which aspects weigh the most and on the basis of this, choose a risk mitigation option.

3.4.1.5 Risk Monitoring:

Risk monitoring is an information gathering effort carried out during the normal course of business with a view to determine whether any risk event has surfaced. It is an ongoing, almost routine process in a sense that it is a preventive maintenance activity. Monitoring process is a combination of checking and follow-up.

Checking: According to (Committee Draft of ISO 31000, 2007) checking requires following and detecting changes in the external and internal supply chain; this includes following and detecting changes to the risk itself and ensuring that the SCRM method is effective in both design and operation. Besides checking the design and operation it is also important to look at the results of the risk mitigation. USCG (2001) has designed three principal criteria, to check mitigating actions which are; Effectiveness: the degree to which the risks will be eliminated or minimized by the proposed risk mitigation actions, Feasibility: the acceptability of staying within the boundaries of the budget while implementing the proposed preventative action and Efficiency: the cost of the action versus the cost-effectiveness of the proposed actions in terms of money lost if no action is taken.

Follow up: It is important in risk mitigation to follow up the action plans to determine whether risks are reduced to acceptable levels or still in need to further treatment. Follow up is not only needed when the risk is not reduced. It is also important to keep checking whether the risk is stable or if the risk might change.

As a conclusion, the ability to recognize potential risk events affecting supply chain is a result of proper implementation of all stages in SCRM process. Moreover, the potential impact caused by an individual risk event needs to be carefully estimated and evaluated according to the individual supply chain operation's definition as not all risk events fall under the category of disruption risk events. Consequently, the supply chain will have a list of potential risk events and an evaluation of how risks could impact it with the completion of the risk analysis process. In order to control a supply chain, managers should decide how to act upon the risks when the need arises. Also, it is vital to identify and evaluate which mitigation strategy should be manipulated and deployed as there are various mitigation strategies implemented to tackle different types of risk. In order to ensure the continuity of all flows in a supply chain and the adaptability of mitigation processes, a supply chain should be closely monitored and continuously reviewed.

3.5 Summarizing Supply Chain Risk Management

There are numerous risk management models in practice across several industries, many with roots in finance and portfolio theory. Within SCRM, there are three basic elements of building an SCRM strategy:

- Visualize and understand risk :The first steps companies struggle with are "getting a hand on risk". Common questions include: What risks are relevant to our business? What risks can I get visibility to? Is there risk I am blind to, unable to mitigate, or unable to measure?
- Measure the impact and likelihood: Once risk elements are identified, they need to be scored on the likelihood of occurrence, and the impact needs to be quantified. High-impact, high-likelihood issues need to be prioritized first.
- Prioritize and take action: Finally, the portfolio of risks needs to be balanced against the risk tolerance of the firm. Firms continually must tradeoff between I can live with that risk and I cannot tolerate that risk and will spend money and resources to mitigate or eliminate that risk.

For some firms, this has meant investment in specific mitigation plans with particular suppliers based on an analysis of the impact of a supplier failure, diversification of sources of supply, and modifying sourcing strategies to be more risk aware.

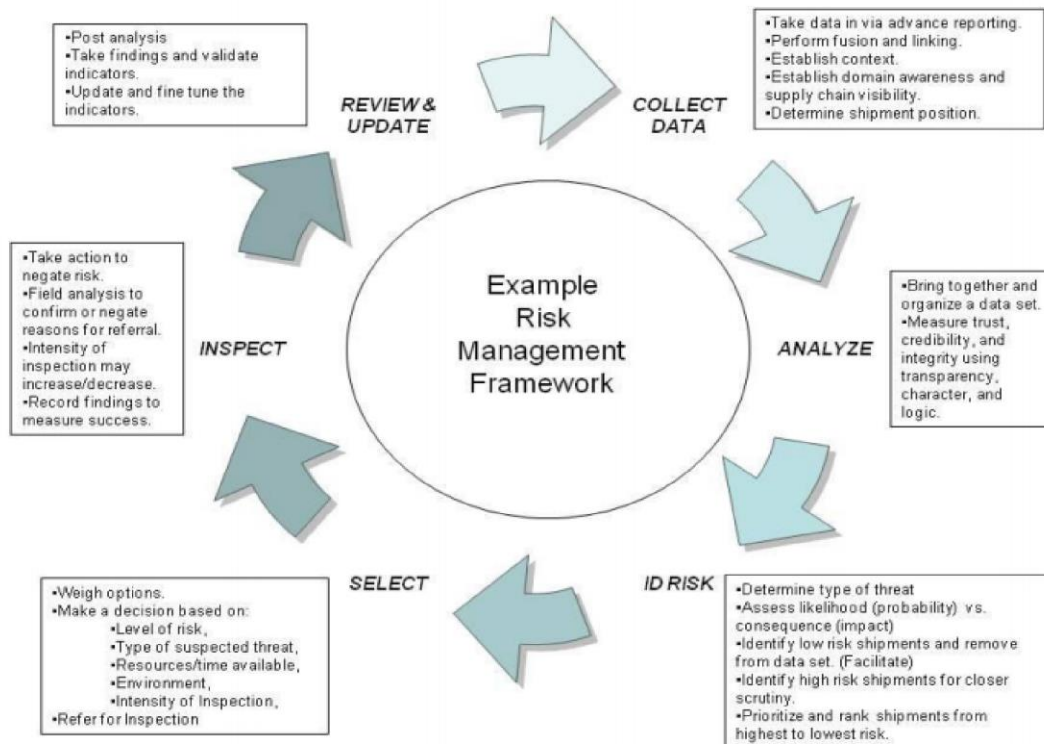


Figure 7: Example Risk Management Frame Work

Source: IADB (2010)

3.6 Robust strategies for mitigating supply chain disruptions

What makes supply chain efficient and resilient? One of the factors that help supply chains to be efficient and resilient is having different robust supply chain strategies. Sodhi and Tang (2012) defines nine different robust supply chain strategies that aim to improve a firm’s capability to manage supply and/or demand better under normal circumstances and to enhance a firm’s capability to sustain its operations when a major disruption hits. These nine robust supply chain strategies are as follows:

(1) **Postponement:** utilizes product or process design concepts such as standardization, commonality, modular design and operations reversal, to delay the point

of product differentiation. This strategy enables a firm first to produce a generic product based on the total aggregate demand of all products, and then to customize the generic product later on. The postponement strategy has been proven to be a cost-effective mass customization tool to handle regular demand fluctuations under normal circumstances.

For example, when Philips informed Nokia that it was not possible to deliver certain parts after the Philips plant was shut down after the fire, the postponement strategy enabled Nokia to deploy a contingency plan by reconfiguring its generic cell phone quickly so that the reconfigured generic phone could accept a slightly different component from other suppliers in the USA and Japan. This product flexibility enabled Nokia to recover from a serious disruption without any significant problem.

(2) **Strategic stock.** Instead of carrying more safety stocks, a firm may consider storing some inventories at certain “strategic” locations (warehouse, logistics hubs, distribution centers) to be shared by multiple supply chain partners (retailers, repair centers, etc.).

For example, (1) Toyota and Sears keep certain inventories of cars and appliances at certain locations so that all retailers in the nearby region share these inventories. By doing so, Toyota and Sears can achieve a higher customer service level without incurring high inventory cost when dealing with regular demand fluctuations. When a disruption occurs, these shared inventories at strategic locations will allow a firm to deploy these strategic stocks quickly to the affected area as well. (2) The Centre for Disease Control (CDC) keeps large quantities of medicine and medical supplies, known as the strategic national stockpile (SNS), at certain strategic locations in the USA. This strategic stockpile is intended to protect the American public if there is a public health emergency (e.g. terrorist attack, flu outbreak, and earthquake) severe enough to cause local supplies to run out.

(3) **Flexible supply base.** Although sourcing from a single supplier will enable a firm to reduce cost (lower supply management cost, lower unit cost due to quantity discount, etc.), it could create problems for managing inherent demand fluctuations or major disruptions.

For example: (1) HP used their plants in Washington and Singapore as their supply base to produce inkjet printers to mitigate the risk associated with sole sourcing. HP used the Singapore plant for the base volume production and used the Washington plant to produce the excess of the base volume to handle regular demand fluctuations and it can also be used to maintain continuous supply of materials when a major disruption occurs. (2) Li and Fung's 4,000-supplier network offers Li and Fung great flexibility to shift production among suppliers in different countries quickly when a disruption occurs in a particular country.

(4) ***Make-and-buy.*** When facing potential supply disruptions, a supply chain is more resilient if certain products are produced in-house while other products are outsourced to other suppliers.

For example (1) **Hewlett-Packard** (HP) used to make a fraction of their Desk Jet printers at their Singapore factory and outsourced the remaining portion of their production to a contract manufacturer in Malaysia. (2) **Zara** produce their fashion items at their in-house factories and outsource other basic items to their suppliers in China. This make-and-buy strategy offers flexibilities that allow firms to shift production quickly should a supply disruption occur.

(5) ***Economic supply incentives.*** In many instances, the buyer does not have the luxury of shifting production among different suppliers because of the very limited number of suppliers available in the market. To gain the flexibility of shifting production among suppliers, the buyer can provide certain economic incentives to cultivate additional suppliers.

For example, In October 2004, Chiron, one of the remaining two vaccine-makers for the US market, was suspended due to bacteria contamination at Chiron's Liverpool plant. Facing a shortage of 48 million flu shots from Chiron, the US government could initially offer flu shots only to those who belonged to certain high-risk groups. To avoid this kind of fiasco in the future, the US government could consider offering certain economic incentives to entice more suppliers to re-enter the flu vaccine market.

(6) ***Flexible transportation.*** Three basic approaches for adding more flexibility in a proactive manner

- 1) *Multi-modal transportation.* To prevent the supply chain operations from coming to a halt when disruptions occur in the ocean, in the air, on the road, etc. some companies utilize a flexible logistics strategy that relies on multiple modes of transportation. This flexible logistics strategy won the hearts of many Japanese when Seven-Eleven Japan used 125 motorcycles and seven helicopters to make rush deliveries of 64,000 rice balls to earthquake victims in Kobe shortly after the earthquake that destroyed many roads in the late 1980s.
- 2) *Multi-carrier transportation.* To ensure continuous flow of materials in the case of political disruptions (landing rights, labor strikes, etc.), various air cargo companies have formed an alliance called Sky Team Cargo that will enable them to switch carriers quickly in the event of political disruptions. Moreover, this alliance provides low-cost global deliveries to 500 destinations in 110 countries.
- 3) *Multiple routes.* To avoid a complete shutdown, various companies are considering alternative routes so as to ensure smooth material flows along the supply chains in the USA. For example, due to long delays at the west coast ports and heavy traffic jams along various west coast freeways, some east coast companies are encouraging shippers to develop new routes in addition to the traditional route (i.e. ocean freight from Asia to the west coast and then rail transportation from the west coast to the east coast). Specifically, after the west coast ports were shut down for 2 weeks in 2002, some shippers considered shipping various manufacturing goods from Asia to east coast ports via Panama Canal.

