RISK MANAGEMENT OF YEMEN'S BEVERAGE MANUFACTURING INDUSTRY THROUGH HAZARD OPERABILITY STUDY

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MASTER OF MANUFACTURING ENGINEERING
(INDUSTRIAL ENGINEERING)

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in fulfillment of the requirements for the degree of Master of Manufacturing Engineering (Industrial Engineering)

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DECLARATION

I declare that this project entitled “Risk Management of Yemen’s Beverage Manufacturing Industry Through Hazard Operability Study” is the result of my own research except as cited in the references. The project has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Muthanna Ali Mousa Algalos

Date : …….

APPROVAL

I hereby declare that I have read this project and in my opinion this project is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

Signature : .....

Supervisor Name : Assoc. Prof. Ts. Dr. Effendi Bin Mohamad

Date : .....

DEDICATION

I would like to sincerely dedicate this piece of work to my beloved father Ali and my beloved mother Nama who supported me and lighted up my life since my birth to this date. To my brothers (Mohammed, Mousa, Abdulwahid, and Mosaed) and sisters (Samera, Krama, Ablah, Rosia, Kafa, and Nadia) for their effort, moral support and endless encouragement. To my dearest wife Ainas and her parents for their patience, support and unfailing encouragement during the preparation of this work. Last but not least, I wish to express my gratitude to my classmates Mohammed Bakar and Mohammed Albaiti for their unconditional trust, encouragement and support enabling this work to be accomplished.

ABSTRACT

Risk can be defined as a situation where there is a probability of both loss and gain. In order to realize the availability of risk, one should have enough awareness about losses and gains incurred. The higher the complexity in companies, the higher vulnerability in supply chain. Complexity and efficiency in supply chain risks are two important drivers. If organizations and manufacturing companies as Beverage Company have problems and difficulties on how to manage their internal and external disruptions, this could cause many problems to supply chain and the quality of products. Satisfaction of customers is the target of all companies and it must not be influenced by an inefficient Risk Management (RM). There is a lack of implementation of RM in Yemen especially in the local company such as beverage companies. Because of the time consuming, this project will discuss only risks related to the supply and manufacturing processes. In addition, some risks related to supply chain will be excluded which are demand internal risks and external environmental issues. The project will focus on the production process risks starting from raw material to finished product. This project involve three objectives which will be discussed in three phases; identification of risks, analysis of risks, and avoidance strategies and the Risk Management Process (RMP) implementation. In the first stage, all risks related to the four areas which are suppliers, material, process and inventory will be identified. In the first stage a brain storming tool is used which is Hazard and Operability Study (HAZOP). The second stage is the evaluation of all identified risks based on their likelihood and impacts in order to determine the critical risks via using risk matrix. The last phase is to carry out strategies to avoid and mitigate the critical risks and to give recommendations for ABC Beverage Company on the implementation of these reactive and proactive strategies. The real conditions, by which data collecting could be analyzed first hand, is examined by quantitative method. All interviews that were done during collecting data were performed qualitatively. This qualitative method was used for obtaining an overall image of the company and to do interviews by Skype and WhatsApp. Furthermore, a written questionnaire was sent to engineers in the company to be answered as a method of collecting data. The result for this project is a list of possible risks that could happen at the beverage company and their causes and consequences which is the first objective of the project. Moreover, the critical risks were specified and gathered into groups after doing risk analysis by risk matrixes. Furthermore, mitigation strategies and suggestions to avoid and mitigate risks are presented based on the interviews, questionnaires, and based on the best practices of the Supply Chain Operations Reference (SCOR) method. Finally, a model for the risk management process implementation and its supporting tools is presented.

