UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF A SUPPLIER SELECTION RISK MANAGEMENT FRAMEWORK FOR IRANIAN AUTOMOTIVE INDUSTRY

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By

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Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the degree of Master of Science

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DEDICATION

This thesis is dedicated to my loving parents, and my wife for their endless support and encouragement.

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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June 2016

Chairman : Associate Prof. Faieza Abdul Aziz, PhD
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Supply chain management (SCM) is the process of managing information, materials, and finances in the whole chain of manufacturing from part suppliers to main manufacturer to wholesalers, market and consumers. SCM is an attempt to coordinate and integrate the processes above amongst companies. Supply chain management focuses on the efficiency and cost-effectiveness of activities across the whole system; the entire system costs from goods transportation, distribution and inventories of parts and raw materials, ongoing works, etc. has to be minimized. Therefore, it is not a plain managerial activity to lower the cost of transportation and inventory, but it is rather a system-wide approach to supply chain management.

Disruption of the supply chain can happen at any level of the process; therefore, investigation on the possible risks in the supply chain is inevitable in any SCM activity. Due to the increase in outsourcing production strategy, which has extended the supply chain elements and complexity, supply chain disruption risk has increased exponentially and risk management policies are supposed to be developed according to this type of risk.

Supplier failure is one of the largest uncertainty sources in the SCM since approximately 70%-80% of the risks are attributed to the vendors failure in the Supply Chain. For instance, unstable financial situation of a supplier can directly affect the supply chain of an enterprise and cause considerable damage and cost. Therefore, supplier selection importance has come to the forefront of supply chain risk management and has attracted to establish a sound and flawless supplier selection process.

Since supplier failure is a major threat to the supply chain and ensuring proper supplier selection is crucial, this study aimed to establish a supplier selection procedure that can reduce the risk in supply chain. Linear weighting method is used to analyze the risk factors and construct an empirically reliable model for supplier evaluation.

A total number of 200 questionnaires were distributed amongst the automobile companies of Iran, Iran Khodro, Kerman Motor, Zagross Khodro. Questionnaire respondents are managers, engineers, and decision makers who are involved in supplier selection process. The analysis of industry responses was completed using SPSS software. The conceptual model development purpose is to define the way that research hypothesis is designed. Pearson correlation test is applied to the data obtained through questionnaire distribution. A multiple linear regression model was employed to build a systematic supplier selection model. In the proposed multi-criteria supplier selection model, product quality had the highest degree of influence on supplier selection risk management. Human resource of supplier is the second influential risk factor that can cause disruption in supply chain. It was found that in a sequential order, product quality(22.3%), human resources(19.9%), financial power(17.1%), governmental support(14.5%), IT and R&D opportunities(13.4%), and environmental(12.8%) vulnerability of the supplier are critical to supply chain management while their degree of influence decreases respectively.

The outcome of the research is a framework that explains the proposed supplier selection model, which is obtained and designed based on combination of conceptual model and vendor selection model. After all, the proposed framework received positive responses from the manufacturer companies supporting its applicability and usefulness. It is claimed that the proposed supplier selection framework can reduce the supplier-induced risks to the supply chain.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN RANGKA KERJA PENGURUSAN RISIKO PEMILIHAN PEMBEKAL UNTUK INDUSTRI AUTOMOTIF IRAN

Oleh

KAMRAN MOHTASHAM

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Pengerusi : Prof. Madya Faieza Abdul Aziz, PhD
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Pengurusan rantaian bekalan (SCM) adalah proses menguruskan maklumat, bahan, dan kewangan dalam keseluruhan rantaian pembuatan daripada pembekal bahagian untuk pengeluar utama kepada pemborong, pasaran dan pengguna. SCM adalah satu percubaan untuk menyelaras dan mengintegrasikan proses yang dinyatakan di atas di kalangan syarikat. Fokus pengurusan rantaian bekalan adalah kecekapan dan keberkesanan kos terhadap aktiviti di dalam keseluruhan sistem; kos keseluruhan sistem yang merangkumi pengangkutan barang, pengagihan dan inventori alat ganti dan bahan-bahan mentah, kerja-kerja yang berterusan, dan sebagainya perlu dikurangkan. Oleh itu, ia bukan satu aktiviti pengurusan biasa untuk mengurangkan kos pengangkutan dan inventori, tetapi ia adalah lebih kepada pendekatan seluruh sistem dalam pengurusan rantaian bekalan

Gangguan rantaian bekalan boleh terjadi pada mana-mana peringkat di dalam proses tersebut; oleh itu, risiko-risiko yang mungkin timbul dan tidak dapat dielakkan dalam aktiviti SCM perlu dikaji. Disebabkan oleh peningkatan dalam strategi pengeluaran sumber luar, yang telah melanjutkan elemen rantaian bekalan dan kerumitan, risiko rantaian bekalan gangguan telah meningkat dengan pesat dan dasar pengurusan risiko sepatutnya dibangunkan mengikut jenis risiko.

