

DOCTOR OF PHILOSOPHY

Evaluation of supply chain risk management for material procurement in Libyan oil industry

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Award date:
2017

Awarding institution:
Coventry University

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"Evaluation of Supply Chain Risk Management for Material Procurement in Libyan Oil Industry"

By

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Jun 2017



Faculty of Engineering & Computing

***A thesis submitted in partial fulfilment of the University's requirements for
the Degree of Doctor of Philosophy***

Table of Contents

List of Figures	7
List of Tables	9
List of Appendices	12
List of Publications	13
List of abbreviations.....	14
Abstract.....	15
Chapter One: Introduction.....	16
1.1 Background	16
1.1.1 Procurement	16
1.1.2 Supply Management:	18
1.1.1 Procurement Risk Management (PRM)	19
1.1.2 Risk management in the oil industry:	21
1.1.3 Supply Chain Link & Challenges in oil material procurement:.....	22
1.2 Research Aims:.....	29
1.3 Research Objectives.....	29
1.3.1 What are the Research problems and challenges?	29
1.3.2 Significance and Contribution to Knowledge:.....	30
1.4 Research Questions:	30
1.5 Research Methodology:.....	31
1.7 Structure of the Thesis:.....	33
1.8 Summary:	35
Chapter Two: Literature Review	36
2.1 Engineering Procurement in the oil Industry.....	36
2.1.1 Oil Engineering, Procurement, and Construction (EPC) Project life cycle:	36
2.2 Project phases:.....	36
2.2.1 Business planning and project strategy:	37
2.2.2 Front End Development (FED):	37
2.2.3 Implementation and operational readiness:	37
2.2.4 Start-up & Operation	37
2.3 Project Supply Function:	38
2.4 Evolution of supply:	39

2.5 Types of Supply:	39
2.5.1 Supply Management:	40
2.5.2 Supply Chain (SC)	41
2.5.3 Supply Chain Management (SCM) and suppliers:	41
2.5.4 Supply Chain Management and Supplier Development within Oil Industry:	42
2.6 Main Concepts of Risk:	44
2.6.1 Supply chain risk types:	46
2.6.2 Supply chain risk factors:	46
2.6.3 Supply Chain Risk Methods:	47
2.6.4 Individual SCRM process:	47
2.6.5. Manufacturing risk assessment	48
2.6.6 Supply risk assessment	49
2.6.7 Information risk assessment	50
2.6.8 General risk assessment.....	51
2.7 Risk monitoring	55
2.8 SCRM developed frameworks.....	55
2.9 SCRM procedures or approaches.....	56
2.10 Supply chain network design	57
2.11 Risk Management Models and Methodologies	58
2.12 Project Management Body of Knowledge (PMBOK) Methodology:	61
2.13 PRINCE2 Model:	61
2.14 SHAMPU Model:	63
2.15 Chapman & Ward's Methodology	63
2.16 Dale Cooper's Model.....	64
2.17 Supply Chain Risk Management (SCRM): The Concept and Its Basic Constructs	65
2.18 Supply Chain Risk Management Frameworks.....	68
2.19 Critique of current risk management models.....	71
2.20 Research gaps and recommendations.....	72
2.21 Summary	74
Chapter Three: Research Methodology.....	75
3.1 Introduction:	75
3.2 Research Philosophy:	75

3.3 Types of Research Methods:	77
3.3.1 Quantitative research:	77
3.3.2 Qualitative Research:	78
3.3.3 A mixed, multi-methods approach	78
3.4 Deductive vs. inductive	79
3.5 Important criteria in research design and approaches	79
3.6 Rationale behind chosen research and research design	80
3.6.1 Sample design:	81
3.6.2 Sample size:	82
3.7 Data collection methods	82
3.8 The Research Questionnaire	84
3.8.1 Objectives of the questionnaire	84
3.9 Pilot Research	84
3.9.1 Purpose of the Pilot Research	85
3.9.2 Selecting participants for the Pilot Research	85
3.9.3 Pilot Research Results and Modifications	86
3.10 Validity and Reliability	87
3.10.1 Validity	87
3.10.2 Reliability	89
3.11 Questionnaire development	89
3.11.1 The content of the questionnaire	90
3.11.2 Questionnaire delivery method	90
3.12 Summary	91
Chapter Four: Questionnaire Survey Data Analysis and Results	92
4.1 Introduction	92
4.2 Research Validity and Reliability	92
4.3 Questionnaire Data Analysis	92
4.3.1 Company General Information	93
4.3.2 Company and Respondent	96
4.3.3 Risk Management	99
4.3.4 Risk Identification	101
4.3.5 Risk Analysis/Assessment	103

4.3.6	Risk Mitigation	105
4.3.7	Risk monitoring and control.....	107
4.3.8	Risk Performance	109
4.3.9	Compares the counts of categorical responses between independent responses.	120
4.4	Main findings of the questionnaire.....	133
4.5	Discussion and Conclusion	136
4.6	Summary	138
Chapter Five: Interview Analysis and Results		139
5.1	Introduction	139
5.1.1	Administration of case research interviews	139
5.1.2	Sampling for case research interview:	139
5.2.	Analysis of the participants' Interviews	141
5.3	Interview Findings.....	142
5.3.1	Challenging and Risks during procurement	142
5.3.2	Reason for risks appear frequently.....	146
5.3.3	Impact of the risks.....	148
5.3.4	Reduced and managed the risks	150
5.3.5	Monitoring system	152
5.3.6	Satisfaction on procurement's team and increase performance	154
5.4	Summary	158
Chapter Six: Framework Development & Validation		159
6.1	Development of Oil supply chain risk management framework	159
6.1.1	Procurement Risk Management Framework (PRMF):	159
6.1.2	Risk Identification.....	160
6.1.3	Risk Assessment	163
6.1.4	Risk Mitigation	163
6.1.5	Monitoring and Control	165
6.1.6	Risk management performance and the hypothesis	167
6.1.7	Hypotheses Validation	168
6.1.8	Concluding Remarks.....	169
6.2	Framework Validation.....	170
6.2.1	Stakeholders' Selection: Rational and Justification	170

6.2.2 The participants' profile.....	171
6.2.3 Summary of stakeholder comments and discussion	171
6.3 Discussion:	175
6.4 Summary	176
Chapter Seven: Conclusion, Recommendation, and Further Study.....	177
7.1 Research Summary	177
7.2 Originality of the Research.....	177
7.3 Objectives Accomplished	178
7.4 Contributions to Knowledge	179
7.5 Research questions and findings	179
7.5.1 Risk Identification.....	181
7.5.2 Risk management strategies	182
7.5.3 Performance and outcomes of risk management strategies.....	182
7.5.4 Risk management and robust procurement process.....	183
7.6. Research Implications & Limitations.....	183
7.6.1. Theoretical implications.....	183
7.6.2 Methodological implications.....	185
7.6.3 Managerial implications.....	185
7.7 Limitations and Recommendations Future Research	187
References:	189
Appendices 1: Questionnaire.....	200
Appendices 2-A: Interview Informed Consent.....	211
Appendices 2-B: Interview Consent Templet Form	213
Appendices 3: Screen shot of N-Vivo (Interview data analysis)	215
Appendices 4: Sample of Risk Record & Supply Evaluation Form	216
Appendices: 5. Framework Validation.	217
Appendices 6: Sample of Request of quotation (RFQ)	222
Appendices 7: Sample of purchasing order (PO)	223
Appendices 8: Sample of Procurement Terms and Conditions	224

List of Figures

Figure 1. 1: Value Chain Diagram adopted from (Porter 1985: 11-15).	16
Figure 1. 2: Future towards PRM excellence ('A short Guide to Procurement Risk' R.C. Russill 2010).	20
Figure 1. 3: Challenges in oil procurement management (Handfield et al. 2013).	25
Figure 1. 4 : LECP Project Life- cycle (Berends 2008).....	26
Figure 1. 5: Typical set-up of large construction project in the O&G industry (Berends 2007: 13)	26
Figure 1. 6: Methodology Framework	33
Figure 1. 7: Generic Thesis Structure.....	34
Figure 2. 1:Evolution of role division in O&G contracting (Bakker 2010: 16):.....	36
Figure 2. 2Nomenclature in the Oil Project Lifecycle (Baker 2010:7).....	38
Figure 2. 3: Evolution of the supply function (Van der Horst T 2013)	39
Figure 2. 4: Supply Classification (Johnson 2011).....	40
Figure 2. 5: Sources of Supply Chain Risk (Christopher and Peck 2004)	44
Figure 2. 6: The risk Management cycle (PRINCE2 2012)	62
Figure 2. 7: risk management process (Cooper et al. 2005)	64
Figure 2. 8: Basic Constructs of SCRM (Svensson 2002)	67
Figure 2.9: Risk Identification Diagram (Hallikas et al. 2004)	69
Figure 3. 1 : Data collection methods	83
Figure 4. 1: Frequency distribution for types of organisation.	94
Figure 4. 2: Frequency distribution of location.	95
Figure 4. 3: Frequency distribution of employees' number.	96
Figure 4. 4: Frequency distribution for years' experience.....	97
Figure 4. 5: Frequency distribution of procurement value.....	98
Figure 4. 6: Frequency distribution of ISO certificate.....	99
Figure 4. 7: Frequency distribution for practicing risk management strategy	100
Figure 4. 8: Risk Identification	102
Figure 4. 9:Risk Analysis	104
Figure 4. 10:Risk Mitigation Practice	106
Figure 4. 11: Risk Monitoring Practice	108
Figure 4. 12:Risk Performance	110
Figure 4. 13:Outsourcing procurement service and risk associated.	112

Figure 4. 14:Benefit of Risk Management Practice	114
Figure 4. 15:Risks often occur during procurement processes	115
Figure 4. 16: More risks often occur during procurement processes	117
Figure 4. 17:supply chain risk management and its drivers	119
Figure 5. 1:Nvivo Screen-shot of tree nodes.....	142
Figure 5. 2:.. The Challenging and risks found in the interview during procurement.....	143
Figure 5. 3:: Nvivo sample of interviewee’s transcript.....	145
Figure 5. 4:: the reasons for risks appear frequently.....	147
Figure 5. 5: impact of the risks during the procurement.....	149
Figure 5. 6:the Interviewee’s answer on how to reduce and manage the risks	152
Figure 5. 7:the way to monitoring the risks.....	154
Figure 5. 8:different ways of team performance.....	157
Figure 6. 1: Procurement Risk Management Framework (PRMF) (Author 2016)	160
Figure 7. 1: The flows of research questions	181

List of Tables

Table 1. 1:: Summary of Research Objectives, and Applied Methodologies.....	29
Table 2. 1: Classic Procurement Process (Johnson et al. 2011)	41
Table 2. 2: Risk management Models (Haghnevis and Sajedi 2006)	61
Table 2. 3: Risk management issues that project manager should consider (Cooper et al. 2005)	65
Table 2. 4 Impact assessment scale	69
Table 2. 5: Probability assessment scale.....	70
Table 3. 1: Pilot research sample	86
Table 4. 1: Frequency distribution of companies' location	94
Table 4. 2: Frequency distribution in terms of company's employee's number	95
Table 4. 3: Frequency distribution of years have been practicing equipment, material procurement and procurement process	96
Table 4. 4: Frequency distribution of procurement value	97
Table 4. 5: Frequency distribution for ISO certificate	98
Table 4. 6: Frequency distribution for practicing risk management strategy	100
Table 4. 7: ANOVA'S test Risk Management.....	101
Table 4. 8: The Percentage of Respondents Practicing Risk Identification.	102
Table 4. 9: ANOVA'S test Risk Identification	103
Table 4. 10: The percentage of managers who frequently practicing risk assessment process	103
Table 4. 11: ANOVA'S test Risk Analysis/Assessment.....	104
Table 4. 12: The percentage risk mitigation activities	105
Table 4. 13: ANOVA'S test of risk mitigation	106
Table 4. 14: The percentage of risk monitoring.....	107
Table 4. 15: ANOVA'S test of risk monitoring, control and continuous improvement	108
Table 4. 16: The percentage of risk performance.....	109
Table 4. 17: variables in risk performance.....	110
Table 4. 18: The percentage of risk related to outsourcing strategy.	111
Table 4. 19: ANOVA'S test of outsourcing	113
Table 4. 20: The percentage of Benefit of using risk management.....	113
Table 4. 21: ANOVA'S test of benefits of using risk managements.....	114
Table 4. 22: The percentage of risks often occur during procurement processes	114
Table 4. 23: ANOVA'S test for risks often occur during procurement processes.....	116
Table 4. 24: The percentage of risks usually occur during procurement implementation	116

Table 4. 25: ANOVA’S test of risks usually occurs during procurement implementation	117
Table 4. 26: The percentage of supply chain risk management and its drivers	118
Table 4. 27: ANOVA’S test for supply chain risk management drives.	119
Table 4. 28: Values of the Chi-squared distribution of Type of organisation & risk management.	120
Table 4. 29: Values of the Chi-squared distribution of type of organisation & risk identification	121
Table 4. 30: Values of the Chi-squared distribution of type of organisation & risk Analysis/assessment	121
Table 4. 31: Values of the Chi-squared distribution of type of organisation & Risk Mitigation.	122
Table 4. 32: Values of the Chi-squared distribution of type of organisation & Risk Monitoring	122
Table 4. 33: Values of the Chi-squared distribution of type of organisation & Risk Performance	123
Table 4. 34: Values of the Chi-squared distribution of organisation size & Risk Management	124
Table 4. 35: Values of the Chi-squared distribution of organisation in size & Risk Identification	124
Table 4. 36: Values of the Chi-squared distribution of organisation in size & risk analysis/assessment	125
Table 4. 37: Values of the Chi-squared distribution of organisation size & Risk Mitigation	125
Table 4. 38: Values of the Chi-squared distribution of organisation in size & Risk Monitoring.	126
Table 4. 39: Values of the Chi-squared distribution of organisation in size & Risk Performance	126
Table 4. 40: Values of the Chi-squared distribution of years of practicing procurement equipment& Risk Management.....	127
Table 4. 41: Values of the Chi-squared distribution of years of practicing procurement equipment & Risk Identification.	128
Table 4. 42: Values of the Chi-squared distribution of years of practicing procurement equipment & risk analysis/assessment	128
Table 4. 43: Values of the Chi-squared distribution of years of practicing procurement equipment and risk mitigation.	129
Table 4. 44: Values of the Chi-squared distribution of years of practicing procurement equipment and risk monitoring	129
Table 4. 45: Values of the Chi-squared distribution of years of practicing procurement equipment & Risk Performance.....	130
Table 4. 46: Values of the Chi-squared distribution for value of procurement projects & Risk Management.....	131

Table 4. 47: Values of the Chi-squared distribution for the value of procurement projects & Risk Identification	131
Table 4. 48: Values of the Chi-squared distribution for the Value of procurement projects & Risk Analysis/Assessment.....	132
Table 4. 49: Values of the Chi-squared distribution for the value of procurement projects and risk mitigation	132
Table 4. 50: Values of the Chi-squared distribution for the value of procurement projects & Risk Monitoring	133
Table 4. 51: Values of the Chi-squared distribution for the value of procurement projects & Risk Performance	133
 Table 5. 1: Interview Questions	 140
Table 5. 2: shows the time and position of each Interviewee.....	141
 Table 6. 1: Hypothesis 1	 168
Table 6. 2: Hypothesis 2	169
Table 6. 3: Participants Profile	171
Table 6. 4: Participants response for question 1	172
Table 6. 5: Participants response for question 2	172
Table 6. 6: Participants response for question 3	173
Table 6. 7: Participants response for question 4	173
Table 6. 8: Participants response for question 5	174
 Table 7. 1: Summary of Research Originality.....	 178

List of Appendices

Appendices 1: Questionnaire	200
Appendices 2-A: Interview Informed Consent	211
Appendices 2-B: Interview Consent Templet Form	213
Appendices 3: Screen shot of N-Vivo (Interview data analysis)	215
Appendices 4: Sample of Risk Record & Supply Evaluation Form	216
Appendices: 5. Framework Validation	217
Appendices 6: Sample of Request of quotation (RFQ)	222
Appendices 7: Sample of purchasing order (PO)	223
Appendices 8: Sample of Procurement Terms and Conditions	224

List of Publications

1. ***“Modelling Trading &Procurement Cycle Based on Insourcing and Outsourcing Strategy”***
*http://ieomsociety.org/IEOM_Orlnado_2015/papers/197.pdfAugust 2016 international
conference of Orlando (USA). IREMOS (**Paper accepted**)
<http://www.praiseworthyprize.org/jsm/?journal=iremos> April 2016.*
2. ***“Benchmark of continuous control policies in a stochastic context of demand and lead time:
based on discrete simulation approach”*** *<http://www.jiem.org/index.php/jiem/index> Paper
(under review) Dec. 2016*
3. ***“Risk Management in Procurement of Oil materials”***
*Proceedings of the International Conference on Industrial Engineering and Operations Management
Rabat, Morocco, April 11-13, 2017-
(Extended abstract been accepted & paper is under process)*

List of abbreviations

Glossary Abbreviation	Definition
NOC (OWNER)	National Oil Company (the owner of The Libyan oil fields)
Contractor / Service provider/ End user/Third party	Party offering a service to owner
Materials	Equipment related to oil industry
Supplier	Original equipment manufacturer representative (OEM) who offering engineering materials to Contractor/service provider.
SCRM	Supply chain risk management
PO	Purchasing orders
SOPs	standard operating procedures
EPC	Engineer, Procure & Construct, the term EPC is used as proxy for integrated projects in this thesis
EC	Engineering and Construction contractor
RFP	Request For Proposal
RFQ	Request For Quotation
ITT	Invitation To Tender
LLI	Long Lead Item
EPIC	Engineer, Procure Install & Commission
SOW	Scope of Work
Specs	Specification
SURF	Subsea/Umbilical/Riser/Flow line; a niche in O&G contracting. Equipment needed to get the oil from seabed to surface.
SCM	Supply Chain Management
Scope	Specific part of a project
Upstream	Segment of the Oil value chain, strictly from exploration to bringing the product to the surface but mostly used to designate everything before refinery
Contractor / end user	Party offering a service to owner
Materials	Engineering equipment and spare parts
Qual.serv	Quality of service

Abstract

The oil industry is considered to be a major industry as it provides energy to all other industries. This industry is exposed to various risks due to extreme circumstances, such as remote area locations, harsh environment, equipment, and functional engineering materials that are exclusively manufactured for this industry. All of these circumstances can disrupt and threaten the existences of the industry.

This is where risk management and supply chain risk management is vitally needed by researchers and practitioners. Therefore, the assessment and prediction of the impact of risks on the procurement operation performance of projects is a very challenging task. As a result of this, many projects in the Libyan oil industry and worldwide are still suffering from the impact of these risks. The aspect of risk in supply chain management is underdeveloped on the body of literature, and very few studies have addressed this issue due to its confidentiality.

The purpose of this research is to investigate the role of supply-chain risk management in the Libyan oil industry and to understand how procurement practitioners assess supply chain risk management to achieve smooth procurement operations. The author derives a set of propositions and preliminary results which contribute to developing strategies to identify and mitigate those risks. Hence, the contribution to knowledge is to investigate these issues within the Libyan oil industry and also to develop a framework that can be used as a risk management supporting tool.

Qualitative and quantitative (triangulation) were adopted for this research. This comprised of the investigation of 65 out of 93 Libyan procurement practitioners, as well as interviews of which 9 Libyan procurement practitioners participated.

This research finds that service providers and contractor companies are the highest percentage within stakeholders, who are practising supply risk management techniques. However, this percentage is still low within its group.

This research also identifies types of risks that majorly affect the performance of procurement operations, such as purchasing clone parts. Thus, providing valuable information for particular stages of response planning. It also explores how the consideration of risk management can reshape supply chain management. Moreover, a Procurement Risk Management Framework (PRMF) that has been developed and empirically validated.

Chapter One: Introduction

1.1 Background

1.1.1 Procurement

In the last decades, the role of procurement and supply management has swiftly risen where procurement is associated with efficient purchase orders (PO) processing. The development in international trade has further expanded the role of procurement in controlling sourcing and acquisition process (Benton and McHenry 2010). In a rapidly changing environment, a disciplined approach, as well as adequate understanding and deployment of new strategy and technology, is needed to decisively manage business relationships (Teece *et al.* 2006).

There are various activities involved with procurement support companies' goal to realise business values. These activities can be by providing human resources, purchasing inputs, technology, raw materials, machinery, suppliers, and office equipment (Porter 1985).

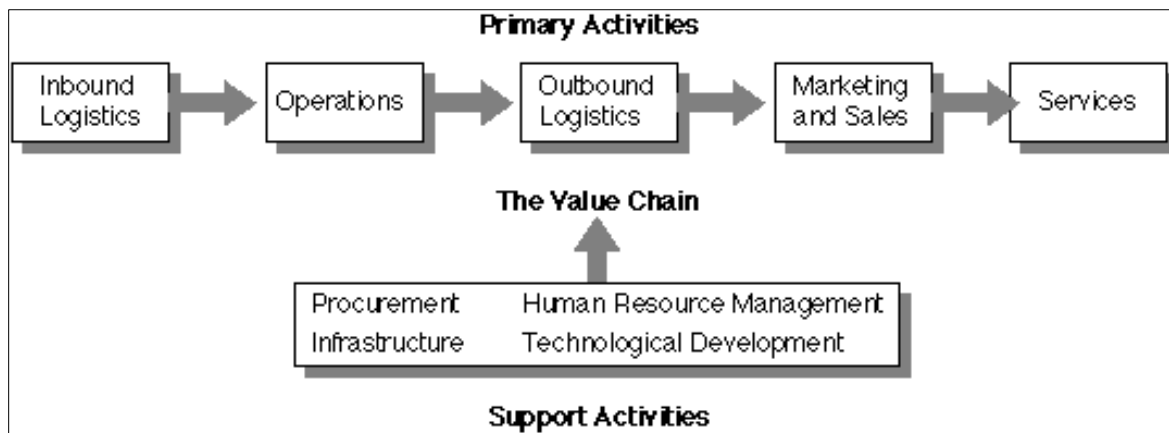


Figure 1. 1: Value Chain Diagram adopted from (Porter 1985: 11-15).

Value chain initiative is focused on the view of organisation process, which sees a service organisation as a system that comprises of other sub-systems each with inputs, transformation processes and outputs. These involve gaining and utilisation of resources such as labour, money, materials, building, land, management, equipment, and administration. The value chain activities engagements are dependent on costs and profits. In most organisations, some activities are embarked upon with the aim of transforming inputs into outputs. This number of activities can be categorised as primary and support activities that all organisation tends to engage in one way or the other. Porter (1985), classified these activities into:

1- Primary activities such as:

- A. **Inbound logistics**- this involves relationships with suppliers and includes all the activities required to receive, store, and disseminate inputs.
- B. **Service** - includes all the activities required to keep the product or service working effectively for the buyer after it is sold and delivered.
- C. **Outbound logistics** - includes all the activities required to collect, store, and distribute the output.
- D. **Marketing and Sales** – activities include informing buyers about products and services, induce buyers to purchase them and facilitate their purchase.
- E. **Operations** -that include all the activities required to transform inputs into outputs (products and services).

2- Support activities such as:

- A.**Procurement** - is the acquisition of inputs, or resources, for the firm.
- B. **Infrastructure** - serves the company's needs and ties its various parts together. It consists of functions or departments such as accounting, legal, finance, planning, public affairs, government relations, quality assurance and general management.
- C. **Technological Development** - pertains to the equipment, hardware, software, procedures and technical knowledge brought to bear in the firm's transformation of inputs into outputs.
- D. **Human Resource Management** - consists of all activities involved in recruiting, hiring, training, developing, compensating and dismissing or laying off personnel (if necessary).

In any organisation, the significant difference between primary activities and support activities is that primary activities can be primitive and cannot be outsourced while support activities can be either be performed within the organisation or outsourced to external suppliers. However, organisations must take cost into consideration when making decisions to outsource. If the cost of outsourcing is higher than performing the activities in-house then, the activity should rather be performed within the organisation in order to save cost. Service providers whose main activities are drilling or exploration, and Engineering Procurement Construction (EPC), seek to provide their

needs like materials and equipment to achieve project completion. This requires procurement process as a support activity and outsource it from suppliers. This is the focus of this research with the investigation of risk management associated with this procurement process within the Libyan oil industry (Nolden and Sorrell 2016).

The benefit of procurement operation cannot be overemphasised as it requires the use of excellent business practices and enhances business values through material, goods and service acquisition. The role of procurement department in an organisation is to provide the right service or material in the right quantity at the right time to the right place and at the right price (Benton & McHenry 2010). The adoption of procurement best practice by a procurement professional in an organisation is ultimately invaluable for excellent decision making. This creates an opportunity for companies to develop correct plans, make adequate strategies and risk management that are in accordance with business goals and objectives. Among the important strategies, sourcing, which is a set of tactical courses of action and daily methods, can be adopted by the organisation for better communication of its business requirements to potential suppliers. In some organisation, the process is referred to as Standard Operating Procedures (SOPs) which is maintained in the business formal document libraries (Cavinato 2010).

1.1.2 Supply Management:

Even though procurement strategy is developed by an organisation to adopt to its internal requirements, it is equally important that the procurement strategy should be developed with market changing expectation plan in mind. This type of change, either in supply or demand, is capable of influencing decisions to delay acquisition plans or to speed them up in the face of temporary opportunities. Prices vary, and so strategies that are specific for commodities need to be developed to respond swiftly to variation in demand and supply. Generally, supply management strategies are based and responsible for important aspect such as technology and spending, seeking formularies to balance various needs at any given time (Ostring 2004).

1.1.1 Procurement Risk Management (PRM)

There are various definitions of risk management, which are considered vague in most cases, for example *'risk is the probability of incurring loss or misfortune'*. In some definitions, the focus is mainly on disruption event probability like a break in supply chain. Meanwhile, what also matter is the inability to seize the opportunity for the benefit of the organisation. In the UK Office of Government Commerce (OGC), risk is defined as *'uncertainty of outcome, whether positive opportunity or negative impact'*. Consequently, procurement risk exists for an organisation *'when supply market behaviour, and the organisation's dealings with suppliers, creates outcomes which harm company reputation, capability, operational integrity and financial viability.'* From these two perceptions, procurement risk management (PRM) is defined as *'the name given to the measures taken including changes to behaviours, procedures and control which remove procurement risks or reduce them to what is considered to be an acceptable level.'* Lowrances (1976) explain the acceptance level of risk: When the combination of probability, exposure and severity is low, people can accept this level of risks.

There are some fundamentals for risk identification to be successful; two important ones are; the need to connect an event to exposure to quantify its impact, and the need for unrestrained creativity in imagining potentially disruptive events in the first place.

A comprehensive search for 'at risk' situations surveys five different landscapes where risks may lurk:

1. External dependencies (e.g. supply chain robustness, supplier viability).
2. Market conditions and behaviours (e.g. competitive or not; supply availability).
3. Procurement process.
4. Management controls.
5. Ability and agility to handle unexpected events.

This research will explore the external dependencies of supply chain e.g. supply companies and its effect on end users, contractors, and service provider companies. Moreover, this research should provide an understanding of risk factors that threaten procurement process. Procurement Risk Management (PRM), can be described with these four states:

1. Ignorance: Neglecting actions when it's needed urgently.
2. Responsiveness: Risk identification comes from asking 'what if?' questions; being streetwise and creative; learning from past incidents, and knowing where to look.
3. Evaluation: Assessing impact and probability in a structured and consistent way.
4. Risk Management: Appropriate measures are in place to contain or mitigate impact or to compensate for loss, plus regular reviews, and receptiveness to supply chain alerts.

PRM can be planned and mapped with risk assessment and risk catcher as shown in figure 1.2 below. The figure illustrates an example of two profiles risk catcher. The typical current condition is represented by the dark grey line while the light grey represents the desired end state. Information from the dark grey line is part of an in-process series of field surveys carried out by private and public sector organisations user. It takes note of participant's company's self-assessment of PRM awareness. The emerging theme is that organisations are assessing themselves as being similarly prepared for risks in the areas of external dependencies, management controls and Procurement Process. However, there are lower scores for market conditions and behaviours, and treating the unforeseen. (Russill 2010)

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1.1.2 Risk management in the oil industry:

Risk and uncertainty associated with the oil industry imply caution for investment decision-making policy (Lind 2013, Raydugin 2013, Watson 1998). Therefore, the oil industry has been popular in the application of decision making analysis in this regard (Grayson 1960). This is evident among research using laboratories in oil industries to carry out experimental analysis on newly developed tools and models to validate expected outcomes (Bailey *et al.* in press, Ball and Savage 1999, Dixit and Pindyck 1998 and 1994, Galli *et al.* 1999, Smith and McCardle 1997). Due to the high rate of decision-making analysis experimentation within the oil industries, as regards to the huge risk involved, many other industries except financial, uses it as a model to benchmark (Schuyler 1997). However, it is safe to say the oil industry offers valuable decision-making measures, which some companies rely on to determine the type of relationship between business success and investment, regarding decision making and analysis judgement. The current study, however, is based on major operating upstream oil companies in Libya. International supply chain management is faced with some challenges; this is because operations involve many uncertainties such as infrastructure, competitive market, culture and environment. (Flint 2004, Manuj and Mentzer 2008b, Meixell and Gargeya 2005). These uncertainties cause disruptions to the flow of information and the material supply (Bode *et al.* 2011). This disruption propagates across the entire supply chain, thus, disturbing the procurement operations of engineering material that are needed by oil exploration and drilling companies to perform their professional task.

Moreover, international supply chains are much exposed to risks than domestic chains. This disadvantage is due to the links connecting an international network of companies involved in the procurement operation (Manuj and Mentzer 2008a). As companies always aim to reduce cost, source the right vendor, inventory management, lean operations, and reduce outsourcing. These aims can be achieved in a stable environment; however, this may change to risks once the supply chain extends to international complex supply chains (Chopra and Sodhi 2004, Faisal *et al.* 2006 Giunipero and Eltantawy 2004, Jüttner *et al.* 2003, Manuj and Mentzer 2008b, Tang 2006 Zsidisin *et al.* 2000). Risks drivers which increase the complexity of supply chain are:

- Outsourcing.
- Integrated manufactories and distributors.
- Efficiency

- Reduce improper suppliers.
- Labour strike, fire, terrorist attack and natural disasters.

As the disruption list expands causing irregularities to company's operations, the concentration of Supply Chain Risk Management (SCRM) is also increasing (Blackhurst *et al.* 2011).

This motivates the author more to focus on supply chain risk management within oil materials procurement operations.

1.1.3 Supply Chain Link & Challenges in oil material procurement:

Around the world today, the oil industry is regarded as a major economic booster. The reason is because the industry provides the largest share of energy consumption relied on many other industries. Oil industry is categorised into five main operational divisions as listed below. (Chima 2011).

Exploration → Production → Refining → Marketing → Consumer

The interaction between the five divisions illustrates the major supply-chain relationship within the oil industry. The interaction depicts boundary in-between materials, companies and consumers that exist within the supply chain. Each supply chain division comprises of several other operations. For instance, the exploration division is made up of the following activities or operations:

- Reservoir,
- Drilling,
- Facilities engineering and
- Production.

In each stages of the listed supply chain division, the output of one is the input of the other, i.e. refining operational output is the input for marketing division. However, any of the mentioned divisions can be a standalone organisation linking the other or unit of an integrated organisation. (Chima 2011).

A certain number of materials and equipment are required by the companies to operate as expected. Among these are valves, chemicals, cranes, gloves, steel, drilling rigs, cements etc. However, range of such materials and equipment varies from one company to the other. In most cases, lack of one material might not hinder smooth operation of the company. Some of the

activities in oil divisions are repetitive, especially in the drilling of oil wells where quite a number of activities are involved from start to finish. Materials used in oil industries are standardised and carefully chosen, ordered, manufactured, transported, stored, prepared, and delivered to the company for installation. Due to the strenuous nature of this activities of ordering materials, most oil companies are having a challenging time in managing challenges associated with the logistics and operational activities in this supply chain link. As a matter of fact, the oil industry faces huge rig downtime in a situation where there is a delay in the arrival of ordered materials or equipment. This type of delay is subsequently classified as a major cause of higher cost of operation. Therefore, supply chain improvement in this area needs continuous evaluation and updating in operational procedures. This is to avoid risks associated with materials and equipment procurement activities. Other advantages such as performance enhancement and lead-time reduction helps to reduce cost of the entire supply chain process. (Turker and Altuntas, 2014).

As part of material and procurement operations, stakeholders such as owners, end-users, and suppliers, contractors or service providers exists as an entity of individual interest. Commonly, at the start of material procurement projects, it is usual for the project owner to perform risk assessment process. This process is expected to enable project owners to recognise risk involved and appraise the risk management activities of the project, to determine if the project is worthwhile (Simth, Merna and Jobling 2009). It is not strange to learn that the task of procurement operation in oil industry is challenging to manage. This is because of several reasons such as sophisticated product types, as well as, high price of product, remote location of oil company and extreme situation as illustrated in Figure 1.2

According to Ebrahim *et al.* (2014), oil companies face procurement operation challenge in term of conflict and instability as well as theft, which can lead to operational disorder and uncertainty. This research intends to tackle and identify the risk factors that threatens the procurement of oil engineering materials from operational aspect. It will also investigate their appearance and consciences on supply chain and mitigation strategy. Presently, most of the challenges encountered in material procurement and its risk management practices are not just restricted to initial identification of the potentials risks but in assigning indicators that will alert the operation owners to the occurrence. Having such indicators will allow the project owners to deploy the mitigation procedures during or before the occurrence of the risk and disruption of the supply chain. With respect to large oil operations, recent studies have identified several limitations in

using existing standard supply chain management (Azambuja and O'Brien 2009, Cox and Ireland 2002, Handfield, *et al.* 2015). These studies indicated reasons for arguing that usual supply chain management approach, such as those applied in manufacturing industry cannot be used directly for the oil industry, despite the similarities in the industries. They pointed out that due to the nature of this industry, and the extreme circumstances usually encountered, managing such operations are particularly challenging, and prone to supply chain and project disruptions. A key reason of such disruptions is because of the macro environment factors associated with such operations, as shown in Figure 1.3 (Ebrahim *et al.* 2014). Finally, another common occurrence in this types of environment or oil producing countries is the corrupt contract award practices that accompanied such operations. This has

major impacts on project outcomes, particularly at procurement and in obtaining permits and permissions as well as the process of negotiations with local governments. From a procurement point of view, these contracting challenges are directly related to the volatility of commodity associated with sourcing the major raw material inputs into oil exploration and downstream capital operations (Handfield *et al.* 2013). Therefore, a significant effort is required to monitor and to plan for effective procurement in these uncertain project environments and against such occurrences. The absence of this effort renders the project at risk of significant shortfalls between supply and demand.

In other words, there is a need to identify a more collaborative and encompassing approach. This is to manage the operational procurement challenges of material supply in the oil industry which forms the main focus of this research.