(7) *Revenue management via dynamic pricing and promotion.* It is a common mechanism for selling perishable products/services. For instance, when selling limited seats on an airplane with uncertain demand, airlines have always adjusted their ticket price dynamically to meet uncertain demand with limited supply. Revenue management via dynamic pricing and promotion can also be an effective way to manage demand when the supply of a particular product is disrupted.

For example, when Dell was facing supply disruptions from their Taiwanese suppliers after an earthquake in 1999, Dell immediately deployed a contingency plan by offering special “low-cost upgrade” options to customers if they chose similar computers with components from other suppliers. This dynamic pricing and promotion strategy enabled Dell to satisfy its customers during a supply crisis.

(8) **Assortment planning.** Retailers have used assortment planning (the set of products on display, the location of each product on the shelves and the number of facings for each product) to influence consumer product choice and customer demand. Assortment planning can be used to entice customers to purchase products that are widely available when certain products are facing supply disruptions.

(9) **Silent product rollover.** Under the silent product rollover strategy, new products are “leaked” slowly into the market without any formal announcement. As such, customers are not fully aware of the unique features of each specific product and they are more likely to choose the products that are available instead of those products that are out of stock or being phased out.

For example (1) Swatch produces each watch model only once, Swatch utilizes the silent product rollover strategy to launch new watches so that its customers will view all available Swatch watches as collectibles. (2)Zara launches its new fashion collection quietly. Since Zara does not usually repeat the production run for the same design of clothes, many of Zara’s fashion-conscious customers purchase the clothes available at their stores right away.

3.6.1 Challenges created by Robust Strategies to handle Supply Chain Risks

While it is clear that these nine strategies are beneficial under normal circumstances and during a major disruption, they also create the following challenges.

- *Costs versus benefits.* Some firms may express concerns regarding the requisite costs associated with these robust strategies, while others would recognize the additional benefits. At a conceptual level, these robust strategies would enhance the competitive

position of a firm, especially when other firms' supply chains are more vulnerable to disruptions.

- *Strategic fit.* Even though these strategies enhance a firm's capability to manage supply and demand better, they may not fit the firm's overall business strategy. Two examples are offered. First, suppose a firm has chosen to reduce product variety as a way to rationalize its product lines, then the value of the postponement strategy is diminished. Second, if a retailer has positioned itself as an "every day low price" store, then the dynamic pricing and promotion strategy is incongruent to the retailer's strategic position in the marketplace.

- *Proactive execution.* A robust strategy is useless unless a firm can execute the strategy in a proactive manner.

3.7 Barriers to Supply Chain Risk Management

There are some barriers in practice which foreclose a more rapid increase of supply chain risk management importance. These barriers comprise company internal aspects as well as aspects of the entire supply chain.

Two closely related barriers, **the lack of transparency** and the **insufficient trust** within the network, are mainly responsible for the slow implementation of supply chain risk management in practice (Kersten, Hohrath and Böger, 2007). Due to the lack of transparency, companies are not able to recognize the current sources of their supply and demand side risks in most cases. (Svensson, 2004) and (Jüttner, 2005) assume that the majority of risks is invisible to companies as the visibility in supply networks still seems to be small and the transparency appears to be low. However, most supply chains comprise of much more members; most companies can only take their own risks and those of their direct partners into account. In addition, a lack of transparency leads to an insufficient confidence along the chain (Christopher and Lee, 2004). (Spekman and Davis, 2004) assume that a lack of confidence leads to companies' fear that their partners may behave opportunistically. Therefore, another potential consequence of such a lack of confidence shows competitive rather than cooperative behavior in the same supply chain.

Additionally, the **lack of understanding** and the **shortage of qualified employees** are investigated as potential barriers of SCRM. The lack of understanding seems to be more important than the insufficient qualified employees, especially for managing risks

However, many companies apply methods related with supply chain risk management despite of these barriers.

3.8 Characteristics of an Effective Risk Management Program

In order to improve the effectiveness of risk management across supply chains and transport networks, company's risks need to be better quantified and made more visible. Companies struggle to quantify the risk exposure of their own organizations due to a lack of understanding, standardized metrics and relevant and up-to-date data on supply chain risk; assessing systemic global exposure is difficult without a platform to share data and information. A study between June and August 2011 by the Business Continuity Institute, found that the impact of disruptions on corporate performance is often insufficiently understood and quantified. The study concluded that 85% of respondents had suffered at least one significant supply chain disruption in the last 12 months. However, 26% of the respondents to the Forum's supply chain and transport risk survey could not estimate the financial impact of disruptions on their business (Supply chain resilience, 2011). As a result, successful risk management programs should have the following common characteristics:

1. Supported organizationally from top to bottom
2. Authorized by an appropriate legal authority
3. Based on clearly identified threats
4. Managed by a standing risk management group that either continuously or at defined intervals re-evaluates the risk management program.
5. Communicated clearly to the private sector and public
6. Supported through inter-agency communication and information sharing
7. Implemented using computerized risk management systems to increase processing capacity and help drive objective determinations that can be supplemented by field observations and which

8. Well trained human resources
9. constant improvement program (iadb.2010)

3.9 Supply chain risk and performance

Supply chain risk is an event that adversely affects supply chain operations and hence its desired performance measures, such as chain wide service levels and responsiveness, as well as cost. It includes both the uncertainties inherent in the operational aspects of supply chain activities, such as uncertain supply and demand, as well as disruptions to its operations resulting from natural and human-inflicted disasters (Tang, 2006) . Researchers discuss the elasticity of supply chain performance, which Sheffi (2005) calls Supply Chain Resilient with the aim of minimizing the effect, avoiding any future risk event, as well as quickly returning to business.

Organizations need to be aware of the potential impact on their risk profile to achieve efficiencies and cost reduction opportunities in supply chain and transport processes. Southwest Airlines reduce costs associated with maintenance, spare parts and training by taking strategic decision to operate a uniform aircraft type. However, when a hole appeared in the roof of one aircraft in April 2011, the airline had to ground the entire fleet of 79 aircraft and cancel 300 flights while the fault was investigated “BBC, 2011” . From this example it is concluded that supply chain risk management failure can have a great impact on the performance and reputation of an organization. It is critical for both the public and private sectors to understand and mitigate risks at every juncture of supply chain and transport networks.

CHAPTER – 4: OVERVIEW AIRLINE INDUSTRY

4.1 Overview Airline industry

Over the past decades the airline industry has faced very significant challenges in its operating environment, including high and volatile fuel price and an economic recession that has reduced the demand for travel. For example, if the operating cost of fuel in 2001 was 10 percent, in 2011 it has risen to 35 percent and it was 40 percent all-time high in 2008. As a result of these challenges the airline industry has faced remarkable financial crises that have led many airlines bankrupt in the last decade. These changes of the operating environment in the airline industry have challenged the company's ability to sustain on its old business model and it promoted companies to go for low cost business model.

In recent years the airline industry has shown impressive changes. This sector has gone through a bigger change on both supply and demand side. Most the countries in the world these changes is not only driven by the technological changes but, the improvements of the cultural factors, institutional factors and legal aspects etc. (Keynes, 2009). Among them, the legal and institutional aspects affect the market structure of the airline industry. On the other hand, cultural factors of the airline industry influence its characteristics. Together all the above factors influence the airline industry to reshape its characteristics, products and pricing strategy and effect on the cost and revenue structures.

Airline provides the only transportation network across the world and it is very important for the global business development. According to Air Transport Action Group (ATAG), 2013, in 2011, over 2.8 billion passengers were carried by the world's airlines. Air transportation is very essential for the faster movement of passengers and cargo shipment around the world. Air transport carries around 0.5% of the volume of the world trade shipments and it is 35% by value (ATAG, 2013). Deliveries of fresh produces from Africa to the UK alone support the livelihoods of 1.5 million people (ATAG, 2013).

To be able to compete and widen their air traffic market, airlines have improved their business models applying new business strategies to reduce cost operations, drop down fares, and maximize profits. Nowadays, it is becoming more difficult to differentiate

between airline business models. Full service carriers (FSC) are reducing costs applying LCC strategies in short-haul operations to compete against low-cost carriers (LCC). Charter carriers achieve the lowest costs, and recently new high fare airline business model has appeared for the business class market. Guillen and Ashish (2004) established that airline business models can be defined with significant differences in network structure and airport choice. In the aviation system there are four main entities, supply entity, demand entity, inside entity and outside entity, as described below. Any disturbance in these entities potentially leads to risks or opportunities.

- Supply entity: produce air transport service directly or indirectly. This entity contains many business forms. Airline, airport, maintenance and ground service, aircraft manufacturer, and regulator.
- Demand entity: used air transport service directly or indirectly. This entity are passenger, travel agent and others customer that used air transport service.
- Inside entity: influence directly in aviation system, inside entity is government and other political organization.
- Outside entity: influence indirectly in aviation system, this entity can be controlled by implemented technology. Outside entity is nature conditions like climatology and geographical conditions.