Kegagalan pembekal adalah merupakan salah satu sumber ketidakpastian terbesar di SCM mana 70% - 80% risiko adalah disumbangkan oleh kegagalan pembekal dalam rantaian bekalan. Sebagai contoh, keadaan kewangan yang tidak stabil daripada pembekal secara langsung boleh menjejaskan rantaian bekalan suatu perusahaan dan ini akan menyebabkan kerugian kos yang agak tinggi. Oleh yang demikian, faktor pemilihan pembekal merupakan satu proses yang penting dalam pengurusan risiko rantaian bekalan bagi mewujudkan satu proses pemilihan pembekal yang baik dan sempurna.

Kegagalan pembekal adalah merupakan ancaman utama kepada rantaian bekalan dan bagi memastikan pembekal dipilih dengan betul, kajian ini dijalankan bertujuan

untuk mewujudkan satu prosedur pemilihan pembekal yang boleh mengurangkan risiko dalam rantaian bekalan. Kaedah pemberat linear telah digunakan untuk menganalisis faktor-faktor risiko dan membina sebuah model empirikal yang boleh dipercayai untuk menilai pembekal.

Sebanyak 200 borang soal selidik telah diedarkan di kalangan syarikat automobil Iran, Iran Khodro, Kerman Motor, dan Zagross Khodro. Responden soal selidik merupakan yang terlibat dalam proses pemilihan pembekal iaitu pengurus, jurutera dan pembuat keputusan. Analisis maklum balas industri dilaksanakan dengan menggunakan perisian SPSS. Tujuan pembangunan model konseptual adalah untuk menentukan cara penyelidikan hipotesis. Ujian korelasi Pearson digunakan untuk data yang diperolehi melalui edaran borang soal selidik, struktur hubungan disediakan dalam model menentukan pembolehubah bersandar yang berinteraksi dengan beberapa pembolehubah bebas berdasarkan faktor yang terlibat dalam model konseptual. Model regresi linear berganda telah digunakan untuk membina model pemilihan pembekal yang sistematik. Dalam cadangan pemilihan model pembekal, kualiti produk merupakan penyumbang terbesar ke atas pengurusan risiko dalam pemilihan pembekal. Pembekal sumber manusia merupakan faktor risiko kedua yang paling berpengaruh ke atas gangguan dalam rantaian bekalan. Didapati bahawa, kualiti produk (22.3%), sumber manusia (19.9%), kuasa kewangan (17.1%), sokongan kerajaan (14.5%), peluang IT dan R&D (13.4%), dan kelemahan persekitaran pembekal (12.8%) adalah penting untuk pengurusan rangkaian manakala tahap pengaruh masing-masing semakin berkurangan mengikut susunan tersebut. Hasil daripada kajian ini adalah satu rangka kerja yang menerangkan cadangan model pemilihan pembekal, yang diperolehi dan direka berdasarkan analisis data penyelidikan ini. Rangka kerja yang dicadangkan menerima maklumbalas positif daripada syarikat pengeluar yang menyokong pengaplikasian dan kegunaannya. Adalah dipercayai bahawa rangka kerja pemilihan pembekal yang dicadangkan boleh mengurangkan risiko pembekal yang disebabkan kepada rantaian bekalan.

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I certify that a Thesis Examination Committee has met on 29 June 2016 to conduct the final examination of Kamran Mohtasham on his thesis entitled "Development of a Supplier Selection Risk Management Framework for Iranian Automotive Industry" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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This is to confirm that:

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LIST OF ABBREVIATIONS

SC	Supply chain
SCM	Supply chain management
SCRM	Supply chain risk management
SSR	Supplier selection risk
RBS	Risk breakdown structure
WBS	Work breakdown structure
CCP	Chance constrained programming
DEA	Data envelopment analysis
MOP	Multi-objective programming
RSCM	Reverse supply chain management

CHAPTER 1

INTRODUCTION

1.1 Background

In main companies, timely preparation of the parts at various workstations in the production line is the most crucial factor that affects the company's performance. In such companies if a specific part is not available at a workstation or its quality does not meet the standards, the workstation would shut down and subsequently the downstream workstations will be put on halt; finally the production line would completely shut down. Consequently, workers will be laid off, machineries will be put down, production volume would diminish and company may be faced with lower profit or no profit.