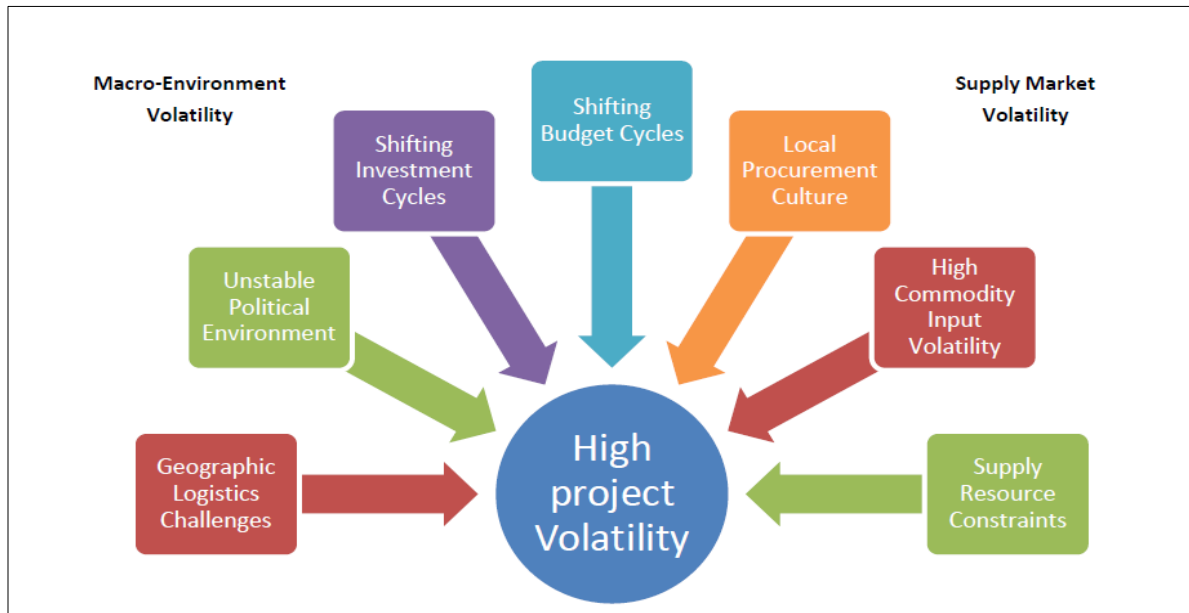


Figure 1. 3: Challenges in oil procurement management (Handfield et al. 2013).

Part of the benefits of these risks to the oil company (Owner/end user) primarily includes the reduction of project costs and improvement of the overall project performance. Meanwhile, from the contractors' point of view, it can increase overall profitability through shared gains and predictability of the project workflow. Thus, allowing improved resource management and allocation (Turner 2006). It is also important to note that because of the scale, cost and duration of Large Engineering and Construction Operations (LECPs), they are usually carried out in phases. There is an economic evaluation at the end of each phase before any more investment is committed. As seen in Figure 1.4 below, these phases are generally categorised as engineering, procurement and construction phases. The last phase of the LECP development is normally contracted out to an Engineering Contractors (EC), as most owners do not have the required in-house competencies for this.

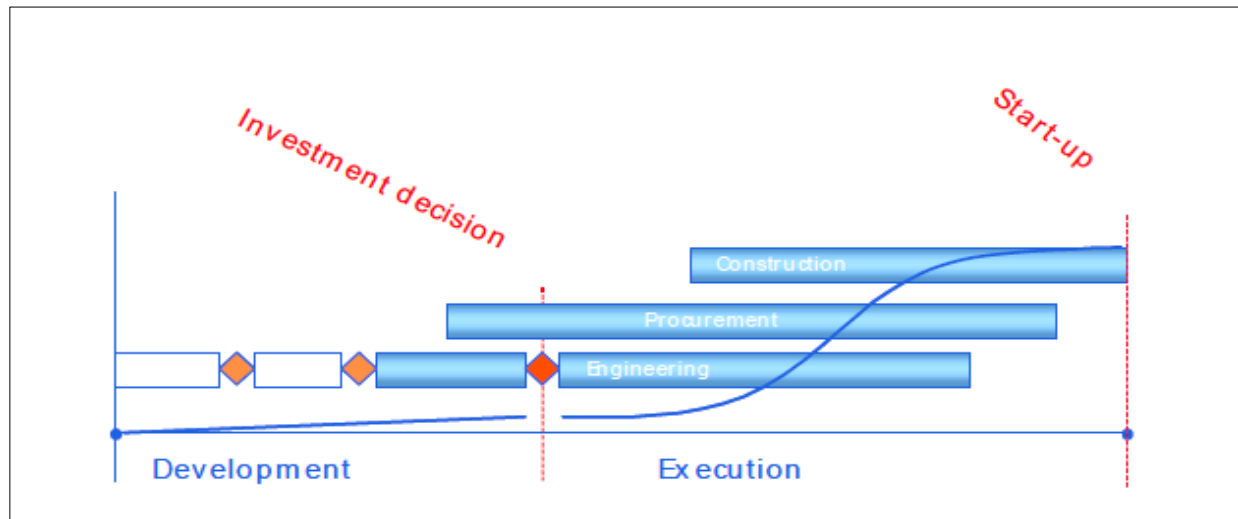


Figure 1. 4 : LECP Project Life- cycle (Berends 2008)

Over the last decades, project owners in the oil industry have contracted out the execution of the Engineering, Procurement and Construction (EPC) contracts of such LECPs to a large extent. This is through a competitive bidding (closed) process by single Lump Sum /Fixed Price (LSFP) contract approach. However, it is also reported that in most cases, around 80-90% of the work (on a value basis) of such contracts are not carried out by the Engineering contractors_(ECs), but by suppliers selected by the ECs to supply the required equipment's and materials or to carry out the actual constructions (Figure 1.5). The EC, on his part, provides a cost and completion guarantee to the owner (Berends 2007).

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This development in the industry has resulted in a situation whereby the ECs are more focused on managerial concern to maximising value and increasing procurement process. They tend to

achieve this by developing a suppliers' base to their supply needs in terms of quality, schedule, quantity, and cost as well as continuous improvement (Johnson *et al.* 2011).

These requirements and trends in the industry have also led to the adoption of total supply chain management practices to manage the supply chains. Given the nature of the industries supply chain with periods of shortages and abundance, price fluctuation and environmental complexities discussed earlier; total supply chain management has gained more prominence in the industry. A limitation of the current body of literature is its scarce use of empirical evidence: some works are purely theoretical, while others are based on examples of reactions to past events. None applies theoretical knowledge in supporting procurement managers to assess the vulnerability of their supply chain. Small and medium oil operation companies are more focused on their core operations such as exploration. They meet their needs through outsourcing their materials using contractors/service providers to provide their requirements and execute the procurement process as a turnkey project on their behalf. The few large multinational operators like BP and Total who have specific procurement departments and expertise to handle every facet of operations from engineering to procurement. Meanwhile, in regarding procurement, the smaller Oil companies have to resort to outsourcing. There are various contracting companies dedicated to the business of procurement on behalf of these small-scale companies. Owners/End users start the process of procurement by inviting suppliers' or contractors' request for quotation (RFQ) containing material specifications and contract terms. The contractor then sources for competent suppliers. The contractor submits the full offer, which is compared to offers from various other contractors. These comparisons are based on price, time of delivery and quality of machinery (Van der Horst 2013). The selected offer is awarded to go ahead with the contract by sending the Purchase Order (PO). The contractor then instructs the supplier to produce or deliver (if readily available) the materials. Upon delivery and successful inspection, the owner/end user performs final payment. The process and the character of appropriately contracting and awarding a project contract in the early project stages are important for the future course and consequently the success of the project (Schramm *et al.* 2010).

1.1.4 Tendering and Procurement Process:

The procurement process occurs upon preliminary project approval to commence the release of procurement documentation to potential suppliers (Figure1.5).

This process includes:

- **Project Documentation Development:** Upon approval to proceed, the engineering contractor (EC) develop the Request for Qualification (RFQ) and Proposal (RFP), a framework for evaluation and the procurement agreement.

The procurement agreement includes the designs, specification, services, energy, security and insurance requirements, as well as, terms and conditions for payment.

Outputs from this stage include the RFQ, RFP and the procurement agreement in such detail to enable service providers or suppliers in procurement initiation.

- **RFQ Process:** The RFQ process includes the release of the RFQ document to the suppliers, the performance of information meetings and responding to Request for Information queries from potential service provider and supplier. This process is the pre-qualification for the RFP process. The output of this process is a shortlist of service providers and suppliers that may proceed to the RFP Process.

- **RFP Process:** The RFP Process includes the release of the RFP document to the shortlisted suppliers, collaborative meetings between the contractor team and short listed suppliers, technical and financial proposal evaluation, and selection of the preferred supplier. The intent of collaborative meetings is to permit formal discussions on terms and feedback on the project agreement. The output of this process is the identification of the preferred supplier.

- **Negotiations and Approval:** Outstanding issues with the project agreement terms and conditions are negotiated with the preferred supplier. Procurement director and team liaise with the approval and funding authorities and seek approval of the project. Multiple levels of decision-making hierarchy require consultation and signoff of final agreement and terms. The output of this activity is a signed effective project approval for proceeding with contract award.

- **Contract Award:** Regarding contract award, the preferred supplier is assigned contractual authority to provide the engineering materials and implementation of the project. The output of this procedure is a signed contract between the Engineering contractor(EC) and selected supplier.

1.2 Research Aims:

The main aim of this research is to determine a comprehensive analysis of the threats that intimidate material procurement operations and develop a framework to help the Libyan service provider companies to mitigate procurement operation risks.

1.3 Research Objectives

Objective	Research Methods
➤ Review the current pieces of literature of Supply Chain Risk Management (SCRM), and procurement operations.	Literature review
➤ To explore the various threats that propagate within the material supply chain in the oil industry.	Literature review, questionnaire, and semi-structured interviews.
➤ To investigate the current practices of risk management for material procurement and how they are handled.	Questionnaire and semi- structured interviews.
➤ To develop a framework for conducting risk management processes for material procurement within the oil industry and validate with a case research.	Literature review, Questionnaire and interview followed by framework validation.
➤ Provide recommendations for the improvement of risk management in the oil industry.	Chapter 7

Table 1. 1:: Summary of Research Objectives, and Applied Methodologies

1.3.1 What are the Research problems and challenges?

Developing of trading policies, globalisation and continuous improvement in procurement companies led to the complexity of supply chain – for example, the move to outsourcing has increasingly exposed the processes to risk and vulnerability of the supply chain because of

unguided information and operation to the third party (Christopher and Lee 2004:388). Due to this increase of vulnerability, Norrman and Jansson (2004:434) stated that *“industries moving towards longer supply chains (e.g. due to outsourcing) and facing increasingly uncertain demand as well as supply, the issue of risk handling and risk sharing along the supply chain is an important topic”*.

Furthermore, Svensson (2000:731) adds an important hint: the increase of the vulnerability of supply chains appears even more substantial when the focal firms' business has become dependent on the suppliers' organisation. In other words, when outsourcing is done through local suppliers, the supply chain will face a higher vulnerability.

“Firms need to understand supply chain interdependencies, identify potential risk factors, their likelihood, consequences and severities. Risk management action plans can then be developed to preferably avoid the identified risks, or if not possible, at least mitigate, contain and control them” (Tummala and Schoenherr 2011:474). In general, supply chain risk management permits reducing the supply chain risks (Norrman and Jansson 2004:455).

Therefore, due to the challenges in the environment, continuing development of risk management strategies and tools is significantly needed to secure materials procurement processes to survive and stay in the market, this is the intention of this work.

1.3.2 Significance and Contribution to Knowledge:

The intention of this research is to contribute to the existing body of knowledge concerning the aspect of procurement and threats associated with the supply chain. This work aims to move a step further towards the understanding of how procurement managers can evaluate their risk in such harsh operating environment such as in the oil industry where end users are usually located in remote areas. This work specifically intends to investigate the main risk factors that affect material procurement operations in the Libyan oil industry. In addition, this work intends to develop a suitable framework for procurement risk management that procurement managers can use as a tool to evaluate their potential exposure to supply chain risks. This is to enable procurement managers' ability to prepare proactive action to deal with such threats. This is what the researcher intends to contribute to knowledge.

1.4 Research Questions:

The development of a research question is a process of looking at identified issue and formulating questions with the intention of resolving it. Sweet and Grace-Martin (2003) states that the

research question emphasises a lack or absence of understanding about an issue. It refers to the gap that the researcher intends to address. To achieve the research aim stated above, the following research questions have been formulated as listed below.

- What are the risk areas to be managed in materials procurement process for Libyan oil industry?
- What are the main risk management strategies to be considered?
- Can these strategies generate positive performances and outcomes?
- How can procurement managers effectively manage risks in supply and procurement process?

1.5 Research Methodology:

This section describes the intended methodology that will be adopted in this research to achieve the objectives. The research will commence with an extensive review of recent available literature relating to the aims of the research. It is intended to adopt a descriptive research process, using both quantitative and qualitative methods (triangulation). Therefore, a questionnaire will be distributed to get an initial opinion of Libyan practitioners in the oil industry, including procurement and operational managers representing end-users and operational companies.

Additionally, the research is adopting exploratory approach, and so a qualitative analysis from an interpretivist epistemological position will be used through semi-structured interview with experienced practitioners in the field of procurement in the Libyan Oil industry. The interviews will be conducted based on the results of the questionnaire, which complement the main themes of the literature review. As Creswell (2003) and Bryman (2004) stated, this approach allows a researcher to understand the dynamics of the phenomena as interpreted by its participants. This research also intends to use a case research strategy to enable the in-depth investigation of dynamics in its natural setting. This would be achieved by iteratively developing and validating the framework with material procurement practitioners. This validation will enable the research to be justifiable and make sense in terms of the people involved (Denzin and Lincoln 1994).

Two stages of the research methodology are anticipated as follows.

Stage1

SPSS and Microsoft Excel as software supporting tools to be used to analyse the findings obtained by the questionnaire.

Stage2

As Joffe and Yardley (2010) explained, the content analysis is systematic qualitative analysis that gives a numerical description of the findings, in the second stage, the findings of the interview will be analysed using NVivo software and thematic analysis to group the findings into related themes.

According to previous researchers (Boyatzis 1998, Braun and Clarke 2006, Holland 2007), thematic analysis allows flexibility in the research in analysing qualitative data while, providing some rich descriptions of participant's experiences, which is not available with other approaches, such as positivist/scientific method.

Stage1 and 2

At the end of research stage 1 and 2, a triangulation of the findings from the literature review, questionnaire and interview will be carried out to further verify the main findings. This will help show the weakness of the findings as well as reinforce the most important facts from those findings that are considered doubtful for this research. This main finding, with the aid of validation process of the proposed framework and the final design of the developed framework can be finalised. This is illustrated in Figure 1.6 below.

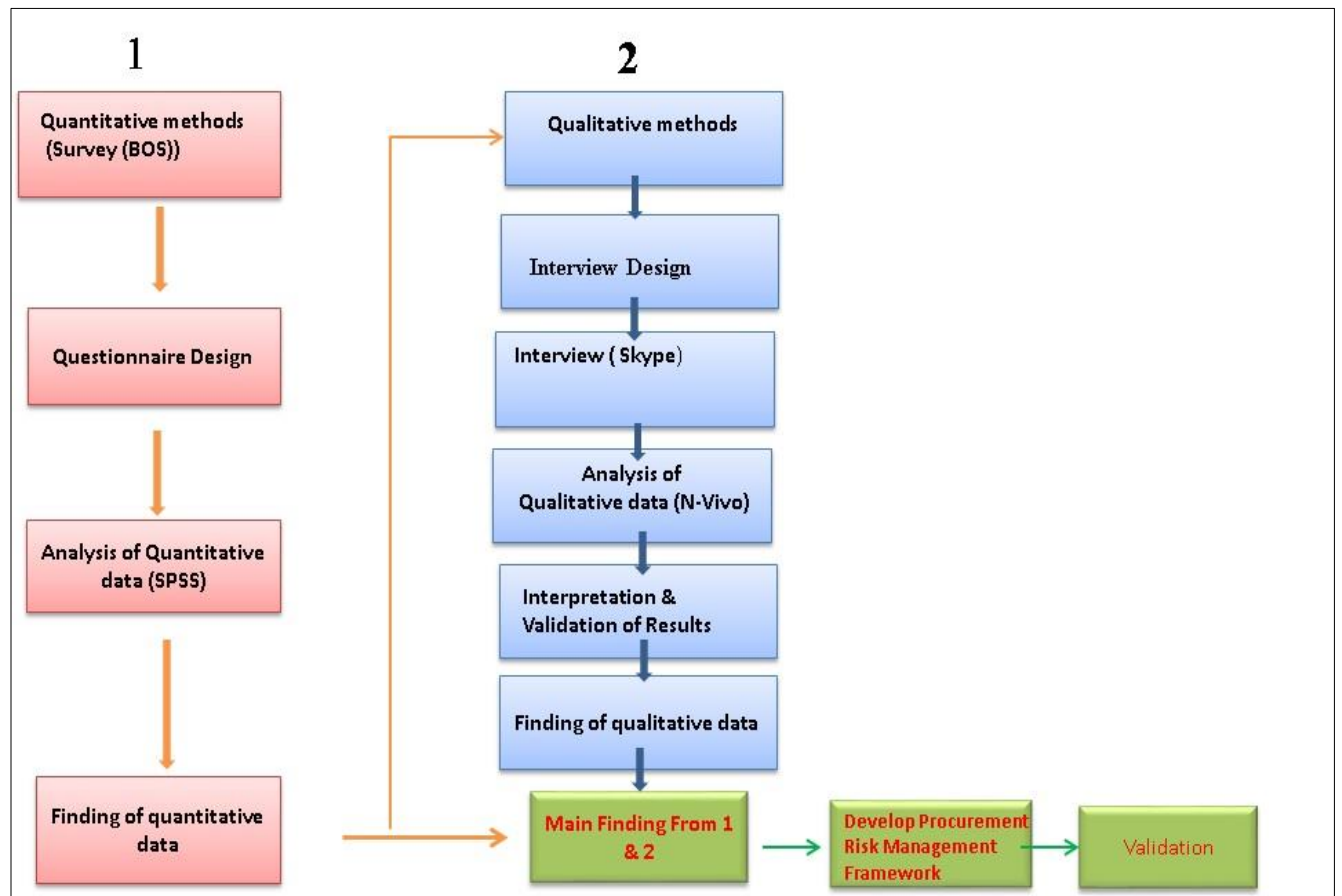


Figure 1. 6: Methodology Framework

1.7 Structure of the Thesis:

Having introduced this research with the aims, objectives and the intended methodology. The rest of this research will be presented in the following structure:

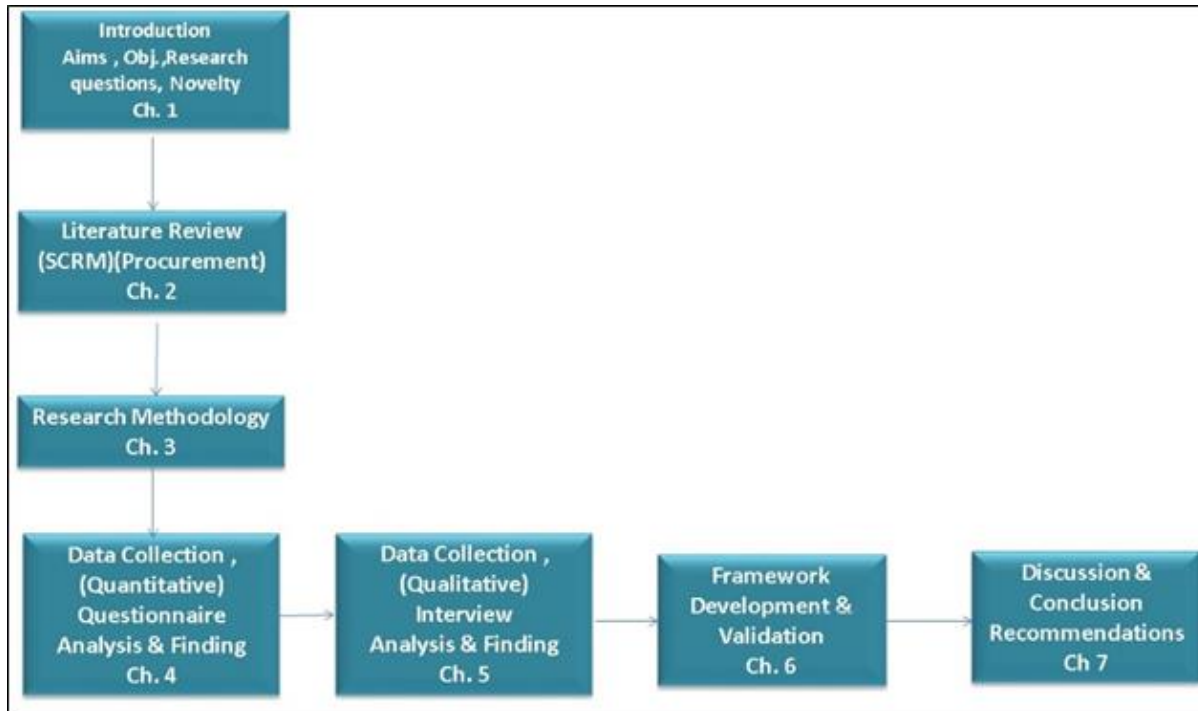


Figure 1. 7: Generic Thesis Structure

A brief description of the research design process is represented above which reflects the development of this research report from the development of literature review all through the questionnaire and interviews as well as analysis and development of the final procurement risk management framework.

- **Chapter One.** This chapter will provide the aim, objectives, research questions and brief description of the methodology that would be adopted.
- **Chapter Two:** This chapter will provide an extensive literature review of existing related literatures. It will consider the various procurement and supply chain management principles as well as the risk and vulnerability management practices presently available. These will be selected based on how closely related they are to the oil engineering operations. Within this chapter, the relevant hypothesis will be developed.
- **Chapter Three:** this chapter will provide an in-depth discussion on the methodology that is adopted in this research. It will explain the rationale for selection of the research approach, strategy and philosophies. This chapter will also explain the assumptions that

are used to justify the choice of research design and how suitable they are for the scope of this research.

- **Chapter Four:** This chapter will present the analysis and finding based on collected data from the questionnaire using SPSS statistical analysis software.
- **Chapter Five:** This chapter will provide the analysis and findings from the results of the interviews been conducted with procurement managers.
- **Chapter Six:** This chapter presents the validation of the framework and the final development been carried out during this research.
- **Chapter Seven:** This chapter will include discussion and final outcomes including the contributions of the findings to the body of knowledge. It will also explain the strengths and weakness of the research as well as areas for further research and recommendation.

1.8 Summary:

Chapter one covers the background of the research and has presented the research aims and objectives which are aligned with the research topic. The chapter has also developed the research questions and problem statement which has been developed from reviewed works of literature that provides a background to the research. These works of literature reviewed indicates the increasing demand for research on supply chain risk management in the oil industry. Definitions of key terms for the research were presented in this chapter together with the background of the research. Furthermore, the chapter has briefly presented an overview of the research methodology followed by presenting the initial risk management framework. Finally, the thesis structure was outlined by providing an overview of the entire research and a description of the content contained in the other chapters.

Chapter Two: Literature Review

2.1 Engineering Procurement in the oil Industry

2.1.1 Oil Engineering, Procurement, and Construction (EPC) Project life cycle:

Over the years, the division of roles in oil contracting has gradually changed (Figure 2.1). This change is in form of integration with a push to increase project performance and client risk adversity, as well as, reduction of project engineering in management capabilities with clients. In the future, O&G contracting will include early contractor involvement and more interdependent cooperation to increase performance. (Bakker, 2010).

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As a result of these developments, the huge investment associated with such EPC contracts, and high engineering complexity has made the ECs and their clients to partly develop their nomenclature for the different phases of the EPC operations life cycle.

2.2 Project phases:

A typical oil project lifecycle is made up of four main phases (Figure 2.2). These phases are described in the following sections.

2.2.1 Business planning and project strategy:

In this phase, the decision to start exploring the feasibility of developing a project is made. Reasons to start a project could be a future lack of capacity in a certain installation or the indication of a producible oil field.

2.2.2 Front End Development (FED):

The main goal of FED is to provide the owner with a sufficiently complete image of the project to enable them to decide whether the project is worth investing resources (van der Weijde 2008). In the oil industry, it is a common practice to divide the front-end development phase into three stages, aptly called: FED 1, 2 and 3. These represent assessment, selection and definition of the project (depending on the source used) respectively. The rationale behind the extensive FED is that the impact of changes on project cost in an early stage is minimal, while changes in the course of the project have a much higher influence on project price. The FED phase should eliminate changes and optimise project schedule, cost effectiveness, safety, and functionality. In short, it is an approach to make the project risk for both clients and EC more manageable.

2.2.3 Implementation and operational readiness:

In this phase, the main engineering operation (construction, drilling, etc.) takes place. Often a project is placed on the market as a competitive tender. The FED 3 or FEED package, drafted by an external EC, serves to communicate the requirements from the customer. A FEED package is typically detailed to a functional level. It is to the construction company to specify exact materials, methods and machinery. The delineation to where the FEED stage stops and where tendering by a construction company starts, depends on the client, type of project and envisaged contract form for the works (Figure 2.2).

2.2.4 Start-up & Operation

The commissioning or start-up of an oil engineering project is a key part of the project requirement. All systems, for instance, have to be coded and signed off by third party bureaus for compliance to regulation. Run in of a large and complex installation can take several months (Speirs *et al.* 1999).

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2.3 Project Supply Function:

Before the World War II, acquiring goods and services was mainly seen as a clerical function. However, during the war and as a result of the limited supply of materials, the survival of any firm is depended on its ability to secure raw materials, supplies and services to keep production going and not necessarily how much it could sell. During subsequent decades, further development in the industries also contributed to making the acquisition goods for competitive prices critical to business success (Johnson *et al.* 2011).

This strategic change in approach meant that managers needed an increased focus on process and knowledge management especially in the area of supply chain. This has also resulted in a variety of organisational concepts such as procurement, procurement materials management, logistics, sourcing, supply management, and supply chain management which are commonly used almost interchangeably. Consequently, recognition was given to the organisation, policies and procedures of the supply function leading to the birth of Supply chain management and associated supply chain security, sustainability, and risk management (Scotti 2007, Johnson *et al.* 2011).

2.4 Evolution of supply:

Similar to the other developments in the industry, supply function had also evolved from simple operational purchasing to tactical procurement, and into strategic supply management. This is a major discipline, driven primarily by a greater awareness to the financial implication of executing the function well (Scotti 2007). This is depicted in Figure 2.3.

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Similarly, the supply types have also evolved depending on the items being purchased. At this stage, it's important to describe the different types of supply in procurement operations.

2.5 Types of Supply:

There are two main types of supply in a project based organisation, according to Johnson *et al.* (2011); the direct and indirect supply. Direct supplies involve the supply of items that are used in the primary process of an organisation, while indirect supplies refer to the supply of items that support the primary process. In regards to direct supply, Van Der-Horst (2014) further classified it into operational and project supply; he explained that operational supply is that which does not in itself create value for the customer or directly involved in a project cycle (such as maintenance and fuel for equipment). On the other hand, project supply are those items that directly add value to the customers in operations. Figure 2.4 represents the supply types from the comprehensive supply portfolio.

Researchers in the supply management field has developed supply management frameworks which are not suited for a project based contracting environment. As some authors, have pointed out that the management of the supply process of the different types of supply should also be different (Kaljic 1983, Van der Horst 2013, Zsidisin 2003). They explained that the differences that affect the various types of supply which can be in the form of the functions involved in the supply process or the risks associated with the procurement activity in different industries. They added that these differences also necessitate different procurement or supply management approaches. At this point, it will also be important to differentiate between the various terms used in the literature of supply chain risk management. Presently, most authors still use the term procurement and supply management interchangeably to indicate the supply function required for modern times. However, for this research, these terms will be separately defined as they relate to supply chain risk management in the oil industry.

2.5.1 Supply Management:

According to Kaufmann (2002), supply management refers to “all the processes involved in supplying an organisation with materials (direct and indirect), machinery, equipment, or services, from external sources to the organisation with the aims of improving the competitive organisational advantage. This means that supply chain management is more complex than the simple seven steps that make up ‘procurement’ (Table 2.1).

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2.5.2 Supply Chain (SC)

Over the years, various authors have also differentiated supply chain from an regular procurement exercise (e.g., Christopher 1998, Janvier-James 2012, Julka *et al.* 2002, Sillanpää, 2010, Slack and Lewis 2008, Thierry, *et al.* 2010). For instance, while supply chain is commonly regarded as a chain/manufacturing process that converts raw material into finished products or services and delivers them from suppliers to customers (Beamon1998, Chow and Heaver 1999).

Other scholars such as, Ayers (2001), Harland *et al.* (2001), Little (1999), Mentzer *et al.* (2001) added that a supply chain involved the associated information flows associated with the processes. In addition, some scholars (Harland *et al.* 2001, Pienaar 2009) also explained that supply chains and supply networks both describe the flow of materials and information by linking organisations together to serve the end-users. The supply chain has been developed much further during the last few years compared to biological or social systems. Surana *et al.* (2005) added that this had made the management of the supply chain process a specific practice requiring a structured approach in an organisation.

2.5.3 Supply Chain Management (SCM) and suppliers:

During the last few years, informed development in SCM especially in the oil industry has advanced as one of the most important aspects of industrial operations. The increased interest of researchers in this area of study shows its importance in the current business world. SCM can be referred to as the means of devising methods and series of steps in the business where goods and services move between suppliers, processed into finished goods then through to the final consumers (Tseng, Yue, & Taylor 2005). It involves information transfers between these supply chain entities.

2.5.4 Supply Chain Management and Supplier Development within Oil Industry:

2.5.4.1 Supply Chain Management:

Various definitions of supply chain management exist in previous literature. Some scholars define supply chain management as the process of managing the chain of activities involved in the transition of goods and services from the manufacturer to the final customer. These activities can include planning, coordination and control (Christopher 1998, Janvier-James 2012, Julka *et al.* 2002, Slack and Lewis 2008, Thierry *et al.* 2010).

Some authors were more specific and described supply chain management to include all the activities used for efficient integration of a supplier's overall capabilities (such as organisational units, stores and warehouse) to the production and distribution channel to transition the required quantity of goods or service, to the specified location within the specified duration and cost, at the same time satisfying all other service level requirements (JussiHalme 2013, Naslund and Williamson 2010 Thierry *et al.* 2010).

Based on the definition above, it is important to explain here that, a typical supply chain will be made up of several components/entities with complex interactions among them. The individual entity will also have their organisational structure and functional relationships with other entities. The relationship between entities in a supply chain can be in the form of logistics, information flow, warehouse management, manpower employment etc. (Liu, Feng and Rong, 2012).

However, for the purpose of this research, The SCMP's (2015) definition of Supply chain management is most suitable. It describes SCM as *"the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies."*

2.5.4.2 Supply Chain Risk (SCR):

It is difficult to compare the definition of "supply chain risk" and "supply chain risk management" (Diehl and Spinler 2013, Sodhi *et al.* 2012,). However, without well-written clarity in developed definition, it is not easy to convey views between academia and industrial experts, especially to investigate academic ideas in industries.

A generally agreed definition of these terms allows researcher and experts to understand the impact, and evaluate the effectiveness of the method of managing risks involved in the supply chain. Therefore, it is important to clearly review the definitive meaning of these terms as presented in Diehl and Spinler 2013, Sodhi *et al.* 2012. However, sections below summarise the current definitions of supply chain risk and SCRM. In the past, researchers have provided various supply chain risk definitions as evident in Ellis *et al.* 2010, Zsidisin, 2003 and supply chain risk evident in (Bogataj and Bogataj 2007, Jüttner *et al.* 2003, Wagner and Bode 2006). The application of the various definition of supply chain risk has come with some keywords, for instance, (Ellis *et al.* 2010, Zsidisin 2003), information flow, product flow risk, and material flow focusing on supply chain specific functions rather than offering meaning to the overall supply chain (Jüttner *et al.* 2003). Based on the presented, developed framework, supply chain risk is defined as: *“the likelihood and impact of unexpected macro and/or micro level events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities”*.

Macro-risks refer to rare external events or situations which usually have negative impacts on companies. It may consist of natural risks (e.g. weather-related disasters) or man-made risks (e.g. war, terrorism and political situation). Simultaneously, micro-risks refer to events originated directly from internal activities of companies and relationships within partners in the entire supply chain. In generally, macro-risks have much greater negative impact on companies in relation to micro-risks.(Wu, Blackhurst, and Chidambaram.2015.)

2.5.4.3 Supply chain risk management:

Increase in service complexity and products, outsourcing and globalisation has led to increasingly complex, dynamic supply networks where the whole supply network community is exposed to different threats. Recognising and managing risk is starting to be a significant provision to reduce these threats to aim for stability in supply chain network. The risk in supply network has been steadied by a large number of researchers and managements (e.g. Clemons 2000, Harland *et al.* 2003, Deleris *et al.* 2004, Ayvaci *et al.* 2005, Deleris and Erhun 2005).

According to the Deleris and Erhun (2005), risk in a supply network creates from the lack of knowledge about the events that may affect processes and operations such as the load on the

network and ability of the supply network to endure the operations. Moreover, this risk and stochastic behaviour within the supply chain network have led researchers to recognise and manage risks from a more diverse range of sources and contexts (Clemons 2000). Different models, tools, techniques have also been experienced and developed in different industries (Harland *et al.* 2003, Wagner *et al.* 2009, Wu *et al.* 2006, Zsidisin and Ellram 2003).

Supply chain vulnerability is considered as the exposure of the supply chain network to various types of factors, which are capable of disrupting the flow along the network (Christopher and Peck 2004, Tang 2006). The factors which can cause the disruption are considered as supply chain risks (Figure 2.5), for instance, little customer demand (Peck 2005, Sodhi and Chopra 2004,).

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Additionally, Zsidisin (2003) highlights that the most critical source of risk lies with suppliers and the supply network. He defined supply risk as *“the potential occurrence of an incident associated with inbound supply from supplier failure or the supply market, in which its outcomes result in the inability of the procurement firm to meet customer demand”*.

Giving the importance of supply chain risk management to the overall supply chain management, the next section will focus on the aspect of risk management, particularly on the concepts of risks, supply risk and supply chain risk management.

2.6 Main Concepts of Risk:

The term “risk” does not have a single definition. Based on the Oxford English Dictionary, a risk is “the possibility that something unpleasant will happen” and its origin refers to the Italian words “risco”, “riscare” and “richiare” from the 17th century (Hay-Gibson 2009, cited in Lemieux

2010:200). Contrarily, Althaus (2005), states that the term risk has an origin in Portuguese with the meaning of “to dare” (Althaus 2005, Hay-Gibson 2009, Lemieux, 2010). In theory, in a project environment, a risk is considered to be any potential deviance from the operations set target and specifications. Risk is usually associated with other terms such as the unknown, unpredictability and uncertainty (Mulcahy 2003). Our daily life is full of situations fraught with uncertainties, some with pleasant or unpleasant consequences. Similarly, every project activity such as movement of materials or people involves uncertainties and risks (Rescher 1983, Mulcahy 2003).

Nevertheless, various scholars have attempted to define risk in a more specific manner including:

- Rescher (1983) referred to project risk as situations with potential undesired consequences. The emphasis here is on uncertainty and the consequences.
- Later on, March and Shapira, (1987) described risk in more operational terms as the variation of likely outcomes, their probability of occurrence and ‘subjective values’
- Williams *et al.* (1998) further defined ‘Risk’ in terms of the variations in likely outcomes and stated that such outcomes could be negative or positive (downside or upside risk). Although, in reality, a positive consequence can also be considered as an opportunity.
- However, Jeynes, (2002) defined Risk only regarding a likelihood that the outcome will result in harm or unwanted consequences.
- ISO 31000 as a family of risk management standards – it is not developed for a particular industry group, but provide best practice structure and guidance to all operations concerned with risk management. This feature encouraged the researcher to investigate ISO 31000 practice in the companies.
- And lastly, Agrawal (2009) came up with a quantitative approach to defining risk. In engineering terms, he stated that “Risk” = (probability of an accident) x (losses per accident)”

In summary, from the review of the above definitions. Two key components of risk can be observed. These are ‘likelihood of the event’ and the ‘consequences of the event’ occurring.