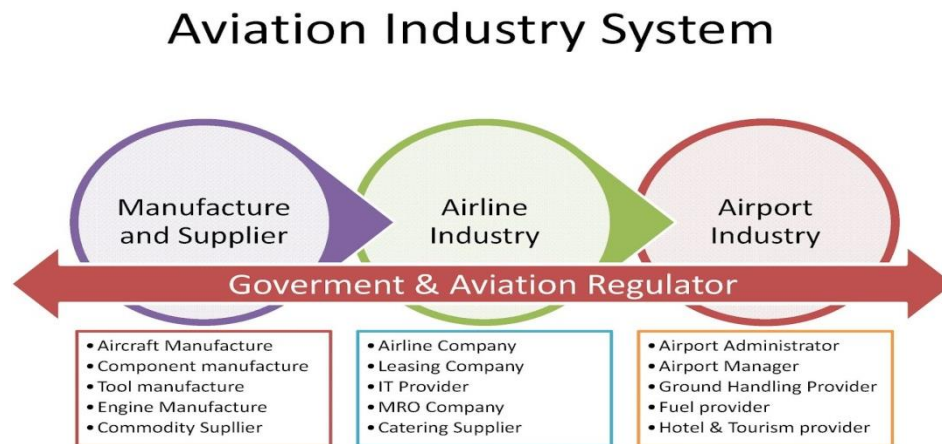


Figure 8: Aviation Industry System

Source: Aircraft-MRO 2012

4.2 Air Travel Demand Elasticity¹

The demand for air travel is sensitive to changes in air travel prices. To ensure that air transport policies are effective, reliable estimates for demand elasticity are essential. Without it, uncertainty over demand leads to ineffective or counter-productive decisions. However, the degree of sensitivity (i.e. its demand elasticity) will vary according to different situations. The elasticity of air travel demand varies according to the coverage and location of the market in which prices are changed and the importance of the air travel price within the overall cost of travel. There often appears to be some confusion in policy discussions about the sensitivity of airline passengers to the price of travel. This has increased as the industry has changed, with the Internet increasing price transparency, deregulated markets and no frill ²carriers increasing competition. The appropriate value of demand elasticity will vary in accordance to the context in which they are considered. For air transport there are five main levels for which demand elasticity can be estimated (IATA, April 2008)

- Price Class Level. This the most disaggregate level, where passengers make a choice between different price classes (e.g. first class, business class, economy class) on individual airlines.
- Airline / Air Carrier Level. This reflects the overall demand curve facing each airline on a particular route.
- Route / Market Level. At the route or market level (e.g. London Heathrow–Paris CDG or London–Paris), travellers faced with a price increase on all carriers serving a route (e.g. due to an increase in airport fees and charges), and have fewer options for substitution.
- National Level. At the national level, travel prices are increased on all routes to and from a particular country (e.g. due to a higher national departure tax), giving travellers fewer options for avoiding the price increase.

¹ Demand elasticity measure the change in the quantity demanded of a particular good or service as a result of changes to other economic variables, such as its own price, the price of competing or complementary goods and services, income levels and taxes

² No-frills airlines are airlines that offer low fares but eliminate all non-essential services, such as complimentary drinks snacks, in-flight entertainment systems, business-class seating etc

- Supra-National Level. This represents a change in travel prices that occurs at a regional level across several countries (e.g. an aviation tax imposed on all member states of the European Union).

It is essential to understand how the sensitivity of air transport demand affects policy and economic decisions, to ensure that these decisions are made on a more effective basis. Air transport policy decisions run the risk of being ineffective or even counter-productive, if the correct demand elasticity is not used.

4.2.1 Potential Sources of Demand Uncertainty

- **Cancellation**: unexpected gaps in the arrival sequence. Typically, this occurs when an air carrier fails to notify of a flight cancellation, but other reasons (e.g. mechanical and upstream delays, flight diversions) are also possible.
- **Pop-ups**: are flights that arrive at the airport but were not expected. Pop-ups are usually general aviation aircraft, military aircraft, or last-minute flights created by scheduled carriers.
- **Aircraft drift**: represents the situation in which a flight deviates from its assigned arrival time. The primary causes for this are en-route congestion and late departure from their origin airports. Although flights can arrive early, they tend to arrive later than their assigned arrival time. Significant drift is commonly caused by en-route congestion or departure delays.

4.3 Aviation Crisis

Since the airline industry is exposed to more risks compare to other industries, risk management became one of the most important aspects in aviation industry. Zea (2002) and Loudon (2004) believe that airlines need to move to the new level of risk management and that they can benefit greatly by managing these risks in a better way.

First of all: operational risk. Aircraft operational disruptions still represent a great threat to airlines although safety has improved as a result of significant technological developments in air transport. In addition, system malfunction greatly impacts operations, due to the necessity for seating reservations and carrying out boarding procedures for many passengers in a short period of time. (Nomura, 2003)

Second: strategic business risks. The airline industry is a long term business planning needs various investments such as purchases of aircrafts, securing flight crews, and securing airport facilities. Moreover, aircraft is a very expensive and purchased in foreign currency (imposing the risk of currency instability), which maintains a large amount of interest bearing debt. This would affect revenues and expenditures over a long time. Airlie industry is also facing risk to financing and currency exchange. Disaster risks also exist as in other industries (Nomura, 2003)



Figure 9: Airline risks

Source: Nomura (2003)

4.4 Impact of 11 September Simultaneous Terrorist Attacks in the USA

The airline industry has affected greatly as a result of the terrorist attacks in the USA, which occurred on 11 September 2001. These attacks were a shocking incident using aircraft as the tool of terrorism (Nomura, 2003). Since this attack, numerous airlines (both in the U.S. and abroad) have been experiencing a financial crisis unlike any in modern aviation history (Ito and Lee, 2004).

Reduction in demand: due to the federal government closed airports, canceling thousands of flights. However, even when the airports reopened, passengers were wary of air travel due to the increased security measures that have made traveling by air post-September 11th more time-consuming and far less convenient than before the terrorist

attacks (Ito and Lee, 2004). Airlines experienced at least a 30 % reduction in demand during the initial shock period immediately following the reopening.

Bankruptcy and Large-Scale Layoffs: several prominent American airlines declared bankruptcy not long after the 9/11 attacks, included US Airways and United Airlines (CNN, 2002). As a result of the massive financial losses due to canceled flights, lack of passenger demand, and increased expenditures for security, even airlines that did not have prior financial issues were forced to lay off high numbers of employees and to renegotiate labor contracts, such as the 7,000 employees laid off by American Airlines (Ito and lee, 2004) The week following the attacks, Congress put together a law that give faltering airlines up to \$10 billion in loans.

Indirect Effects of New Air Security Procedures: Airport security processes were one of the most immediate consequences of the 9/11 attacks. An economic study from Cornell University in 2007 showed that federal baggage screenings brought about a 6 percent reduction in passenger volume across the board, with a 9 percent reduction in the nation's busiest airports, totaling a nearly \$1 billion loss for the airline industry.

The airline industry is generally characterized by high fixed costs and low profit margins, primarily for aircraft fuel, debt service, personnel, and aircraft lease rentals. A relatively small change in the number of passengers or in pricing could have a disproportionate effect on an airline's operating and financial results as the expenses of an aircraft flight do not vary significantly with the number of passengers carried. In addition, the airline industry is highly competitive and is particularly liable to price discounting to occupy unsold seats.

CHAPTER – 5: DISCUSSION AND ANALYSIS

5.1 Egyptair Company Presentation

Egyptair is Africa's largest airline, established in May 1932 is the flag carrier airline of Egypt and a member of Star Alliance since July 2008. The airline is based at Cairo International Airport, its main hub, operating scheduled passenger and freight services to more than 75 destinations in the Middle East, Europe, Africa, Asia, and the Americas. The airline's logo is Horus. Egyptair is taking a lot of new strategies at the moment to expand and to reach more worldwide audiences. They are well on the right road and going in the right direction. Their main mission is to create value for their customers, employees, owners & stakeholders. Their vision is to deliver competitive customer service with true Egyptian spirit. Their fleet is total of 79. Main areas of business are passenger, cargo, catering, tourism, duty-free, medical services, in-flight services, supplementary Industries, maintenance & engineering. Their objectives are customer focus, both internal and external.

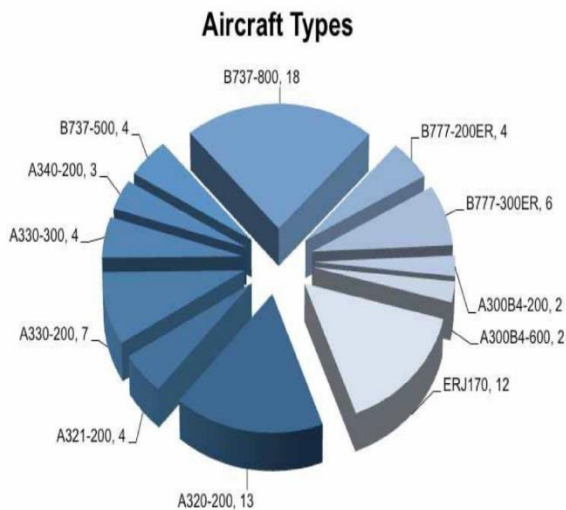


Figure 11: Egypt Air Aircraft Types

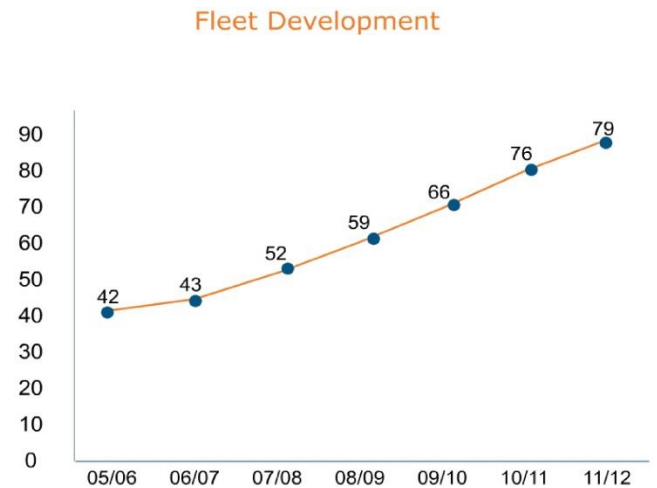


Figure 10: Egyptair Fleet Development

5.2 Analysis of Egyptair Risks

5.2.1 Risks from political crises, wars or natural disasters

Risks from political crises, wars, natural disasters and similar events and developments cannot be prevented. These risks are various low probability high impact events where a systematic presentation would make no sense. Responses to such events and developments are made on a case-by-case basis.

Political risks may have potential effects on global economic growth which have also an impact on Egyptair. For example the unrest situations in the Arab area have an effect on the oil price and therefore influence the Egyptair fuel costs. Although sudden events require an appropriate response, the first priority is to anticipate potential dangers and to take effective protective measures beforehand, if possible.