ABSTRAK

Risiko boleh ditakrifkan sebagai keadaan di mana terdapat kebarangkalian kerugian dan keuntungan. Untuk merealisasikan adanya risiko, seseorang harus mempunyai kesedaran yang cukup tentang kerugian dan keuntungan yang ditanggung. Semakin tinggi kerumitan dalam syarikat-syarikat, kelemahan yang lebih tinggi dalam rantaian bekalan. Kompleks dan kecekapan dalam risiko rantaian bekalan adalah dua pemacu penting. Sekiranya organisasi dan syarikat pembuatan sebagai Syarikat Minuman mempunyai masalah dan kesukaran untuk menguruskan gangguan dalaman dan luaran mereka, ini boleh menyebabkan banyak masalah untuk membekalkan rantaian dan kualiti produk. Kepuasan pelanggan adalah sasaran semua syarikat dan tidak boleh dipengaruhi oleh pengurusan risiko yang tidak cekap (RM). Terdapat kekurangan pelaksanaan RM di Yaman terutamanya di syarikat tempatan seperti syarikat minuman. Oleh kerana memakan masa, projek ini akan membincangkan hanya risiko yang berkaitan dengan proses bekalan dan pembuatan. Di samping itu, beberapa risiko yang berkaitan dengan rantaian bekalan akan dikecualikan yang memerlukan risiko dalaman dan isu alam sekitar luaran. Projek ini akan memberi tumpuan kepada risiko proses pengeluaran bermula dari bahan mentah hingga produk siap. Projek ini melibatkan tiga objektif yang akan dibincangkan dalam tiga fasa; pengenalpastian risiko, analisis risiko, dan strategi pencegahan serta pelaksanaan Proses Pengurusan Risiko (RMP). Pada peringkat pertama, semua risiko yang berkaitan dengan empat bidang yang menjadi pembekal, bahan, proses dan inventori akan dikenalpasti. Pada peringkat pertama, alat menyerang otak digunakan untuk HAZOP. Tahap kedua ialah penilaian semua risiko yang dikenal pasti berdasarkan kemungkinan dan kesan mereka untuk menentukan risiko kritikal melalui menggunakan matriks risiko. Fasa terakhir adalah untuk melaksanakan strategi untuk mengelakkan dan mengurangkan risiko kritikal dan memberi cadangan kepada Syarikat Minuman ABC mengenai pelaksanaan strategi reaktif dan proaktif ini. Keadaan sebenar, di mana pengumpulan data boleh dianalisis terlebih dahulu, diperiksa oleh kaedah kuantitatif. Semua wawancara yang dilakukan semasa mengumpul data dilakukan secara kualitatif. Kaedah kualitatif ini digunakan untuk mendapatkan gambaran keseluruhan syarikat dan melakukan wawancara oleh Skype dan WhatsApp. Selanjutnya, satu soal selidik tertulis telah dihantar kepada jurutera dalam syarikat untuk dijawab sebagai kaedah mengumpul data. Hasil projek ini adalah senarai kemungkinan risiko yang boleh berlaku di syarikat minuman dan sebab dan akibatnya yang merupakan objektif pertama projek. Selain itu, risiko kritikal telah ditentukan dan dikumpulkan ke dalam kumpulan selepas melakukan analisis risiko oleh matriks risiko. Tambahan pula, strategi mitigasi dan cadangan untuk mengelakkan dan mengurangkan risiko dibentangkan berdasarkan wawancara, soal selidik, dan berdasarkan amalan terbaik kaedah SCOR. Akhirnya, model untuk pelaksanaan proses pengurusan risiko dan alat sokongannya dipaparkan.

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LIST OF ABBREVIATIONS

ABC	Unreal name for the Beverage Company
CIP	Cleaning In Place
HAZOP	Hazard and Operability Study
Imp.	Impact
MTBF	Mean Time between Failures
MTTR	Mean Time to Repair
PFD	Process Flow Diagram
Prob.	Probability
RM	Risk Management
RMP	Risk Management Process
SCC	Supply Chain Council
SCFD	Supply Chain Flow Diagram
SCOR	Supply Chain Operations Reference
TLP	Tension Leg Platform
VMI	Vendor Managed Inventory

CHAPTER 1

INTRODUCTION

The main goal of all manufacturing companies is to minimize cost and maximize quality in order to have more satisfied customers. One of the most important things that help to achieve this goal is applying an effective risk management (RM) strategy. This chapter shortly introduces the background of RM and the plan of this project.

1.1 Background

The word risk has many definitions based on the purpose or the point of view we aim for. (Kaplan and Garrick, 1981) and (Andersen and Terp, 2006) described risk as uncertainty situation combined with a loss. The Society for Risk Analysis (SRA) defines risk as "*The possibility of realization for undesired consequences and aftermaths to human life, property and environment*." In addition, risk might be explained as a situation where the risk taker aim to get a gain but the possibility of loss is still available (Khan and Zsidisin, 2011). The higher the possibility of loss, the higher the risk included. Risk could be defined the possibility of damage and loss caused by a hazard (Islam and Tedford, 2012). It is also a combination of the occurrence frequency and severity of the hazard (Bahr, 2014).