Therefore, a fitting definition of risk from these observations is that ‘Risk is the probability that an uncertain unpleasant event will occur with unpleasant consequences’.

2.6.1 Supply chain risk types:

Some closely related journals have been reviewed, and they were found to focus mostly on supply chain risk types. Some of these papers (Blackhurst *et al.* 2008, Bogataj and Bogataj 2007, Cavinato 2004, Chopra and Sodhi 2004, Harland *et al.* 2004, Manuj and Mentzer 2008, Samvedi *et al.* 2013, Tang and Musa 2011, Tang and Tomlin 2008, Tummala and Schoenherr 2011, Wagner and Bode 2008), were found to only identify risk type rather than classification. Additionally, a few number of them classify the risk types into two main categories such as external and internal (Kumar *et al.* 2010, Olson and Wu 2010, Trkman and McCormack 2009, Wu 2006), disruption and operational (Ravindran *et al.* 2010, Tang 2006a). In others, risk types were divided into three categories of the supply chain risk types using the same ideas but different terms (Christopher and Peck 2004, Jüttner *et al.* 2003, Lin and Zhou 2011). The categories include organisational or internal risks such as process and control risks; network-related risk or risk within the supply chain such as demand and supply risks; and environmental risk or risk in the external environment such as natural disasters, war and terrorism, and political instability. Micro risks are similar to operational risks described in Tang (2006a) and Miss-the-target (MtT) described in (Ravindran *et al.* 2010). The macro risk is similar to Value at Risk (VaR) discussed in Ravindran *et al.* (2010), and disruption risks discussed in Tang (2006a). Likewise, Tang (2006a) and Ravindran *et al.* (2010) based their work in terms of degree of negative impact of supply chain risk types on companies. Some micro risks such as demand, manufacturing, and supply risks have been widely researched and suggested. Other risk types such as information, transportation, and financial risks have however received little or no attention by researchers. Most importantly, the developed framework for the supply chain risk classification is believed to be unique and more comprehensive. This is because it considers a holistic set of risk types with many degrees of effect (micro and macro risks), in both external and internal supply chain (demand, manufacturing, and supply risks), as well as various types of flow (information, transportation, and financial risks). This holistic risk classification has not been suggested in the past studies particularly within material procurement operations.

2.6.2 Supply chain risk factors:

Supply chain risk factors can be referred to as diverse events and circumstances that trigger specific risk type. In the past researches, (Chopra and Sodhi 2004, Cucchiella and Gastaldi 2006,

Manuj and Mentzer 2008, Samvedi *et al.* 2013, Tummala and Schoenherr 2011, Tuncel and Alpan 2010, Wagner and Neshat 2010, Wu *et al.* 2006) risk factors of multiple risk types have been identified. Chopra and Sodhi (2004) also based their work on several risk factors. Also, in Zsidisin and Ellram (2003), five different supply risk factors were identified, similar to Kull and Talluri (2008). Tsai's (2008) work is based on time-related factors with the special interest in the cash flow risk. In another set of work in this area, potential risk factors have been researched without classification (Gaudenzi and Borghesi 2006, Hahn and Kuhn 2012a, Schoenherr *et al.* 2008).

Concerning to the proposed, developed framework in this study, five categories of supply chain risk factors were presented. They include macro, demand, manufacturing, supply, and infrastructural (information, transportation, and financial) factors. A critical review of related journals helps to identify that most risk factors are vague and are rather classified as risk types instead of risk factors. For instance, Manuj and Mentzer (2008) on risk affecting suppliers and customers and Schoenherr *et al.* (2008) on logistics risk, transportation risk, supplier risk, and demand risk. Various supply chain risk types are considered as having various levels of negative impact causing operational, tactical, or strategic level failures. In the same view, different risk factors within the same risk type would also have different levels of negative effect. Nevertheless, these papers identified and classified the possible risk factors and ignored measuring and assessing the degrees of adverse effects.

2.6.3 Supply Chain Risk Methods:

Researchers have developed and applied some quantitative and qualitative methods in managing supply chain risks. Some works have implemented a single type of SCRM process such as risk assessment, risk identification, risk monitoring as well as risk mitigation. Others explored process integration where more than one processes have been used. In the next section, both individual and integrated processes will be discussed.

2.6.4 Individual SCRM process:

2.6.4.1 Risk identification

In SCRM process, risk identification is regarded as the first step (Snyder 2016) which involves identifying risk type and factors. In Tsai *et al.* (2008) both quantitative and qualitative methods of

identifying risk are adopted for supply chain risk, tagged analytic hierarchy process (AHP) method. Other methods have been explored such as developed model (Trkman and McCormack 2009) and supply chain vulnerability map (Blos *et al.* 2009). From risk factor identification perspectives, AHP was implemented by Gaudenzi and Borghesi, (2006) and the hazard and operability analysis method by Adhitya *et al.* (2009). However, in other researches, qualitative method to identify both risk factors and risk types have been proposed. Neiger *et al.* (2009) proposed qualitative value-focused process engineering methodology while Kayis and Karningsih (2012) proposed SC risk identification system, focusing on the approach of knowledge-based system. As a result of the above researches on risk identification, it is important to note that most of them have not put in their priority the quantification of the adverse effect of risk types and factors.

2.6.4.2 Risk assessment

Risk assessment is related to the likelihood of occurrence happening as well as the implication of its impacts, according to Harland *et al.* (2003). There are types of risk assessment such as demand risk assessment, manufacturing risk assessment, supply chain risk assessment, and financial risk assessment. However, supply chain risk assessment is of highest interest in this research.

2.6.5. Manufacturing risk assessment

Regarding risk assessment from the manufacturing perspective, different methods have been applied for assessing risk in different supply chains. Cigolini and Rossi (2010) suggested the fault tree methods, analyses and assesses the operational risk at the primary transport, drilling, and refining stages of an oil supply chain. They concluded that different stages were affected due to the difference in plants. This means individual plant need to embark on plant specific risk management process. Pugh method of risk assessment was applied by Dietrich and Cudney (2011) within manufacturing to show technology acceptability in the global aerospace supply chain. The outcome of the applied method reveals that the proposed methodology can provide effective management evaluation of emerging technology. In Tse and Tan (2011), a product quality risk and visibility assessment framework was constructed using the margin incremental analysis for a toy manufacturing company. The outcome reveals that a better view of risk from

supply tier could reduce quality risk. In some other studies, some limitations are identified. Cigolini and Rossi (2010) paid no attention to operational risk assessment but focused on only the three stages of the supply chain. They failed to consider other stages such as outsourcing, design and construction. Likewise, in Tse and Tan (2011) only constructed quality risk assessment framework that did not consider risk factors or any action of mitigating the identified risk.

Another conventional method called Event-Tree (ET) based methodologies are extensively used as tools to perform reliability and safety assessment of complex and critical engineering systems. One of the disadvantages of these methods is that timing/sequencing of events and system dynamics is not explicitly accounted for in the analysis (Addresses only one initiating event at a time). To overcome these limitations several techniques, also known as Dynamic Probabilistic Risk Assessment (DPRA), have been developed. Monte-Carlo (MC) and Dynamic Event Tree (DET) are two of the most widely used D-PRA methodologies to perform safety assessment especially for Nuclear Power Plants (NPP) (Alfonsi *et al.* 2013)

2.6.6 Supply risk assessment

Among researchers in this area, supply chain risk assessment has attracted some attention. In Talluri and Narasimhan, (2003); and Talluri *et al.* (2006) the focus was on supply chain risks in terms of poor quality. Talluri and Narasimhan, (2003) and Talluri *et al.* (2006) discussed late delivery while Kumar *et al.* (2006); Viswanadham and Samvedi (2013) emphasised on capacity uncertainty. In other reports, dispersed geographical location was considered by Chan and Kumar (2007), while supplier failure, supply chain risk assessment was the focus of Kull and Talluri (2008), Ravindran *et al.* (2010), Ruiz-Torres *et al.* (2013). Supplier's financial stress is the basis of Lockamy III and McCormack's (2010), Meena *et al.* (2011) Wu and Olson, (2010). In addition, focus on supply disruption and poor supplier service was the highlight of Wu *et al.* (2010), Chen and Wu (2013). Furthermore, risk management ability and experience from suppliers' perspective is the focus of Ho *et al.* (2011), while lack of supplier involvement was recorded in Chaudhuri *et al.* (2013).

The ways in which the supply chain risks have been analysed and assessed have also been researched. Kull and Closs (2008) analysed second-tier supply failure. Schoenherr *et al.* (2008) based their work on risk relating to offshore sourcing while Iakovou *et al.* (2010) focused on unreliable dual supply network. Also in Wiengarten *et al.* (2013) supplier non-conformance risk

was the subject, and supplier incapability has been analysed in Johnson *et al.* (2013), against supplier unreliability in Cheong and Song (2013).

Apart from assessing supply chain risks, a lot of studies have rather focused on risk assessment methods and models of supply chain. In Zsidisin *et al.* (2004), different approaches were examined for buying organisation trying to assess supply chain risks. The result of the examination revealed that risk assessment uses the techniques to achieve improved supplier processes, as well as reduced supply interruption probability. Ellegaard (2008) analysed the supply risk management practices by implementing a case-based methodology. This was applied for 11 small company owners (SCOs) in which the supply risk management practices were characterised as defensive. Wu and Olson (2008) also compared three risk types from simulated data to evaluation of the models, through which they determined a consistent supplier's selection. Azadeh and Alem (2010) based their suppliers' selection models comparison of three types of suppliers using three models. They used the exercise to reveal a consistent selection for worst suppliers.

Considering the evaluation and selection of suppliers, few studies focused on development of developed model and demonstration through simulation data (Chan and Kumar 2007, Meena *et al.* 2011, Ravindran *et al.* 2010, Ruiz-Torres *et al.* 2013, Wu and Olson 2010, Wu *et al.* 2010, Viswanadham and Samvedi 2013). The fact that these studies are based on simulated data means the use of real data is check the effectiveness of these methods is missing. Similarly, the work of Talluri and Narasimhan (2003) and Talluri *et al.* (2006) only includes a single input measure in the Data Envelopment Analysis (DEA). Similarly, Kull and Talluri (2008) based their study on the assumption that current supplier's capabilities stay constant into the future (Ruiz-Torres *et al.* 2013).

2.6.7 Information risk assessment

The Information risk assessment was investigated by Durowoju *et al.* (2012) by developing a discrete-event simulation to find the disruptive effect in the flow of vital information required in manufacturing operations. The result of the simulation run showed that retailers experience the most uncertainty in the supply chain while the holding cost creates the most unpredictable cost measure when a system failure breach happens. However, their study only presented a generic information technology risk whereas no consideration for risk factors.

2.6.8 General risk assessment

Most researches have been identified to be based on non-specific risk types, the records of which are as follows. Four categories were found within these works;

- ***Evaluation, assessment, and quantification of generic supply chain risks***

In this category, Wu *et al.* (2007) based their work on disruption analysis network approach to determine how changes or disruptions propagated in supply chains and calculated their impact on the supply chain system. Brun *et al.* (2006) established a method related to supply network opportunity assessment to assess sophisticated planning and scheduling and SCM implementation projects with risk analysis. Also, Olson and Wu (2011) used Monte Carlo and discrete-event simulation to recognise different measure of risks for outsourcing in comparison with the expected performance of vendors under risk and uncertainty in a supply chain.

- ***Assessment of relationship between supply chain risks and strategies***

Among this category Laeequddin *et al.* (2009) suggested the reduction in risk associated with membership risk levels by developing trust instead of trying to maintain risk reduction measures. Hult *et al.* (2010) based their work on high level of uncertainties related to SC investment decisions. They extended real options theory to the SC context by determining how options can be implemented relatively to supply chain project investments. Craighead *et al.* (2007) suggested that the best practices in purchasing, including supply base reduction, global sourcing, and sourcing from supply clusters might have negative impact on the severity of supply chain disruptions.

- ***Evaluation of the supply chain resilience***

In this category, Pettit *et al.* (2013) suggested a correlation between increased resilience and improved supply chain performance. Jüttner and Maklan (2011) revealed in their work that knowledge management appears to improve the flexibility of SC through visibility, velocity, and collaboration capabilities of the SC.

- ***Assessed supply chain vulnerability***

Berle *et al.* (2013) argued identifying the “vulnerability inducing bottlenecks” of transportation systems allows for realising more robust versions of these systems in a cost-effective manner. Wagner and Neshat (2010) that concluded that if supply chain

managers were more capable of measuring and managing supply chain vulnerability, they could reduce the number of disruptions and their impact.

2.6.9 Risk Mitigation

This section discusses the classifications of risk mitigation methods such as demand risk mitigation, macro risk mitigation, supply chain, manufacturing, financial, transportation, information and general risk mitigation methods.

2.6.9.1 Manufacturing risk mitigation

The following works have been done in the area of manufacturing risk mitigation considering various aspects of manufacturing risk factors. Hung (2011), Kaya and Ozer (2009) and Sun *et al.* (2012) focused on risk quality in their studies, while lead time uncertainty in term of manufacturing risk has been considered by Li (2007). However, in He and Zhang (2011), they based their research on random yield risk unlike non-conforming product design researched by Khan *et al.* (2008). Meanwhile, machine failure as a form of risk, and capacity inflexibility was discussed in Kenné *et al.* (2012) and Hung (2011) respectively. From different models' point of view, stochastic dynamic model was implemented in Kenné *et al.* (2012) while Kaya and Özer (2009) used linear programming model for manufacturing risk mitigation. Sun *et al.* (2012) used P-chart solution model, and Hung (2011) combined fuzzy GP, Analytic Network process (ANP), Value at Risk (VaR) and five forces analysis for manufacturing risk mitigation. However, the work of Li (2007) is found to be restricted to only types of products and demand function is assumed to be linear in Kaya and Ozer (2009).

2.6.9.2 Supply risk mitigation

There has been a substantial amount of publications focusing on methods of mitigating supply chain risk. Giunipero and Eltantawy (2004) and Hallikas *et al.* (2005) suggest that supply chain risk can be reduced by establishing good and strategic relationship with suppliers. This was supported by Zsidisin and Smith (2005), which suggested the importance of involving suppliers from the early stage for risk mitigation. Another means of mitigating supply chain risk is by adopting behaviour-based management methods as suggested in Zsidisin and Ellram (2003). A

risk management technique such as business continuity planning was proposed in Zsidisin *et al.* (2005) for supply chain risk mitigation.

When it comes to supply chain risk mitigation, the decision to outsource services becomes paramount. In literature, research has been done to determine the optimal number of suppliers needed in case of disastrous risks, as it was established that extra suppliers would be required, as the extent of the risk involved increases (Berger *et al.* 2004). On the other hand, even if there are more additional suppliers to tackle the risk, Ruiz-Torres and Mahmoodi (2007) questioned suppliers' reliability.

In this case, Li *et al.* (2010), Xanthopoulos *et al.* (2012), Yu *et al.* (2009) presented an evaluation of the type of sourcing strategy such as single, dual or multiple sourcing. Dual sourcing strategy was experimented against single sourcing and found to outperform single sourcing in an incidence of supply disruption (Yu *et al.* 2009). Meanwhile, there are evidences to support that the adoption of multiple sourcing is not important (Costantino and Pellegrino 2010, Fang *et al.* 2013). Other papers revealed that supplier's selection is often compared with order allocation when trying to find a way of minimising supply chain risk.

Some quantitative methods have been implemented in the past towards supply chain risk mitigation. Among them are; mixed integer model, stochastic linear programming model, and multi-stage stochastic programming model among others (Shi *et al.* 2011). As a result of the conclusion of the outcome of some of these methods, suppliers were found to have high probability to disrupt supply chain. However, order allocation is said to be influenced by supplier's cost than actual likelihood of supplier's failure (Meena and Sarmah 2013).

Even though supply chain risk mitigation has been well researched as evident in the reviewed paper, there are certain restrictions to the extent of their findings. Berger *et al.* (2004) assumed the same likelihood of unique event occurrence of one supplier to be applicable for all other selected suppliers. A single case supply chain risk occurrence was conducted in Zsidisin and Smith (2005). Also, in Xanthopoulos *et al.* (2012), a single period and a single product were considered to reach their conclusion. The suggestion of Son and Orchard (2013) was only based on the assumption that demand is deterministic. The work of Grötsch *et al.* (2013) is regarded as limited as a result of small sample size used to carry out their experiment. Therefore, it is believed that it is difficult to find one-fit-all approach regarding supply chain risk mitigation.

2.6.9.3 Transportation risk mitigation

Based on study related to risk mitigation, only one research is found on transportation risk reduction. This is found in Hishamuddin *et al.* (2013) which developed an integer nonlinear programming model to determine the optimal production and order quantities for the supplier and retailer, and the duration for recovery subject to transportation disruption, which produces the minimum relevant costs of the system. The outcome revealed the dependency of the optimal recovery schedule on the relationship between the backorder cost and the lost sales cost parameters. The study was based on a simple two-tier supply chain between one supplier and one retailer and assumed the demand to be deterministic.

2.6.9.4 Information risk mitigation

The research on information risk is found in Du *et al.* (2003) who proposed companies to construct attribute correspondence matrices for databases to share data with both upstream and downstream supply chain partners, hereby securing information away from competitors. However, the work only focuses on the vertical relationships of companies, while ignoring the horizontal relationships of new partners. In another view of Le *et al.* (2013), they studied the potential of data transfer in producing enterprises risk in retail SC association, and suggest a relationship rule hiding algorithm to remove sensitive knowledge from the released database, and minimise misrepresentation of data.

2.6.9.5 General risk mitigation

Generally, risk mitigation is classified into two main categories. The first is the approach in which empirical quantitative methods are conducted and developed to examine the effective means of risk minimisation. In this category, various of papers were reviewed. Wagner and Silveira-Camargos (2012), Xia *et al.* (2011) investigated the case of managing suppliers, Christopher and Lee (2004) and Faisal *et al.* (2006) both focus on sharing information in the supply chain while Chen *et al.* (2013), Faisal *et al.* (2000), He (2013), Lavastre *et al.* (2012), Leat and Revoredo-Giha (2013) investigated building collaborative relationships among supply chain members. In the second category, framework is developed with the aim of mitigating risk. The framework is in form of a model that incorporates social networks with global supply chain networks. Example of such is found in Pujawan and Geraldin (2009), where Quality Function Deployment (QFD) and Failure

Mode Effects Analysis (FMEA) are integrated to mitigate risk, and in Hahn and Kuhn, (2012b) with two-stage stochastic integer programming model. The limitations to general risk mitigation are found in Cruz *et al.* (2006) that assumed manufacturing involvement in homogeneous product production. The internal stakeholders are the only focus in Manuj and Mentzer (2008). Likewise, the benefits of combined strategies were not examined in Tang and Tomlin (2006). Also, the work of Chiu *et al.* (2011) considered only one retailer and one supplier.

2.7 Risk monitoring

Compared to others, risk monitoring has seen few attentions among researchers. However, a very useful work of Zhang *et al.* (2011) was identified. They developed an integrated abnormality diagnosis model which combined neural network and fuzzy set theory to provide pre-warning signals of production quality in the food production supply chain. The outcome of the simulation of the proposed system revealed an effective identification of abnormal data types which is used to make warning decision. However, no real data was available for the model verification aside the fact that quality risk is the only focus.

Integrated SCRM processes

The idea of integrated SCRM processes has been the focus of several works of literature. The account of these studies is discussed in terms of the framework, approach and design.

2.8 SCRM developed frameworks

Different types of developed framework, which are based on qualitative and quantitative methods, have been suggested to integrate two or more SCRM processes. Risk identification and assessment were found to receive the most attention in Cheng and Kam (2008), Peck (2005), Smith *et al.* (2007), Wagner and Bode (2008). Likewise, risk identification and mitigation in (Christopher and Peck 2004, Oke and Gopalakrishnan (2009), also risk assessment and mitigation in (Kleindorfer and Saad 2005, Blome and Schoenherr 2011, Giannakis and Louis 2011, Speier *et al.* 2011, Hahn and Kuhn 2012a, Kumar and Havey 2013).

However, in Kern *et al.* (2012), better risk mitigation is found to be as a result of risk identification supporting succeeding risk assessment.

Therefore, this establishes a significant relationship among these three SCRM processes, which need to be closely considered rather than integrating two processes as suggested in some of the papers. The developed framework that integrates the three processes has been developed by some researchers (Bandaly *et al.* 2012, Foerstl *et al.* 2010, Ghadge *et al.* 2013, Kern *et al.* 2012, Ritchie and Brindley 2007). The compositions of the developed framework in these studies are;

- Risk consequences
- Risk performance outcomes
- Risk identification,
- Risk assessment, and
- Risk management response.

There are limitations to some of the researches in this area such as lack of real data for validation, use of single case study, and lack of wider range of perception as evident in Kern *et al.* (2012).

2.9 SCRM procedures or approaches

Research related to the SCRM approaches are found in some articles that have adopted qualitative approaches.

Five major steps involved in SCRM approaches are identified in (Hallikas *et al.* 2004, Norrman and Jansson 2004, Tummala and Schoenherr 2011). They are:

- Supply chain risk analysis
- Risk types and factors identifications
- Assessment of probability of occurrence and overall impact
- Selection and implementation of risk mitigation strategies
- Continuous improvements

From a quantitative point of view, SCRM integration is found to cover two processes such as risk assessment and identification, according to Wu *et al.* (2006). Risk identification and mitigation (Diabat *et al.* 2012, Xia and Chen 2011). The mitigation of risk and its assessment (Tuncel and Alpan 2010). However, these quantitative approaches have their pros through probabilistic measures of occurrence and overall risk effect factors with AHP (Wu *et al.* 2006) or the failure

mode, effects and criticality analysis approach (Tuncel and Alpan 2010). Also, calculating the efficiency of risk mitigation techniques through the use of Petri-net based simulation (Tuncel and Alpan 2010), risk identification and mitigation through ANP method (Xia and Chen 2011) and interpretive structural modelling (Diabat *et al.* 2012). A limitation related to the qualitative journals is; it majorly discusses the SCRM approaches phases without establishing the applicability of the approach (Chopra and Sodhi 2004, Cucchiella and Gastaldi 2006, Hallikas *et al.* 2004, Knemeyer *et al.* 2009, Tummala and Schoenherr 2011). Only two examples have been given of a real life implication of the approach. For instance, Norrman and Jansson (2004) confirmed their four-step SCRM method through Ericsson case study. Sinha *et al.* (2004) implemented their Supply Chain Operations Reference (SCOR) model in the aerospace SC. In the same instance, there are problems with some of the quantitative articles. Wu *et al.* (2006) limited the scope of their model to a single-tier environment. Tuncel and Alpan (2010) focused only on the point of view of the manufacturer. Diabat *et al.* (2012) stated that their model is highly reliant on the verdicts of the professionals.

2.10 Supply chain network design

Many papers developed mathematical programming models for the optimal SC network design challenges, constituting decision-based on production, location, inventory and transportation. The models acknowledged and mitigated various risk types, like demand risk (Baghalian *et al.* 2013, Georgiadis *et al.* 2011, Goh *et al.* 2007, Park *et al.* 2010, Poojari *et al.* 2008, Qiang and Nagurney 2012), manufacturing risk (Kumar and Tiwari 2013, Qiang and Nagurney 2012), supply risk (Baghalian *et al.* 2013, Mak and Shen 2012), and financial risk (Azad and Davoudpour 2013, Azaron *et al.* 2008, Goh *et al.* 2007).

An example of mathematical programming models developed has been found, including multi-stage stochastic programming model (Goh *et al.* 2007), multi-objective stochastic programming model (Azaron *et al.* 2008), two-stage stochastic integer programming model (Poojari *et al.* 2008), integer nonlinear programming model (Park *et al.* 2010), mixed integer linear programming model (Georgiadis *et al.* 2011), stochastic linear programming model (Mak and Shen 2012), linear programming model (Qiang and Nagurney 2012), convex mixed integer programming model (Azad and Davoudpour 2013), stochastic mixed integer nonlinear programming model (Baghalian *et al.* 2013), and mixed integer nonlinear programming model (Kumar and Tiwari 2013).

A common disadvantage of the above journals is the real life application of their proposition instead of just simulated data to prove their effectiveness and efficiency, except Baghalian *et al.* (2013), who studied a real-life case in the rice industry of a country in the Middle East.

2.11 Risk Management Models and Methodologies

In developing an effective risk management strategy for managing EPC operations in the oil industry, it is necessary first to review, analyse and compare the different available methodologies and models of risk management. Table 2.2 summarises some of the available risk management frameworks and models including a description of the aspects they cover.

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The most relevant of these models are explained further in the section below

2.12 Project Management Body of Knowledge (PMBOK) Methodology:

This model is defined by the Project Management Institute (PMI) and is the most frequently used method in project management. This model of managing project risk is made up of six iterative processes as listed below:

- Planning of risk management process.
- Identification of all potential risks.
- Qualitative analysis of identified risks.
- Quantitative analysis of the risks.
- Planning of response strategies for each identified.
- Continuous Monitoring and Control of each risk.

The PMBOK model is an input-output based framework. It works using inputs which are analysed using certain techniques and tools to deliver defined outputs for each stage of the process. (PMBOK 2013).

2.13 PRINCE2 Model:

The models were developed by the UK cabinet office (2012), and the Name PRINCE2 is abbreviation used to represent Project IN Controlled Environment. It is now the official project management standard used by the UK government and widely among the private industry across the world.

This is a process-based approach for managing operations in organisations. It is now the most widely adopted 'non-proprietary' model for project management in the public domain. Originally the model was developed for managing the UK government's information technology operations by the CCTE (Central Computer Telecommunications Agency) in 1989. However, it is globally

recognised and accepted across all industries since its release to the public in 1996. Figure 2.6 illustrates the risk Management cycle

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The model prescribes that a project should be carried out in small manageable components to enable that the organisation effectively controls the project resources.

In respect to risk management the model supporters two-stage approach consisting of six steps.

The two main stages and corresponding steps are as follows:

- Risk Analysis:
 1. Identification
 2. Evaluation
 3. Response
 4. Selection
- Risk Management:
 1. Planning and assignment of resource
 2. Risk Tracking and Risk Reporting

2.14 SHAMPU Model:

Chapman and Ward (2003), developed SHAMPU framework. It is used to represent 'Shape, Harness, And Manage Project Uncertainty'. The model comes in three classes. The detailed class is made up of nine steps while the simplest class can be carried out in three steps. The first step is carried out at a strategic level. It involves shaping a management strategy to handle the uncertainty which will support productivity. As the name suggests, harnessing is the second step which is carried out at the tactical level. It involves the development of a productive risk plan which addresses the uncertainty identified at the strategic level. And lastly, managing the implementation is the last step. It is made up of four parts which include: 'the planned work management, the action plan development, and monitoring, control and crisis dealing'.

2.15 Chapman & Ward's Methodology

In Chapman and Ward's (2003) methodology, the framework is the source of each identified risk. It should also be specified along with the project life cycle that is at which project phase is the risk likely to occur and from which source. The project lifecycle considered under the framework include conceptive phase, the design/plan/allocate stage (Planning), the execution stage (execute), and the delivery/review/support stage (Termination). They also stated that for increased accuracy, each of phase could further be broken down into individual steps depending on the nature of the project.

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Figure 2.7 shows the Cooper *et al.* (2005) project risk management approach:

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Figure 2. 7: risk management process (Cooper et al. 2005)

Using this approach, the project manager is required to develop an appropriate response to the common questions relating to individual stages of the project risk management process. This is summarised in Table 2.3 below.

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By focusing on these issues and answering the questions listed, the project manager will be able to identify, assess and develop an appropriate risk response.

2.17 Supply Chain Risk Management (SCRM): The Concept and Its Basic Constructs

Supply Chain Risk Management (SCRM) is defined as the management of supply chain risks through collaboration or by coordination of the partners along the supply chain to ensure profitability and continuity (Tang 2006, Guido *et al.* 2015). The primary purpose of this discipline is to support organisations with a means to evaluate the vulnerabilities of their supply chain and develop a mechanism that will help minimise their risk exposure. In other words, the main aim of the SCRM is the improvement of supply chain activities by ensuring that the entire network remains robust and efficient.

There are three main reasons supply chain risk are difficult to manage (Guido, Cagno and Zorzini 2015, Shi 2004).

- Mutual interactions among supply chain partners makes it difficult to identify the risks
- They are likely to occur in any part of the supply chain;
- They are generally managed in a specific manner, and again there are only a few well-defined supply chain risk management techniques and tools for SCRM

These three situations are also very common in the oil industry. Furthermore, material procurement in oil industry supply chain is generally complex in nature, due to geographical locations and harsh environment that makes it challenging to meet the target of cost, schedule, quality and revenue (Longwell 2002). Keeping in mind the adverse impacts of common supply chains risks on an organisation's competitive advantage. The effective management of the supply chain risk is a vital process in the procurement of oil equipment. There are four basic constructs that make up supply chain risk management. This includes supply chain risk sources, risk consequences, risk drivers and risk mitigating strategies. For the purpose of this research 'Risk sources' are regarded as all those unpredictable variables in the organisation, its environment and the project supply chain which can have a negative outcome on the project goals. Furthermore 'Risk Consequences' are regarded as the outcomes of the variables as they affect the project goals. For instance, this can be the effect on schedule or cost. In considering the definitions of supply chain 'risk drivers' and risk mitigating strategies', it is important to explain that the changes and developments (like globalisation or the trend towards outsourcing) over time, in the oil industry have further increased the exposure of its project supply chain to risk as well as the consequence of their occurrence (Christopher and Lee 2004). These two factors (exposure and impact), coupled with the competitive pressure in the industry are referred to as 'Risk drivers'. These are the reasons why Svensson (2002) used the term "calculated risks" to describe the types of risk companies are willing to take if they stand to gain competitive advantage, gain more profits or even to just to maintain profitability.

On the other hand, 'Risk mitigating strategies' are those processes an organisation can put in place to minimise the impact of the identified risk or to even avoid their occurrence in the first place (Miller 1992). From the discussion above, the four main constructs of SCRM and how they are interrelated can be represented as shown in the figure below.

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The four basic constructs of the supply chain risk are:

(1) Assessing the risk sources for the supply chain; (2) identifying the risk concept of the supply chain by defining the most relevant risk consequences (3) increase (+) tracking the risk drivers in the supply chain strategy. (4) decrease (-) the mitigating risks in the supply chain.

Svensson (2002) defined Supply chain vulnerability as *“the propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse supply chain consequences”*.

From an organisation’s point of view, the adverse consequences will affect its ability to accomplish its goals or the ability of the project supply chain to enable it to satisfy the end customer market.

The key objective here is to ensure that all potential sources of risk are identified, and corresponding mitigation measures to help prevent or reduce the supply chain risks effect are established. Consequently, Jutnner *et al.* (2003) described SCRM as: *“the identification and management of risks for the supply chain, through a coordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole.”*

From the definition above, it is obvious that SCRM is a coordinated and holistic approach to prevent or minimise the impact of supply chain vulnerabilities. This holistic approach can also be unique or tailored to a specific industry.

For this research, it is intended to establish an effective approach for managing supply chain vulnerabilities in material procurement operations related to oil industry.

2.18 Supply Chain Risk Management Frameworks

As described in the section above, general supply risk management process typically consists of four processes (Hallikas *et al.* 2004):

- Identification of potential risk.
- Assessment of identified risks.
- Risk mitigation and implementation.
- Continuous monitoring and control.

It is important to point out that risk identification is a unique function in the SCRM process. This is because each industry, organisation or project has its unique set of risks, even though some individual risks are common across industries, organisation and operations (for instance human factors).

Several authors have studied supply risk with the aims of developing risk management framework. For instance, while Chopra and Sodhi (2004) developed a general model for categorising potential risks with their corresponding risk drivers along the supply chain, and also the necessary approach to developing mitigation strategies. Zsidison (2003) proposed a model that focusses only determining risk sources from his research on supply chain managers. On the other hand, Johnson (2001) was only concerned with developing a framework that serves the toy industry.

Nevertheless, a common feature of all the framework is the phased process of firstly identifying the potential risks and carrying out the assessment of the identified risk to determine the likelihood of occurrence and possible consequence of the risk on the project goals.

The below risk diagram (Figure 2.9) can be used to represent the general approach to risk assessment (Hallikas *et al.* 2004).

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Figure 2.9: Risk Identification Diagram (Hallikas et al. 2004)

This risk diagram indicates whether the risks can be reduced by decreasing their probability or their consequences. The two components of risk; the probability and the consequences of a risk event are assessed separately on a five-class scale.

Tables 2.4 and 2.5 present the assessment scales for the consequence and probability of risk events.

Identification and implementation of mutual means for risk reduction helps to find out risk management actions that may be too expensive to be implemented by a single partner, but cheap to be implemented by collaboration. Further, mutual risk reduction means may include co-operative sharing of risks.

Rank	Subjective estimate	Description
1	No impact	Insignificant in terms of the whole company
2	Minor impact	Single small losses
3	Medium impact	Causes short-term difficulties
4	Serious impact	Causes long-term difficulties
5	Catastrophic impact	Discontinue business

Table 2. 4 Impact assessment scale

Rank	Subjective estimate	Description
1	Very unlikely	Very rare event
2	Improbable	There is indirect evidence of event
3	Moderate	There is direct evidence of event
4	Probable	There is strong direct evidence of event
5	Very probable	Event recurs frequently

Table 2. 5: Probability assessment scale

After conducting the risk assessment, various policies can be adopted in managing the risk. These can be done by transferring the risk, removing the risk, minimising the risk, or breaking down the risk into smaller levels for further analysis. For example, while Zsidisin and Smith (2005) recommended early supplier involvement in managing supply risk, Faisal *et al.* (2007) suggested the use of graph theory and matrix methods in deciding on a mitigation strategy for the supply chain risk. Meanwhile, Nagurney *et al.* (2005) also showed how multi-criteria decision-making approach could be used in managing risk among manufacturers and distributors.

The last step in the SCRM process is the 'risk monitoring'. This activity is used to observe and control the risk, as well as to make adjustment to the mitigation strategy where necessary. For instance, Humphreys *et al.* (2005) developed a tool for assessing suppliers, especially for new product development processes. This approach includes involving the development of a risk index which will be used to measure the supplier's ability to meet customer requirements. Again, Wu *et al.* (2006) developed a methodology based on an Analytical Hierarchy Process (AHP) to assess supply risk. The model has a detailed risk enumeration process; however, its major weakness is that it gets complicated when a large number of suppliers are involved (Saaty 1990). However, none of this framework and approaches presents a comprehensive and complete approach specifically, to managing material procurement in oil engineering operations. Therefore, the next section will further review the rationale for a holistic approach as well as the variously available frameworks, with the aims of developing a hypothesis and framework that can best meet the objectives of this thesis.

2.19 Critique of current risk management models

Considering all the models reviewed above, it can be observed that they broadly fall into two main groups: The first group are those models that address total risk management practices, for instance, Cooper's Model. They specify the detailed approach for the process and describe case studies and solutions. The second group are those models that form a subset or part of other project management processes. In other words, these groups of models do not describe the detailed process of analysing the risks. Instead, they prescribe the general approach for conducting project risk management.

Furthermore, the following weakness has been observed from the Models:

- All the models discussed above are generic for any industry; none of them are focused/tailored to a particular industry.
- As mentioned above, apart from Cooper and PRINCE2, none of the models provides a sample approach for implementation.
- None of the methods has been developed to be applied together with PERT (Program Evaluation Review Technique) or GERT (Graphical Evaluation and Review Technique) methods or project management software.
- The Models reviewed do not describe a detailed instruction for implementation but are provided as a general overview of the approach.