5.2.2 Environmental Risks

Environmental risks can materialize suddenly and without warning, as in 2010 and 2011 when sections of European airspace were closed because of the threat of volcanic ash in the atmosphere. Also, SARS and H1N1 flu pandemic has demonstrated the vulnerability of international air traffic at times of increasing mobility and globalization. Travel restrictions by public health authorities, uncertainty on the part of travellers and aircraft crews, and employee unavailability can mean that flights to certain destinations may no longer be possible or that flight operations have to be suspended altogether. Egyptair has professional medical services and emergency plans at the ready which are updated taking business continuity considerations into account.

5.2.3 Risks from Market Developments and Competition

After several successful years that have seen Egyptair gain access to the Star Alliance and launch its own regional subsidiary, Egyptair Express, Egypt's national carrier faces a major new competitive threat from Air Arabia's latest JV, Air Arabia Egypt. Air Arabia Egypt is a low cost carrier airline that is launched in Mar-2010, with a fleet of just two leased A320s. It will operate from multiple airports in Egypt to destinations in the Middle East, Levant, North Africa and Europe, posing a direct challenge to Egyptair. Two A320s

may not seem much in comparison with Egyptair, which has one of the larger fleets in the Middle East/North Africa region, but Air Arabia Egypt is sure to grow quickly.

Egyptair already appears to be moving to meet the challenge that Air Arabia Egypt presents head on. Egyptair dropped an order for two B777s, replacing them with eight B737-800s, which signaled an evolution in strategy following its entry into the Star Alliance. As B777 is a large air craft (capacity of 305 passengers) with high operational costs so during off-peak demand seasons there will be reductions load factor³ which will result in low yields as a result this aircraft will be inefficient for Egyptair, in contrast to B737-800 which is smaller in size (capacity of 162 passengers) which will be more efficient and flexible for Egyptair to use for variation in demand⁴. Moreover, a regional route strategy has been developed, aimed at strengthening links between the Middle East with Europe and North Africa. Egyptair's Jul-2008 entry into the Star Alliance added nine new airports to the alliance's network, crucially providing a fast growing in Middle East and North African markets. Also, the B737 order builds on the dozen that the carrier already had on order from Boeing. Egyptair has also had the opportunity over 2009 to focus on better developing its utilization of Cairo International Airport, which it already dominates in terms of capacity, as a key regional hub. Apart from the regional development, Egyptair is also focusing on domestic tourism traffic opportunities.

³ measures the capacity utilization of airlines as it is used to assess how efficiently a transport provider "fills seats" and generates fare revenue

⁴ Egyptair now has 20 of the air craft B737-800 and is planning to lease 6 more.

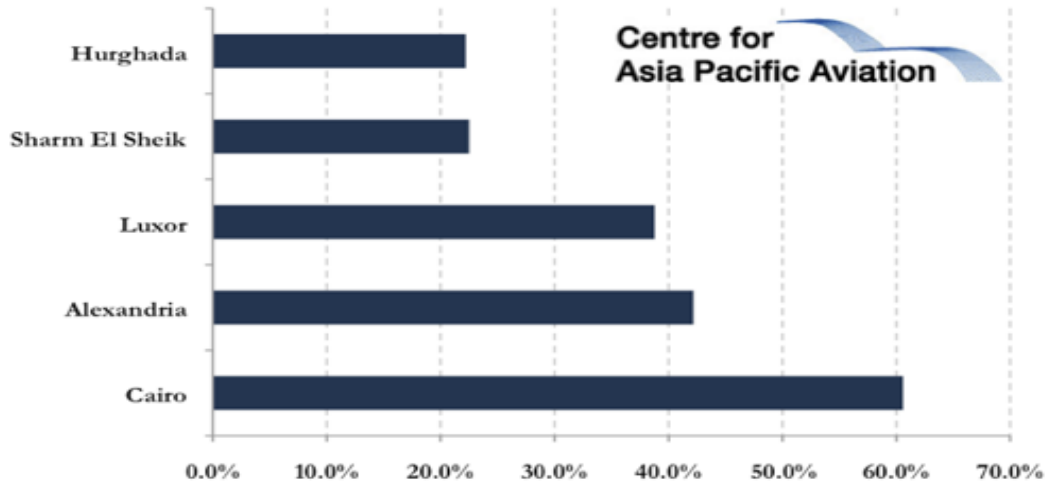


Figure 12: Egyptair market share at Selected Egyptian Airports

Source: CAPA (2009)

5.2.4 Fuel Price Movement Risk

Fuel is the only major cost item that has become significantly larger over time. Egyptair as a member of Star Alliance has adopted the new strategy determined by Star Alliance to reduce fuel consumption. Star Alliance has determined that if every carrier reduces fuel use by just 50 kg per flight, more than a million kg of fuel can be saved daily by Alliance member carriers. Egyptair reduction in fuel consumption is achieved through removing heavy, excess potable water, galley ovens, publications and unused catering. Egyptair also reduces Auxiliary Power Units⁵, and increased use of single engine taxiing⁶, engine washing and cutting the number of newspapers loaded to reduce weight. Egyptair turns its attention to air traffic management to increase fuel efficiency (Eng. Hussein Massoud, Chairman and CEO) which will result in yearly savings of some 4,000 tons of fuel. As mentioned by Egyptair CEO *“It’s also important to have good aircraft utilization, to reduce the amount of time they spend on the ground. We average around 11 hours a day flying time”*.

Egyptair will also use the Lido/Flight from Lufthansa Systems to benefit from more efficient flight planning processes and as consequence achieve additional fuel savings

⁵ that run generators to provide electricity on board and also provide cabin air conditioning when aircraft engines are switched off

⁶ is the movement of an aircraft on the ground, under its own power, in contrast to towing or push-back where the aircraft is moved by a tug.

Lido/Flight uses a number of parameters to calculate the optimal route regarding flight time, fuel consumption or costs for each flight. This can lead to fuel savings of up to five percent (Arabian Aerospace 2010).

5.2.5 Investment Risk

Egyptair has to keep investing in modernizing its fleet, its in-flight and ground products, its infrastructure and expand its services, if it is to hold its ground against the competition in general and against the still rapidly growing airlines from the Middle East in particular. EGYPTAIR wants to maximize returns on its routes by striking the right balance between demand, load, and yield with respect to its fleet. In 2010, Egyptair selected SAP, the world's leading provider of business software, to support the airline's growth and expansion plans by supplying solutions that improve the company's financial visibility and optimize route profitability (Global SAP 2010). This will help Egyptair with the latest decision-making tools required to fulfill its objectives.

5.2.6 Operational Risks

Assessing the risk events can give a guideline on what risk events Egyptair should focus on. The bow-tie method, as mentioned earlier in the theoretical part, is one way of doing this. The bow-tie examines the possible causes of the risk event, actions to reduce likelihood of event, actions to reduce consequences of the event and finally possible consequences of the event. Egyptair operational risks can be categorized into ground operations risks and flight operations risks. The bowtie method illustrated that these operational risks are mainly concerned with events of **loss of control, runway excursion, controlled flight into terrain, runway incursion, airborne conflict, ground handling and fire**. These risk events have been analyzed and evaluated as the most urgent and current issues for Egyptair. As a three-step process, Egyptair implement strategies to mitigate operational risks in terms of protecting the supply chain, responding to events, and continue business operations while recovering.