In terms organizational characteristics, four sources can affect the behavior of risks; a) group decision making (Stoner, 1968), b) culture values (Douglas and Wildavsky, 1982), c) leadership and d) control system. In fact 'risk management' is not a modern term, it was first known in the 1950s, it was presented in one of the oldest publications caring about risk

management, its name was The Harvard Business Review in 1956 (Gallagher, 1956). Risk management aimed to take over the risks level and to reduce their impacts, and it became a vital portion of a company's operations with the main purpose which is to reach the goals of the company effectively (Kirchsteiger, 2002); (Simpleman *et al.*, 2003) and (Labodová, 2004). As all definitions indicated that identification of risks is the first procedure of RM in companies (Smallman and Smith, 2003) and (Dhillon, 2003).

The effective participation of workers in the process of risk management can assure efficient strategic implementation. Risks regenerating from day-to-day activities should be described. Companies have to build and spread an effective risk culture. It has been found that plentiful researches have been performed on risk management. Most of these studies have concentrate on specific industries such as aviation, nuclear plants, chemical plants, space exploration, and other aspects where the outcome and impact of system breakdown is hazardous or catastrophic for sources or finance (Janic, 2000), (Strupczewski, 2003) and (Seastrom *et al.*, 2004). Research on RM in other fields involving transportation, medical science, and construction engineering has improved with time (Uher and Toakley, 1999) and (Andersson, 2007).

1.2 Problem Statement

For manufacturing companies that need to offer a wide range of various product within its brand; customers of those companies in many countries have different preferences, so it is important to satisfy all customers. The higher the complexity, the higher vulnerability in supply chain (Harland *et al*., 2003). Complexity and efficiency in supply chain risks are two important drivers of RM as indicated in (Thun and Hoenig, 2011). If organizations and manufacturing companies have problems and difficulties on how to manage their internal and external

disruptions, this could cause many problems to supply chain and the quality of products. Satisfaction of customers is the target of all companies and it must not be influenced by an inefficient risk management. Furthermore, managing suppliers, in terms of delivery and quality of raw material, is a significant part of the total value chain that company should be able to do (Thun and Hoenig, 2011).

According to a small primary survey targeted a group of engineers who are members in Yemeni Engineers Association, 42% said that their companies have full risk management strategies, 26% said that no risk management strategy implementation planned, while 32% said that their companies do not have risk management strategies but they plan to have in the coming five years. The 42% companies are international companies working in oil, gas and chemical sectors while the rest are local companies working in structure, power, cement, food manufacturing and beverage manufacturing as shown Figure 1.1.