Other scholars, who have highlighted similar weaknesses in the models discussed above (Zsidison 2003, Johnson 2001), have criticised them as the major reasons managers have found it difficult to implement in operations or reduce the occurrence of avoidable failure and consequently poor performance. Recently, a trend is emerging for scholars, researchers, and industry experts to define new, more detailed and practical methods for risk management for specific industries and operations.

For the Libyan oil industry, it will be necessary to assess the application of these tools and their weaknesses, especially in regards to procurement of specialised equipment.

As international supply chains are much exposed to risks than domestic chains, this disadvantage is due to the links connecting an international network of companies involved in the procurement operation (Manuj and Mentzer 2008a). Meanwhile, as most oil fields are located in remote areas such as deserts or oceans, this will increase the potential risk related to logistics. This

characteristic in engineering material procurement for the oil industry has been considered in risk analysis after collecting huge amount of data using questionnaire and interviews.

2.20 Research gaps and recommendations

SCRM research prospect is wide open and evolving. In previous works, it is evident that a large percentage of supply chain risk have been considered among all types of risk, of which little or no attention has been given to other types of risk particularly procurement operation risk. The gap in knowledge in this procurement risk research area is revealed for information, logistics, and financial risks. Procurement is considered very important when it comes to effective management of supply chain in terms of identifying, managing and mitigating risks.

Although most organisations face more than one type of risk, they found it advantageous to tackle a single risk type. This remains an issue that needs attention for risk interdependencies, as well as interrelationships, needs further exploration. Investigation collective impact of risk can lead to better risk management in supply chain rather than focusing on a particular type of risk separately.

Also, the lack of research in determining the link between risk types and equivalent risk factors is one key limitation in previous works that needs more attention. To investigate such links, case study approach is an important consideration with focus on designing approaches to examine the likelihood of event of risk types. This is to develop methods to calm such risks through mitigation tactics.

Although there are numerous works in the area of SCRM, most of these works are considered theoretical. A good number of SCRM methods and frameworks have been proposed without been validated experimentally. It is, therefore, vital to fill in this gap by validating primary data through the investigation of its applicability and effectiveness. Also, the application of various SCRM methods and framework in different geographical location is missing gap, which the current study is filling. The contribution of this research in this regard, is, therefore, the application of validated developed framework experimentally in Libyan oil industry that can support procurement managers in their operations.

In most studies, manufacturing supply chain, such as electronic, aerospace and automotive, is their focus whereas service supply chain has attained little attention in the past. However, based on the important role of service industry, it is equally important for an improved research domain.

There is minimal awareness of risk monitoring process by researchers; this is not the case for others such as risk assessment, mitigation and identification. Just one paper was found that focused on early risk monitoring warning in SC using case study of food manufacturing (Zhang *et al.* 2011). Advanced risk prevention system is more accessible compared to the practice of risk mitigation. Researchers are expected to deal more on developing an early warning monitoring system, which is adaptive for different types of SC and empirical validation of the system.

The concept of mitigating risk has been researched widely in terms of different propositions. However, the research is lacking in the area of further consideration to establish the proposed strategies. Academia and professionals have not completely done justice to effectively choosing strategies that will be appropriate for specified situations. Thus, the efficiency of such strategy is only subject to existing work. The evaluation of a number of risk mitigation strategies subjected to different situations has been embarked upon by Talluri *et al.* (2013). However, the work did not attempt to merge more than one strategies to determine the impact. Therefore, researchers could deal with the issue through evaluation and selection of best mitigation strategies from the many that are available to determine their performance. It is not strange that many available frameworks are focusing on the four processes of SCRM. Aside this four, risk recovery is equally relevant and needs to be included in the study of SCRM approaches, especially when a quick return to original state is important when risk event is experienced. The study of Hishamuddin *et al.* (2013) based on risk recovery is not entirely on recovery processes but rather strategies and methods of a simple 2-tier SC with a single supplier and customer interaction. Due to its importance, risk recovery is suggested to receive more attention within the context of SCRM approaches.

Conclusively, the quantification of costs and benefits of SCRM is worth considering. For instance, value added to the organisation as a result of SCRM methods implementation could be quantified. Moreover, some case study research approach can be analysed and scaled to the losses among the selected case studies for SCRM experimentation. These studies would attract more organisations to focus on SCRM, and also shed light on effective practices for implementing SCRM to obtain the maximum profits.

2.21 Summary

This chapter presented the review of related journal articles up to 2016 in the area of SCRM. They are considered in terms of definition, types, factors and SCRM methods. The critical review of different definitions of SC risk and SCRM has been used to frame new one for the two concepts that will be clear to researchers and practitioners. The idea is not only to enhance efficient communication between the two parties in gaining access to industry to conduct empirical studies, but also help researchers identify and measure the probability and effect of the entire supply chain risks, and evaluate the effectiveness of supply chain risk management methodologies. Five common risks have been identified to associate with supply chain risk. They are classified as macro risk, demand risk, manufacturing risk, supply risk, and infrastructural risk (information risk, transportation risk, and financial risk). This comprehensive classification could help researchers and practitioners identify various risk types with differing degrees of impact that are both external and internal to supply chains.

Further, in this chapter, both quantitative and qualitative SCRM methods have been discussed based on identified SCRM processes such as risk identification, risk assessment, risk mitigation, and risk monitoring. These are emphasised to provide valuable understandings to researchers and practitioners for SCRM, such as which methods (qualitative against quantitative; individual and integrated) are applicable in particular SCRM processes.

However, the limitation associated with this chapter is mainly on its basis on the analyses from academic's perspective contrary to practitioners' view. The restriction is because of scarce published papers in this area, and the confidentiality of this focused field of oil material, procurement, and supply risk management.

Chapter Three: Research Methodology

3.1 Introduction:

In this chapter, different methods of analysis, procedures and techniques for data processing will be discussed. The risk factors influencing management of supply chain will be investigated along with the process for materials procurement operations.

This chapter begins with a general overview of research design and the philosophy behind the concept, and studies various research approaches. Next, the chosen research method for this research will be explained and justified. The chapter will also explore the design, structure and content for the chosen data collection methods for this research; which are; questionnaires and semi-structured interviews. Any issues with the data collection methods will also be explored.

This chapter is an essential component for this research and it concludes with an analysis of the appropriate statistical methods and techniques used to fulfil the research objectives.

3.2 Research Philosophy:

Saunders *et al.* (2011), stated that research philosophy refers to the way the researcher reflects on the development of knowledge. Western academic literature is dominated by two main research philosophies; positivism and phenomenology (Collis and Hussey 2003, Easterby-Smith *et al.* 2002, and Saunders *et al.* 2011). Both these philosophies vary in assumptions and methodological implications, and interpret the social world in various ways (Creswell 1998, 2003 and 2007). By researching the philosophy of this research, one can decide which research approach, strategy, data collection and data analysis techniques are best suited to the research. Easterby-Smith *et al.* (2002) believes philosophical issues should be recognised in order to:

- Clarify research designs
- Help researchers decide which design to choose; the philosophy can help understand the limitations of some approaches
- Enable researcher to create designs that they have not done so previously; it can also provide researchers to adopt previous research designs to different subjects.

In order to become an effective researcher within the positivism paradigm, the correct literature, theory and hypothesis regarding two or more variables are tested empirically or data is gathered on the relevant variables and statistical tests are applied in order to identify significant relationships.

This philosophy is characterised by five main features; deductive (theory can be tested by observation), explains key relationships between variables, utilises quantitative data, allows the testing of hypotheses and uses a structured methodology to facilitate replication (Collis & Hussey 2003, Gill & Johnson 2002).

Whereas, a phenomenological approach is portrayed as the meaning attached to social phenomena by research subjects. This approach regards reality as being not just objective but also socially constructed. A phenomenological researcher's main aim is to understand what is happening and why; therefore, the context in which events take place is considered very crucial in this approach. A phenomenological researcher's main method for obtaining data is by undertaking accurate, lengthy interviews to obtain qualitative data from a select group of participants (Leedy and Ormrod 2001).

Hussey and Hussey (1997) described the key differences between the two models; the positivistic approach is considered to be more traditional, quantitative and "scientific"; whereas the phenomenological approach is more modern, subjective, and qualitative and driven by social interactions. Many philosophers have argued as to which approach is best used. In recent times, many researchers prefer to use a combination of both in order to come to a conclusion that both models reinforce. The main reason to combine both models is because each approach has advantages and disadvantages; therefore, by using both models the strengths are maximised and the weaknesses minimised (Collis and Hussey 2003, Easterby-Smith *et al.* 2001). The most important thing to consider when choosing what research philosophy to adopt is the problem being studied and the objectives of the research (Benbasat 1984, Pervan 1994).

Therefore, in relation to this research, a positivistic approach will be used; as this will be the most appropriate method to explain the main factors that influence the performance of supply chain risk management in procurement equipment's for oil engineering operations in Libya.

3.3 Types of Research Methods:

Within a positivistic philosophy there are three main types of research methods; quantitative, qualitative and mixed methods. A short description of each of these methods will be described below:

3.3.1 Quantitative research:

This method is best used to establish key relationships between variables and to examine detailed hypotheses. Researchers often use statistical methods in order to evaluate and derive key relationships between variables. Quantitative research can also be used to seek previously identified variables and implement in the current research. The main strategy of obtaining quantitative data is through the use of questionnaires and interviews. Easterby-Smith (1991) stated that like all approaches quantitative approach has many strengths and weaknesses. These are outlined below:

Strengths

- Can be used to cover a wide variety of situations and variables,
- Fast and economical,
- Interprets large samples of data using statistics in order to derive results that may be considered relevant to policymakers.

Disadvantages:

- The method tends to be rigid and artificial,
- Processes are sometimes not understood well
- The significance that people attach to actions are not well recognised using this method
- Can be difficult for policy makers to understand what changes and actions are required as a result of the data.

Even with all the disadvantages, quantitative methods are still the preferred method for many studies involving social sciences due to its efficiency, ease of use, organisation and generalisation

of the data collected and scientific approach being able to organise the data collected (Cohen 1988, Hartmann 1988).

3.3.2 Qualitative Research:

Gorman and Clayton (1997) defined qualitative research as; “A process of enquiry that draws data from the context in which events occur, in an attempt to describe these events, as a means of determining the process in which events are conducted and the perspectives of those participating in the events, using induction to derive possible explanations based on observed phenomena.” Spencer *et al.* (2003) stated that “Qualitative research aims to provide an in-depth understanding of people’s experience, perspectives and histories in the context of their personal circumstances or setting”. In comparison to the quantitative approach; which can often be restricting, the qualitative approach makes it easier for researchers to explore wonders in an unnatural environment (Rudestam and Newton 2014). A qualitative approach expresses data as words instead of numbers, it also accentuates description and discovery, and focuses less on hypothesis testing and corroboration.

This approach utilises many data collection methods; such as; case studies, interviews, group discussion, participant observation and documents and records analysis. The main strengths of qualitative research is that specific responses can be identified and simplified; especially responses relating to the views and opinions of the participants in order to provide an understanding into the organisational climate. This approach also allows researchers to obtain an in depth insight into people and situations (Easterby- Smith *et al.* 2001).

3.3.3A mixed, multi-methods approach

In modern times, it is very rare to find research that follows one specific research philosophy; i.e. positivism with a quantitative approach or phenomenology with a qualitative approach. The majority of studies use a mixture of both; as stated by Saunder *et al.* (2000) it is more appropriate to combine approaches. Easterby-Smith (1991) reasoned that sometimes it is very hard to differentiate between qualitative and quantitative approach as some research methods can be used for both methods; e.g. interviews; as the interview transcript, can be examined in both ways. However, in research studies there are no limits on choosing one particular approach therefore researchers are free to combine in order to optimise research findings.

The use of a combination of approaches is also known as 'triangulation'; this was defined by Leedy and Ormord (2001) as; using two or more sources of data collection methods within one research so that the data obtained by the various methods are all coherent. One valuable way of triangulating data within the construction industry for example, is by using semi-structured interviews. Saunders *et al.* (2003) believes that semi-structured interviews enhances the validity of data as it ensures the information obtained follows some sort of structure but also allows freedom to participants to address any concerns they may have or share what they think is important. Saunders *et al.* (2000, 2003) and Yin (1994) summarised triangulation as crosschecking data for consistency and validity.

The multi-method approach is very beneficial because both methods complement each other rather than competing and ensure that the advantages of both approaches are enhanced and the weaknesses are minimised (Moahi 2000, Saunders *et al.* 2003).

3.4 Deductive vs. inductive

Inductive approach can be described as collecting data and developing theories based on data analysis; i.e. creating new theories that emerge from data. On the other hand, a deductive approach has an initial theory and hypothesis and designs a research project in order to test the hypothesis; this method is also known as a 'top-down' approach and can work for generic and specific research (Saunders *et al.* 2000). The inductive approach is referred to as 'bottom up' as it tends to focus on specific observation in order to generate wider theories (Trochim 2002).

3.5 Important criteria in research design and approaches

This research will use a deductive approach; it will initially investigate previous literature and theories relating to the topic. In the past, there have been very few studies on supply chain risk management; especially focusing within the equipment and procurement operations within the Libyan oil industry. Once all previous research relating to the topic have been investigated; a framework will be established and developed following validation process.

This will allow the researcher to develop specific hypotheses that can then be tested and confirmed or declined; this can then be related back to the original theories found from the

literature research. In order to find the most suitable methodology, there are two main considerations; firstly, the nature of research questions and objectives- as the type of method chosen depends on what needs to be found and the type of question the research aims to address. The second point is to look whether there are many relevant literatures in regards to a topic or limited availability of literature. For topics where there it is rich in literature a deductive approach is best suitable as hypotheses can be drawn, however an inductive approach is useful for research topics that are new or controversial where there will be less studies done; the inductive theory can be used to create some data and data analysis can be conducted to formulate a theory.

In recent years, there have been numerous studies on supply chain risk management and supply; therefore, a research framework can be used from previous literatures and implemented in this research.

One main drawback of using previous literature is that a large amount of data and theories are derived but known variables and existing theories have not necessarily been tested or verified (Creswell 2003).

3.6 Rationale behind chosen research and research design

This research has combined both the positivism and phenomenology philosophy in order to create a research design that is adaptable so social science matters can be addressed. In order to decide which method (quantitative or qualitative) to use for this research, literature relating to the topic was reviewed and the research objectives were chosen. After taking into account the rationale of the approaches, the researcher decided that the most appropriate method for this research is the mixed method of triangulation (also known as the multi-method approach). Therefore, this research will use questionnaires and semi-structured interviews in order to complement each other. The points written below justify the rationale for choosing the multi method approach:

- Within Libya, there are scarce studies relating to material procurement operations, supply and risk dedicated to material procurement operations within the oil industry.
- Lots of data been collected from Libyan procurement managers whose operate locally and abroad, however, the research will focus on Libyan managers who works locally. It will investigate the effective risk factors affecting materials procurement processes. Therefore,

in order to obtain this information, both qualitative and quantitative methods need to be used including a semi- structured interview and a questionnaire.

- There are various subjective factors that need to be further explored and clarified in depth; therefore, the multi-method approach can be used to analyse the data in both a quantitative and qualitative way.
- The triangulation method allows the researcher to collect data through the use of questionnaires, semi-structured interviews and literature review. Saunders *et al.* (2003) described the benefit of semi-structured interviews as being a valuable way to triangulate data by increasing validity as it ensures that any changes in the variable is due to the subject nature being examined rather than the method used for investigation.
- Once all data has been collected, statistical analysis of both the quantitative and qualitative data will explain and describe the events, actions, attitudes and behavioural aspects to answer the research objectives.
- Due to participant's time limitation and time zone, questionnaire is more convenience to cover all aspects of a topic, where with interview is difficult to perform.
- Questionnaire can provide a platform of preliminary answers that can be complemented afterward by using interview for deeper clarifications. (Gillham, B., 2008)

3.6.1 Sample design:

For this kind of research, it will be extremely difficult and impractical to collect and analyse all the data available from the entire group that the research is focusing on. Instead, it is far more sensible and appropriate to choose a small sample to represent the entire group (Sekaran 2003). Sampling can produce an overall level of accuracy whilst saving the researchers time, money and other resources (Yoon 2002). Many studies have looked at sampling design benefits and issues. There are two important criteria that should be considered when sampling (Sekaran 2003);

1. The representatives of the sample.
2. The objectives of the research.

The researcher invite 93 procurement managers, where 65 responses been received .

3.6.2 Sample size:

There is no correct number for a small or large sample; it is up to the researcher to decide what the most sensible sample size is according to the research. Yoon (2002) states that whilst there is no exact sample size, larger samples tend to be preferred as they yield more accurate results, however if the increase in accuracy does not justify the added cost then small samples are favoured. Saunders *et al.* (2003) makes a case that a sample size of 30 or more is large and adequate, however Hair *et al.* (2003) believes that at least 100 sample results should be available in order to conduct accurate multiple regression statistical techniques. In both Comrey and Lee (1992) and Tabachnick and Fidell (2001) a sample size of 300 is seen as good and 500 as exceptional. A theory was developed by Chin (1998) that the sample size for a research is linked to the number of variables in a research; he believes that the sample size needs to be seven to ten times bigger than the number of variables being measured.

The research will be using ANOVA (Analysis of Variance) in order to establish a relationship between the different variables and supply chain risk performance and the relationships within the various components of the variables and its effect on the overall SCRM performance. Therefore, after careful consideration, the researcher decided that the most appropriate sample size will conduct the 65 Libyan managers who operate both locally and abroad with 11 semi-structural interviews.

3.7 Data collection methods

In order to meet research objectives, the method to collect data is imperative. There are many ways to collect data; such as interviews, questionnaires, observations or past literature. These methods can be used individually in a research or combined. Generally, Figure 3.1 shows the method this research implements in collecting data.

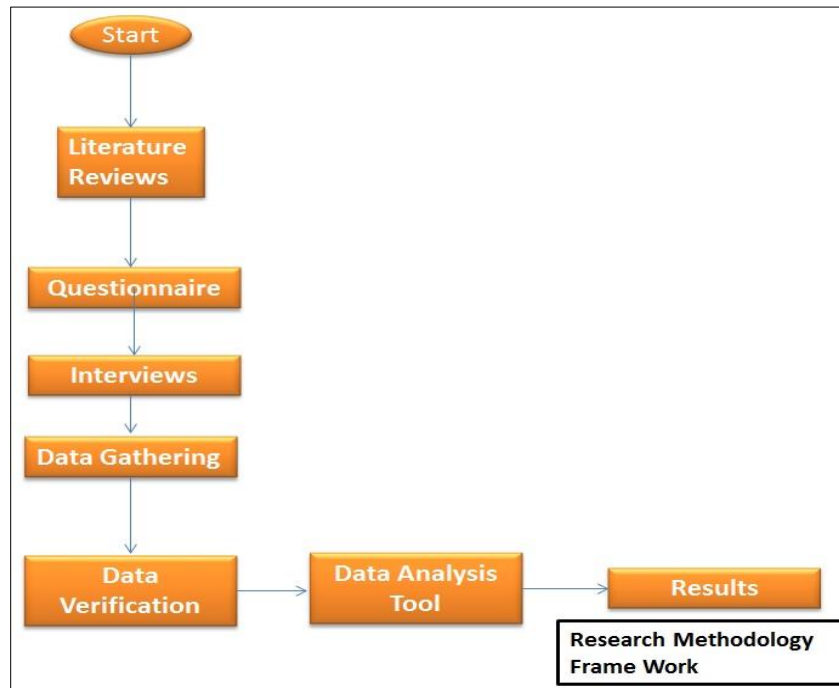


Figure 3. 1 : Data collection methods

All data collection methods can be divided into two main types; primary or secondary data collection. Primary data collection is when the researchers collect data first hand through observation, interviews or questionnaires. Whereas, secondary data collection looks at previous resources, secondary data can be further divided into documentary data; which includes books, journals, reports and internet.

Both ways of collecting data can be used in qualitative and quantitative research (Silverman 2001). Quantitative research will collect data from predetermined tools; such as questionnaires in order to generate statistical data, whilst qualitative research will look closely on words used in the interview. It is strongly recommended for a research to use both secondary and primary data and combine qualitative and quantitative methods (Malhotra and Birks 2003, Saunders *et al.* 2003). Hence, in this research, both primary and secondary data collection methods were used.

As mentioned previously in chapter one, a mixed method approach will be used in this research, semi-structured interviews and questionnaires were chosen shown in Figure 1.6, which illustrated these two chosen methods in more detail.

3.8 The Research Questionnaire

A questionnaire can be defined as: “a pre-formulated written set of questions to which respondents record their answers”. A questionnaire is very useful as it allows data to be collected from a large sample prior to analysis. Saunders *et al.* (2003) explains that there are many different types of questionnaire designs; the design chosen depends on how it will be distributed and the time that the researcher is in contact with respondents. Questionnaire designs can be divided into two main types; self-administered questionnaires and interviewer administered questionnaires. Self-administered questionnaires are completed by respondents; the questionnaire can be returned to the researcher via email, the questionnaire may be posted to the respondent and the respondents send it back to the researcher once completed (this is more outdated), it could be hand delivered to each respondent and collected later or, nowadays, questionnaires are posted online and once respondents submit their answers the researcher can instantly see the response. An interviewer administered questionnaire is based on a structural interview where respondents need to answer predetermined questions. Choosing which style of questionnaire to have in a research depends on numerous factors; such as characteristics of respondents, size of sample and required response rate. The main advantages of using a questionnaire is that it is a very versatile method, its low cost for both the researcher and subjects, it is not necessary for the researcher to be highly skilled or trained, the data obtained can be analysed using advanced statistical analysis, it also allows for easy comparisons to be made. However, the weakness of questionnaires is that they require some expertise in the design, conduct and interpretation.

3.8.1 Objectives of the questionnaire

The main purpose of the questionnaire is to obtain as much information as possible in order to gain a relative idea on the topics and to determine the risk factors that influence procurement operations within a supply chain.

3.9 Pilot Research

Once the content of the questionnaire was developed and finalised, a pilot research was performed. A pilot research is done initially in order to minimise questionnaire errors, reduce respondent confusion on some questions and minimise any misunderstanding or ambiguous questions. The pilot research also clarifies the processes that should be used to conduct the questionnaire in order to increase the accuracy of data analysis, questionnaire validity and reliability (DeVaus 1991, Churchill 1999).

Pilot studies enable researchers to refine data collection plans and allows them to to plan ahead in terms of the content of data and procedures to follow (Yin 1994). The pilot is a chance for the researcher to see if the research questions and objectives are adequately covered by the questions. It also assesses whether the length of the questionnaire is adequate, instructions are clearly written and easily understood and the layout of the questionnaire is clear. Pilot studies reveal potential gaps or problems in the questionnaire and it is a vital stage in increasing the questionnaires reliability and validity by reducing potential variations causes by errors in interpretation.

3.9.1 Purpose of the Pilot Research

The main aim of the pilot research was to test the questionnaire and find and resolve any serious flaws in the design. It was also used to validate questions to ensure all questions were relevant and did not go off topic, and to check that respondents understand the questions well. The pilot research also provided information on the response rate and helped the researcher develop and test the competency of the questionnaire, design a research procedure, assess whether the research procedure is workable and determine the sample size and collect preliminary data (Gilbert 2001).

Once respondents completed the pilot questionnaire, the researcher asked respondents to comment on areas of the questionnaire they found unclear or if any questions were difficult, respondents were also asked how long it took them to complete the questionnaire and if they felt the time they completed in was reasonable. In terms of the questions, respondents were asked if they felt any questions were worded badly, if they felt any questions should be removed, as they were unnecessary, difficult or unclear. Once the questionnaire was completed the researcher looked at the responses to each question to check whether an adequate range of responses can be given.

3.9.2 Selecting participants for the Pilot Research

A small sample of participants was chosen to test the questionnaire and its procedures. A reasonable sample size for a pilot research is 10% of the overall research size (Churchill 1999). The questionnaire was distributed and completed by users, the participants chosen to partake in the pilot research helped give the best feedback on the questionnaire content and research

procedures. The questionnaire was given to various people in different fields and locations. Table 3.1 shows a summary of the pilot research sample.

Category	Distributed questionnaire	Returned Questionnaire/ feedback	Response rate
Procurement managers	10	8	80%

Table 3. 1: Pilot research sample

The pilot research was given to the researcher's supervisor initially as the main concern was the content of the questionnaire; to ensure all research objectives have been covered, the length of the questionnaire is reasonable, ensure instructions were easy to follow and the layout is clear and attractive. Next, the questionnaires were distributed to University staff and research students at different universities within the UK. It was at this point that a few questions were added or redesigned and small modifications were made.

Finally, the last stage in the pilot research was distributing the questionnaire to the target group in and out of Libya. The overall comments received from the target group were that the questionnaire was well structured and organised and it was very detailed. A cover letter was attached to the questionnaire to introduce the research, explain its purpose, how data from the questionnaire will be collected and the importance of responding to the questionnaire in order to help the research achieve its research objectives. The questionnaires were emailed to participants along with the covering letter (Appendices 1). During the pilot research, participants were also asked to make any comments on the question at the end of each section.

3.9.3 Pilot Research Results and Modifications

The results of the pilot research provided the researcher with a preliminary indication to the basic issues being studied and to the factors involved in supply chain risk management during procurement processes. The results of the pilot research showed that the allocated time for the questionnaire was practical and realistic, as participants stated they needed around 10-15 minutes to complete the questionnaire. The response rate to the pilot research was 80% as shown

in table 3.1 this is a reasonable response rate and showed the researcher that using a self-administered questionnaire is the best approach in order to have high response rates.

To summarise the pilot research's findings, it was found that the questionnaire was easy to complete and very clear. Participants highlighted a few questions that were hard to answer or they misunderstood and these questions were modified. The researcher was happy with the pilot research results and confident in the research, therefore no further pilot tests were needed and the draft questionnaire was used to write the final version of the questionnaire with a high level of reliability and validity. The final version of the questionnaire is included in Appendices (1).

3.10 Validity and Reliability

The validity and reliability of all research tools heavily impact a research. Therefore, it is essential to evaluate the accuracy and precision of a research. Validity can be defined as 'whether the research process measures what the researcher intends it to measure'. Whilst reliability can be defined as 'how well a measurement repeated by other researchers at different times and in different places can provide the same results and observations (Saunders *et al.* 2003). By adopting a multi-method approach, this research already had high validity and reliability, and by using two different types of data collection methods (self-administered questionnaires and semi-structured interviews) this increased the reliability and validity of the research. Finally, by conducting a pilot research, the reliability and validity were further enhanced.

3.10.1 Validity

The definition of validity, as mentioned above is "whether the research process measures what the researcher intends it to measure" (Saunders *et al.* 2003). Babbie (1990) wrote an alternative definition of validity referring to "the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration". In other words, validity is concerned with the completeness and effectiveness of the measuring instrument; it checks to see if the instrument is measuring what it intended to measure and how accurately it was measuring it (Leedy 1997).

Therefore, it was important for the researcher to consider whether the questionnaire and the validation of the proposed framework measured what it was meant to measure and whether it complied with the validity criteria set out below:

- **Face Validity:** this looks at whether questions asked were related to the topic of the research.
- **Criterion Validity:** this uses one performance measure from the research and sets it as a standard and compares other performance measures against it, and the results are measured.
- **Content Validity:** This is very close related to face validity. Content validity examines the accuracy of the instrument in measuring the factors of concern.
- **Construct Validity:** This concerns the degree to which the content of the research was measured by the questionnaire.
- **Internal Validity:** This refers to conclusions reached based on results from the research and not based on opinions influenced by research bias.
- **External Validity:** This examines the degree in which the conclusions of the research can be applied to a wider population, not just focusing on the sample research.

Punch (2005) believes that the most optimal way of determining content validity is to defining the research topics and items included in the measurement scale. In this research, content validity was established by conducting an extensive literature review in order to define and simplify the scales used in this research. Churchill and Iacobucci (2004) found that most literatures had already defined and used scales. As well as using literature to identify scales, opinions from field experts were also used to provide relevant insight; during the pilot trial the questionnaire was distributed to several PhD students and academic experts in both UK and Libya and they were asked to evaluate the content validity of the questionnaire.

Zikmund (2000) defined construct validity as the extent to which the results obtained from the research match theories used when the research was designed. In order to achieve construct validity two other criterias have to be present; convergent validity and discriminant validity; convergent validity is obtained when a positive correlation between items that measure the same construct is obtained, whereas discriminant validity refers to items showing a negative correlation with items from different factors (Hair *et al.* 2003, Parasuraman 1991). In this research, pilot trials and pre-testing were used in order to enhance construct validity. As mentioned previously, the pilot research tested the questionnaire, validated the questions, ensured that respondents

understood questions and minimised any serious mistakes made in the questionnaire design. Pearson Correlation co-efficient and t-test were used to examine correlations from the same variables. The results found that all correlations between items with the same variable were significant at the 0.01 levels and are considered satisfactory.

3.10.2 Reliability

Next, the data collection instrument has to be evaluated using reliability, convergent and discriminate validity to test all variables within the proposed model. Cronbach's Alpha was used to measure internal consistency; it ensured that all variables were closely related. In this research, in order to ensure the data collection methods measured what they intended to measure and produced stable and consistent results different processes were used. For example, the questionnaire was modified several times to ensure it was not biased and that people understood the questions. The researcher also tried to engage participants in an informal discussion when gathering the questionnaires. The method for distribution of the questionnaires also reduces errors, misunderstanding and ambiguity. Some questions used in past studies were modified and included in the questionnaire so that findings from these questions can be compared to previous studies. The Cronbach Alpha test is one of the best methods of measuring instrument stability and consistency.

Hair *et al.* (1995) states a good reliability test should produce a coefficient value between 0.6 and 0.7, however Bagozzi (1994) and Thompson *et al.* (1995) believed that the acceptable level for a newly developed scale is 0.6. In this research, the Cronbach Alpha test result was 0.677; which denotes that all constructs had high internal consistency, therefore, the scales are considered to be reliable.

3.11 Questionnaire development

Appendices 1 shows the self-administered questionnaire designed for this research in order to collect quantitative data relating to supply chain risk management and materials procurement. A self-administered questionnaire will increase the response rate, help the researcher to address questions or comments regarding the topic and also increases the reliability and validity of the information collected (Saunders *et al.* 2003). It was vital to ensure that the questionnaire was fair

and unbiased, therefore some sections of the questionnaire featured both positive and negative items (Dillon *et al.* 1993, Zikmund, 1991).

A Likert scale was also incorporated into the research; it is a simple scale used to measure the attitude of respondents (Burns 2000). It is a widely-used form of scaled items where the respondent chooses a point on the scale that they best believe represents their views (Allison *et al.* 1996), it is also one of the most common method used with the factor analysis test (Moser and Kalton 1983). Regular and standardised responses are produced from a Likert scale and this simplifies respondent attitudes and increases the validity and reliability of the research.

The most common Likert scales have 3, 5 or 7 points; whilst there is no ideal number of points to have some researcher have found that opinions can be clarified clearer using a five-point scale in comparison to a seven-point scale (Malhotra, 1999; Sekaran, 2000). Researchers have found that by increasing the scale to more than five points does not improve the reliability of the results and tends to confuse respondents (Sekaran, 2000; Hair *et al.* 2003).

Therefore, for the reasons stated above, this research used a five-point scale, where one represents not important or extremely poor and five represents extremely important or extremely good. The advantages of using a Likert scale are outlined below:

- It allows the researcher to use a variety of statistical techniques and to conduct powerful statistical analysis, such as correlation.
- It allows respondents a degree of flexibility to choose what their opinion is on a variable.
- Respondents are not confused as it is easy to follow because the number of choices they have is restricted.

3.11.1 The content of the questionnaire

The literature review will discover some key points; these will be put into the questionnaire. It is important to ensure the content of the questionnaire will reflect the hypotheses of the research.

3.11.2 Questionnaire delivery method

Different questionnaire delivery methods have been evaluated. The advantages of online questionnaires are; low cost, faster response rate, easier data processing, use of interactive

instructions and the capability to use multimedia features; such as audio ad animations (McDonald and Adam 2003, Cobanoglu *et al.* 2001, Dillman *et al.* 1998). Bristol Online Questionnaires (BOS) is an example of an online questionnaire organisation that provide the essential instruments to develop, organise and analyse questionnaires online. Over 300 organisations and 130 universities worldwide currently use BOS, as it is knowledge-driven platform that can help researchers obtain data. Therefore, the research will utilise BOS to collect data from questionnaires.

The researcher developed a web-based questionnaire and in August 2015, it was hosted on Bristol Online System (BOS) hosted by Coventry university.

93 procurement practitioners have been invited to participate by sending them an emails.

Appendices 1. presents the last version of the questionnaire, and Appendices 2: Interview Consent Form

3.12 Summary

This chapter provide the overall research design of this research and explain methods to be applied to each phase. Research philosophy been discussed, approach, strategy and methodology. It illustrates and justify the mixed data collection methods. This chapter also explain the sampling process, developing questionnaire, interview administration, and pilot research and finally the validation and reliability of the questionnaire. The following chapter (4) will present the results and analysis.

Chapter Four: Questionnaire Survey Data Analysis and Results

4.1 Introduction

This chapter demonstrate the analysis and results of the research. The data is presented in form of tables and figures based on both SPSS and Excel software programs. Presentation and explanation of the results has been organised and controlled in harmony with the research objectives. This chapter intends to address the main research questions in investigating the risk areas in procurement materials for Libyan oil industry. The main findings of this research will support procurement and operational managers to examine its current situation in terms of identify and mitigate risks that are associated with materials procurement within oil industry. Additionally, the results of this research might be of interest to procurement managers who are practicing materials procurement operations and intend to secure and add value to their procurement process. Furthermore, the findings of this research will contribute in developing Procurement Risk Management Framework (PRMF) dedicated to Libyan oil industry.

4.2 Research Validity and Reliability

To add a value to this research, it considers internal validity and reliability for the questionnaire which been administrated by the researcher based on the topic. To certify these internal validity and reliability of the questionnaire, Cronbach's Alpha test was applied using SPSS software. This test is important in terms of examining the strength and stability of measure applied to relationships between variables. The test of the strength and validity of the questionnaire, indicate a result of (0.68). Cronbach's alpha was a high value (0.799) for five points related to the risk managements as well as it was very high value (0.9156) for five points that related to the participants' views on the analysis / identify sources of risk.

Moreover, Cronbach's alpha value was a 0.929 for three different points relevant to the risk mitigation and it recorded a high value (0.699) for three different points related to the risk identifications.

4.3 Questionnaire Data Analysis

This part will present the results achieved from questionnaire data analysis that has been collected from the result of questioning 65 response out of 93 materials procurement managers

been invited within the oil industry. The results were grouped into different sections includes company general information, company and respondent, risk management, risk identification, risk analysis, risk mitigation, risk monitoring, control and continuous improvement, risk performance, advantage of outsourcing, benefits of using risk management, risks often occur during procurement processes, risks usually occur during procurement implementation and issues are drivers of supply chain risk management in the company. The sections also have sub sections representing data that comprises the answers to the proposed research questions.

4.3.1 Company General Information

This part is dedicated to obtain general information related to the companies. Three main questions were considered, and these were; the type of organisation, size of organisation and the country in which the organisation is operating from. Information obtained from responses can be used later for further statistical analysis.