Figure 13: Egyptair Flight Operational risks

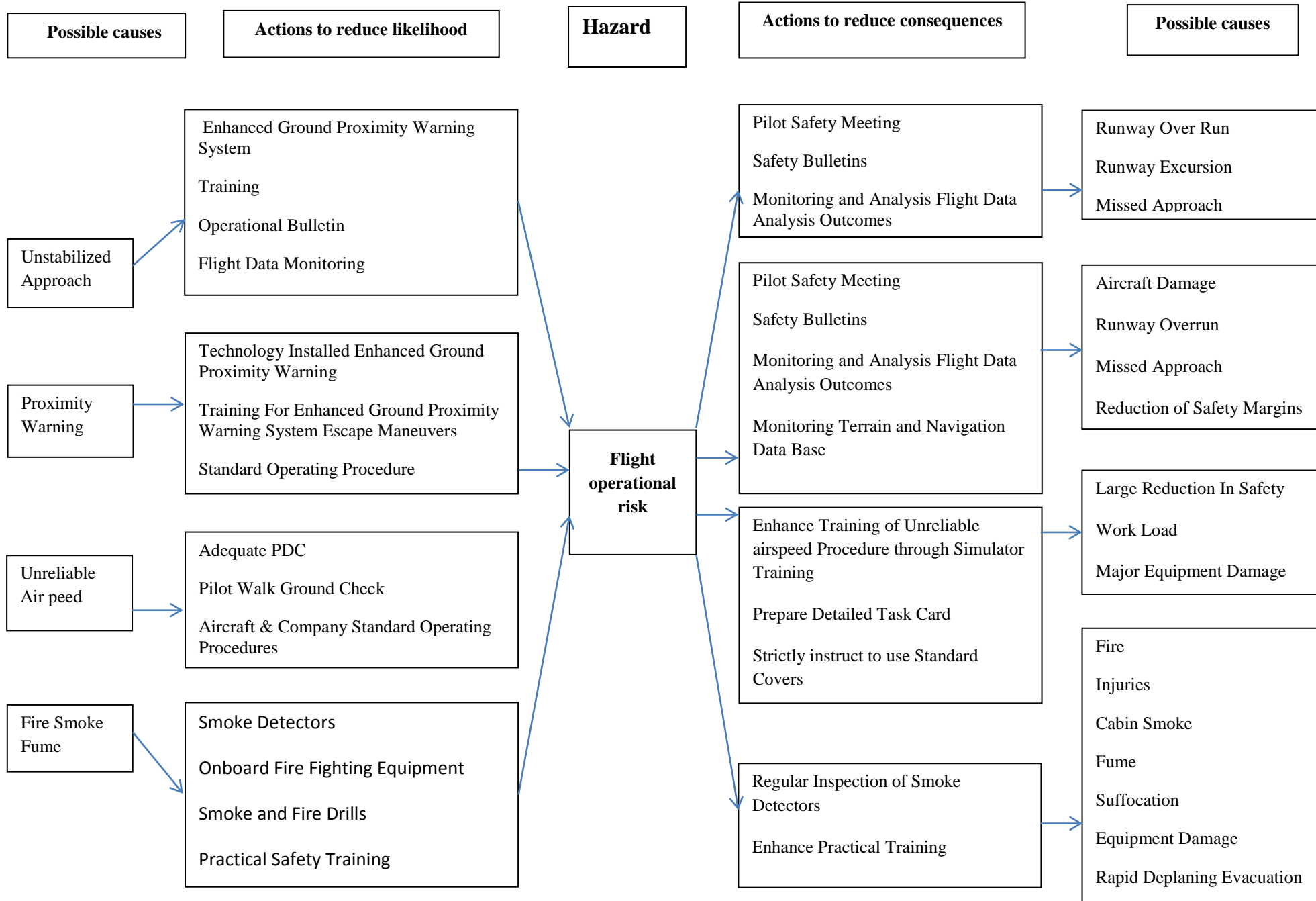
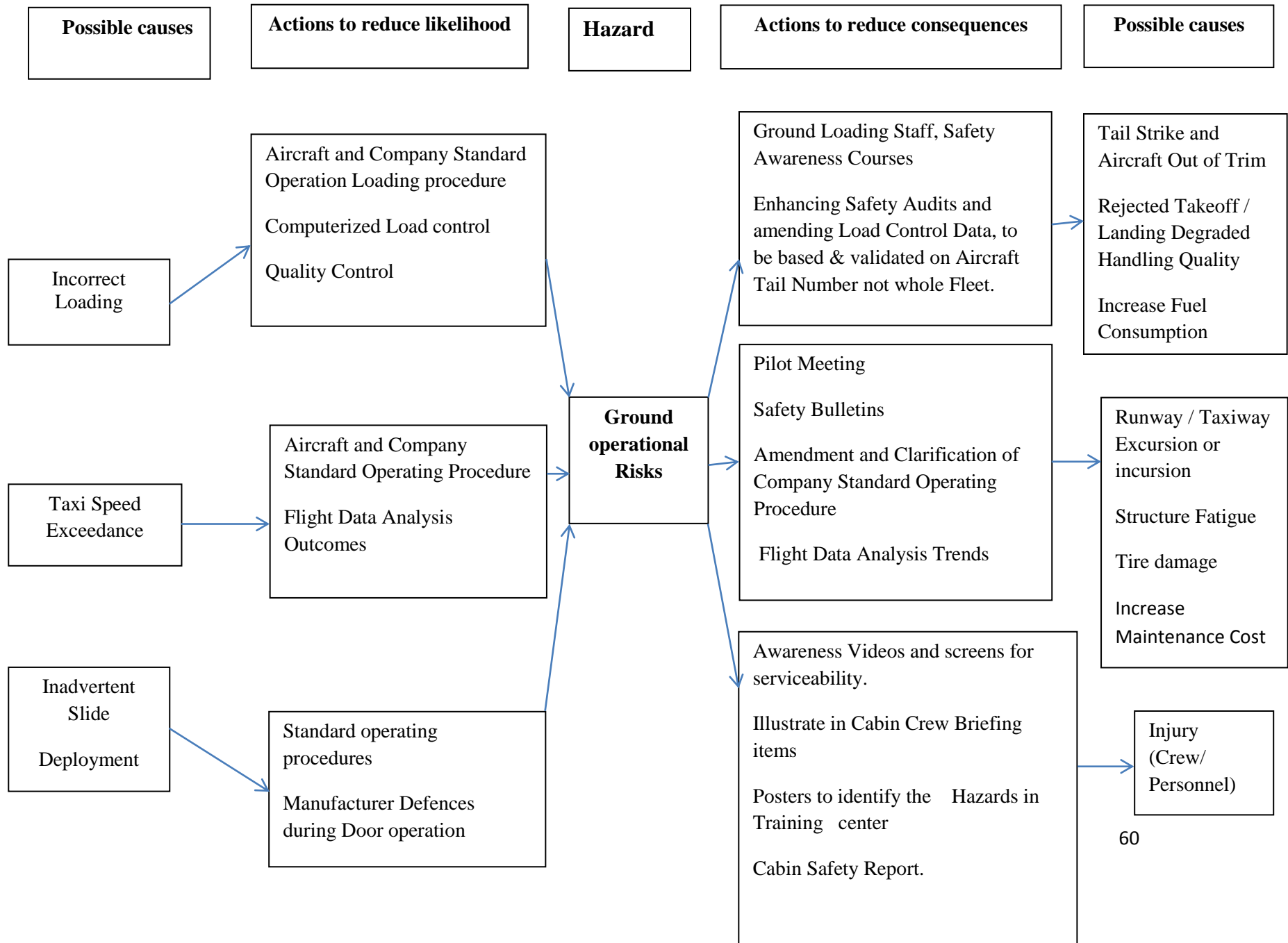


Figure 14: Egyptair Ground operational Risks



	Probability				
Impact	Difficult to happen	Never	Rare	Sometimes	Frequent Occurrence
Catastrophic					
High Risk			3	2	
Moderate Risk			1,4,5	7	
Minor Risk			6		
Neglected					

Figure 15: Egyptair probability Impact Matrix



Table 2: Egyptair Risk probability/Degree

Symbol	Risk Probability	Symbol	Risk Degree
1	Difficult to happen	A	Catastrophic
2	Never before	B	High risk
3	Rear	C	Moderate Risk
4	Sometimes happens	D	Minor Risk
5	Frequent occurrence	E	Neglected

1. Unstabilized approach
2. Proximity Warning
3. Unreliable Air speed
4. Fire Smoke Fume
5. Incorrect Loading
6. Taxi Speed Exceedance
7. Inadvertent Slide Deployment

Risks number 1, 4, 5, 6, and 7 are of moderate risks because they have moderate/major impact and their probability of occurrence is of sometimes/rare nature. Risks number 2 and 3 are of high significance in nature because their impact is high although proximity

warning has shown to be the more significant as its likelihood of occurrence is of sometimes while unreliable airspeed is rare to occur. The significance of all these risks is based on Egyptair at Alexandria airport head's knowledge, experience, observation and perception.

5.2.6.1 Operational Safety Culture in Egyptair

Egyptair with good safety culture is managed to successfully institutionalize safety as a fundamental value of the organization with personnel at every level in the organization sharing a common commitment to safety. One of key elements is effective support from top levels of the organization, for safety. It is necessary for senior management to demonstrate their commitment to safety in practical terms, not just verbally or only as long as safety is a no-cost item. Egyptair policy to act upon safety recommendations & its commitment to safety as long-term & safety initiatives are not the first items to be cut in terms of financial support when the organization is looking for cost saving. Egyptair safety error management program should lead to good safety culture.

5.2.6.1.1 Safety Policy:

Egyptair establish safety policy which defines the senior management's intentions in terms of commitment to ensuring that aircrafts are operating in safe condition safety policy was published and made known to all employees & subcontracted staff.

- It is Egyptair M&E Policy to:
 - Set safety standards
 - Ensures that safety standards are not eroded by commercial drives
 - Promotes safety culture
 - Encourages staff to report safety concerns without fear of in appropriate punitive action.
 - Makes effective use of our resources & do things right first time
 - Provides staff with appropriate tools, procedures & time to carry out tasks in accordance with procedure.
 - All levels of management are accounted for safety performance.

- Established the following to practice the safety policy.
 - Safety management system
 - Disciplinary policy based on culture concepts
- Safety is the responsibility of all employees & each one has opportunity to participate in developing safety standards & procedures.
- Provide the necessary training to build & maintain safety skills.

5.2.6.1.2 Safety Management System (SMS)

The ultimate goal of safety management system is to promote safety through organization activities & procedures by implementing safety standards & safety – related practices to keep the primary objective of safety of aircrafts, parts & components as well as staff equipment, tools & facility safety.

- Safety policy was published and issued to all the company staff as well as to the sub-contractors working under Egyptair quality system.
- Safety Management system is defined as systematic management of the risks associated with operational activities to achieve high levels of safety performance.
- Safety policy is reviewed periodically in yearly basis by Safety Review Board and in case of significant change.
- Egyptair selected safety performance indicator (SPI) as the percentage of maintenance related occurrences to the total number of certified maintenance activities over a period of time.
- Acceptable level of safety performance indicator for year 2009 is taken not to exceed 0.080% as a base line
- The objective of SMS is to reduce (SPI) with 5% every year.
- Egyptair is committed to ensure continual improvement of safety performance of staff & activities through personnel adequate safety training & continual training of human factors.

5.2.6.1.3 Functions of SMS and Responsibilities

Egyptair manager ensures that the safety related responsibilities are assigned to safety manager & to each senior director in his nominated area such as overhaul workshops senior director & A/C maintenance senior director, Material director & human resources

director. It is important that all above mentioned management personnel involve themselves unrestrictedly towards safety in practice on the field through actual facts not only verbally or only when safety related action do not involve any cost.

- Safety manager is nominated by the accountable manager & report directly to the accountable manager.
- Safety coordinators are nominated by each area directorate to deal on the field with safety related issues. (Appendix: 2 safety manager organization chart)
- Main functions of safety system are :
 - Focal point of the management of safety related major occurrences.
 - Analysis of risks.
 - Coordination / follow-up of human factors approach
 - Safety information feedback to the accountable manager
 - Promotion of safety within the organization.

5.2.6.1.4 Safety Management procedures

The procedures associated for hazard identification, risk assessment (Analysis / Investigation related to incidents / maintenance error) and mitigation process can be developed in accordance with the following considerations.

5.2.6.1.5 Hazard Identification Process

Any deviation / violation of manufacturer (Airworthiness) maintenance document warning or caution is considered as a potential source of hazard. Identification of hazards can be achieved by brain storming during safety management meetings through reviewing accident / incident investigation records from internal & external sources; this may include identification of potential human errors (factors) during maintenance activities which may affect the safety. SMS ensures the following items:

- Mandatory reporting
- Voluntary reporting
- Confidential reporting
- Reporting of hazards, events and / or safety concerns.
- Collecting & storing data
- Analyzing reports.

- Distributing the information from analysis

5.2.6.1.6 Safety Assessment & Mitigation Processes

Safety management policies & principles are based on assessment of safety significance of existing organization & future changes this would normally involve:

- Identification of functions being performed.
- High level risk assessment of the functions.
- Risk management adapted all safety related functions.
- Safety performance measurement.
- Corrective procedures that modify the original function to address inadequate performance.