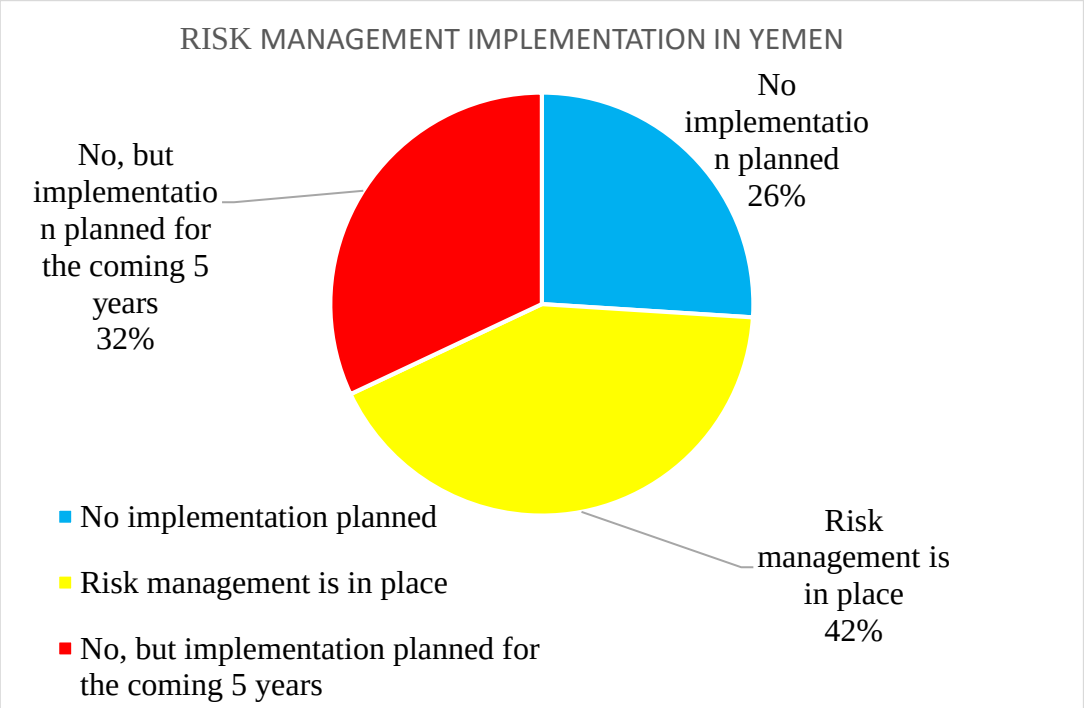

Figure 1.1: Risk Management Implementation in Yemen

ABC Beverage Company is one of those companies who do not have a strategy to manage internal and external risks that happen during its activities. ABC Beverage Company handles internal disturbances depending on reactive method than a proactive strategy, so guidelines are not existed to identify and manage risks and consequences on company. The Beverage Company needs to apply risk management strategy in the coming years in order to keep its customer satisfied, applying risk management will enhance the quality of products and decrease prices which will reflect on the competitiveness and satisfaction of customers. Berg and Skoogh (2012) indicates that risks must be described at particular levels in company, so a strategy or process need to be set up to classify disturbances and risks. In addition, companies and organizations must have a documented policies and roles in order to conduct a systematic process for risk management.

1.3 Objectives

There are several objectives of this project which are:

a) To identify the internal risks at the Beverage Company.
b) To rank the criticality of all risk that are identified in the first stage based on their probability (likelihood) and impacts.
c) To propose a strategies and recommendation to control over, handle or mitigate the most critical risks when it happens or before.

1.4 Scope

So many sorts of risks that can occur at the manufacturing companies such as ABC Beverage Company. Because of the time consuming, this project will discuss only risks related to the supply and process. In addition, some risks related to supply chain will be excluded which

are demand internal risks and external environmental issues. The project will focus on process risks starting from raw material to finished goods. The risk related to finished product handling and inventory will not be involved. The main attention will be on risks that influence the financial outcomes, utilization of production, and level of service for customers such as delivery and quality. Finally, the work environment risks related to worker safety and health will not be highly focused.

1.5 Project Outlines

This project consists several chapters, first chapter include a brief summary about the problem statement and objectives. Chapter two explains a literature of risk management strategies at manufacturing companies and tools to mitigate risks. Chapter three discusses the methodology of the project during data collection and analyzing while chapter four explains the analyzing of the collected data of all risks at ABC Beverage Company. Finally, chapter five is the conclusion chapter that discusses the results and presents some recommendations regarding risk management strategies and tools.

CHAPTER 2

LITERATURE

This chapter describes the literature review on risk management in manufacturing involving its techniques. Furthermore, it will give the readers a better understanding of concepts, terms, and tools regarding risk identification, analysis and avoidance that will be applied in the project.

2.1 Risks

Most risks end up lead to negative results while some risks can provide positive outcomes. The negative risks can be described as unwanted situation in an organization or company. For instance, the (SRA), (2012) defines risk as the possibility of realization for undesired consequences and aftermaths to human life, property and environment. Sometimes we take risks in order to get gain. For example, owning factory tools and facilities is considered as risk taking since the factory will spend money, but the factory most likely might not take this risk if the outcome will not be positive (Hopkin, 2012). So many authors believe that risk is an uncertainty state (Kaplan and Garrick, 1981).

2.1.1 Types of Risks

Risks are divided into three types as per (Hopkin, 2017), these three types will lead to different outcomes. The three types are hazard, opportunity, and control. The first type which is hazard, can only lead to negative results if it happen, so organizations aim to avoid or at least

mitigate existence of these risks. Organizations must learn how to treat these sorts of risks to a certain level which can be different from company to another. As an example for the levels of tolerance for risks and disturbances, the level of acceptance of theft vary from store to store. In a super market, the acceptance of theft is much higher than a jeweler store and, because of the low tolerance to the theft of jewelers, they definitely spend more money for security than the supermarket do.

The second type of risks which include control risks that can be described as risks with a degree of uncertainty in their outcome. In order to handle this kind of risks, there ought to be a cohesion between expected outcomes and actual outcomes. The third category of risks as per (Hopkin, 2017) is opportunity risks. The previous example of an owning of a factory is a good example of this type because there is a hope of gaining benefit from taking this risk. Table 2.1 shows three types of risks in an example risks in computer (Hopkin, 2017).