4.3.1.1 What kind of organisation are you currently working for?

The respondents to the questionnaire were asked to provide information on the best description of their organisation; service provider/ contractor, material supplier and owner/ end user (Table 4.1). The result is represented graphically by Fig. 4.1. As it can be seen, 19 of these managers who responded to the questionnaire are material suppliers' managers with 29.2%, 38 managers as service provider/contractor with 58.5%, and 36 managers from owner/ end user with 55.4%.

: Frequency distribution for type of organisation

Type of organisation	Percentage
Contractor/ service provider	58.5%
Material Supplier	29.2%
Owner/ end user	55.4%

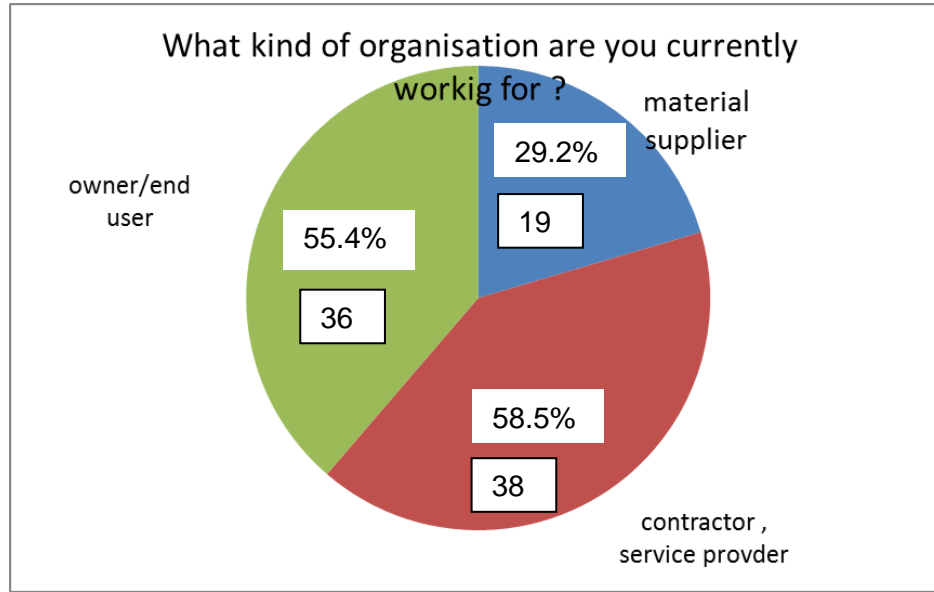


Figure 4. 1: Frequency distribution for types of organisation.

4.3.1.2 Which country are you currently operating from?

This question was designed to help identify companies and managers operating locally (in Libya) or abroad.

The results show that, 47.7% of the respondents were operating locally (in Libya), while the rest 38.5 % operates abroad. (Table 4.2). This is graphically represented in Figure 4.2.

Table 4. 1: Frequency distribution of companies' location

Country are you currently operating from	Percentage
Libya	47.7% *
Libya/Abroad	38.5%
Italy	4.6%
UK	4.6%
Indonesia	1.5%
Saudi Arabia	1.5%
Turkey	1.5%

*The intention of the researcher is to focus on Libyan oil companies based in Libya, but because the researcher was not sure about the location of these companies, therefore he invite (broadcast) everybody regardless the location , and after receiving their responses , the focused national companies are selected from international ones.

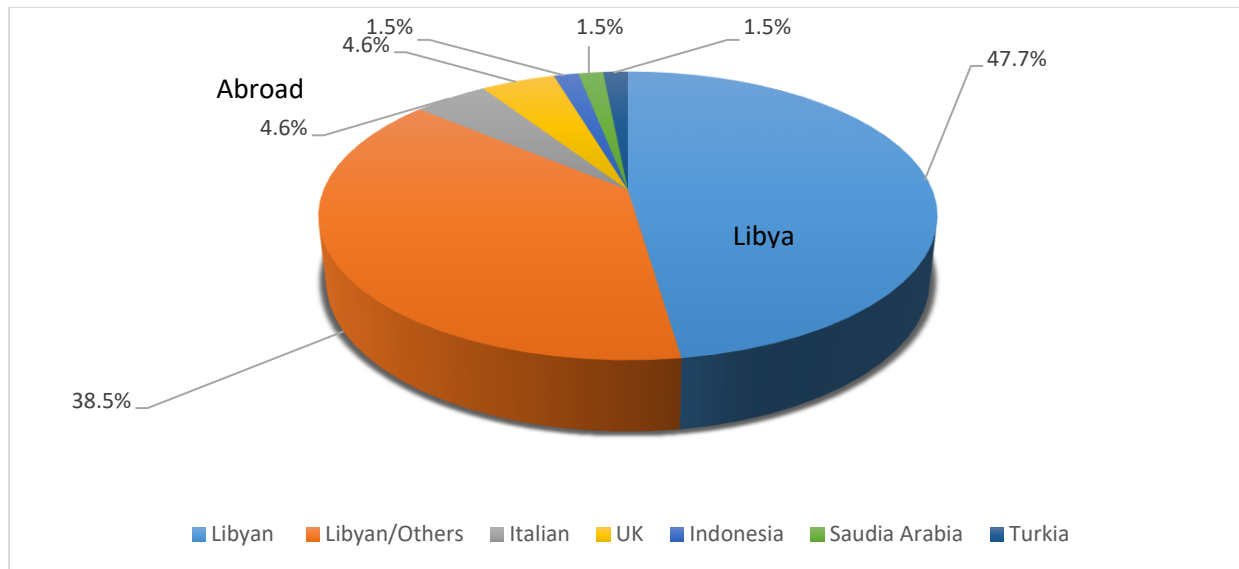


Figure 4. 2: Frequency distribution of location.

4.3.1.3 How would you classify your organisation in terms of size?

Number of employees may indicate few issues such as company performance.

As it can be seen (Table 4.3), analysis showed that 41.5% of total response has less than 50 employees (the lowest number of employees), while 16.9% has between fifty to two hundred fifty (50-250) employees, and 41.5% has the highest employee number with over 250 employees. This is graphically represented in Figure 4.3.

Table 4. 2: Frequency distribution in terms of company's employee's number

Classify of organisation Size	Percentage
Less than 50	41.5%
From 50 to 250	16.9%
Higher than 250	41.5%

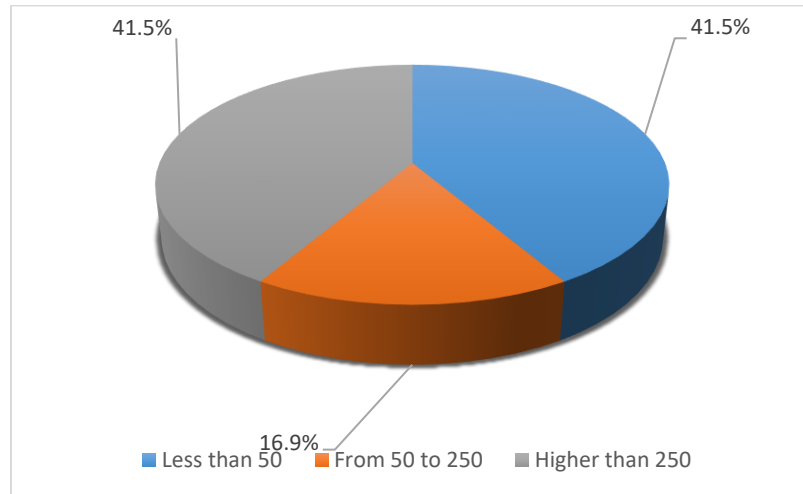


Figure 4. 3: Frequency distribution of employees' number.

4.3.2 Company and Respondent

In this part, three main questions have been considered, these are; number of years the employees have been practicing procurement operations, value of procurement operation they authorised to execute or normally carry out and whether their company hold ISO certificate.

4.3.2.1 Years of practicing equipment, material procurement and procurement process

The questionnaire respondents were asked about years of experience at material procurement (Table 4.4). The results show that 58.5% of the respondents have 11 to 15 years working experience, 9.2% with 6 to 10 years of experience and 10.8% with less than 5 years. Also, 18.5% have 16 to 20 years of experience while 3.1% have more than 21 years of experience. This is graphically represented in Figure 4.4.

Table 4. 3: Frequency distribution of years have been practicing equipment, material procurement and procurement process

Years have been practicing equipment	Percentage
Less than 5 years	10.8%
From 6 to 10 years	9.2%
From 11 to 15 years	58.5%
From 16 to 20 years	18.5%
Higher than 21 years	3.1%

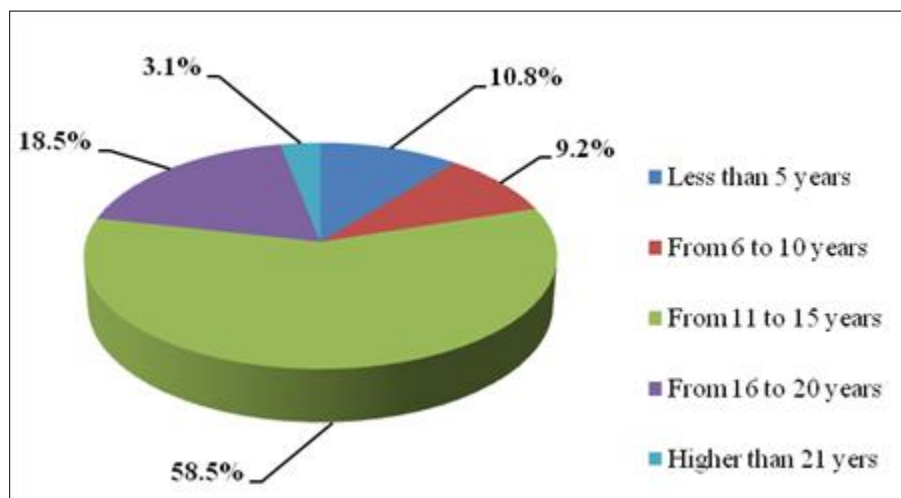


Figure 4. 4: Frequency distribution for years' experience

4.3.2.2 What is the value of procurement projects you are authorised to execute or normally carry out?

The data (table 4.5) below show the value of procurement projects managers can authorise to execute or normally carry out. This can indicate the level of authority the manager holds since the level of experience and responsibility he/she own. It also indicates the average value of material procurement. This is graphically represented in Figure 4.5.

Table 4. 4: Frequency distribution of procurement value

Value of procurement	Percentage
\$10,000-50,000	6.2%
\$51,000-100,000	13.8%
\$101,000-250,000	21.5%
\$251,000-500,000\$	52.3%
Higher than \$500,000	6.2%

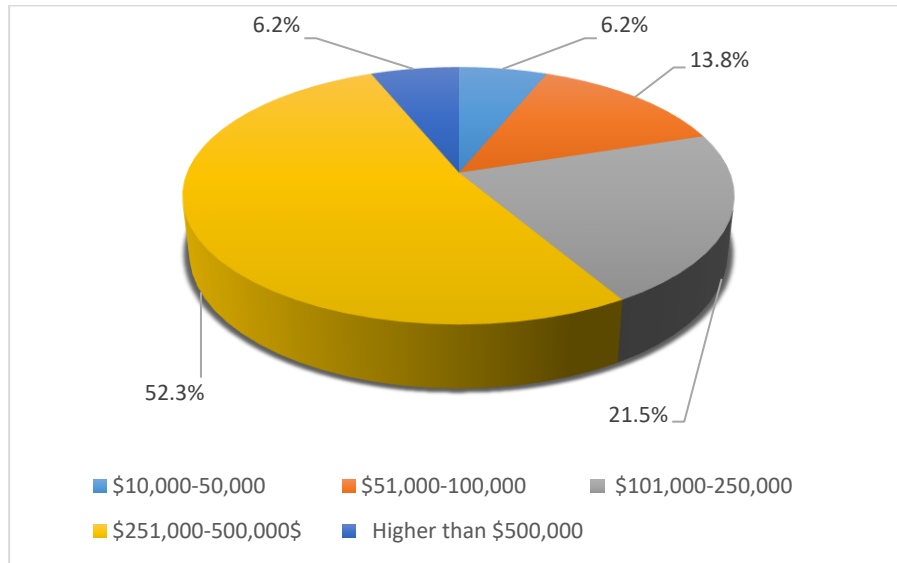


Figure 4. 5: Frequency distribution of procurement value.

4.3.2.3 ISO certified

International Standard Organisation (ISO 31000) provides generic guidelines for the design, implementation and maintenance of risk management processes throughout an organisation. This approach to formalizing risk management practices will facilitate broader adoption by companies who require an [enterprise risk management](#) standard that accommodates multiple management systems.

The scope of this approach to risk management is to enable all strategic, management and operational tasks of an organisation throughout projects, functions, and processes to be aligned to a common set of risk management objectives.

This question indicates company's standard. The questionnaire respondents were asked about ISO certificate that organisations may hold. The result (table 4.6) shows that 60% of the respondents were ISO certified, 38.5% are not, and 1.5% do not know. This is graphically represented in Figure 4.6.

Table 4. 5: Frequency distribution for ISO certificate

ISO certified	Percentage
Yes	60.0%
No	38.5%
Do not Know	1.5%

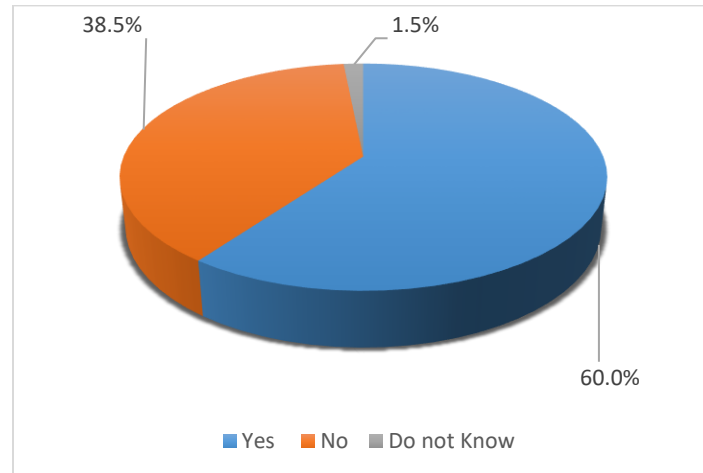


Figure 4. 6: Frequency distribution of ISO certificate

4.3.2.4 Correlation Analysis

Correlation analysis is an inferential statistical method adopted to show how pairs of variables are related (Pallant 2010). There are different approaches used in correlation analysis, depending on the nature of data. The study examined relationships between independent and dependent variables to determine statistical association. The categorical nature of the data meant that a non-parametric technique (Chi-Square test) was required to determine the level of association (p -value) and strength of linear relationship (r) between pairs of variables. (r , p -value).

4.3.3 Risk Management

4.3.3.1 Do you practice the following activities during procurement processes?

This question examines the possibility of practicing risk management strategy by managers. Risk management strategy include: risk Identification, analysis / assessment, mitigation and risk monitoring. Table 4.7 shows the highest and lowest risk management practice. 40% of managers practice identification risk factor every time, 55.4% applies risk analysis sometimes, 50.8% mitigate risk sometimes and 38.5% monitor and control the risk sometimes. This is graphically represented in Figure 4.7.

Table 4. 6: Frequency distribution for practicing risk management strategy

Risk Management	Every time	Almost-every time	Sometimes	Almost never	Never
Identification	40.0%	24.6%	32.3%	3.1%	0.0%
Analysis	21.5%	10.8%	55.4%	7.7%	4.6%
Mitigation	26.2%	21.5%	50.8%	0.0%	1.5%
Monitoring	20.0%	30.8%	38.5%	7.7%	3.1%

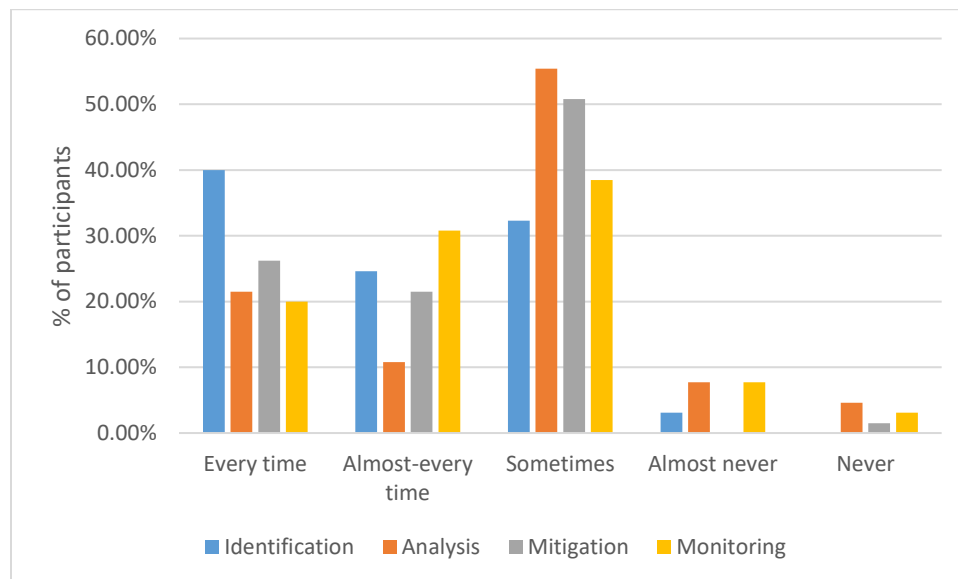


Figure 4. 7: Frequency distribution for practicing risk management strategy

Drawing from the conclusion of the chart above in Figure 4.7, every participating manager react to risk management strategies in their individual companies. The result of their practice shows that 40 % of the managers identifying risk every time but only 21.5 % of them analysing it. and 55.4% of the managers sometimes they analysing risk, 50.8% of them mitigating risk and 32.2 % sometimes identifies risks. Almost every time 24.6 per cent of the managers identify risk, 10.8 per cent analyse it, 21.5 % mitigate risk, while 30.8 % of the participating managers practice risk monitoring. 3.1 % of manager answered to almost never for risk identification, and none for mitigation of risk. No managers answer for never identify risk, while 4.6 % mainly analysis the risks.

4.3.3.1 Statistical Association

To check whether there are significant associations within these five statements that related to the Risk Management. A series of ANOVA has been applied to examine whether there were associations between variables. Specifically, if there are statistically significant differences or not between responses at confidence level 95% have been set out to test this statement. The result shows that, there are significant differences within the variables as shown in Table 4.8. The result shows that, P-value is less than 0.05, which indicates that, there are significant differences within those variables. This is graphically represented in Figure 4.8.

Table 4. 7: ANOVA'S test Risk Management

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	15.028	4	3.757	3.987	0.004	2.400
Within Groups	301.569	320	0.942			
Total	316.597	324				

4.3.4 Risk Identification

4.3.4.1 How frequently do you practice the following statements? (In terms of risk identification)

This part is considered to be the first and most important part in risk management strategy. Risk identification allow managers to search and detect the potential risks associated with their operation that owns potential threats. Searching and detecting potential risks can be accomplished by using previous records of operations been executed. Also, communication with partners such as suppliers can provide valuable information that can be used as early risk indicator. Early Identification of risk can help to minimise its impact and level of disruption to the procurement operation. This is depicted in Table 4.9 and graphically represented in Figure 4.9.

Table 4. 8: The Percentage of Respondents Practicing Risk Identification.

Risk Identification	Every time	Almost-every time	Sometimes	Almost never	Never
We are informed about possible risks	7.7%	32.3%	58.5%	1.5%	0.0%
We are constantly searching for short-term risks	21.5%	10.8%	63.1%	3.1%	1.5%
We define early warning indicators	7.7%	15.4%	67.7%	6.2%	3.1%

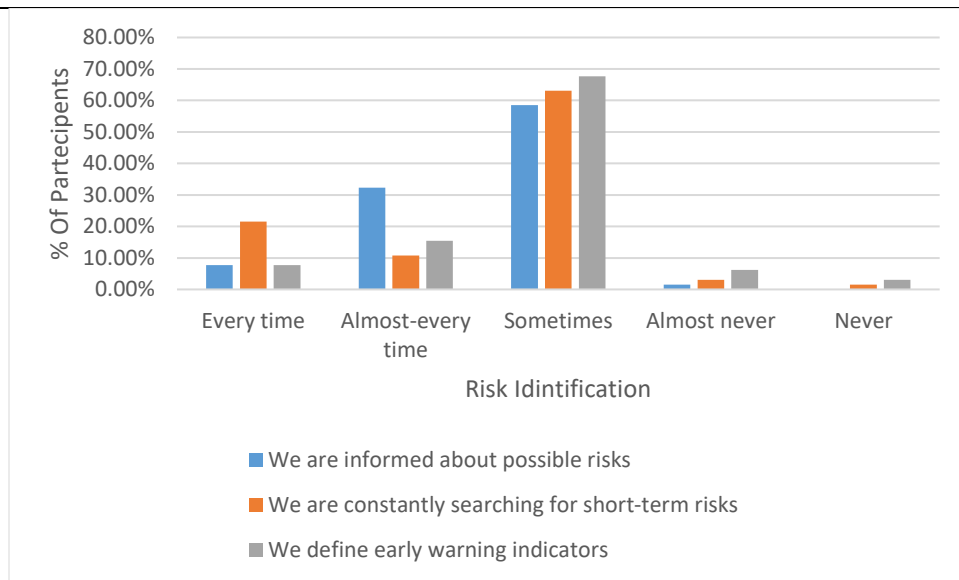


Figure 4. 8: Risk Identification

4.3.4.1 Statistical Association

A series of ANOVA has been applied to examine whether there were associations between the variables in risk identification, specifically if there are statistically significant differences or not between responses at confidence level 95% have been set out to test this statement (Table 4.10). The result shows that, P-value is higher than 0.05, which indicate that no significant differences within the variables.

Table 4. 9: ANOVA'S test Risk Identification

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	3.517	2	1.758	2.764	0.065	3.042
Within Groups	122.153	192	0.636			
Total	125.671	194				

4.3.5 Risk Analysis/Assessment

4.3.5.1 Do you practice the following activities?

Risk Analysis/Assessment is the second stage of risk management strategy. It involves an evaluation of the likelihood risk factor occurring as well as its impact. The aim of this activity is to provide managers with necessary information on each identified risk factor through risk registry. This valuable information allows managers to identify risks with their trigger events, hence mitigate their impacts or avoid occurrences.

Table 4. 10: The percentage of managers who frequently practicing risk assessment process

Risk Analysis/Assessment	Every time	Almost- every time	Sometimes	Almost never	Never
Look for the possible sources of supply risks	29.2%	23.1%	47.7%	0.0%	0.0%
Evaluate the probability of supply risks	9.2%	23.1%	64.6%	3.1%	0.0%
Analyse the possible impact of supply risks.	10.8%	35.4%	50.8%	3.1%	0.0%
Evaluate the urgency of our supply risks	10.8%	35.4%	50.8%	3.1%	0.0%
Classify and prioritise our supply risks	24.6%	16.9%	55.4%	1.5%	1.5%

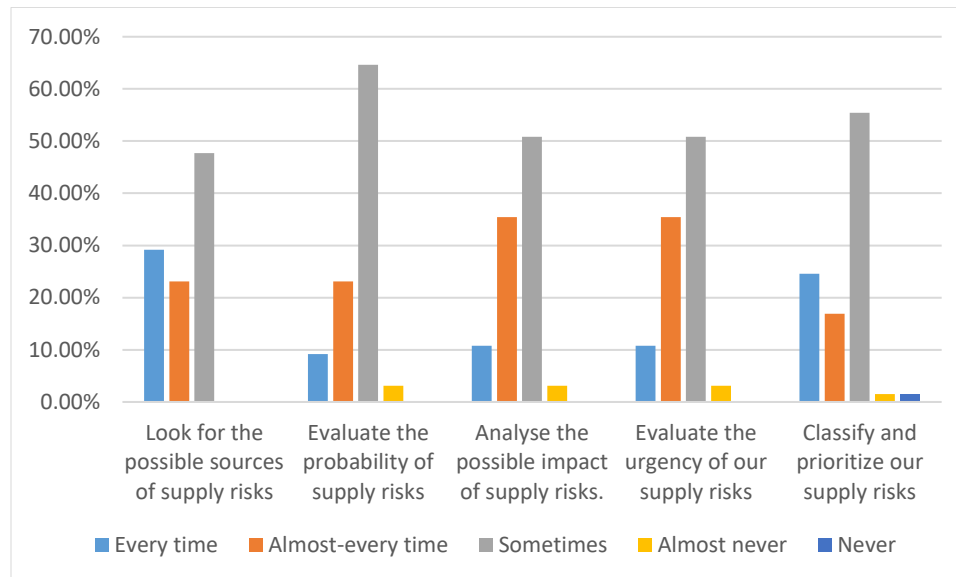


Figure 4. 9:Risk Analysis

4.3.5.1 Statistical Association

ANOVA test has been applied to examine whether there were associations between the variables in risk analysis, specifically if, there are statistically significant differences or not between responses at confidence level 95% have been set out to test this statement. The result (table 4.12) shows that, P-value is lower than 0.05 (0.041), which indicate that significant differences exist within the variables.

Table 4. 11: ANOVA'S test Risk Analysis/Assessment

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	6.388	4	1.597	2.519	0.041	2.400
Within Groups	202.862	320	0.634			
Total	209.249	324				

4.3.6 Risk Mitigation

4.3.6.1 How frequently do you practice the following activities?

Risk Mitigation is the third stage in risk management process. It involves the development of measure to reduce the likelihood of the risk before it occurs or minimise it after occurrence (Table 4.13). This is graphically represented in Figure 4.10. This process is based on the information established in the previous stages.

Table 4. 12: The percentage risk mitigation activities

Risk Mitigation	Every time	Almost- every time	Sometimes	Almost never	Never
Demonstrate possible reaction strategies	26.2%	15.4%	55.4%	3.1%	0.0%
Evaluate the effectiveness of reaction strategies	26.2%	18.5%	49.2%	6.2%	0.0%
Supply Risk Management is an important activity in our company	15.4%	33.8%	44.6%	6.2%	0.0%

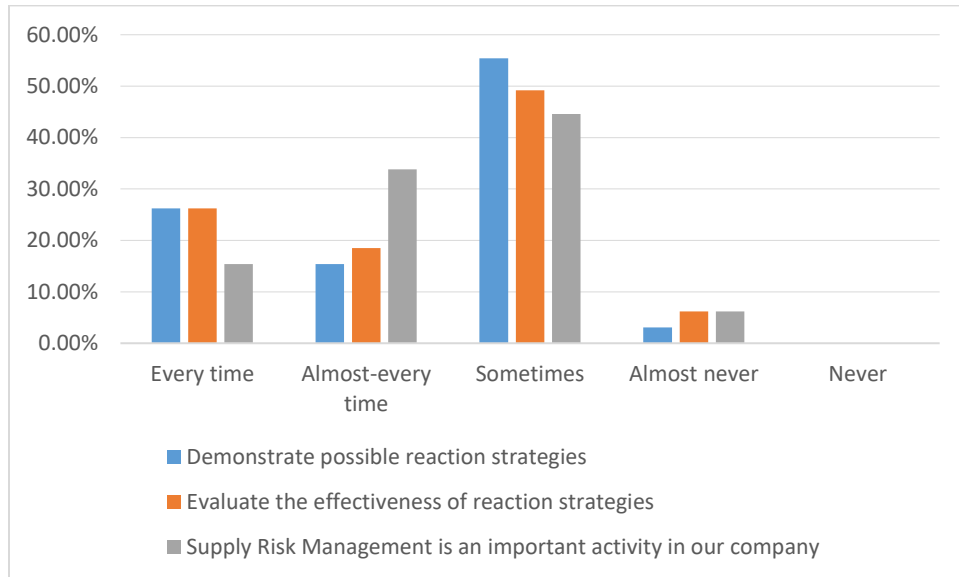


Figure 4. 10: Risk Mitigation Practice

4.3.6.1 Statistical Association

ANOVA test has been applied to examine whether there were associations between the variables in risk mitigation, specifically if, there are statistically significant differences or not between responses at confidence level 95% have been set out to test this statement (Table 4.14). The result shows that, P-value is higher than 0.05 (0.901), which indicate that no significant differences within the variables.

Table 4. 13: ANOVA'S test of risk mitigation

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	0.16	2	0.08	0.101	0.901	3.04
Within Groups	154	192	0.8			
Total	154	194				

4.3.7 Risk monitoring and control.

4.3.7.1 Do you agree with the following statements?

A fourth stage in the risk management process is continuous monitoring. This process is required to recognise new potential risks, check the occurrence (or potential occurrence) of previous identified risk, review the effectiveness of mitigation measures, auditing documentation, reports and making adjustment to the risk management plan where necessary. The question to managers is how frequently they practice risk monitoring and control in their supply chain. Table 4.15 below shows the percentage of Risk Monitoring. This is graphically represented in Figure 4.11.

Table 4. 14: The percentage of risk monitoring

Risk Monitoring	Every time	Almost- every time	Sometimes	Almost never	Never
We control our risk management methods in Procurement and supply.	7.7%	40.0%	26.2%	26.2%	0.0%
We control the progress for critical supply risks	15.4%	20.0%	36.9%	27.7%	0.0%
We control our activities for identifying and analysing supply risks.	3.1%	36.9%	33.8%	24.6%	1.5%

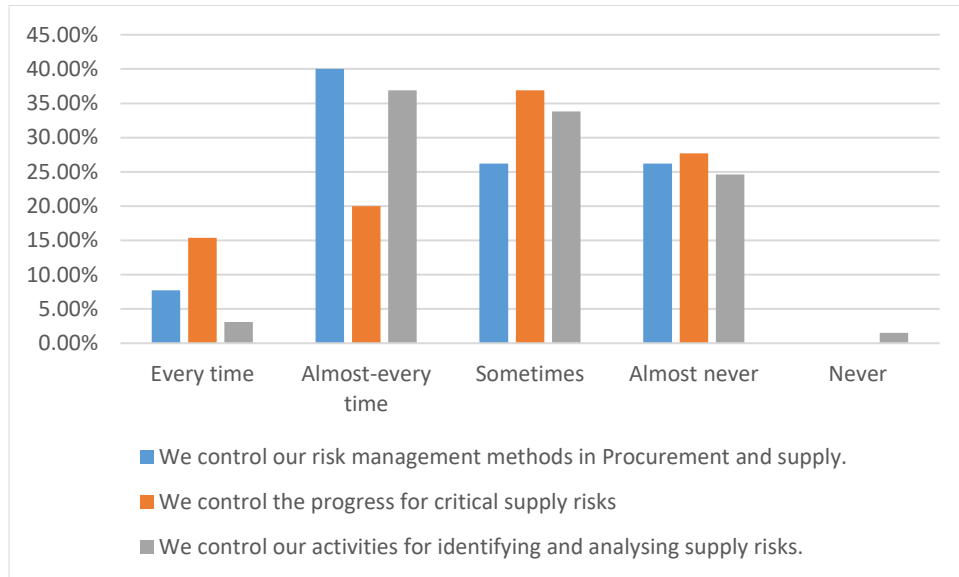


Figure 4. 11: Risk Monitoring Practice

4.3.7.2 Statistical Association

By applying ANOVA test to examine whether there are associations between variables in risk monitoring and control, specifically if, there are statistically significant differences or not between responses at confidence level 95% been set out to test this statement (Table 4.16). The result shows that, P-value is higher than 0.05 (0.7105), which indicate that no significant differences exist between the variables.

Table 4. 15: ANOVA'S test of risk monitoring, control and continuous improvement

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	0.6256	2	0.3128	0.3423	0.7105	3.043
Within Groups	175.45	192	0.9138			
Total	176.07	194				

4.3.8 Risk Performance

4.3.8.1 Do you agree with the following statements in regards to your organisation?

Risk performance is the last stage of risk management process; it is required to evaluate the previous stages in terms of deliverability and outcomes. This outcome can include evaluation of employees' proficiency in term of risk management, or evaluate the impact of risk occurrence within last 3 years. Table 4.17 illustrates the percentage of risk performance. This is graphically represented in Figure 4.12.

Table 4. 16: The percentage of risk performance

Risk Performance	Strongly agree	Agree	Nether Agree or Disagree	Disagree	Strongly disagree
Our employees are experienced in solving occurrence of supply risks	9.2%	24.6%	29.2%	36.9%	0.0%
Our risk management processes in procurement are very professionally designed	0.0%	29.2%	33.8%	35.4%	1.5%
We managed to minimise the frequency of occurrence of supply risks over the last three years.	3.1%	21.5%	43.1%	32.3%	0.0%
We managed to minimise the impact of occurrence of supply risks over the last three years.	3.1%	24.6%	38.5%	33.8%	0.0%

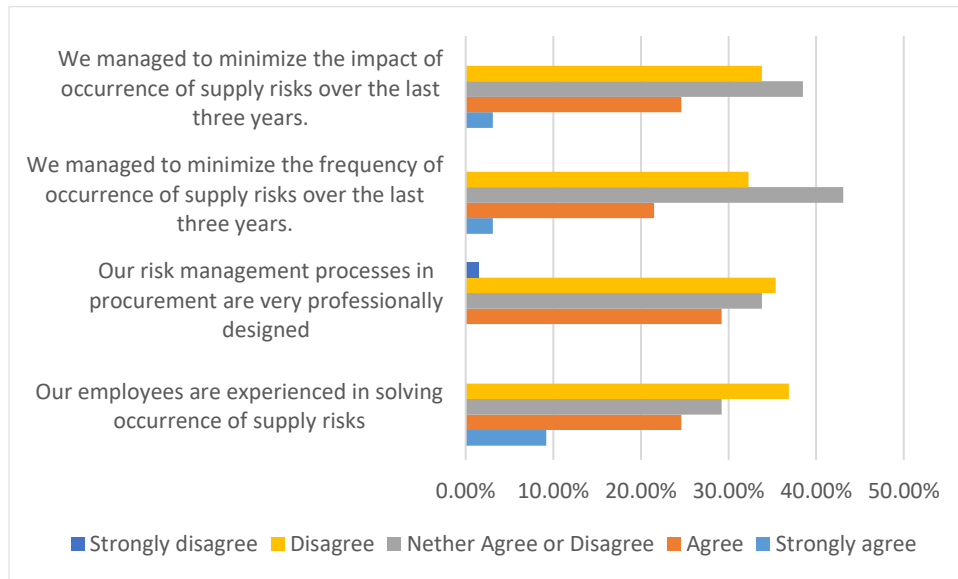


Figure 4. 12: Risk Performance

- *Statistical Association*

A series of ANOVA has been applied to examine whether there were associations between the variables in risk performance, specifically if, there are statistically significant differences or not between responses at confidence level 95%. The result (Table 4.18) shows that, P-value is higher than 0.05 (0.78936), which indicate no existing significant differences within the variables.

Table 4. 17: variables in risk performance

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	0.81154	3	0.27051	0.34975	0.78936	2.63986
Within Groups	198	256	0.77344			
Total	198.812	259				

4.3.8.2 Do you agree the following is an advantage of outsourcing?

Outsourcing is type of job which can be executed externally. Usually organisations that focus on their proficiency, execute some of their jobs with external partners (outsource). Table 4.19 shows the percentage of risk related to outsourcing strategy in regards to the organisations. This is graphically represented in Figure 4.13.

This strategy can be useful; however, it contains few risk factor.

Table 4. 18: The percentage of risk related to outsourcing strategy.