Industry practitioners have come to a consensus that on time production and availability of a part in the supply chain is the key factor in companies' success and development. In other words, supply chain management (SCM) is believed to be the main strategy in order to achieve organizational competitiveness (Gunasekaran and Ngai, 2004). Industry managers have realized that the best way to stay competitive in today's market is to shape a powerful and reliable supply chain that is empowered to prevail other companies' supply chain (Monczka and Morgan, 1997). Therefore, the companies with better management and leadership strategies that are empowered to fully integrate the supply chain components from customer demand to the suppliers, are the most successful competitors in the marketplace.

Overall, Supply chain management (SCM), is the process of managing information, materials, and finances in the whole chain of manufacturing from part suppliers to main manufacturer to wholesaler, market and consumer (Figure 1.1) (Kara, 2011). Figure 1.1 depicts the inter-relationships between the supply chain components and information flow. SCM attempts to coordinate and integrate the processes mentioned above amongst companies.

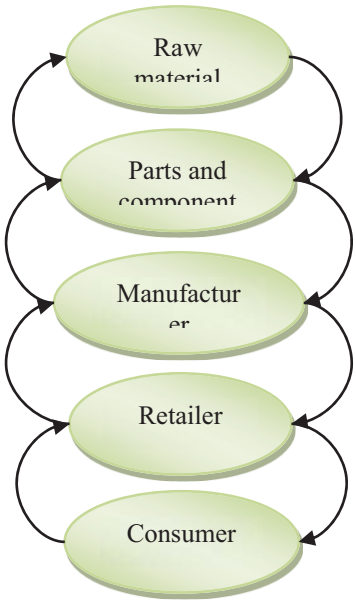

Figure 1.1: Key concepts of supply chain management

Supply chain managements' focus is on the efficiency and cost-effectiveness of activities across the whole system; the entire system costs of transportation of goods, distribution and inventories of parts and raw materials, ongoing works, etc. are aimed to be minimized. Therefore, it is not simply a managerial activity to diminish the cost of transportation and inventory, but is rather a system wide approach to supply chain management (Handfield and EL Nichols, 1999).

Disruption in the supply chain can occur at any level of the process; thus, investigation on the potential risks to the supply chain and mitigation is inevitable at any SCM activity. Thus, risk management of supply chain is the primary focus in supply chain management. Supplier failure, supplier quality failure, oil crisis, terrorist attack, strike, malfunction of it-systems, natural disaster, machine breakdown, import or export restrictions, transportation failure, delivery chain disruption, increasing custom duty, change in customer demand, technological change, increasing raw material price are some of the potential risks to the supply chain (McCormack et al., 2008; Tang, 2006; Tang and Musa, 2011).

In order to manage the risk in supply chain effectively, many quantitative methods are developed and are applicable. A very diverse range of models, from a simple heuristic to a complicated mathematical models, with various levels of success differ in their undertaken resources for the modelling (Troxler and Schillings, 1993). With this being stated, supplier failure is notably defined as one of the largest uncertainty sources in the supply chain management (Ruiz-Torres et al., 2013). Nowadays, due to the increasing dependency between companies, they are more vulnerable to the risks of other companies or suppliers (Hallikas et al., 2004). Those dependencies are defined within a supply chain, hence to establish an effective and responsive supply chain supplier selection and evaluation is a determinant factor to consider (Ávila et al., 2012). The aim of the present research, is classification and prioritization of the risk factors originated from supplier selection in organizing the supply chain, in

order to facilitate the supplier selection process through a more practical procedure and eventually, decrease the supply chain risk.