Egyptair were among the early companies to obtain IOSA⁷ Certificate as the first audit took place in 2004 and the certificate has been renewed for 4 times in 2006, 2008, 2010 and 2012. The audit gone smoothly with no remarks at all and is expected to be renewed in 2014

5.3 Analysis of Egyptair Situation due to the 25th of Jan. Revolution Crisis

5.3.1 Identifying Risk

The 2011 Egyptian revolution took place following a public uprising that began on Tuesday, 25 January 2011 that led to the step-down of President Hosni Mubarak on Feb. 11. As a result, Egyptair business was affected following massive flight cancellations during the nearly three weeks of civil unrest in Egypt. By the 28th of January many tourists became nervous and wanted to leave the country, Internet, mobile service and

⁷ The IATA Operational Safety Audit (IOSA) program is an internationally recognized and accepted evaluation system designed to assess the operational management and control systems of an airline. All IATA members are IOSA registered and must remain registered to maintain IATA membership (

text messaging were interrupted. The unrest and curfews hit the operation to/from Egypt in addition that it was winter, the high season for tourism in Egypt.

5.3.2 Assessing risk

The airline lost EGP 700 million, Revenues in the first weeks of the revolution dropped by 80% due to grounding up to 40% of its fleet. In Feb-2011, travel at Egyptian airports collapsed two thirds flight operation decreased by 50%, Ticket sales shrunk by 60% and seat occupancy has fallen 50 % due to increased concerns to the region. By May-2011, the effects had eased, but airport data showed passenger numbers were still down by more than a third, with flight levels 29% lower than the previous May. Load factors have been hovering around 65%, compared with 75% pre-crisis. Moreover, yields have been impacted, as Egyptair has not been able to increase fares to offset the surge in fuel prices.

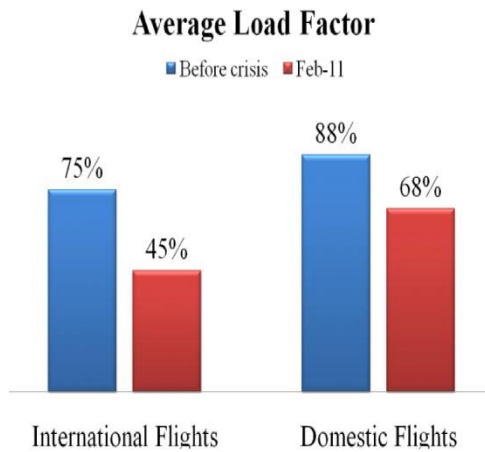


Figure 17: Average load Factor

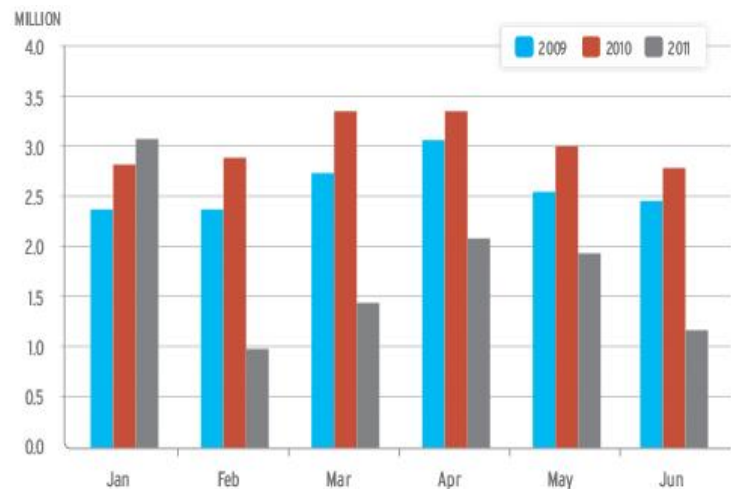


Figure 16: Egyptain Airport Passenger Traffic

Source: Airline leader. 2012.

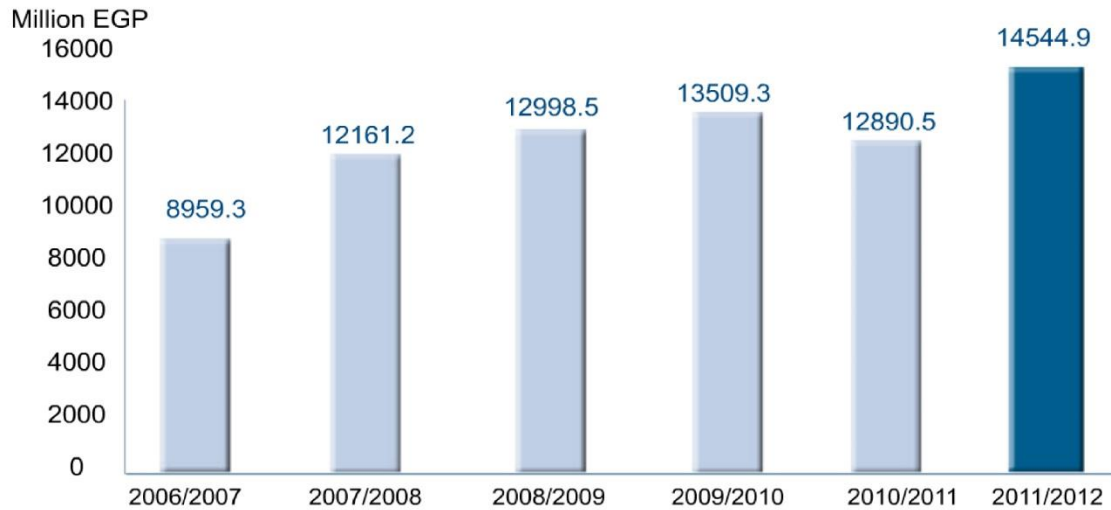


Figure 18: Egyptair Profits

Table 3: Egyptair Profits

Year	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012
Consolidated Profit or Loss	578.6	695.1	573	533.1	-2059.5	-3106.4

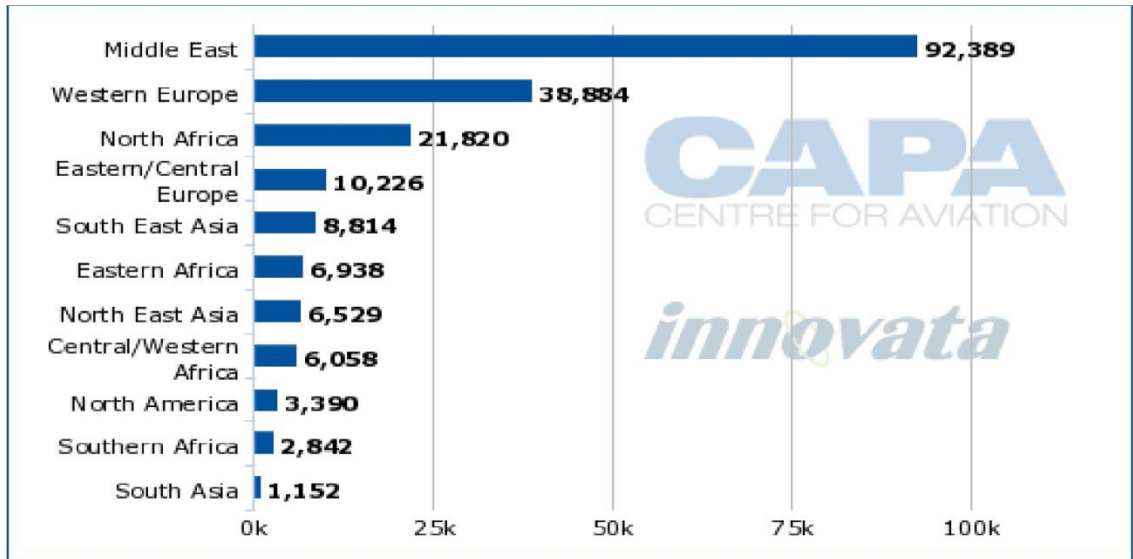
The figure and table above shows the effect of the 25th revolution on the profit of Egyptair. While profits reached a pick in 2007/2008 they started to decline in 2008/2009 and 2009/2010 due to global financial and economic crisis. However, those profits turned into losses by 2010/2011 and 2011/2012 due to the rescission resulting from the 25 of January revolution. Moreover, Due to these unstable situations many Egyptair employees had been unable to get to work , The few number of staff, who was able to get to work, worked endless hours under considerably difficult conditions to keep Egyptair flying as best as possible.

According to Mr. Wael al-Maddawy (Egypt’s Minister of Civil Aviation) “*Egyptair’s losses are huge, but not catastrophic, as they won’t lead to the closure or selling of the company*”

5.3.3 Handling Risk

In the aftermath of the crisis, Egyptair has made a significant restructure to its network that is designed to improve connections between Europe and Middle East, Africa and Asia.

- *Egyptair increased its focus on transfer traffic; that is, focus on creating flexibility to adapt demand variations. Although Cairo has traditionally not been a transit hub as it only accounts for 3% of Egyptair's traffic. For example, Egyptair re-time its flight from Bangkok, opting to have the aircraft sit on the ground in Thailand for several hours in order to improve connections once the aircraft lands back in Cairo. As a result this figure has increased to 12% and is expected to rise further. Also, capacity in the summer 2011 schedule was increased compared with summer 2010, to six European and three African destinations as part of the network changes.*
- *The network was also restructured to focus more on the Middle East, where demand has recovered more quickly, as Egyptians living in the region are now again returning home for visits; that is, focus on determining a 'less uncertain' share of the travel demand. In Jun-2011, services from Cairo to Abha and Medina in Saudi Arabia were launched as well as to Erbil and Baghdad in Iraq. Egyptair increase frequencies to Saudi Arabia including more than doubling Alexandria-Madinah from three times weekly to daily and Alexandria-Jeddah to double daily from 11 times weekly. Also, deploy B777-300ERs on flights to Riyadh and Dubai, where there is high demand.*
- *Egyptair has decided to hold off on any intercontinental route launches that are more dependent on tourism traffic and focus only on all these routes that cater mainly to point-to-point VFR traffic; that is, focus strategy on 'core' customers. As only about 10% of Egyptair's pre-crisis traffic was tied to tourism, it is more focused on the visiting friends and relatives (VFR) market.*



Egyptair international capacity, seats by region: 11-Mar-2013 to 17-Mar-2013

Source: CAPA – Centre for Aviation & Innovata

- *In Jun-2013 Manchester and Toronto were added to Egyptair network. Manchester is served five times weekly operating 720 one-way seats per week using a Boeing 737-800. Toronto is served four times per week with a Boeing 777-300ER, offering 1,356 one-way seats per week.*

Egyptair has also stuck with its original plan to take delivery of three A330-300s and two B737-800s. The two B737-800s were delivered in Jun and Nov-2011, while all three A330s are to be delivered in the third quarter of 2011 and take delivery in the first half of 2011 of the two new B777-300ERs initially earmarked for the new North American routes. As not to destroy its network, Egyptair has instead looked for opportunities to operate short-term charters. Egyptair will most likely lease planes, which could also include current or re-engined variants of the Airbus A320 or Boeing 737-800 for short-haul routes.