Statements in regards to your organisation	Strongly agree	Agree	Nether Agree or Disagree	Disagree	Strongly disagree
Improved timescales	1.5%	64.6%	9.2%	24.6%	0.0%
Reduced risk exposure	16.9%	64.6%	7.7%	10.8%	0.0%
Reduced cost	9.2%	43.1%	21.5%	24.6%	0.0%
Improved administration	13.8%	61.5%	15.4%	7.7%	0.0%
Quality of service improvements	9.2%	75.4%	10.8%	3.1%	1.5%
Risk sharing	49.2%	36.9%	10.8%	1.5%	1.5%

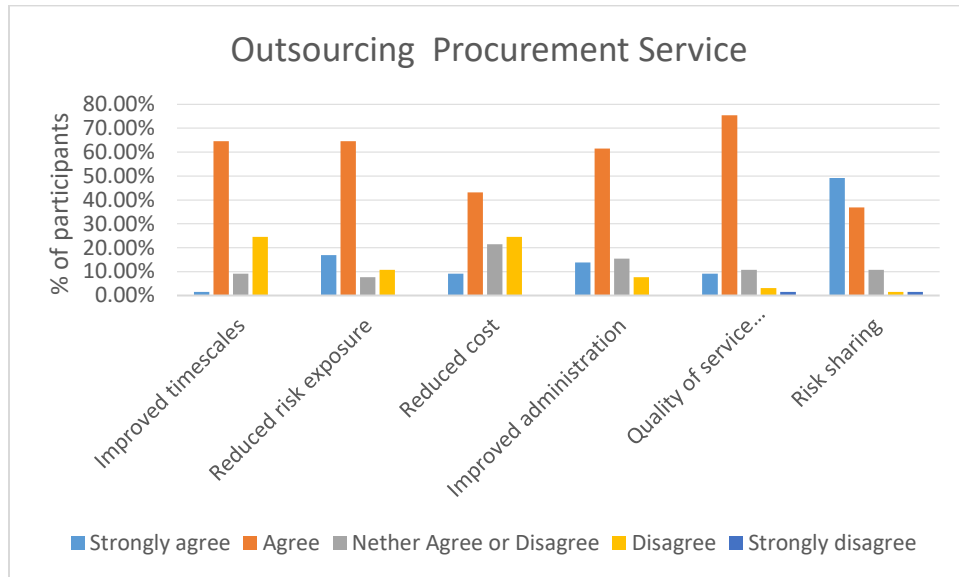


Figure 4. 13: Outsourcing procurement service and risk associated.

Outsourcing strategy is one of issues any organisation may consider. Referring to Porter's classify (Figure 1.1). He classifies procurement as a support activity that organisation may practice. Meanwhile number of researchers highlight the risk behind outsourcing service as procurement service. One of these risks, that organisation's strategy can be exposed to external organisation, so a trade-off should be considered.

Figure 4.13 show that more than 64.6% of participants, agreed that outsourcing their materials will improve their project time scale (reduce delay), were 24.6% disagree.

Moreover, 64.6% think that outsourcing can reduce risks exposed to organisation related to material procurement process, this due to risk sharing between two organisations as 49.2% mention.

4.3.8.2 Statistical Association

ANOVA has been applied to examine whether there were associations between outsourcing variables, specifically if there are statistically significant differences or not between responses at confidence level 95% which was set to test this statement (Table 4.20). The result shows that, P-value is lower than 0.05 (7E-10), which indicate an existing significant difference within the variables.

Table 4. 19: ANOVA'S test of outsourcing

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	37.8897	5	7.57793	10.9682	7E-10	2.23762
Within Groups	263.925	382	0.6909			
Total	301.814	387				

4.3.8.3 Do you agree the following statements are benefits of using Risk management?

This question aims to capture the point of view of managers regarding the benefit of practicing Risk management. Table 4.21 depicts their responses. This is also graphically represented in Figure 4.14

Table 4. 20: The percentage of Benefit of using risk management

Benefits of using Risk management	Strongly agree	Agree	Nether Agree or Disagree	Disagree	Strongly disagree
Secure project time frame	10.8%	75.4%	13.8%	0.0%	0.0%
Better use of resources	6.2%	52.3%	35.4%	6.2%	0.0%
Cost savings	15.4%	44.6%	20.0%	20.0%	0.0%
Time savings	9.2%	53.8%	16.9%	20.0%	0.0%
Following international standards	27.7%	69.2%	1.5%	0.0%	1.5%
Sustainability	18.5%	76.9%	1.5%	1.5%	1.5%

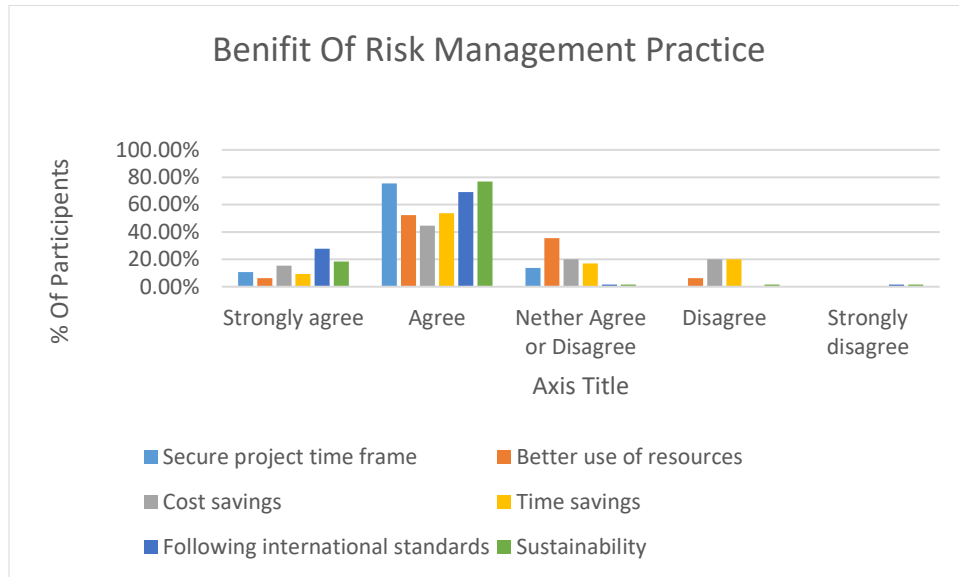


Figure 4. 14:Benefit of Risk Management Practice

4.3.8.4: Statistical Association

ANOVA has been applied to examine whether there are associations between benefits of using Risk management, specifically, the existence of statistically significant differences between responses at confidence level 95% have been set out to test this statement (Table 4.22). The result shows that, P-value is lower than 0.05 (8.46E-10), which indicate an existing significant difference within the variables.

Table 4. 21: ANOVA'S test of benefits of using risk managements

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	30.36154	5	6.072308	10.87	8.46E-10	2.237492
Within Groups	214.4308	384	0.558413			
Total	244.7923	389				

4.3.8.5Do you agree the following risks often occur during procurement processes?

This question provides the research with manager's point view regarding the frequency occurrence of risks during procurement operations. Table 4.23 depicts the responses and Figure 4.15 graphically represents it.

Table 4. 22: The percentage of risks often occur during procurement processes

Risks often occur during procurement processes	Strongly agree	Agree	Nether Agree or Disagree	Disagree	Strongly disagree
Unreliable Suppliers	7.7%	49.2%	15.4%	27.7%	0.0%
Shortage of suppliers	15.4%	67.7%	3.1%	13.8%	0.0%
Financial Issues	6.2%	44.6%	26.2%	23.1%	0.0%
Logistic Issue	6.2%	72.3%	3.1%	18.5%	0.0%
Inappropriate Inventory	7.7%	23.1%	16.9%	52.3%	0.0%
Raw material price fluctuation	53.8%	36.9%	6.2%	3.1%	0.0%
Government Issue (Tax, regulation)	9.2%	78.5%	1.5%	9.2%	1.5%
Lack of communication with supplier	3.1%	47.7%	18.5%	*29.2%	1.5%
Lack of technical experts within our organisation	7.7%	64.6%	10.8%	13.8%	3.1%

* Quality of communication service is depended on the location , in some areas of the communication infrastructure is better than in other areas.

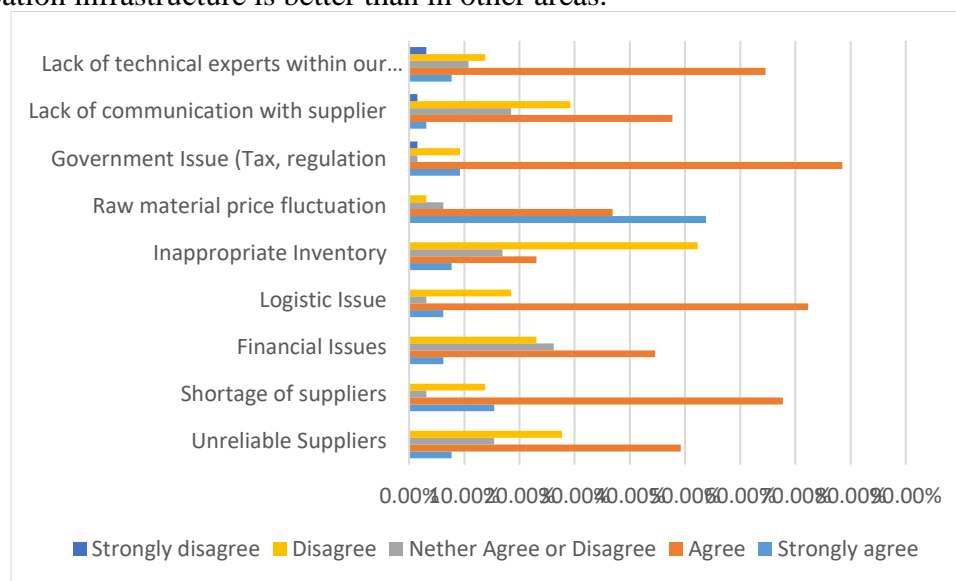


Figure 4. 15: Risks often occur during procurement processes

4.3.8.6 Statistical Association

ANOVA has been applied to examine whether there are associations in the different types of risks occurring during procurement processes, specifically statistically significant differences between responses at confidence level 95% which was set out to test the statement. The result (Table 4.24) shows that, P-value is lower than 0.05 (1.3E-11), which indicate an existing significant difference within the variables.

Table 4. 23: ANOVA'S test for risks often occur during procurement processes

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	103.87	8	12.9838	16.1424	1.3E-11	1.95446
Within Groups	463.292	576	0.80433			
Total	567.162	584				

4.3.8.7 Do you agree the following risks usually occur during procurement implementation?

Table 4. 24: The percentage of risks usually occur during procurement implementation

Risks usually occur during procurement implementation	Strongly agree	Agree	Nether Agree or Disagree	Disagree	Strongly disagree
Un-clear scope of work	0.0%	35.4%	15.4%	49.2%	0.0%
Un-clear material specifications	0.0%	53.8%	16.9%	29.2%	0.0%
Lack of suppliers	3.1%	70.8%	15.4%	10.8%	0.0%
Suppliers operations	26.2%	58.5%	7.7%	7.7%	0.0%
Contract Terms & Conditions	9.2%	29.2%	18.5%	43.1%	0.0%
Lack of resources	0.0%	41.5%	24.6%	33.8%	0.0%
Lack of expertise	0.0%	53.8%	29.2%	16.9%	0.0%
Financial stability	4.6%	72.3%	13.8%	9.2%	0.0%

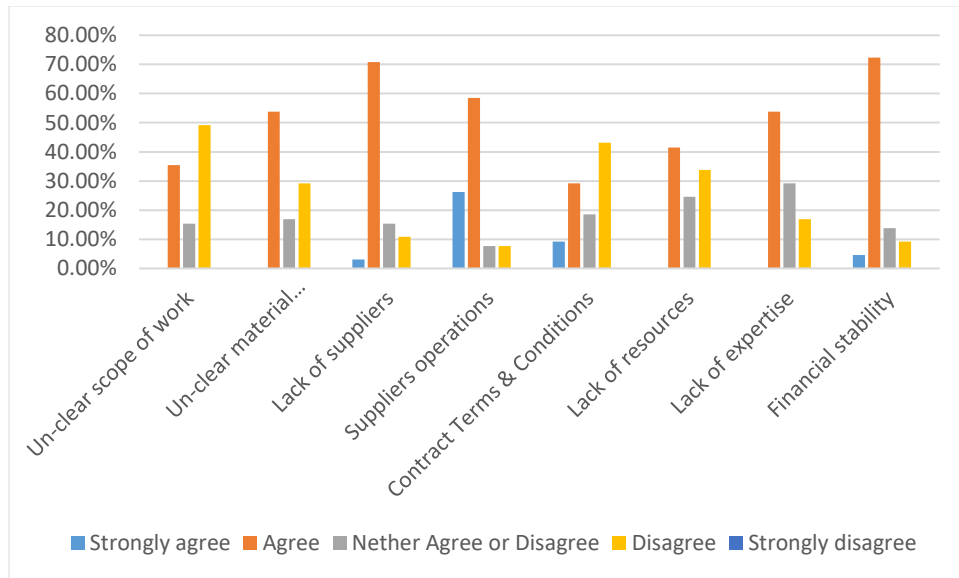


Figure 4. 16: More risks often occur during procurement processes

- **Statistical Association**

ANOVA has been applied to examine whether there are associations between risks usually occur during procurement implementation, specifically if, there are statistically significant differences or not between responses at confidence level 95% have been set out to test this statement. The result (Table 4.26) shows that, P-value is lower than 0.05 (1.3E-21), which indicate an existing significant difference within the variables.

Table 4. 25: ANOVA'S test of risks usually occurs during procurement implementation

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	72.1846	7	10.3121	14.4281	3.6E-17	2.02745
Within Groups	365.938	512	0.71472			
Total	438.123	519				

4.3.8 Do you agree these issues are drivers of supply chain risk management in your company?

This question lists several risk issues that might drive supply chain risk management. Table 4.27 shows the result and Figure 4.17 graphically explains the result.

Table 4. 26: The percentage of supply chain risk management and its drivers

Supply chain risk management	Strongly agree	Agree	Nether Agree or Disagree	Disagree	Strongly disagree
Government regulations	24.6%	55.4%	16.9%	3.1%	0.0%
Gaining competitive advantage	6.2%	60.0%	29.2%	4.6%	0.0%
Customer perception of company's image	6.2%	60.0%	30.8%	3.1%	0.0%
Organisation's values	7.7%	69.2%	18.5%	4.6%	0.0%
Cost reduction	36.9%	53.8%	6.2%	3.1%	0.0%
Avoidance of problems with stakeholders	20.0%	64.6%	13.8%	1.5%	0.0%
Industry regulatory compliance	7.7%	75.4%	13.8%	3.1%	0.0%
Pressure / encouragement by customers	43.1%	44.6%	10.8%	1.5%	0.0%
Deregulation of the downstream oil industry	6.2%	80.0%	10.8%	3.1%	0.0%
Supply chain integration	23.1%	66.2%	9.2%	1.5%	0.0%
Strategic issues	13.8%	73.8%	12.3%	0.0%	0.0%

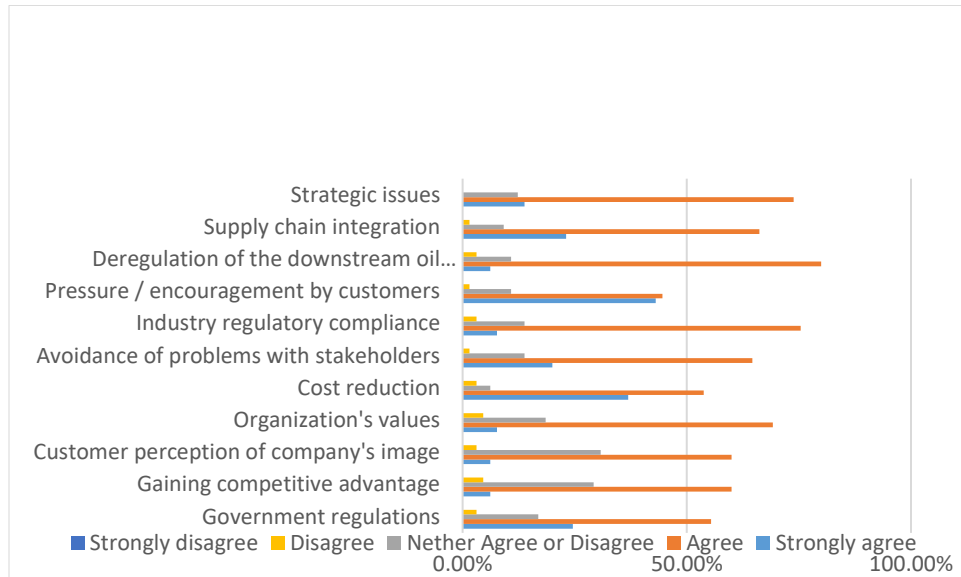


Figure 4. 17: supply chain risk management and its drivers

• Statistical Association

ANOVA has been applied to examine whether there are associations between drivers of supply chain risk management, specifically if there are statistically significant differences or not between responses at confidence level 95%, which was set to test this statement. The result (Table 4.28) shows that, P-value is lower than 0.05 (8.6E-10), which indicate an existing significant difference between drives.

Table 4. 27: ANOVA'S test for supply chain risk management drives.

Source of Variation	SS	df	MS	F	P-value	F critical
Between Groups	26.875	10	2.6875	6.5836	8.6E-10	1.84414
Within Groups	287.38	704	0.4082			
Total	314.26	714				

4.3.9 Compares the counts of categorical responses between independent responses.

In this research, the Chi Square distribution test has been used to find out the statistic differences between theoretically expected, observed frequencies and relationships between variables. It used to investigate whether distributions of categorical variables differ from one another.

4.3.9.1 Statistical association between type of organisation and Risk Management

To decide whether the difference between observed and expected values is actually significant through and to see if there is a significant association within type of organisation; material supplier, contractor, service provider, third party and owner/ end user have been shown in Table 4.28 as independent factor and risks of management, analysis/assessment mitigation and monitoring & control as dependent factor. In general, statistical association have been found at 11 of the whole total 38 cases (31.4%), with p-values were less than 0.05.

- **Type of Organisation & Risk Management**

To see if there is a significant association within type of organisation and risk management; risk identification, risk analyses/assessment, risk mitigation and risk monitoring and control are listed in Table 4.29. The results show that, the P-values are less than the significance level (0.05), at two of five cases that have been analysed. Significant associations have been found between type of organisation and risk analysis/assessment (0.026), and risk monitoring & control (0.028) (Table 4.29). Therefore, it is concluded that risk management such as analyses/assessment and risk monitoring are affected by type of organisation.

Table 4. 28: Values of the Chi-squared distribution of Type of organisation & risk management.

Type of organisation & Risk Management	P-value
Risk Identification	0.328
Risk Analyses/Assessment	0.026
Risk Mitigation	0.058
Risk Monitoring & Control	0.028

- **Type of organisation & Risk identification**

To see if there is a significant association within type of organisation and risk identification, Chi square test is applied. Results show that, the P-values are less than the significance level (0.05), at two of three cases that have been analysed (Table 4.30). A significant association have been found in one case between type of organisation and risk identification (0.037) we are constantly searching for short-term risks. Therefore, it is concluded that risk identification are affected by type of organisation.

Table 4. 29: Values of the Chi-squared distribution of type of organisation & risk identification

Type of organisation & risk identification	P-value
We are informed about possible risks	0.076
We are constantly searching for short-term risks	0.037
We define early warning indicators	0.105

- **Type of Organisation & Risk Analysis/Assessment**

To see if there is a significant association within type of organisation and risk analyses/assessment, Chi square test is used to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at three of five cases that have been analysed (Table 4.31). A significant association have been found between type of organisation and risk analysis/assessment. Look for the possible sources of supply risks (0.012). Analyse the possible impact of supply risks (0.050). Classify and prioritise our supply risks (0.010). Therefore, it is concluded that risk analysis/assessment are affected by type of organisation.

Table 4. 30: Values of the Chi-squared distribution of type of organisation & risk Analysis/assessment

Type of organisation & risk Analysis/assessment	P-value
Look for the possible sources of supply risks	0.012
Evaluate the probability of supply risks	0.162
Analyse the possible impact of supply risks.	0.050
Evaluate the urgency of our supply risks	0.120
Classify and prioritise our supply risks	0.010

- **Type of organisation & Risk Mitigation**

Chi-square test is used in order to see if there is a significant association within type of organisation and risk mitigation. As well as, to decide whether there is actually significant associations between observed and expected values. (Table 4.32) shows that, the P-values are less than the significance level (0.05), at three of five cases that have been analysed. Significant associations have been found between type of organisation and risk mitigation. Therefore, it is concluded that risk mitigation is affected by type of organisation.

Table 4. 31: Values of the Chi-squared distribution of type of organisation & Risk Mitigation

Type of organisation & Risk Mitigation	P-value
Demonstrate possible reaction strategies	0.016
Evaluate the effectiveness of reaction strategies	0.029
Supply Risk Management is an important activity in our company	0.006

- **Type of organisation & Risk Monitoring& Control**

Chi-square test was employed to see if there is a significant association within type of organisation and risk monitoring and to examine the significant difference between observed and expected values (Table 4.33). The results show that, the P-values are less than the significance level (0.05), at one of three cases that have been analysed

A significant association have been found between type of organisation and risk monitoring. Control our risk management methods in Procurement (0.048). Therefore, it is concluded that risk monitoring is affected by type of organisation.

Table 4. 32: Values of the Chi-squared distribution of type of organisation & Risk Monitoring

Type of organisation & Risk Monitoring	P-value
Control our risk management methods in Procurement	0.048
Control the progress for critical supply risks	0.070
Control our activities for identifying and analysing supply risks	0.175

- **Type of organisation & Risk Performance**

In order to see if there is a significant association within type of organisation and risk performance, Table 4.34. shows the results. The results show that, the P-values are less than the significance level (0.05), at two of four cases that have been analysed. A significant association have been found between type of organisation and risk performance. Therefore, it is concluded that risk performance is affected by type of organisation.

Table 4. 33: Values of the Chi-squared distribution of type of organisation & Risk Performance

Type of organisation & Risk Performance	P-value
Our employees are experienced in solving occurrence of supply risks	0.093
Our risk management processes in procurement are very professionally designed	0.035
We managed to minimise the frequency of occurrence of supply risks over the last three years	0.160
We managed to minimise the impact of occurrence of supply risks over the last three years	0.030

4.3.9.2Classify of organisation in size and Risk Management.

In order to decide whether the difference between observed and expected values is actually significant and if there is a significant association within classification of organisation in size; less than 50 employees, from 50 to 250 employees and higher than 250 employees have been shown in Tables below as independent factor and risks of management, identification registration analysis / assessment mitigation and monitoring & control as dependent factor. In general, statistical association, have been found at 18 of the whole total 35 cases (51.4%), with p-values were less than 0.05.

- **Classify of organisation in size & Risk Identification**

In order to see if there is a significant association within organisation size and risk identification; Table 4.35 shows the results. The results show that, the P-values are less than the significance

level (0.05), at three of four cases that have been analysed. A significant association have been found between size of organisation and risk Identification (0.000), and risk monitoring (0.039). Therefore, it is concluded that risk identification, and risk monitoring are affected by size of organisation.

Table 4. 34: Values of the Chi-squared distribution of organisation size & Risk Management

Classify of organisation in size & Risk Management	P-value
Risk Identification	0.000
Risk Analyses/Assessment	0.092
Risk Mitigation	0.307
Risk Monitoring & Control	0.039

- **Classify of organisation in size & Risk Identification**

In order to see if there is a significant association between size of organisation and risk identification, (Table 4.36). The results show that, the P-values are higher than the significance level (0.05), at the three cases that have been analysed. Therefore, it is concluded that the risk identification is not affected by size of organisation.

Table 4. 35: Values of the Chi-squared distribution of organisation in size & Risk Identification

Classify of organisation in size & Risk Identification	P-value
We are informed about possible risks	0.261
We are constantly searching for short-term risks	0.447
We define early warning indicators	0.344

- **Classify of organisation in size & Risk Analysis/Assessment**

To see if there is a significant association between size of organisation and risk analyses/assessment (Table 4.37) shows the results. Moreover, to decide whether the significant difference between observed and expected values is actually. The results show that, the P-values are less than the significance level (0.05), at one of five cases that have been analysed. A significant association have been found between type of organisation and risk

analysis/assessment (0.002). Therefore, it is concluded that risk analysis/assessment are affected by the organisation size.

Table 4. 36: Values of the Chi-squared distribution of organisation in size & risk analysis/assessment

Classify of organisation in size & risk analysis/assessment	P-value
Look for the possible sources of supply risks	0.138
Evaluate the probability of supply risks	0.002
Analyse the possible impact of supply risks.	0.205
Evaluate the urgency of our supply risks	0.205
Classify and prioritize our supply risks	0.086

- **Classify of organisation in size & Risk Mitigation**

In order to see if there is a significant association within organisation in size and risk mitigation, Table 4.38 shows the results. Moreover, to decide whether there is significant difference between observed and expected values. The results show that, the P-values are less than the significance level (0.05), at two of three cases that have been analysed. A significant association has been found between size of organisation and risk mitigation Therefore, it is concluded that risk mitigation is affected by organisation size.

Table 4. 37: Values of the Chi-squared distribution of organisation size & Risk Mitigation

Classify of organisation in size & Risk Mitigation	P-value
Demonstrate possible reaction strategies	0.028
Evaluate the effectiveness of reaction strategies	0.000
Supply Risk Management is an important activity in our company	0.326

- **Classify of organisation size & Risk Monitoring.**

To see if there is a significant association within organisation size and risk monitoring (Table 4.39) demonstrate the results. Moreover, to decide whether is there significance difference between observed and expected values. The results show that, the P-values are less than the significance

level (0.05), at the three cases that have been analysed. A significant association has been found between organisation size & Risk Monitoring. Therefore, it is concluded that Risk Monitoring is affected by organisation size.

Table 4. 38: Values of the Chi-squared distribution of organisation in size & Risk Monitoring

Classify of organisation in size & Risk Monitoring	P-value
Control our risk management methods in Procurement a	0.082
Control the progress for critical supply risks	0.003
Control our activities for identifying and analysing supply risks	0.040

- **Classify of organisation in size & Risk Performance**

In order to see if there is a significant association between organisation in size and risk performance (Table 4.40) shows the results. The results show that, the P-values are less than the significance level (0.05), at three of four cases that have been analysed. Significant associations have been found between organisation size & Risk Performance. Therefore, it is concluded that risk performance is affected by organisation in size

Table 4. 39: Values of the Chi-squared distribution of organisation in size & Risk Performance

Classify of organisation in size & Risk Performance	P-value
Our employees are experienced in solving occurrence of supply risks	0.031
Our risk management processes in procurement are very professionally designed	0.014
We managed to minimise the frequency of occurrence of supply risks over the last three years	0.040
managed to minimise the impact of occurrence of supply risks over the last three years	0.221

4.3.9.3 Years of practicing procurement equipment and Risks

In order to decide whether the difference between observed and expected values is actually significant through to see if there is a significant association within years have been practicing procurement equipment; less than 5 year, from 5 to 10 years, from 11 to 15 years, from 16 to 20 years and higher than 20 years have been shown in tables below as independent factor and risks

of management, identification registration analysis / assessment mitigation and monitoring & control as dependent factor. In general, statistical assessments have been found at 11 of the whole total 35 cases (31.4%), with p-values less than 0.05.

- **Years of practicing procurement equipment operations & Risk Management**

In order to see if there is a significant association between practicing equipment procurement and risk management (Table 4.41) shows the results. Also, to decide is there the significance difference between observed and expected values. The results show that none of the P-values are less than the significance level (0.05), at all the five cases that have been analysed (Table 4.41). A significant association have not been found between years practicing procurement equipment & Risk Management. Therefore, it is concluded that risk management are not affected practicing procurement equipment.

Table 4. 40: Values of the Chi-squared distribution of years of practicing procurement equipment& Risk Management

Years of practicing procurement equipment & Risk Management	P-value
Risk Identification	0.159
Risk Analyses/Assessment	0.280
Risk Mitigation	0.157
Risk Monitoring & Control	0.342

- **Years of practicing procurement equipment & Risk Identification**

In order to see if there is a significant association between years practicing procurement equipment and risk identification (Table 4.42) shows results. The results show that, the P-values are higher than the significance level (0.05), at all the three cases that have been analysed (Table 4.42). A significant association have not been found between years of practicing procurement equipment and risk identification. Therefore, it is concluded that risk identification is not affected by years practicing procurement equipment.

Table 4. 41: Values of the Chi-squared distribution of years of practicing procurement equipment & Risk Identification.

Years of practicing procurement equipment and risk identification	P-value
We are informed about possible risks	0.168
We are constantly searching for short-term risks	0.067
We define early warning indicators	0.127

- Years of practicing procurement equipment & Risk Analysis/Assessment**

In order to see if there is a significant association between Years have been practicing procurement equipment & Risk Analysis/Assessment and to decide if there is a statistically difference between observed and expected. The results show that, the P-values are less than the significance level (0.05), at three of five cases that have been analysed (Table 4.43). A significant association have been found between years have been practicing procurement equipment & Risk Analysis/Assessment. Therefore, it is concluded that Risk Analysis/Assessment have been affected by years practicing procurement equipment.

Table 4. 42: Values of the Chi-squared distribution of years of practicing procurement equipment & risk analysis/assessment

Years been practicing procurement & risk analysis	P-value
Look for the possible sources of supply risks	0.280
Evaluate the probability of supply risks	0.018
Analyse the possible impact of supply risks.	0.034
Evaluate the urgency of our supply risks	0.055
Classify and prioritise our supply risks	0.031

- Years of practicing procurement equipment & Risk Mitigation**

In order to see if there is a significant association within Years have been practicing procurement equipment & Risk Mitigation Table 4.44 shows the results and to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at one of three cases that have been analysed (Table 4.44). A significant association have been found between years have been practicing

procurement equipment and risk mitigation Therefore, it is concluded that Risk Mitigation is affected by years have been practicing procurement equipment.

Table 4. 43: Values of the Chi-squared distribution of years of practicing procurement equipment and risk mitigation.

Years of practicing procurement equipment & Risk Mitigation	P-value
Demonstrate possible reaction strategies	0.115
Evaluate the effectiveness of reaction strategies	0.167
Supply Risk Management is an important activity in our company	0.042

- **Years of practicing procurement equipment & Risk Monitoring.**

In order to see if there is a significant association within practicing procurement equipment & Risk Monitoring (Table 4.45) shows the result and to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are higher than the significance level (0.05), at all the three cases that have been analysed. A significant association have not been found between years practicing procurement equipment & risk Monitoring. Therefore, it is concluded that risk monitoring not affected by years practicing procurement equipment.

Table 4. 44: Values of the Chi-squared distribution of years of practicing procurement equipment and risk monitoring

Years of practicing procurement & Risk Monitoring	P-value
Control our risk management methods in Procurement a	0.590
Control the progress for critical supply risks	0.963
Control our activities for identifying and analysing supply risks	0.428

- **Years of practicing procurement equipment & Risk Performance**

In order to see if there is a significant association within years have been practicing procurement equipment & risk performance and to decide whether the difference between observed and expected values is actually significant (Table 4.46) shows the results. The results show that, the P-values are less than the significance level (0.05), at two of four cases that have been analysed. A significant association have been found between years have been practicing procurement

equipment & risk performance. Therefore, it is concluded that risk performance is affected by years been practicing procurement equipment.

Table 4. 45: Values of the Chi-squared distribution of years of practicing procurement equipment & Risk Performance

Years of practicing procurement equipment & Risk Performance	P-value
Our employees are experienced in solving occurrence of supply risks	0.463
Our risk management processes in procurement are very professionally designed	0.280
We managed to minimise the frequency of occurrence of supply risks over the last three years	0.021
managed to minimise the impact of occurrence of supply risks over the last three years	0.101

4.3.9.4 Value of procurement projects & Risk Management

In order to decide whether the difference between observed and expected values is actually significant through to see if there is a significant association within value of procurement projects you are authorised to execute or normally carry out; less than \$50,000, from \$51,000 to \$100,000 from \$101,000 to \$250,000 from \$251,000 to \$500,000 and higher than \$500,000 have been shown in Table 4.47 as independent factor and risks of management, identification ,analysis / assessment mitigation and monitoring & control as dependent factor. In general, statistical assassinations recorded the highest percentages been found at 19 of the whole total 35 cases (54.2%), with p-values were less than 0.05.

- **Value of procurement projects & Risk Management**

In order to see if there is a significant association between value of procurement projects and risk management illustrate the result and also to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at all the five cases that have been analysed (Table 4.47). A significant association have been found between value of procurement projects & risk management. Therefore, it is concluded that risk management is affected by value of procurement projects.

Table 4. 46: Values of the Chi-squared distribution for value of procurement projects & Risk Management

Value of procurement projects & Risk Management	P-value
Risk Identification	0.018
Risk Analyses/Assessment	0.025
Risk Mitigation	0.001
Risk Monitoring & Control	0.002

- **Value of procurement projects & Risk Identification**

In order to see if there is a significant association within value of procurement projects and risk identification (Table 4.48) shows the results and additionally to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at all three cases that have been analysed. A significant association have been found between Value of procurement projects and risk identification. Therefore, it is concluded that risk identification is affected by the value of procurement projects.

Table 4. 47: Values of the Chi-squared distribution for the value of procurement projects & Risk Identification

Value of procurement projects & Risk Identification	P-value
We are informed about possible risks	0.025
We are constantly searching for short-term risks	0.002
We define early warning indicators	0.000

- **Value of procurement projects & Risk Analysis/Assessment**

In order to see if there is a significant association within the value of procurement projects & risk analysis/assessment and to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at two of five cases that have been analysed (Table 4.49). A significant association have been found between Value of procurement projects & Risk Analysis/Assessment.

Therefore, it is concluded that risk analysis/assessment is affected by the value of procurement projects.

Table 4. 48: Values of the Chi-squared distribution for the Value of procurement projects & Risk Analysis/Assessment

Value of procurement projects & Risk Analysis/Assessment	P-value
Look for the possible sources of supply risks	0.155
Evaluate the probability of supply risks	0.000
Analyse the possible impact of supply risks.	0.075
Evaluate the urgency of our supply risks	0.000
Classify and prioritise our supply risks	0.052

- **Value of procurement projects & Risk Mitigation**

In order to see if there is a significant association within the value of procurement projects and risk mitigation and additionally, to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at all three cases that have been analysed (Table 4.50). A significant association have been found between Value of procurement projects and risk Mitigation. Therefore, it is concluded that risk mitigation is affected by the Value of procurement projects.

Table 4. 49: Values of the Chi-squared distribution for the value of procurement projects and risk mitigation

Value of procurement projects & Risk Mitigation	P-value
Demonstrate possible reaction strategies	0.034
Evaluate the effectiveness of reaction strategies	0.000
Supply Risk Management is an important activity in our company	0.000

- **Value of procurement projects & Risk Monitoring.**

In order to see if there is a significant association within the value of procurement projects & risk monitoring (Table 4.51) and also to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at all the three cases that have been analysed.

A significant association have been found between the value of procurement projects & risk monitoring. Therefore, it is concluded that risk monitoring is affected by the value of procurement projects.

Table 4. 50: Values of the Chi-squared distribution for the value of procurement projects & Risk Monitoring

Value of procurement projects & Risk Monitoring	P-value
Control our risk management methods in Procurement	0.000
Control the progress for critical supply risks	0.020
Control our activities for identifying and analysing supply risks	0.000

- **Value of procurement projects & Risk Performance**

In order to see if there is a significant association between the value of procurement projects and risk performance and to decide whether the difference between observed and expected values is actually significant. The results show that, the P-values are less than the significance level (0.05), at two of four cases that have been analysed (Table 4.52). A significant association have been found between the value of procurement projects & risk performance. Therefore, it is concluded that risk performance is affected by the value of procurement projects.