1.2 Problem Statement

In the early 1980s, manufacturers repeatedly stated the strategic importance of the suppliers (Croom et al., 2000). The relationship between manufacturers and suppliers was diverted from adversarial to cooperative and it was apprehended that reliable suppliers can enable firms to freely put their main attention on their goals such as cost reduction, timely product development, and products' quality development plans simultaneously. Different types of relationships according to the length of contraction has been identified from short-term to long-term and one-time contract to partnership (Tang, 2006). It has been argued that long-term contracts and relationships with a supplier may not necessarily be an optimal choice; as firms may expand the scope of the work and grow globally, the respective supply chain would change and involve with global suppliers and partners. Therefore, decision makers need to choose reliable and responsive suppliers with low failure potential due to possible changes in enterprise agenda and production plans (Das and Abdel-Malek, 2003). Thus, they are required to identify the critical supplier-induced risk factors in order to choose the more reliable suppliers and construct a flexible supply chain that can accommodate the uncertainties and risks involved.

Just-In-Time manufacturing technology is one of the strategies that are utilized by companies in order to reduce the product cost and be able to compete in different markets. Recently, it is discovered that such technologies that focus on manufacturing and supply chain cost reduction considerably enlarge the uncertainties and risks in the supply chain (Xia and Chen, 2011). For instance, optimal inventory (especially Zero-inventory) and Just-In-Time delivery that are utilized in numerous companies, significantly increase the possibility of supply chain disruption and minor issues (e.g. a brief delay) can turn into big issues instantly (McCormack et al., 2008). Therefore, cost reduction activities such as Just-In-Time approach and resulting risks must be balanced. It is worth mentioning that suppliers' failure is the major driver of supply chain risk when Just-In-Time technology is applied. Therefore, supplier-induced risks and supplier selection uncertainties should be explored and incorporated into the decision-making process in order to overcome supply chain disruption threat in Just-In-time technology application.

On the whole, assembly lines are common methods in automotive industry and 70% of production cost in manufacturing is aimed for purchasing goods and services from suppliers, which in high-tech firms such as automotive industry this portion arise to 85%. supply chain is known to the automotive industry as a complex system, which involves considerable risk and uncertainties (Wu et al., 2013). The basic step in supply chain management is the supplier selection, since supplier failure is one of the largest uncertainty sources in the SCM since approximately 70%-80% of the risks are attributed to the vendors failure in the Supply Chain which is also of paramount importance to risk reduction in this process. In line with the stated importance of supplier-induced risks identification for proper supplier selection—to build a flexible supply chain or to run Just-In-Time technology—it should also be highlighted that 70% of production cost in manufacturing is aimed for purchasing goods and services

from suppliers, which in high-tech firms this portion arise to 80% (Faez et al., 2009; Vanteddu et al., 2011). Ericsson (Norrman and Jansson, 2004) and Bosch (Wagner and Bode, 2006) companies are well-known examples of the high-tech firms failure due to supplier failure in their supply chain. Therefore, it is of paramount importance to stressfully assess the potential suppliers and evaluate their performance in terms of contributing risks and uncertainties to the supply chain and identify the critical supplier-induced risk factors in order to choose the more reliable suppliers.

Most of researches limited to internal or external risk factors only and focus on a few risk criteria but it is claimed that the proposed supplier selection framework can be used as a tool for measuring the high range of risk factors (internal and external) in a specific supplier company. Thus, the present study investigates supplier-induced risks in supply chain to develop a low risk supplier selection framework for overall supply chain risk management.

1.3 Objectives

The overall objective of this study is to develop an empirically reliable framework for evaluation and selection of suppliers. The study's sub-objectives are stated below:

1. To develop a supplier selection risk-associated conceptual model.
2. To develop a supplier evaluation model.
3. To develop an empirically reliable framework for supplier selection process.
4. To validate the capability and feasibility of the developed framework.

1.4 Scope of the work and limitations

This study is aiming the investigation of the risk factors involved in the supply chain through a questionnaire-based interview with managers, engineers, and decision makers of three car manufacturer companies in Iran automotive industry. They are objected to interviews about their perspectives of several risk factors, which are highlighted in the questionnaire. The analysis of the questionnaire outcomes is the basis of our final model for the supplier selection risk management.

The first objective of the project is pursued through an extensive review of the literature to develop a risk breakdown structure for the better understanding of supplier-induced risks to supply chain and establishing a conceptual model for risk management in supplier selection. The first objective is examined through Pearson correlation analysis of the industry inputs for validation as well as utilization in following objectives. Next, a linear weighting method will be applied to satisfy the second objective and to develop a supplier evaluation model. The outcome of the research is a supplier selection framework for effective management of the supplier induced risks in supply chain, which is validated through the pilot case study method in two main automotive manufacturers in Iran. Chapter three and four describe the methodology and results of the study, accordingly. The general conclusions and recommendations are discussed in chapter five.

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