In Mar-2012 Egyptair signed a codeshare agreement with fellow Star alliance member Air Canada in Mar-2012 with Egyptair placing its code on Air Canada's London-Toronto and London-Montreal services. Air Canada in return placed its code on Egyptair's services between Cairo and London and Frankfurt.

More than two years after the January 2011 revolution, Egyptair continues to incur massive losses as it struggles to recover from the effects of the popular uprising, when it was forced to temporarily ground up to 40% of its fleet. Egyptair is betting there is enough local and transit demand to keep the carrier from hemorrhaging and this could be a way to it be in position to quickly resume profitable expansion.

From the above analysis, it is concluded that as a direct effect of political instability, there was a great decrease in revenues due to a decrease in the number of passengers, a large increase in costs due to strengthening in security systems and appreciation of insurance premiums. As an incidental impact, Egyptair was forced to review service routes, review scales of investing in businesses, and even now some negative effects from this political risk still remain. Another point of view to this political risk as positive aspects in that reviews were conducted as a turning point. First, risk consciousness has been changed and a review of cost structures has commenced so as to correspond to risk.

CHAPTER-6: CONCLUSION AND FUTURE RESEARCH

6.1 Conclusion

Undoubtedly, in current era, the risks including upstream, downstream or in its operational areas that exist in company's complex supply chain networks are critical. It is very important to understand the entire supply chain system, the consequences of the potential risks and the actors involves in it, in order to design suitable actions to mitigate these risks effectively. There are always challenges in analyzing the risks within the supply chain network but the manager and his team should be proactive and up-to-date to first identify risks and then to mitigate these risks from the company's perspective. If a company is not proactive in risks mitigation in the supply chain network then the business continuity may suffer dramatically, and reactive actions to handle risks may be reduced to 'firefighting' activities. This thesis investigated the major risks arising in Egyptair, and actions designed to mitigate, handle them. Below, the findings to the two major research questions are concluded.

- **Research Question 1: What are the most significant supply chain risks in Egyptair?**

The international airline industry is complex, dynamic and subject to rapid change and innovation. Egyptair, as concluded from the analysis, is facing various types of risks; Political, The entire Egyptair supply chain team is responsible for risk identification in their respective operational areas within the company. Based on electronic interviews performed with Egyptair managers, a number of *flight and ground operational risks are identified*; risks which have a great concern with loss of control, runway excursion, controlled flight into terrain, runway incursion, airborne conflict, ground handling and fire. The *risk rating matrix* method is used to prioritize/rank the identified risks, based on their impact on the business and likelihood of occurrence. Out of the above mentioned identified risks, the *political risk of the 25th January revolution* was the recent significant risk in Egyptair and its signification is based on Egyptair managers experience, knowledge, and perception and on ground situation.

- **Research Question 2: What strategies Egyptair utilizes to mitigate supply chain risks?**

Based on the mitigation strategies discussed in the theoretical part of the thesis Egyptair is depending on different mitigation strategies of risk avoidance, risk reduction and risk acceptance, and creating flexibility to adapt different situations. Flexibility creation is potentially the main mitigation strategy at Egyptair. Information and knowledge improvements are also very important to reduce the risks and improve safety. For example, to reduce the risk of travel demand uncertainty (partially arising from the competition with Air Arabia, a low cost Egyptair replaced an order of B777 air craft with B737-800 which is more *flexible and efficient in dealing with demand variations*.

It is concluded that Egyptair is utilizing a good strategy in handling operational risks in its two types with that it was able to obtain IOSA Certificate four times, and expected to be renewed by the end of this year.

Taking the political risk of the 25 of January revolution, one major risk mitigating action of Egyptair is to separate out "less uncertain share of the travel demand" (that is, Middle East, 'core ' customers, Manchester & Toronto) and create stable schedules for this market share. Furthermore, flexibility to adapt changes is created by focus on the transfer traffic. which are considered to be the two major aspects of creating flexibility to adapt changes. From a theoretical point of view, separating between 'less uncertain' and 'highly uncertain' share of the travel demand, and creating stable schedules for the less uncertain part, and flexible schedules to adapt changes for the uncertain part (here, by focus on transfer traffic), are two major aspects of creating flexibility to adapt changes.

As an **overall conclusion**, focusing on identifying and concretizing risks, can help companies in developing effective risk management strategies and robust business environments. Risk management strategies and actions potentially differ between different departments within the same organization, and risks identified in one department are potentially to be treated at different levels in the organization. For example, market risks are potentially treated at a strategic level (by purchasing a flexible fleet) or at tactical planning level (defining the uncertain and less uncertain shares of demand and planning for them separately).

In addition, the prioritization of certain types of risks differ in time, as the internal and external situations surrounding the organization changes by time, enhancing the need for continuous revisions of risk management strategies and monitor the mitigation and robust plans to ensure their validity. Risk management needs further attention from researchers and practitioners, to help organizations adapt to the highly uncertain contemporary market situation.

6.2 Future Research

This study may provide the basis for future research in airline risk management, with particular focus on airlines facing vulnerable political and economical environments. Another dimension regarding future work may involve future studies on risk tracking and traceability in upstream supply chain.

This case study was limited to qualitative investigations to identify risks and actions to mitigate risks. Quantitative approaches are recommended for further investigations in Egyptair, particularly in crew planning and flight scheduling.

6.3 Limitations

The thesis has some limitations. To conduct a case study on the airline industry that is characterized by continued and rapid growth for demand in its services and to cover a company that has nine large subsidiaries, with each of its own business areas, has been more extensive than anticipated. Therefore, the discussion in this thesis is more-or-less a broad overview, with focus on the main risk aspects in the entire Egyptair. For a better understanding on the risks facing the company, each of the subsidiaries should be examined individually. This has not been possible within the time frame of this thesis.

It has also been difficult to get accurate information about the company studied. This has resulted in more use of secondary data compared to what was expected before the work on this thesis commenced. This gives a limitation since the data presented in this thesis may not be accurate for the current situation for Egyptair.

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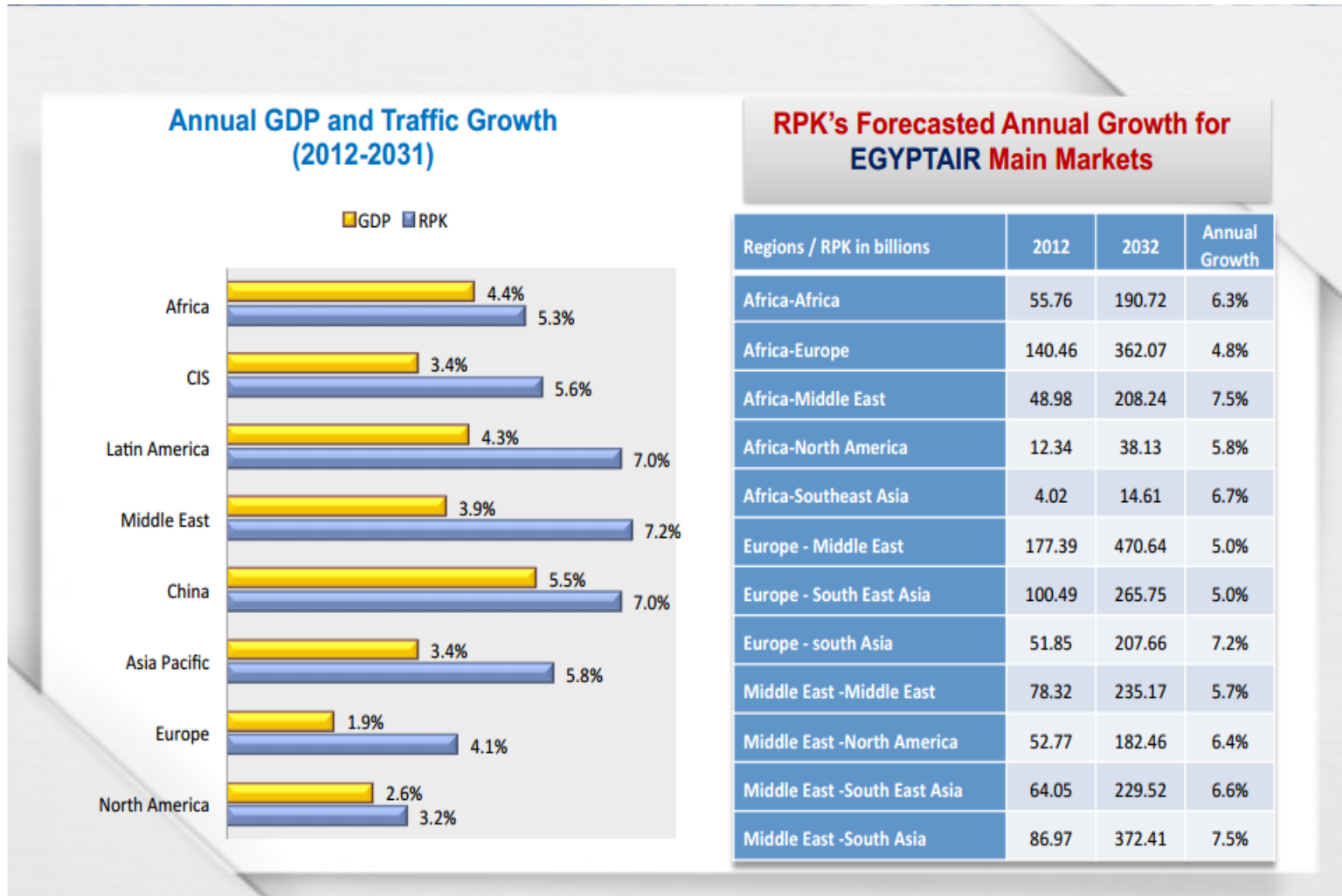
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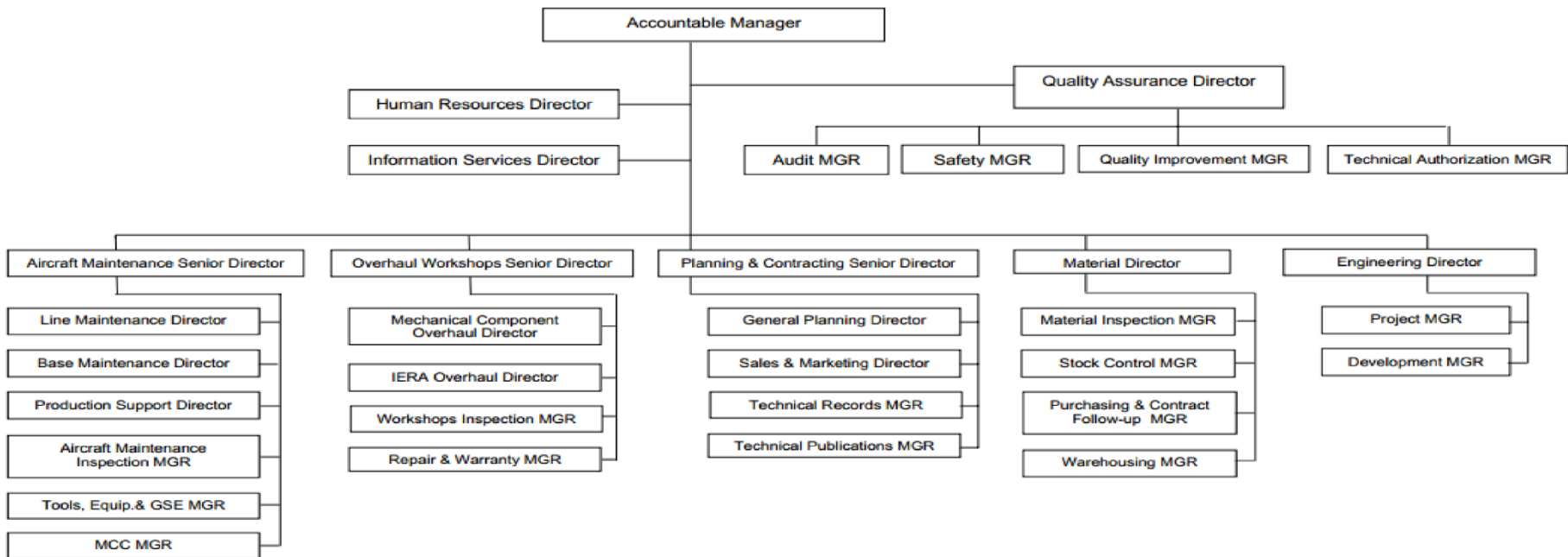
8 APPENDIX