Table 4. 51: Values of the Chi-squared distribution for the value of procurement projects & Risk Performance

Value of procurement projects and risk performance	P-value
Our employees are experienced in solving occurrence of supply risks	0.297
Our risk management processes in procurement are very professionally designed	0.108
We managed to minimise the frequency of occurrence of supply risks over the last three years	0.015
Managed to minimise the impact of occurrence of supply risks over the last three years	0.029

4.4 Main findings of the questionnaire

This study mainly based on questionnaire and semi-structured interviews to achieve the objectives and main aims of the study.

A number of results and findings have been obtained and listed as following:

1. 58.5% of managers who respond to the questionnaire are managers from service provider companies where they are the main focus of this research.

2. 47% of the respondents were operate locally (in Libya).
3. A 41.5% response are having the lowest number of employees (<50),
4. 58% of the respondents have 11 to 15 years working experience, 9.2% with 6-10 years' experience and 10.8% with less than 5 years.
5. 60% of the respondents certify ISO, were 38.5% do not have.
6. The result shows that, P-value is lower than 0.05 (0.041), which indicate that significant differences is exist within the practice of risk management.
7. The result shows that, P-value is lower than 0.05 (0.00), which indicate an existing significant differences within the variables at agreement to the advantage of outsourcing, agreement to the benefits of using risk management, agreement to the risks often occur during procurement processes, agreement to the risks occur during procurement implementation and agreement to the issues is drivers of supply chain risk management in company
8. A significant association have been found between type of organisation and risk analysis/assessment (0.026), and risk monitoring & control (0.028); (Table 4.28). Therefore, it is concluded that risk management and risk monitoring are affected by type of organisation.
9. A significant association have been found in one case between type of organisation and risk identification (0.037) we are constantly searching for short-term risks. Therefore, it is concluded that risk identification is affected by type of organisation
10. A significant association have been found between type of organisation and risk analysis/assessment. Look for the possible sources of supply risks (0.012). Analyse the possible impact of supply risks (0.050). Classify and prioritise our supply risks (0.010); (Table 4.30). Therefore, it is concluded that risk Analysis/assessment are affected by type of organisation.
11. A significant association have been found between type of organisation and risk mitigation; (Table 4.31). Therefore, it is concluded that risk mitigation are affected by type of organisation

12. A significant association have been found between type of organisation and risk monitoring (0.048). Therefore, it is concluded that risk monitoring are affected by type of organisation.
13. A significant association have been found between type of organisation and risk performance. Therefore, it is concluded that risk performance is affected by type of organisation.
14. A significant association have been found between size of organisation and risk Identification (0.000), risk registration (0.000) and risk monitoring (0.039). Therefore, it is concluded that risk identification, risk registration and risk monitoring are affected by size of organisation.
15. The results show that, the P-values are higher than the significance level (0.05), at the three cases that have been analysed. Therefore, it is concluded that the risk identification is not affected by size of organisation.
16. A significant association have been found between type of organisation and risk analysis/assessment (0.002). Therefore, it is concluded that risk analysis/assessment are affected by the type of the organisation.
17. A significant association have been found between organisation size & both of risk monitoring and risk performance therefore, it is concluded that risk monitoring and risk performance are affected by organisation size.
18. A significant association have not been found between years practicing procurement equipment & Risk Management, risk identification& risk Monitoring. Therefore, it is concluded that risk management, risk identification& risk Monitoring are not affected by number of years practicing procurement equipment.
19. A significant association have been found between years have been practicing procurement equipment & Risk Analysis/Assessment, risk mitigation & risk performance. Therefore, it is concluded that Risk Analysis/Assessment & risk performance and risk mitigation have been affected by years practicing material procurement.
20. A significant association have been found between the value of procurement projects & risk management, risk identification, risk analysis/assessment, risk Mitigation, risk monitoring and risk performance. Therefore, it is concluded that risk identification, risk

analysis/assessment, risk mitigation, risk monitoring and risk performance are affected by the value of procurement projects.

4.5 Discussion and Conclusion

The findings of the current research based on results and statistical data generated from the designed questionnaires and the responses is discussed.

Among the respondents to the questionnaire, 58.5% of them were contractor/ service provider managers. This carries majority of the whole representation of the type of organisation compared to 55.4% and 29.2% for owner/end user and material supplier respectively. 47.7% of these respondents operate their business in Libya while the rest have business located abroad . Although, 38.5% of Libya companies are located abroad, the main focus are those that have business operation in Libya.

The employees' numbers of less than 50 of these companies carries 41.5% of the total categories including 41.5% for employees higher than 250 and 16.9% for employees between 50 and 250.

In terms of working experience in the oil industry, 58.8% of the respondents have 11 to 15 years of working experience, which represent the majority of the entire respondents, with over 21 years of experience having the lowest at 3.1%. In table 4.7, the question about ISO certification is represented. Two third of the respondent companies are ISO certified, and 38.5% were not certified while 1.5% of them do not know. From the analysis of the risk management practice the result of the P-value is lower than 0.05(0.041), which indicates significant differences existing within the practice of risk management. Also, P-value result lower than 0.05 (0.00) reveals existing significant differences within the variables at agreement to the advantage of outsourcing agreement to the benefits of using risk management, agreement to the risks often occur during procurement processes, agreement to the risks occur during procurement implementation and agreement to the issues is drivers of supply chain risk management in company.

A significant association have been found between type of organisation and risk analysis/assessment (0.026), and risk monitoring & control (0.028); (Table 4.28). Therefore, it is concluded that risk management and risk monitoring are affected by type of organisation.

A significant association have been found in one case between type of organisation and risk identification (0.037) we are constantly searching for short-term risks. Therefore, it is concluded that risk identification is affected by type of organisation

A significant association have been found between type of organisation and risk analysis/assessment. Look for the possible sources of supply risks (0.012). Analyse the possible impact of supply risks (0.050). Classify and prioritise our supply risks (0.010); (Table 4.30). Therefore, it is concluded that risk Analysis/assessment are affected by type of organisation.

A significant association have been found between type of organisation and risk mitigation; (Table 4.31). Therefore, it is concluded that risk mitigation are affected by type of organisation

A significant association have been found between type of organisation and risk monitoring (0.048). Therefore, it is concluded that risk monitoring are affected by type of organisation.

A significant association have been found between type of organisation and risk performance. Therefore, it is concluded that risk performance is affected by type of organisation.

A significant association have been found between size of organisation and risk Identification (0.000), and risk monitoring (0.039). Therefore, it is concluded that risk identification, and risk monitoring are affected by size of organisation.

The results show that, the P-values are higher than the significance level (0.05), at the three cases that have been analysed. Therefore, it is concluded that the risk identification is not affected by size of organisation.

A significant association have been found between type of organisation and risk analysis/assessment (0.002). Therefore, it is concluded that risk analysis/assessment are affected by the type of the organisation.

A significant association have been found between organisation size & both of risk monitoring and risk performance therefore, it is concluded that risk monitoring and risk performance are affected by organisation size.

A significant association have not been found between years practicing procurement equipment & Risk Management, risk identification& risk Monitoring. Therefore, it is concluded that risk management, risk identification& risk Monitoring are not affected by number of years practicing procurement equipment.

A significant association have been found between years have been practicing procurement equipment & Risk Analysis/Assessment, risk mitigation & risk performance. Therefore, it is concluded that Risk Analysis/Assessment & risk performance and risk mitigation have been affected by years practicing material procurement.

A significant association have been found between the value of procurement projects & risk management, risk identification, risk analysis/assessment, risk Mitigation, risk monitoring and risk performance. Therefore, it is concluded that risk identification, risk analysis/assessment, risk mitigation, risk monitoring and risk performance are affected by the value of procurement projects.

4.6 Summary

This chapter present respondents' statistical analysis that will help in identify the patterns of risks between the main independent variables that disturb procurement process and supply chain management. This based on associations and relationships between variables. Stockburger (1998) confirms that regression models are powerful tools for predicting a dependent variable based on independent variables. This information relies on the analysis of relationships between the main variables that explain the influence of the various factors especially from the end-user or service provider point view of the Libyan oil material managers. Moreover, the finding of this chapter, should fulfil the first aim of this research. To complement the questionnaire findings, next chapter (5) will provide and analyse data been collected as semi-structural interviews conducted by 9 procurement managers.

Chapter Five: Interview Analysis and Results

5.1 Introduction

This chapter presents the analysis of the qualitative data obtained from in-depth semi-structured interviews designed for the research questions. The rationale for choosing in-depth semi-structured interviews as data collection instrument was presented in the methodology (chapter 4).

5.1.1 Administration of case research interviews

The research interviews were conducted with nine managers involved in procurement management within their organisation. The time of each interviewee and position is detailed in the Table 5.1. These interviews covered risk identification and allowed the interviewer to clarify the most frequent and threatening risks in the procurement operations.

Due to lack of direct physical access to the interviewees, this interview was conducted via phone call and Skype between April and June 2016. During the interviews, notes were taken to record the expected risks, and appropriate permissions was obtained in order to conduct audio or film recording. Following the interviews, the risk register (created from those interviews) was sent to the interviewees to get their final feedback about the risks identified (Davis 2007).

Average duration for the interviews was 30:34 min. The researcher provided the interview questions to the interviewees in advance so that they could prepare their answers. After the interviews, interviewees were asked to send archival documents and data that can present the risk management structures of their companies.

A copy of the semi-structural interview documents is attached in Appendices 2-A & 2-B.

5.1.2 Sampling for case research interview:

The interview began with questions regarding general information of the important risks that interviewees frequently face, and then moved on to questions about the impact of these risks and how they can be reduced. This section is to stimulate the interviewees to think about risks within their operations as well as their reactions. In the second phase of the interview, they were requested to explain the risk management strategies and practices. The third part was dedicated to evaluating the outcome and performance of the procurement team. (Table 5.1)

End user and service provider companies with large size in terms of number of employees were considered. The size of a company is associated with the extent to which it invests financial and

human resources in risk management, which may lead to different approaches to risk management. In consideration of these factors, twelve service provider companies were selected for interview. For the case research interviews, procurement managers in each company were contacted via email/skype with an invitation letter (Appendices 2-A) enclosing the interview questions and the interview consent form (Appendices 2-B).

Eventually, 9 interviewees from 12 agreed to participate in the interview. All interviewees have minimum work experience of 6 years.

Table 5.2 shows participants with time duration for each interview.

Table 5. 1: Interview Questions

Interview Questions

General Risk Profiles

- What are the challenging risks you most frequently face during the procurement process? Why are they the most important ones?
- Is there any reason why these risks appear frequently?
- What are the impacts, likelihood and predictability of these risks?
- Can these risks be reduced/managed?

Determinants of the Strategies

- Do you use any system for documenting incidents i.e. tools, software or contingency plans to monitor or mitigate the consequences of these risks?

Outcome of the Strategies

- Are you satisfied regarding the performance of your procurement team in terms of managing/mitigating risks? Can this performance be increased through training?

Table 5. 2: shows the time and position of each Interviewee.

No	Participants	Time	Position
1	MN1	30.54	Manager
2	MN2	30.33	Manager
3	MN3	30.58	Manager
4	MN4	30.10	Manager
5	MN5	30.25	Manager
6	MN6	30.50	Manager
7	MN7	30.53	Manager
8	MN8	30.50	Manager
9	MN9	30.55	Manager
Average		30.34	

5.2. Analysis of the participants' Interviews

In the qualitative analysis part of this research, the NVivo software package version 11 for Windows was used for data analysis due to its advantages, see Figure 5.1. One of the advantages of using the NVivo software is its facility to decrease the problem of 'drowning in data' by allowing data to be separated into sub-subjects and categories, which provide a simpler structure for discovering emergent themes (Rowe 2007). The responses of the nine respondents captured through the semi-structured interviews were transcribed, and then the themes were carefully selected and coded. The coded themes with its findings from interviewees were then grouped into different families in tree nodes and graphically presented as networks of relationships (Figure 5.1).

Name	Sources	References	Created	Created By	Modified	Modified By
Challenging and Risks during procurement	0	0	12/08/2016	LARADI	12/08/2016	LARADI
Clone Part	7	8	12/08/2016	LARADI	13/08/2016	LARADI
Delay	8	8	12/08/2016	LARADI	13/08/2016	LARADI
Oil Fluctuation Price	3	4	12/08/2016	LARADI	13/08/2016	LARADI
Security	1	1	12/08/2016	LARADI	13/08/2016	LARADI
Product discrepancy	1	1	12/08/2016	LARADI	12/08/2016	LARADI
Reason for risks appear frequently	0	0	12/08/2016	LARADI	12/08/2016	LARADI
Hard to identify clone (Experience)	7	7	12/08/2016	LARADI	13/08/2016	LARADI
No control on the oil market price	1	1	12/08/2016	LARADI	13/08/2016	LARADI
Goods Transhipment	3	3	12/08/2016	LARADI	13/08/2016	LARADI
Impact of the risks	0	0	12/08/2016	LARADI	12/08/2016	LARADI
Problems to the machine	6	6	12/08/2016	LARADI	13/08/2016	LARADI
Penalties	6	6	12/08/2016	LARADI	13/08/2016	LARADI
Cancel projects	1	1	12/08/2016	LARADI	13/08/2016	LARADI
Reduced risks and managed	0	0	12/08/2016	LARADI	12/08/2016	LARADI
Select supplier	6	6	12/08/2016	LARADI	13/08/2016	LARADI
Clear required specifications to supplier	4	4	12/08/2016	LARADI	13/08/2016	LARADI
Original parts	6	6	12/08/2016	LARADI	13/08/2016	LARADI
Add budget	1	1	12/08/2016	LARADI	13/08/2016	LARADI
Expertise	5	5	12/08/2016	LARADI	13/08/2016	LARADI
Monitoring system	0	0	12/08/2016	LARADI	12/08/2016	LARADI
Record for supplier's performance (Form)	9	9	12/08/2016	LARADI	13/08/2016	LARADI

Figure 5. 1:NVivo Screen-shot of tree nodes

5.3 Interview Findings

This section presents the findings from the interview, revealed the challenges and risk during procurement processes. It also analyses and discusses the outcome of the interview from findings.

5.3.1 Challenging and Risks during procurement

The questions posed to the interviewees were open ended, for example, *“What are the challenging risks you most frequently facing during the procurement process? Why they are the most important ones?”* Most of the interviewees mention Oil Fluctuation Price, Product Discrepancy, Security, Clone Part, and Delay as the most challenging risks that they frequently face during the procurement process (Figure 5.2). In case of Clone Part, the majority (89%, 8Nr) mentioned this risk when they responded to this question and they cited why it is the most important one. One of interviewees (Interviewee MN1, and sample of interviewee transcript in Figure 5.2) stated that a clone part is very crucial, because installing clone parts will damage our drilling machines, causing delay in the project management schedule. He provided more explanation for that”...*And because the global market contains various levels of quality standards, therefore quality as original parts is our top priority; this is the most challenging risk we frequently face*”. Interviewee MN2, add the same point to the risks that mentioned in his answer of this

questions as he stated: “...Another risk we facing is specifically with our suppliers who by mistake supply unoriginal parts or equipment (clones), this issue can harm our project timetable, hence identifying clone parts is important to prevent such delay”. Moreover, interviewees MN8 and MN9 have the same opinion about the clone part which can harm their project timetable, as one of those respondents mentioned that the crucial risk they face is specifically with the suppliers who unintentionally supply unoriginal parts or equipment (clone), this is due to the wide number of manufacturers in the world market with identical specifications to originals. These clone parts cause failure to machines which disturbs project timetables (MN8).

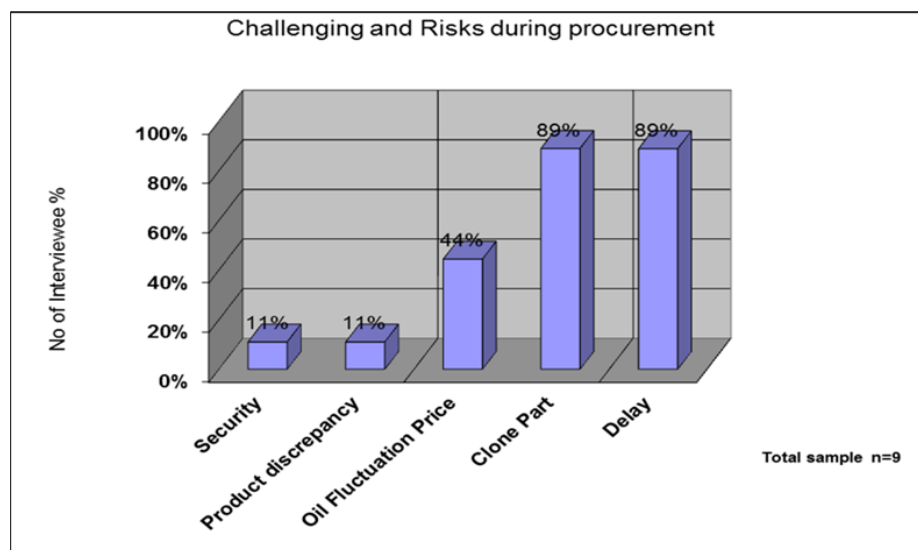


Figure 5. 2: The Challenging and risks found in the interview during procurement.

Even more, interviewee MN7 linked clone part and a delay of project timetable as causing penalties on the company as he specified:

“...more risk we facing is specifically with our suppliers who by mistake supply unoriginal parts or equipment (clone), this issue can harm our equipment’s hence delay our project timetable and breach the contract with the owner causing penalty, hence identifying clone parts is important to prevent these consequences”.

Oil Price Fluctuation is considered one of the most challenging risks that they frequently face during the procurement process, as three sources of interviewees and four references as interviewee MN7 referred twice to this risk (44%, 4Nr).

Interviewee MN2 mentioned that and explained why it is the most important one as he stated that: *“As end users, few risks can harm our businesses, for example oil price fluctuation can reduce or even cancel plans or potential projects that the owner intends to execute. Cancellation of projects due to budget overspending will obviously reduce the number of contracts with owner.”*

Interviewee MN7 has the same point of view with Interviewee MN9, as Interviewee MN7 mentioned that from his experience, “As exploration and drilling company executing projects to the national oil corporation (NOC) the owner, many risks can harm our business”. He adds and gave example of that:

“...for example, oil market price fluctuation can reduce or even cancel plans or potential projects that the owner intends to execute. Cancellation of projects due to budget overspending will obviously reduce number of contracts with owner”.

In case of delay, majority of respondents (88.9%, 8Nr) mention this theme as one of the challenging risks that they most frequently face during the procurement process, and provided explanation on why it is the most important one.

In this context, MN3 provide an explanation in details and gave example of the issues of delays as stated:

“In general, there are tens of risks that can harm the procurement process in different ways, however from my personal experience some of them can be classified as low risk which does not affect the core of the project timetable. For example, a supplier who fails to provide a product on time. This can be overcome using dual suppliers and switching to another supplier immediately; this technique will prevent any delay affecting time scale”

Interviewees MN4 and MN5 have the same attitude about this theme, as they mentioned that the most frequent risks that their companies are facing during the procurement process is the delay of receiving required parts or equipment. Delay of receiving parts or equipment from suppliers, can affect negatively the project timetable This delay may cause penalty to be paid to owner.

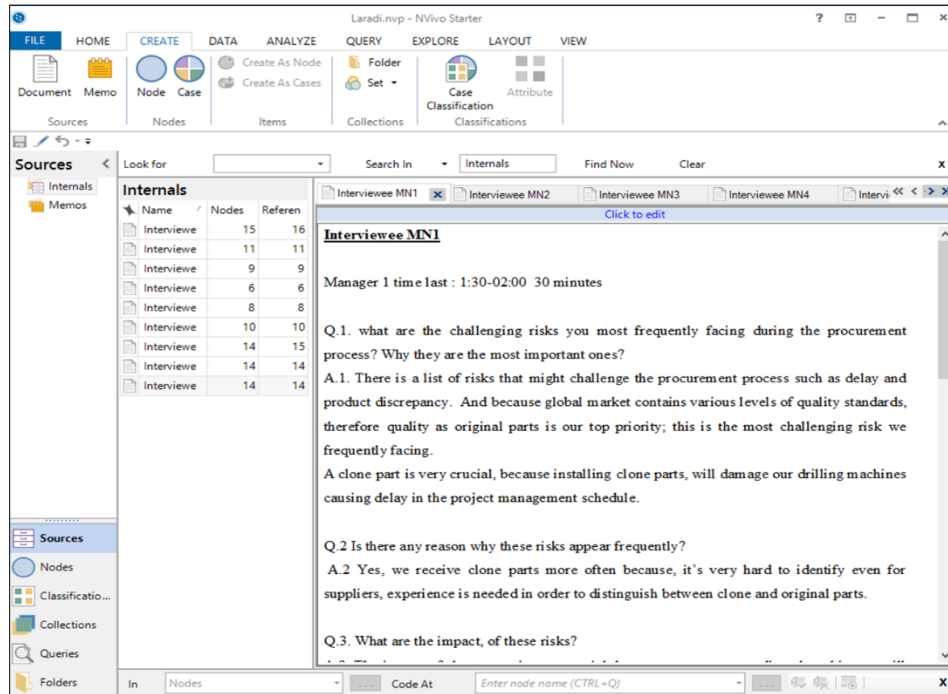


Figure 5. 3:: Nvivo sample of interviewee's transcript.

The respondent MN8 linked risk and timetable and penalties, and stated when he answers the question:

“As a drilling company having a contract with the owner (NOC), our time table is very tight and any delay may cause a penalty”.

Only one interviewee (11%, 1Nr) referred to security issues as the most challenging risk that he frequently faces during the procurement process, as interviewee MN8 stated that when he answered the question:

“Most frequent risk is related to security, we've been in many occasions were our equipment been stolen, however we minimise this issue by strengthen security guards around field.”

Even more, only one interviewee (MN1, 11%, 1Nr) mentioned that there is a list of risks that might challenge the procurement process such as delay and product discrepancy.

5.3.2 Reason for risks appear frequently

The question posed to the interviewees from were open ended *“Is there any reason why these risks appear frequently?”*

Most of the interviewee's answers cover the points that are: hard to identify clone, Goods Transshipment, and No control on the oil market price are the reasons why the risks appear frequently. Figure 5.2 shows the percentage of the reasons for risks that appear frequently.

In case of hard to identify clone, the majority of interviewees (78%, 7Nr) consider this risk amongst the most important factor for risks appear frequently.

Interviewee MN1 when he responded to this question said “yes”. He said that they receive clone parts more often because it's very hard to identify even for suppliers. He mentioned the need for experience and knowledge to distinguish between clone and original parts.

According to MN3 who assigns that to open market and competition between manufacturers and explain in details the situation as he stated:

“With the open market and competitions between manufacturers, some of them manufacture clone parts which is similar to original ones but with a lower quality and price. These parts are difficult to identify and distinguish them from original ones, and suppliers may intentionally provide them as original parts. For these reasons, clone part problems appear frequently”

Even more, interviewees MN6, MN7, MN8 and MN9 have the same point of view about clone parts which cannot be easily identified even by the supplier. This is due to the similarity of the products to original ones, and that's why these types of risks appear frequently. All of them agree that experience is needed in order to distinguish between clone and original parts. Experience is also needed in the open market, as lots of manufacturers claim they are original parts makers.

In the same context, three interviewees (33%, 3Nr) count that the risk of goods transshipment is one amongst the most risks appears frequently. MN4 and MN5 have the same attitude about it, as they mentioned that the reason for the delay is the supplier's responsibility, and usually because of the transshipment of the goods and changing ports.

Interviewee MN6 has the same opinion and from his experience in the field, he stated that by saying:

“Some risks cannot be controlled by the supplier, as they outsource some of their operations such as logistics by hiring freight forward companies to carry out the delivery process on their behalf. This makes it difficult for the supplier to fulfil their commitment regarding the delivery.”

Only one respondent (interviewee MN2, 11%, 1Nr) referred to this risk. He mentioned that they have no control on the oil market price and they take these issues as serious in their meetings as indicated:

” Regarding the market fluctuation, we have no control on the oil market price; however, in our proposal to the owner we consider this financial risk by adding margin to the total budget of the project to protect ourselves from this fluctuation.”

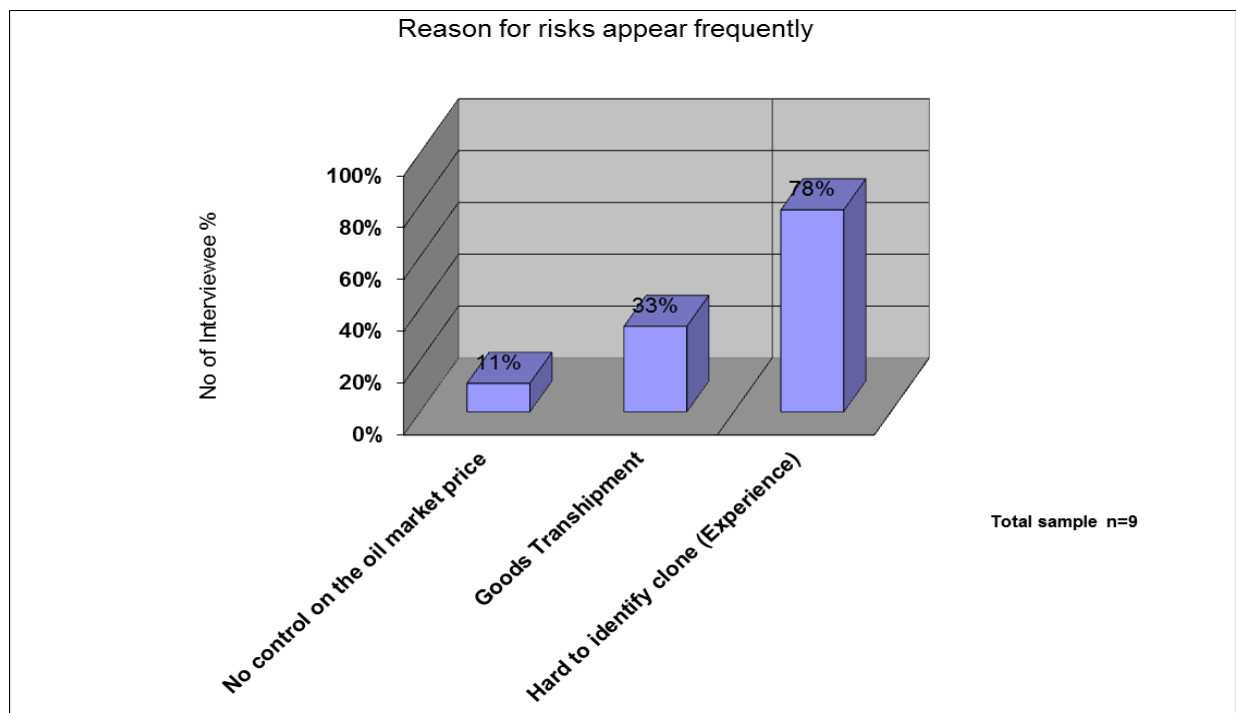


Figure 5. 4:: the reasons for risks appear frequently

5.3.3 Impact of the risks

The question posed to the interviewees were open-ended “*What are the impacts of these risks?*”

Most of the interviewee’s answers count the points that are Penalties, Problems to the machine, and Cancel projects as the impact points of these risks. Figure 5.5 shows the impact of the risks during the procurement.

The majority of interviewees (67%, 6Nr) cited that Penalties are one of the impact points of these risks, as one interviewee (MN1) mentioned it among other impacts. He refers to the clone parts which cause major problems to the machine, that led to project delay and result of that paying penalties to the field owner, he explained that when responding to the question as stated:

“The impact of clone parts is very crucial, because no one can predict when this part will fail causing major problems to the machine, causing project delay and paying penalties to the field owner.”

In the same context, another interviewee (MN”) had the same opinion as he declared that the delay may cause penalty to be paid to owner and also extra cost on maintenance.

However, interviewees MN4 and MN5 have the same opinion about delay penalties as MN5 indicated that “Delay of receiving parts or equipment can negatively affect the project timetable, and with our company as a service provider, we have to finish the job according to the contract being agreed with the owner, otherwise a heavy penalty should be paid by our company”.

Moreover, interviewee MN8 pointed out Security and Clone parts as they should take priority in this issue:

“Security and clone parts should be in highest priority as it can disrupt project time table, hence paying delay penalty to owner which obviously harms our reputation and record as a service provider.”

Another impact of risks as mentioned by many respondents (67%, 6Nr) is Problems to the machine, as interviewee MN4 talked about Procurement of unoriginal parts and how it impacts the machine: “Procurement of unoriginal parts or clone parts can cause crucial loss. If these parts

are installed to a machine, this machine can be defected any time by this clone part causing general failure to the machine and stopping it from completing the job”.

In the same manner, interviewee MN7 agrees with interviewee MN9 about the risks that affect the machines and have the same opinion in this subject, as he stated:

“The impact of clone parts is crucial, because no one can predict when this part will fail causing major problem to the machine causing project delay and paying penalties to the field owner.”

Interviewee MN2 has the same attitude as he stressed that it is a crucial problem, especially regarding cloning unoriginal parts. He adds “...Clone parts can harm equipment during operation causing project delay.”

In this context only previous mentioned interviewee (MN2) warned from cancelation of the projects because of the instability of oil price, as he stated:

“Oil price fluctuation may force the owner to reduce or even cancel their projects; this will limit our business opportunities with this owner.”

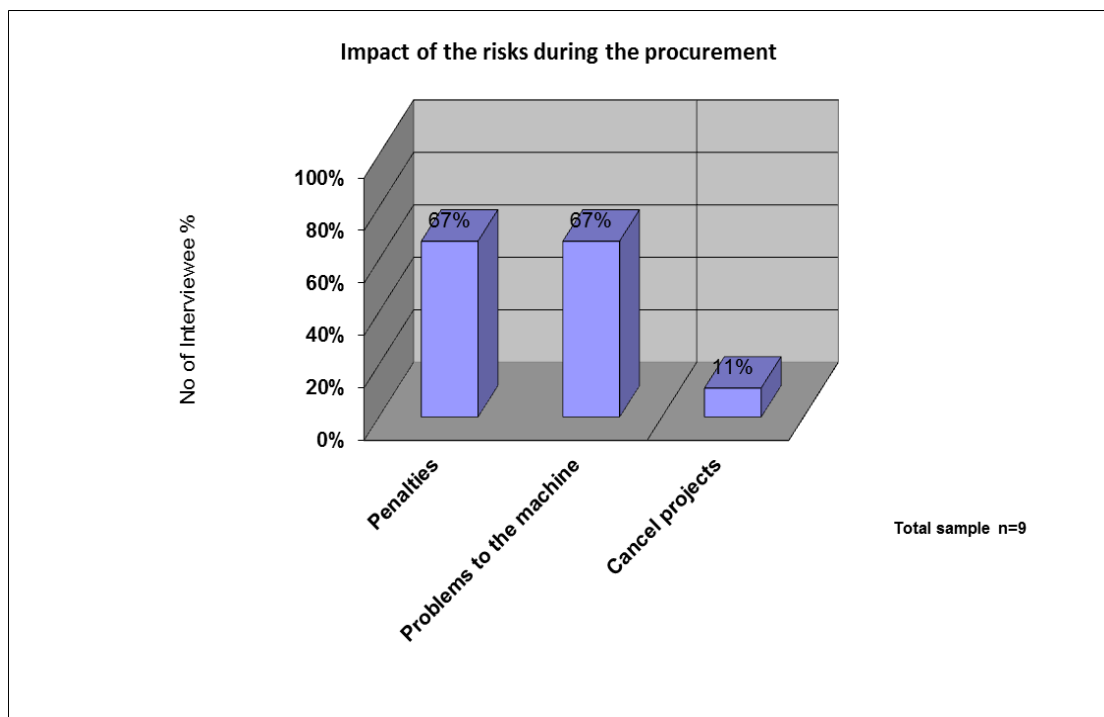


Figure 5. 5: impact of the risks during the procurement

5.3.4 Reduced and managed the risks

The question posed to the interviewees was open-ended *“Can these risks be reduced / managed?”*

Most of the interviewee's answers considered the themes that are Add budget, clear required specifications to supplier, Expertise, select supplier and Original parts as the best ways to reduce and manage risks. Figure 5.6 shows the Interviewees' answers on how to reduce and manage risks.

Most of the respondents (67%, 6Nr) declared that providing original parts is one of best approaches to reducing risks. Interviewee MN1 stated that the supplier should be held responsible for that as he mentioned “...the contract should clearly indicate that providing original parts is the supplier's responsibility; clone parts are not acceptable and should be returned to supplier.” This answer matched with those of Interviewee MN7 and interviewee MN8.

In the same context, interviewee MN3 said reducing risks is not an easy task. But in his answer, he specified the procedure on how to reduce and manage risks.

“...it needs execution of various phases starting from identifying the risk then analysing it and evaluating. Mitigation and monitoring continue during all these phases. It continues process, meanwhile procurement of unoriginal parts is a serious problem, causing unpredictable failure to machines”.

In the case of selecting suppliers as one way to reduce and manage risks, interviewees MN1, MN7, MN8 and MN9 have the same point of view as MN9 mentioned in this situation “So, in order to reduce risks few precautions can be considered such as: Suppliers should be carefully selected based on their proficiency and reliability”

However, interviewee MN5 has the same attitude in different way in this point, as he explained in details the situation:

“Selecting the right supplier is a key issue in minimizing the delay, however most suppliers cannot control logistic process, because they hire freight forwarders to perform the delivery. In general, selecting the right supplier based on their previous record and performance should limit the potential risk.”

Five interviewees (56%, Nr5) declared that managing risks is a quite difficult task, and four of them said this because it depends on many factors such as procurement team performance that is based on experience. In the same manner, interviewee six from his experience explains in detail the steps that should be taken to manage risks as he said it is a strategic issue that needs planning, monitoring, and analysis of the data:

“Managing risks is a strategic issue that requires information in order to minimise risk. It starts with monitoring the procurement process and identifying the risk associated with it, assisting and analysing information, then finding a way to mitigate it. In our case minimizing the risk of having clone parts is a very difficult task. This is due to the similarity of these parts with original ones, therefore managing this risk require lots of effort and expertise.”

Stating required specifications to suppliers is considered one of the ways we can reduce and manage risks (44%, 4Nr). In this context, interviewee MN1, interviewee MN7, interviewee MN8, and interviewee MN9 have the same point of view, as all those four respondents affirm that the required specifications have to be stated clearly to suppliers.

In case of add budget, only interviewee MN2 mentioned it regarding to market fluctuation in oil price. They have not controlled the oil price and he mentioned this tactical solution they used sometimes previously:

“Regarding oil market price, as mentioned previously, we have no control on the oil price market and market fluctuation, however sometimes our teams are able to mitigate its consequences by adding certain margins to protect the project budget from unpredicted spending.”