Table 2.1: An Example for the Three Categories of Risks in Computers (Hopkin, 2017)

Type	Event	Impact
Hazard	Infection by virus	Negative result
Control	Updating the existed software	Uncertain result
Opportunity	Installing new software	Wanted to be positive, but it could be negative

2.1.2 Categorization of Disruptions

As mentioned before, organization or companies should consider all the different categories of risks especially the hazard type risks which are significant to be known because they definitely lead to negative results. The interruption of risks can be happened by a group of various factors. These factors are listed as four categories (Hopkin, 2017).

- **People:** the interruption may result from a lack of skills, a lack of employees or a poor workforce, wrong mental attitudes, or accidents and personal injuries. Furthermore, leadership's lack and the poor culture about the organization (Alexa and SimonaValeria, 2011) and (Toma *et al*., 2012).
- **Premises:** the stealing of physical resources or properties, damaged or lost, this can cause serious disruption to an organization. In addition, inadequate or sufficient access to the premises and contamination of premises can also pose risks when the organization should intervene to prevent or mitigate its negative consequences.
- **Process:** incorrect information and lack of communication are processes that must work correctly to avoid risks associated with the process. Transportation, defects and faults in production, or software system.
- **Products:** in terms of products there are some factors such as late delivery of raw material from suppliers, the poor quality of the products and the bad marketing for products.

All four categories that I mentioned above are internal risk because they originate in events within the company. However, external risks are the risk that happen to the company due to events happening outside the company. This kind of risks are difficult to handle and control. The internal risks are easy to be predicted since their probability is determinable, while the probability of external risks is very difficult and impossible to predict. External risks may include, for instance, natural disasters, legal or political issues, as well as wars, sadden attacks of terrorist groups, or international health problems (Toma *et al*. , 2012). In general, the probability of external risks is much less than the probability of internal risks, but their impacts and consequences are much more serious than the internal risks (Thun and Hoenig, 2011). Authors classified internal supply chain risks into three main parts based on where the risks of

supply chain occur. The three parts are supply-side, company and demand-side Figure 2.1 (Blecker and Kersten, 2006). The crosshatched area indicate to the internal risks while the external risks are shown in the chart as external risks or environmental risks.

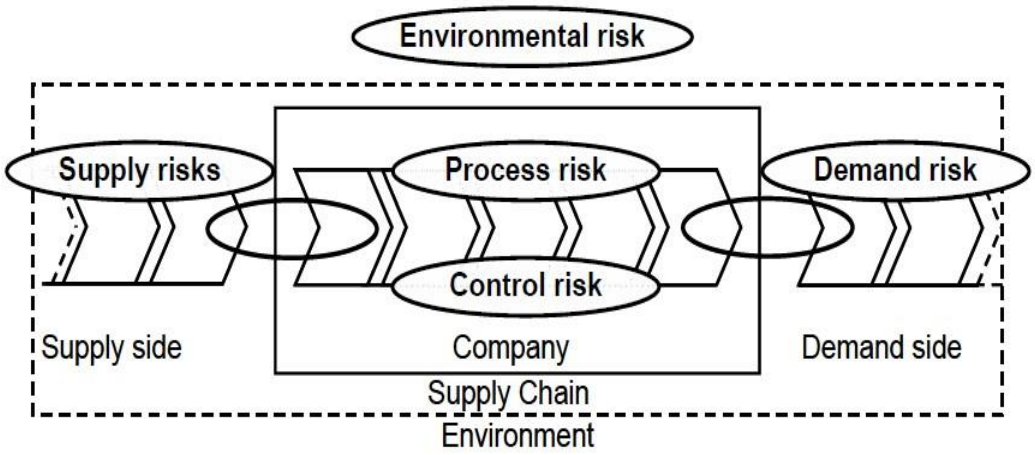

Figure 2.1: Supply Chain Risks (Blecker and Kersten, 2006)

2.2 Risk Management

There are several definitions of RM in terms of standards as stated by institutes. The Institute of RM (2012), indicates that RM is a process to increase the probability of success and reduce bankruptcies or failure, and the risk management process (RMP) will be discussed in more details in this chapter. For proper work of RM, we need to illustrate its frame work clearly.

2.2.1 Importance of Risk Management

In recent years, taking actions against external and internal risk has become a significant trend for companies. A series of serious natural catastrophes and global crisis of finance are some of the causes why companies have to be ready to counter disturbances or risks (Jüttner and Maklan, 2011). Organizations nowadays are increasingly dependent on actors in a global