Appendix 1: Egyptair Forecasted Annual and Traffic Growth



Appendix 2: Safety Management Organizational Chart

Management Organization Charts



Appendix 3: Egyptair Operational Risk Management at Alexandria Airport:

N	Work Description	Determine Work Risk										Decision		Procedure to Remove or Reduce the Risk	
		Risk Probability					Risk Degree					Risk Value	Accept the Risk		Can't Accept
		1	2	3	4	5	A	B	C	D	E				
1	Small Distance Between Planes				√			√				4B		√	New Plan for Planes Distribution from Egypt Air Airports Company
2	Fire Truck stands close to Ground Equipments maneuvering area				√					√		4D		√	Contact Fire Department
3	There is no shelter for all ground equipments			√				√				3B		√	Required building ground equipments shelter (Development Tender)
4	Some workers didn't use safety equipments			√					√			3C		√	Strong warning for all workers to use safety equipments on aircraft tarmac
5	Shortage of some tools in back shop				√				√			4C		√	Contact ground station department to review and obtain tools for back shops
6	Bad shop floor				√				√			4C		√	Maintain shop floor (Development Tender)
7	Clogged drainage of equipment washing area			√						√		3D		√	Replacement of the drainage system
8	Some Passengers luggage are overweight which may injury shipping workers					√			√			5C		√	Contact Egypt Air airlines to stick to weight limits
9	Lack of staff of the Department of Administrative Affairs				√				√			4C		√	Risk under control can be recovered by an administrative decision
10	Quality					√			√			5C		√	Quality control department should train some employees on quality assurance
11	Shortage of ground crew personnel affect aircraft handling					√			√			5C		√	Train ground crew

#	Task	Risk due to that task		Risk Value		It's Probability	Value	Risk Degree	Value	Can be Removed	Procedure to Remove or Reduce the Risk
				Accepted	Not Accepted						
1	Work on Terrain	1	Foot injury due to not wearing safety shoes		√	Frequent	5	Major	C	Yes	Wear safety shoes
		2	Ear injury due not wearing ear plugs		√	Frequent	5	Major	C	Yes	Wear ear plugs
		3	Injury due to not wearing safety vest		√	Rear	3	Minor	D	Yes	Wear safety vest
		4	Longshoremen hands injury due to not wearing safety gloves		√	Rear	3	Minor	D	Yes	Wear safety gloves
		5	Injury due to walk or stand on luggage belt		√	Occasional	4	Major	C	Yes	Notify longshoremen never walk on luggage belt
		6	Injury due to jump from moving ground equipment		√	Occasional	4	Major	C	Yes	Notify workers never jump from moving ground equipment
		7	Injury due to walk near jet engine		√	Occasional	4	Major	C	Yes	Notify workers never walk near jet engine
		8	Injury due to walk near loading area(Entrance of luggage trucks)		√	Occasional	4	Minor	D	Yes	Notify workers never walk near loading area
		9	Injury of hands of workers in moving parts		√	Occasional	4	Major	C	Yes	Notify workers to be care of moving parts
		10	Injury of longshoremen due to bad estimation of luggage weights		√	Occasional	4	Major	C	Yes	Notify workers to good estimation of luggage weights

#	Task	Risk due to that task		Risk Value		It's Probability	Value	Risk Degree	Value	Can be Removed	Procedure to Remove or Reduce the Risk
				Accepted	Not Accepted						
2	Equipment on Terrain	1	Operation of ground equipment by an untrained personnel		√	Frequent	4	Major	C	Yes	Train Personnel on Ground Equipments
		2	Not pulling the hand break when parking and left transmission engaged		√	Rear	3	Major	C	Yes	Notify workers with safety instructions when working on flight line
		3	Park equipment on distance less than safety limits from Aircraft		√	Rear	3	Minor	D	Yes	Notify workers with safety instructions when working on flight line
		4	Drive with high speed when approaching near Aircraft		√	Rear	3	Major	D	Yes	Notify workers with safety instructions when working on flight line
		5	Not using wheel jakes when equipment not in use		√	Rear	3	Minor	D	Yes	Notify workers with safety instructions when working on flight line
		6	Not inspecting ground equipment before use it		√	Rear	3	Major	C	Yes	Notify workers with safety instructions when working on flight line
		7	Not to gather equipment hoses or cables before moving it		√	Improbable	1	Major	C	Yes	Notify workers with safety instructions when working on flight line
		8	Transfer luggage on ground equipment		√	Improbable	1	Minor	D	Yes	Notify workers with safety instructions when working on flight line

		9	Not putting wheel jakes and studs for luggage trucks		√	Rear	3	Major	C	Yes	Notify workers with safety instructions when working on flight line
		10	Not leaving suitable distance between equipments and Aircraft		√	Rear	3	Major	C	Yes	Notify workers with safety instructions when working on flight line

#	Task	Risk due to that task		Risk Value		It's Probability	Value	Risk Degree	Value	Can be Removed	Procedure to Remove or Reduce the Risk
				Accepted	Not Accepted						
2	Equipment on terrain	11	Didn't check brakes twice before approaching Aircraft		√	Rear	3	Major	C	Yes	Train Personnel on Ground Equipments
		12	The collision of rubber fenders of ladders, luggage belts, and food carts with Aircraft		√	Rear	3	Major	C	Yes	Notify workers with safety instructions when working on flight line
		13	Not putting phosphoric tab on the ground equipment sides		√	Rear	3	Minor	D	Yes	Putting phosphoric tab on equipment sides at workshop
		14	No beacon or defective beacon on moving equipment		√	Rear	3	Major	D	Yes	Putting beacons or repair defective beacon

#	Task	Risk due to that task		Risk Value		It's Probability	Value	Risk Degree	Value	Can be Removed	Procedure to Remove or Reduce the Risk
				Accepted	Not Accepted						
3	Operations on the plane	1	Wrong opening and closing of aircraft storage doors		√	Improbable	1	Major	C	Yes	Notify workers to use Aircraft instruction according to Aircraft type
		2	Not to leave the appropriate clearance between the equipments and the plane to avoid vertical movement up and down of the plane during loading and unloading operations		√	Rear	3	Major	C	Yes	Notify workers with safety instructions when working on flight line
		3	Lack of caution during loading and unloading operations which cause damage to the Aircraft doors		√	Rear	3	Major	C	Yes	Notify workers to take caution during loading and unloading operations to avoid damage to the doors of the plane
		4	Exceeded the load maximum limit of the aircraft floors		√	Improbable	1	Major	C	Yes	Notify loading officers to use load plan and no exceed load limits
		5	Put wheel shocks before complete stop of aircraft engine		√	Improbable	1	Major	C	Yes	Notify workers with safety instructions when working on flight line

Appendix 4: Statistics on airline flights Alexandria

Total Flight No.	Alexandria Airport						year
Total Flights 2006	Jun	Mai	Apr	Mar	Feb	Jan	2006
1346	370	239	137	181	230	189	
Total Flights 2007	Jun	Mai	Apr	Mar	Feb	Jan	2007
1367	236	222	240	214	191	264	
Total Flights 2008	Jun	Mai	Apr	Mar	Feb	Jan	2008
2964	571	582	579	392	370	470	
Total Flights 2009	Jun	Mai	Apr	Mar	Feb	Jan	2009
3811	842	693	704	603	531	438	
Total Flights 2010	Jun	Mai	Apr	Mar	Feb	Jan	2010
3104	457	616	766	474	418	373	
Total Flights 2011	Jun	Mai	Apr	Mar	Feb	Jan	2011
2540	505	442	370	371	381	471	