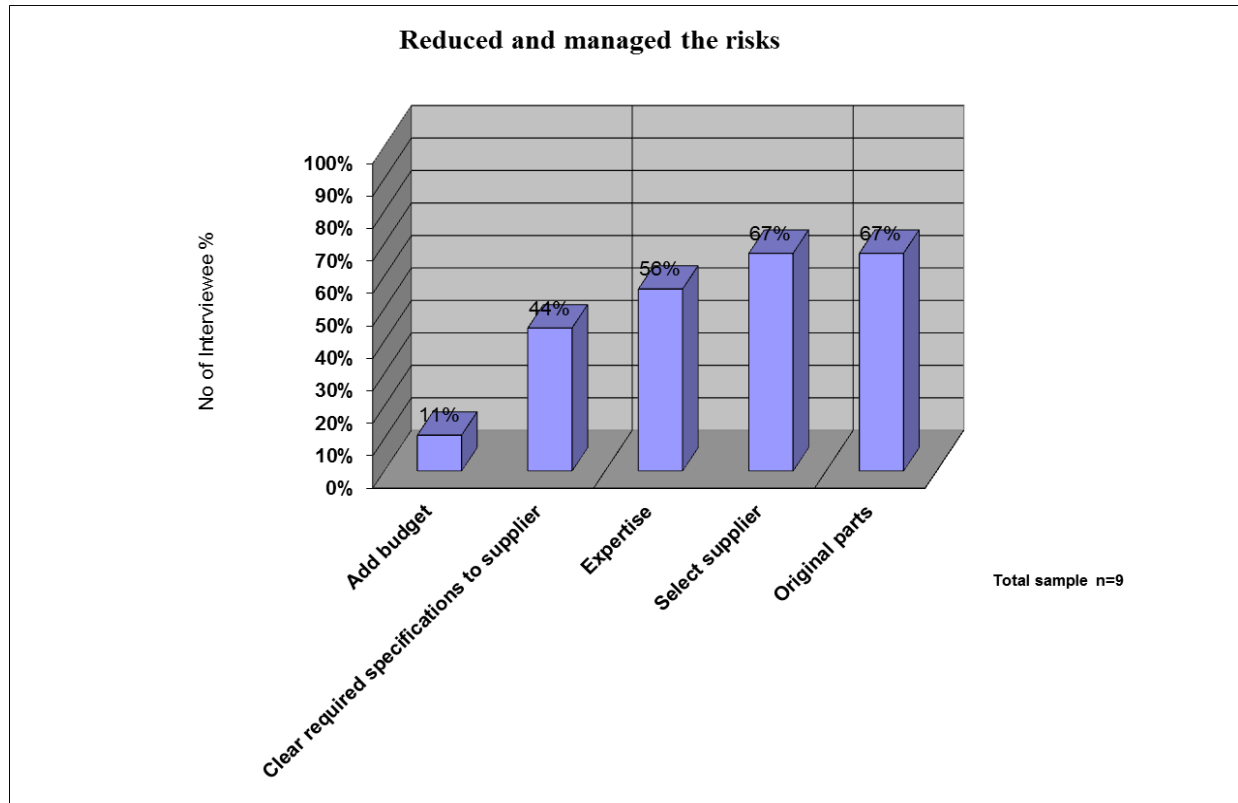


Figure 5. 6: the Interviewee's answer on how to reduce and manage the risks

5.3.5 Monitoring system

The question posed to the interviewees from were open ended *“Do you use any system for documenting incidents, tools, software or contingency plans to monitor or mitigate the consequences of these risks?”*

All the respondents answer that they use any system for documenting incidents, tools, software or contingency plans to monitor or mitigate the consequences of these risks. In their answers consider three main methods to which is Procurement guide book, Follow manufactures product, and Record for supplier's performance (Form). Figure 5.6 shows percentage of this ways to monitoring the risks

All interviewees (100%, 9Nr) declare that they have use record for supplier's performance (Form). In this regards, interviewees MN4 and MN5 have the same attitude about this issues as MN5 said Yes they have a monitoring system for risks they faces:

“Yes, we keep records for all suppliers we deal with in a database to evaluate and classify suppliers based on their reliability and performance.”

Moreover, interviewee MN3 stated from his point of view that his company works with forms to evaluate and classify suppliers:

“In our company, we use forms that evaluate our suppliers; we classify them as class A, B, or C in order of reliability. These forms help us in evaluating reliable suppliers based on their previous records.”

In the same manner, four interviewees (interviewee MN1, interviewee MN7, interviewee MN8, and interviewee MN9) have same beliefs, as they declared that they monitor and record the supplier’s performances then rank their reliability accordingly.

According to interviewee MN2, who has the same opinion with the previous ones, he insists for re-evaluation of the supplier’s reliability and proficiency

“Yes, we use previous procurement projects data to indicate incidents especially with supplier’s performance to re-evaluate their reliability and proficiency.”

Even more, interviewee MN6 when answering the related question, talked about the documentation of incidents and tools that are used in his department and how they are dealing with, monitoring or mitigating the consequences of these risks.

“Yes, our procurement department keeps a list of our suppliers with their performance ability. These records help selecting the right supplier based on their previous reliability and performance. These records (attached) are very important tools in minimising and mitigating risks.”

In regards to follow manufacturer’s product, this technique for monitoring or mitigating the consequences of these risks that are being faced was mentioned by four interviewees (44%, 4Nr), as all agree that they encourage the procurement team to follow manufacturer’s products and updates.

In this context, only one interviewee (MN2, 11%, 1Nr) has the same attitude that they use previous procurement data projects to indicate incidents especially with supplier’s performance in order to

re-evaluate their reliability and proficiency. He adds that they use a special book “...*We also use procurement guide book.*”

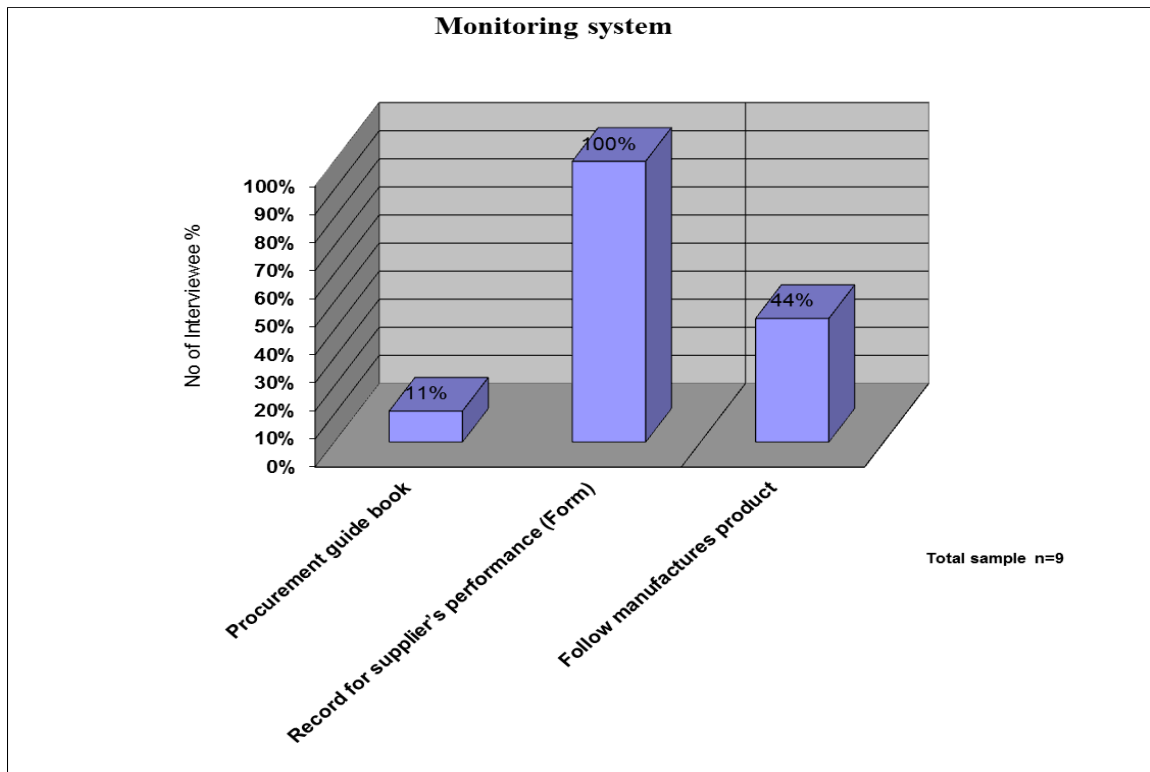


Figure 5. 7:the way to monitoring the risks

5.3.6 Satisfaction on procurement's team and increase performance

The questions posed to the interviewees were open-ended “*Are you satisfied regarding the performance of your procurement team in terms of managing/mitigating risks? Can this performance be increased (i.e. Training?)*”

All answers of interviewees were satisfied on performance of procurement teams, but all of them suggested different methods on how they increase performance. Some of which include: Planning, Communication and Cooperation, Analysis of data, Experience, and Training (Figure 5.7).

The majority (78%, 7Nr) consider training as the most important tool to increase performance of the procurement team.

In this theme, interviewee MN3 answer was satisfied about the performance of his company's procurement team and their plan mitigate the consequences of facing any risk, and he suggests more training to increase this performance:

"Yes, I am satisfied about our team performance. They always plan to mitigate the consequences of any risk that might affect our job. Continuous training with experience will increase our ability to manage and mitigate our risks."

Interviewee MN1 included training amongst other mentioned points he stated

"There is always room for increasing the performance in risk management by providing constant training, continuous communication and cooperation with suppliers, analysing records and data. All these procedures will help predict potential risks and enhance the performance of our team".

Interviewees MN7, MN8, and MN9 have the same opinion as MN1 which is that the provision of constant training will help predict potential risks and enhance the performance of the procurement team.

Moreover, interviewee MN5 mentioned that their records show significant progress has been achieved by the team. This achievement is due to experience, continuous training and good planning.

Even more, interviewee MN6 explains the situation in the company in the last two years, as the number of risks decreased. He also provided the percentage for, as he referred to training programs which reflect performance of staff:

"During the last 2 years, it's been noticed that the number of risks has dropped by 30%. This improvement is due to the experience and training programs our staff participated in, and I believe there is still room for further improvements."

Regarding experience, five respondents (56%, 5Nr) mentioned it will increase performance of the procurement teams. Interviewee MN2 mentioned that the team get lots of experience in this field, and he describes the importance of that:

“Yes, our team gains lots of experience which increase their progress. Our team managed to mitigate the consequences of few risks such as supplier failure. If a particular supplier fails to fulfil the terms and conditions of the contract, our team switches to another supplier without causing any delay to the project time scale.”

In this regard, interviewee MN4 stated that it is the responsibility of the procurement team. He talked about their experience and the significant progress they made in reducing the risk of delay: *“Depending on the contract’s terms and conditions, delivery duration can be the buyer’s responsibility or the supplier’s. In both cases, it is our procurement team’s responsibility to select the right supplier or freight forwarder. Our team has made significant progress in minimizing the risk of delay. This success is as a result of interpretation and analysis of previous procurement records and data.”*

Analysing data is considered by four respondents (44%, 4Nr) as one of the tools that increases the performance of the procurement team. Those respondents were interviewee MN1, interviewee MN7, interviewee MN8, and interviewee MN9.

“...there is always room for increasing the performance in risk management by providing constant training, continuous communication and cooperation with suppliers, and analysing records and data. All these procedures will help predict potential risks and enhance the performance of our team”. As well as the same above four interviewees (MN1, MN7, MN8, and MN9) mentioned that communication and cooperation with suppliers to provide original parts without delay is essential to increase performance of the procurement team, because it will build the trust between the companies.

In the same context, interviewee MN5 (11%, 1Nr) mentioned good planning procurement team will help to identify the company and the original part in order to receive the parts just in time.

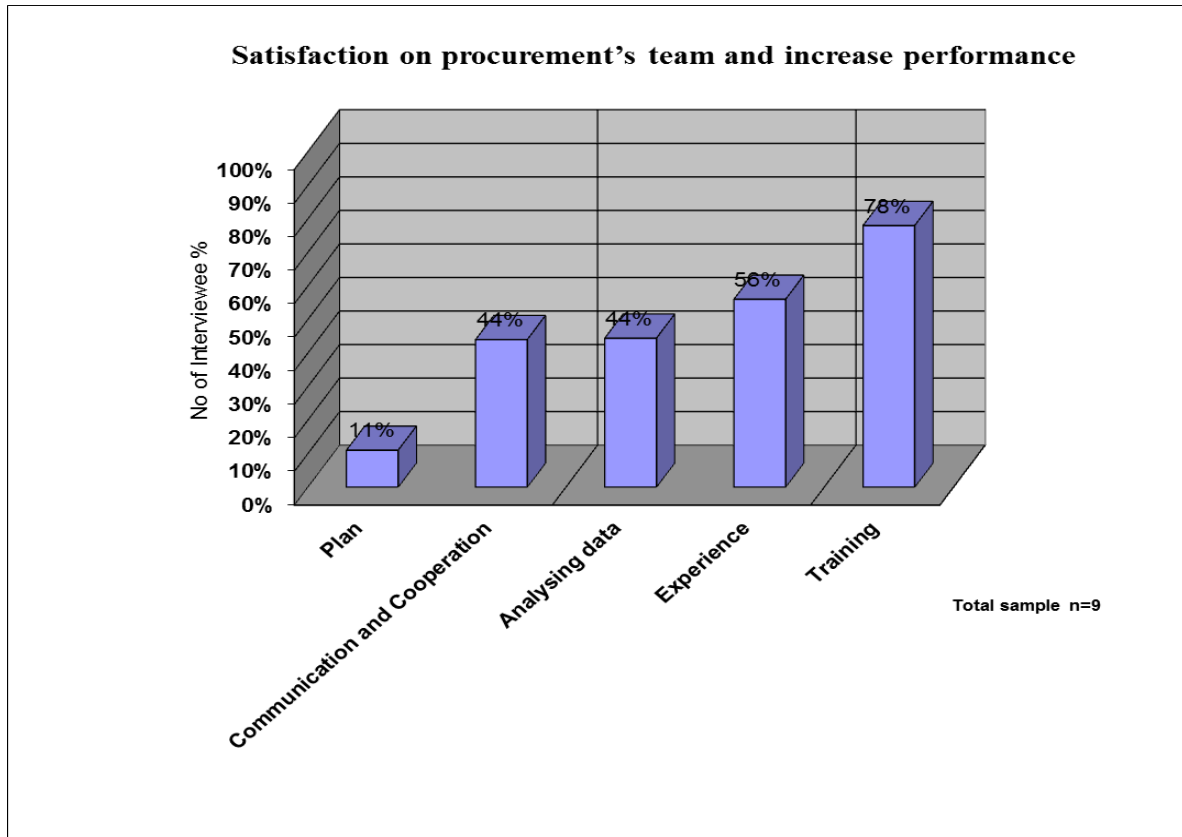


Figure 5. 8: different ways of team performance

5.4 Summary

This chapter presented results of the data collected through the field research, using semi-structured interviews which were classified and coded using NVivo software (eleventh version) as a tool. They were then analysed using content analysis (developed analysis). The findings in this chapter were covered in detail. The subjects, themes and sub-themes of challenges and risks during procurement frequently appear. Reasons for risks appear frequently. Impacts of the risks, how to reduce and manage the risks, monitoring available systems, satisfaction of procurement teams and how to increase performance also appear.

However, the findings of themes derived from the literature and from the semi-structured interviewees' responses will be further discussed thoroughly in the next chapter in light of the aims and objectives of the research.

Chapter Six: Framework Development & Validation

This chapter presents the proposed, developed framework for the procurement risk management. It also explains the different components of the framework and how they relate. Furthermore, the framework validation is detailed in relation to the two hypotheses of the research.

6.1 Development of Oil supply chain risk management framework

6.1.1 Procurement Risk Management Framework (PRMF):

The significant part of this research is aimed at developing Procurement Risk Management Framework (PRMF); this is achieved by considering the model developed by Kern (2012) to be used as a foundation for developing the developed framework (Figure 6.1). In other words, the current PRM framework is presented as an improved and innovative version of the model developed by Kern (2012). In Kern (2012), the risk management performance is a direct result of risk management mitigation, whereas in the current framework, the performance is dependent on the risk identification and risk mitigation, in which the two hypotheses (H1 and H2) are proven to agree practically that risk performance is the result of both risk identification and mitigation. The proposed, developed framework provides the detailed description of the risk management approach as well as the relationship between the various construct and the performance of the risk management approach. It includes the five basic constructs of a supply chain risk management. These constructs will be described in the following sections with further developed details. According to Eiser and Bostrom (2012), the relationship between the constructs, is such that, risk identification has a direct and positive effect on risk assessment. Similarly, risk assessment has a direct and positive impact on risk mitigation, while risk mitigation also directly contributes to risk performance. They further explained that each of the individual constructs would therefore indirectly affect performance. Accordingly, this argument will use this statement as a basis for further development of the developed framework. However, the following sections give detailed explanation of the framework components and broad justification for the development of the framework and the hypotheses guiding the constructs and the interrelationships.

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Phase 1:

The process of PRMF in figure 6.1 shows the structure of the process been developed from the risk management standard models discussed in the literature review (Refer to Chapter 2). Once this process is started, a risk register needs to be generated for the material procurement project. This Risk Register is collection and archiving of previous documentation operations which need to be regularly updated and consulted with the project team members. Also, one of the procurement team will be a dedicated risk coordinator who always updates the risk register. Further details on the content of the risk register provided in the next section.

6.1.2 Risk Identification

Risk Identification is the primary step and the most important stage in any risk management process (Kleindorfer and Saad 2005). The main purpose of the risk identification is to identify all the relevant risks associated with the project. It is therefore important at this stage to take a detailed and complete view of the supply chain and its environment to pinpoint any weak points

or potential causes of disruptions (Buhman *et al.* 2005). The target of risk identification is to discern, as specific as possible, all potential threats and all relevant vulnerabilities within the procurement process and its supply chain. The scope of risk identification can be seen in parallel to the research progress. Basic research at the very beginning needs to be widened in order to discover various possible sources of disruptions. According to Craighead *et al.* (2007), an early awareness of a risk can help to minimise its impact and level of disruption to a supply chain. This makes risk identification crucial for an organisation to be able to assess the impact of the risk and determine the best mitigation technique to put in place. In this way, 'early warning signals' can be established to help recognize the occurrence of a risk (or its likely occurrence) and to enable the mitigation measures to be deployed, in a timely manner, to prevent its undesirable consequences or to minimize the impact (Craighead *et al.* 2007, Hendricks and Singhal 2003, Tomlin 2006, Zsidisin *et al.* 2004). It is important to have a structured and focused approach to risk identification, which ensures effective use of resources. This will require a definition of the observation fields to direct the search from areas of vulnerability and sources of risks. It will also require an in-depth knowledge of the organisation (or experience of similar operations), its process, and various components of the supply chain and partners (Hallikas, *et al.* 2002, Kleindorfer and Saad 2005, Steele and Court 1996). As risk identification affects all the subsequent risk management activities, it can be considered that an effective risk management process will affect the effectiveness of the risk assessment activity and will also result in a more effective risk management exercise such as performance.

6.1.2.1 Risk Identification Tools and Techniques

Risk identification process is considered to be the initial stage of risk management Chapman (2003).

Therefore, failure in the identification of risks may cause lack in the whole process, which can censoriously affect the organisation's resources. The benefit of this process is to recognise the best and most relevant input data, it recognises risks and their potential impacts and provides information for decision-makers (Wang 2007).

The risk identification process can be accomplished by various tools and techniques. The most common tools and techniques are documentation reviews, expert judgment, diagramming techniques, assumption analysis, information gathering, checklists and SWOT technique. (British Standard 2010).

6.1.2.2 Documentation Review

This review holds documents of the previous business campaigns, strategies, activities, contracts, and other stored information in either hard copy or electronic formats. This technique is used to collect feedback information to understand and identify the new business risk probabilities and uncertainties (Witkin 1995).

This review assists to recognise the strengths and weaknesses of the organisation and understand the history and philosophy of the business.

6.1.2.3 Expert Judgment

People with specialised knowledge, either part of the organisation or involved in a specific activity of the business, are known as the experts in the business (Otway 1992). The expert judgment in organisations highly relies on the experiences and skills of the owners and managers. They used their managerial experiences due to their familiarities with the business activities, instead of the costly advice of consultants.

6.1.2.4 Checklist Analysis

The third technique that emerged was checklist analysis. This technique is known as a basic method of risk identification in which pre-identified threats and opportunities are investigated for signs of potential risk situations (Cross 2001). Checklists within organisation are developed over time through functional experts' contributions and collective experiences.

The checklist helps to speed up the whole process and stops organisations from forgetting the critical steps due to disruptions.

6.1.2.5 Information Gathering

The fourth common set of techniques is information gathering techniques. The process of information gathering helps to enhance the organisation's memory, develop effective management and save resources. The most important techniques in this method include interviewing, brainstorming technique and root cause analysis. These are the most utilised information gathering techniques in risk identification.

Therefore, this research will hypothesise that:

Hypothesis 1(H1): Procurement managers practicing risk identification activities have a positive impact on risk management performance of the material procurement in the Libyan Oil Industry.

6.1.3 Risk Assessment

Risk Assessment is the second stage of the risk management process. Generally, in project management literature, risk assessment involves an evaluation of the likelihood of the risk factor occurring as well as an evaluation of the impact of the risk if it occurs (Hallikas *et al.* 2002, Kleindorfer and Saad 2005, Manuj and Mentzer 2008, Ritchie and Brindley 2007, Schmitt and Singh 2009, Souza, Goh, and Meng 2009, Zsidisin *et al.* 2004). These actions are also applicable to supply chain management literatures. The main aim of the risk assessment activity is to provide managers with necessary information on each identified risk factor through risk registry to mitigate their impacts or avoid their occurrence (Baird and Thomas 1985). This will require an understanding of the causes of each risk factor, and major risk drivers in the supply chain. This needs to be supported by the knowledge of the interrelatedness of the identified risks with their 'trigger' events (Harland *et al.* 2003, Kleindorfer and Saad 2005, Manuj and Mentzer 2008, Ritchie and Brindley 2007). Scholars and researchers have explained that the impact of a risk factor on the supply chain depends on when it occurs in the project lifecycle, as well as, the speed with which it occurs (Braunscheidel and Suresh 2009, Hendricks and Singhal 2003, Manuj and Mentzer 2008, Schmitt and Singh, 2009). As a result, a risk assessment should result in clear and simple breakdown of all the identified risks, listed in order of their effect on the project. This can be represented in the results by a graphical manner which easily communicates the likelihood, impact and priority of each identified risk, as well as, anticipated location and time of occurrence in the project lifecycle (Hallikas *et al.* 2002, Harland *et al.* 2003, Manuj and Mentzer 2008, Matook *et al.* 2009, Schmitt and Singh 2009, Steele and Court 1996, Souza *et al.*, 2009). For an effective risk assessment exercise, an in-depth understanding of each risk factor (or experience from similar operations) is very important to enable managers to develop the right mitigation and contingency strategies. As such, it is expected that an effective risk assessment will result in an effective risk mitigation activity.

Phase 2

6.1.4 Risk Mitigation

In the management process of risk, risk mitigation is the second phase. This phase involves the development of measure to prevent or minimise the likely impact of the identified risks based on the information established in the previous risk assessment stage. Risk mitigation measures can be developed with the aim of preventing a risk before it occurs (classic or preventive mitigation

approach) or aimed at minimising the impacts of the risk after it occurs (Contingency approach) (Tomlin 2006). In other words, the main objective of this stage is to reduce the likelihood of the risk occurring or to reduce the negative impact on the project goals. This can be achieved, for example, by using dual supplier's technique, where depending on one supplier may increase the potential risk.

In the developed framework (Figure 6.1), few ways of managing risk are mentioned to provide comprehensive view in mitigating risks.

There are four ways to manage risk: 1- Risk avoidance. 2-Risk transfer. 3-Risk reduction and 4- Risk retention.

6.1.4.1 RISK AVOIDANCE (ELIMINATION OF RISK)

This is completely avoiding an activity that poses a potential risk. Although attractive, this is not always practical.

6.1.4.2 RISK TRANSFER (INSURING AGAINST RISK)

Most commonly, this is to purchase an insurance policy. The risk is transferred to a third-party entity (in most cases an insurance company). To be clearer, the financial risk is transferred to a third-party. Risk sharing is also a type of risk transfer. For example, members assume a smaller amount of risk by transferring and sharing the remainder of risk with the group.

6.1.4.3 RISK REDUCTION (MITIGATING RISK)

This is the idea of reducing the extent or possibility of a loss. This can be done by increasing precautions or limiting the amount of risky activity. For example, diversification of assets and hedging are forms of risk reduction with investments. Investments in information is a way of mitigating risk because the organisation is better informed, thus reducing the uncertainty. Another way of employing risk reduction is the safety in numbers approach. When discussing risk transfer, risk sharing is mentioned too. The larger the number of people sharing risk, the less severe the shared effects will be. Statistically, only a small number of individuals in the group will experience an unfortunate event. Insurance companies exist based on this concept.

6.1.4.4 RISK RETENTION (ACCEPTING RISK)

Risk retention simply involves accepting the risk. Although the risk is mitigated, if it is not avoided or transferred, it is retained. Retention is effective for small risks that do not pose any significant financial threat. The financial status of the company will determine the acceptability of a risk. An examples of risk retention: A company does not obtain health insurance for employments; therefore individuals are retaining risk. Risk retention augments risk transfer through deductibles.

For each identified risk, a suitable mitigation strategy needs to be established and deployed appropriately (Chopra, Reinhardt and Mohan 2007, Kleindorfer and Saad 2005, Manuj and Mentzer 2008, Wagner and Bode 2006). Most researchers have recommended that an effective risk mitigation process requires a close collaboration and consultation with supply chain partners. It also requires the support and involvement of various functions within the project organisation. Consequently, top management support is required to unite the various function of the project in decisions making and also educate all function about the importance of the risk management activities (Berg *et al.* 2008, Chen and Paulraj 2004, Kleindorfer and Saad 2005, Zsidisin *et al.* 2004).

Risk identification is hypothesised to directly improve risk performance by making available the necessary information at the right time. On the other hand, risk mitigation activities will contribute directly to the performance of the SCRM operation. As a result, it is hypothesised that:

Hypothesis 2 (H2): Procurement managers practising risk mitigation activities have a positive impact on risk management performance of procurement materials in the Libyan Oil Industry.

Phase 3

6.1.5 Monitoring and Control

During phase 3 in the PRMF, planning and scheduling, progress monitoring, cost control, estimating and accounting procedure, close out report and control is required to be developed and implemented. Planning and scheduling should meet the procurement project completion System. It should be capable of producing a comprehensive range of reporting options to provide timely and concise decision-making information. Actual progress, showing start, delivery date and duration should be monitored against ongoing basis to support the progress (Qatargas project documentations 2005). Penalty damages are payable in case performance guarantees are not

met. It should guarantee the quantity of product defined with respect to the required materials specifications. The test is undertaken in order to verify the performance guarantees for capacity and quality. If any guarantee is not met, contractor or service provider shall have the option to pay liquidated damages instead of undertaking modifications due to performance deficiencies (Qatargas project documentations 2005). After completion of the procurement project, closeout report is produced, which summarises the technical scope, project schedule, and cost of the activities. This report should incorporate overall summaries at the end of the work. It should further include a lesson learned report that covers engineering procurement. Lessons learned should focus on recommended strategies, plans, procedures and tasks that should be modified to enhance the execution success of the subsequent project (Qatargas project documentations 2005).

Researchers recommend that a continuous monitoring process is required to recognise new potential risks, check the occurrence (or potential occurrence) of already identified risk, review the effectiveness of mitigation measures, documentation, reports and adjustment of the risk management plan where necessary. This also needs to be carried out on a frequent basis throughout the project lifecycle (Craighead *et al.* 2007, Giunipero and Eltantawy 2004, Kendrick, 2009, Kleindorfer and Saad 2005, Norrman and Jansson 2004, Rees and Allen 2008, Matook *et al.* 2009). Similarly, Kerzner (2009) proposed that cost, schedules and quality project metrics are fundamentals, required to monitor and evaluate the progress of projects and to provide quick signs of potential problems so that actions can plan accordingly. This idea was supported by Kendrick (2009), who recommended using “project dashboard” software to monitor projects. PMI (2008) suggested using management plan, project risk register, and progress reports as the inputs of the monitor and controlling project risks stage. Data from different sources have identified techniques other than metrics to be used for monitoring and controlling project risks such as; risk reassessment; risk audits; status meetings; earned value; Value at Risk; and risk exposure trends. (Kerzner 2009, OGC 2010, PMI 2008, Sirr *et al.* 2011). Smith *et al.* (2006) point out that monitoring portfolio risks is a vital process in the PRM process since each risks’ probability and impact may possibly vary during the project lifecycle - which as a consequence might negatively impact the success of the portfolio. Alternatively, Alhawari *et al.* (2012) claim that the risk identification process does not stop after the risk monitoring stage, but new risk should be evaluated and analysed as they appear. In addition, Kendrick (2009) highlighted that at the portfolio level, resources usage needs to be monitored to avoid resources contention and

constraint risks. It has been found that resource monitoring is very important in a portfolio because sometimes resources used in less important projects might delay critical projects. Previous researches on supply chain risk management had considered risk from either operational and disruptions point of view or a supply-demand coordination and disruption point of view (Kleindorfer and Saad 2005, Tang 2006). Operational risks are those risks that can occur within regular functions of the supply chain. On the other hand, disruptions risks are those risks that rarely occur, for instance, natural disasters (Kouvelis *et al.* 2006). Tang (2006) added to this by suggesting that a supply chain risk management process should be structured, so that each activity within the process is focused towards the development of a successful mitigation strategy. Some of the essential activities within the supply chain risk management process he mentioned include demand management, supply management, product management, and information management and mitigation strategy. Furthermore, some researchers have developed distinctive models and management tools targeting the various segments of the supply chain. For instance, developing different frameworks that focus either on the upstream or downstream segment of the supply chain (Kouvelis *et al.* 2006, Manuj and Mentzer 2008, Wagner and Bode 2008), or classifying risk management approaches by differentiating the supply management and the demand management (Tang 2006). However, most recent researchers have advocated for the adoption of an integrated and holistic approach to supply chain management that is tailored to the unique condition of the focal firm (Buhman *et al.* 2005, Wagner and Bode 2006). For the purpose of this research, it can be argued that in a typical oil material and equipment purchase, supply chain risks can occur on the supply side and on the demand side, which makes it necessary to have a complete view of the supply chain.

6.1. 6 Risk management performance and the hypothesis

Risk management performance is the significant addition to the proposed procurement risk management framework. It is very important because it poses a challenge to both researchers and practitioners in the supply chain oil industrial sector. Risk performance aims to evaluate and measure impact and frequency reduction to supply chain risk through risk management. In Berg *et al.* (2008), a case study approach was used to study risk performance assessment in which they draw conclusion of its contribution to the risk performance development. The time horizon was suggested by Hendricks and Singhal (2005) as a means of measuring the reduction of frequency and impact of risk management on risk performance. However, in this study, two

hypotheses have been suggested. One for direct impact of risk identification, and the other for the impact of risk mitigation on risk performance. Hypothesis 1(H1) is proposed to determine whether risk identification has a direct impact on the risk management performance. Hypothesis 2 (H2) is in place to check the direct impact of risk mitigation on risk management performance. The two hypotheses were conducted and approved through the analysis using SPSS and found to be valid propositions to ascertain that; Risk identification and risk mitigation have significant impact on risk management performance.

6.1.7 Hypotheses Validation

The two hypotheses (H1, H2) investigates as to whether practising risk identification and mitigation management strategies can generate positive performance and outcomes in the Libyan procurement operations. These two hypotheses (H1, H2) relationships in this study (Figure 6.1) comprises three components which are; risk identification, risk mitigation and risk performance. Since the previous section explained these components, this section focuses on the hypothetical relationships and statistical analysis validation. In this study, hypotheses have been validated and have positive impacts on risk strategies as follows.

Hypothesis 1(H1): Procurement managers practising risk identification activities have a positive impact on risk management performance of the material procurement in the Libyan Oil Industry.

The percentage of procurement managers who are practising risk identification strategy is found to be 31.8%; this means that 68.2% does not practice this strategy. (question 9).

By using statistical analysis and testing the hypothesis.

Z	-4.153001485
p-value	3.3E-05

Table 6. 1: Hypothesis 1

It's been found that p-value is lower than 0.05 which indicate that significant differences exist within practising risk identification strategy. This means that procurement managers are practising this strategy that positively impacts on risk management performance.

Hypothesis 2 (H2): Procurement managers practising risk mitigation activities have a positive impact on risk management performance of procurement materials in the Libyan Oil Industry.

The percentage of procurement managers who are practising risk mitigation strategy is found to be 45.1 %. This means that 54.9% does not practice mitigation strategy. (question10).

By using statistical analysis and testing the hypothesis.

Z	-4.518418682
p-value	6.23032E-06

Table 6. 2: Hypothesis 2

It's been found that p-value is lower than 0.05 which indicate that significant differences exist within practising risk mitigation strategy. This means that procurement managers are practising this strategy that positively impacts on risk management performance.

6.1.8 Concluding Remarks

From previous survey results, it is clear that most managers do not make enough effort to identify nor mitigate risks related to supply. According to Zsidisin *et al.* (2000), the reason is partly attributed to little time or resource that they invest into risk management due to the return on investment, lack of knowledge, lack of experience and a justification problem when a risk never materialised. Tang (2006) illustrates the underlying reasons as follows based on Rice and Caniato (2003) and Zsidisin *et al.* (2000): (1) Firms misjudge the risk; (2) Firms are suffering from lack of knowledge relating to risk management; (3) Firms find it difficult to implement risk management strategies in the cost/benefit analysis.

However, in the case study survey and interviews of this study, it revealed that service provider companies are more engage in risk analysis and mitigation than end users or owners' companies. The survey showed that large-sized service provider companies recognised the supply and procurement risks as a kind of disturbance to their material flow within supply chain which must be tackled. As for service providers company, implementation of risk management strategies was regarded as a competitive advantage which can appeal to their customers (Owner).

This chapter proposed the developed research framework with the hypotheses about the relationships between identification, mitigation risk management strategies and risk management

performance (outcomes). These hypotheses were validated and tested by statistical analyses of survey data. The next section will consult procurement managers in providing their point view regarding the validity and reliability of the developed framework.

6.2 Framework Validation

This part validates the framework through empirical responses via qualitative technique, semi-structural interview. Lindland et al. (1994) defines a framework as a developed model and set of statements in a language-based activity. The framework for this research expresses a new framework of knowledge transfer to improve procurement risk management activities. It was developed to address the empirical study challenges and applicable to other risk frameworks awareness activities that affect procurement processes. The framework considers important risk factors that could threaten the procurement processes. Moody and Shanks (2003) suggested the effective system application, the stakeholders' engagement in the validation process and critical discussion of it. The framework has incorporated the viewpoint of end user managers at the validation stage. Involvement of these stakeholders in the framework validation enhanced its competence if employed. The validation routine has established the frameworks' ability to be applied, its consistency and availability for oil companies to deal with the current situation in procurement risk management activities.

6.2.1 Stakeholders' Selection: Rational and Justification

Eight Libyan oil operation companies that operate under the administration of the Libyan national oil company (NOC) has been selected to validate the proposed framework, however six of them has response to our query. This validation is based on the activities of end users and contractors who regularly practice procurement process. The justification behind the selection of stakeholders is their strength and the challenges of their operation to consider these factors in the framework validation. (Bali et al. 1999).

6.2.2 The participants' profile

Six out of eight participants responded to the validation. They were individually consulted by answering 5 questions with their comments. The target was to validate the framework and the possibility of practicing the framework within the Libyan oil industry.

The profile of the participants is briefly described in below.

Table 6. 3: Participants Profile

Participant Ref. No.	Area of activities	Position
MN.1	Exploration	Procurement Manager
MN.2	Seismic & Data acquisition	Purchasing Manager
MN.3	Drilling	Material Manager
MN.4	Operation & Service	Procurement Manager
MN.5	Maintenance & Workover	Purchasing Manager
MN.6	General Service	Purchasing Manager

6.2.3 Summary of stakeholder comments and discussion

The contributors remarked on the framework presentation and questions. Their responses on the framework are summarised below, and detailed questions and response can be found in (Appendices. 4 Framework Validation Responses).

- Do you see opportunity to apply this framework to your projects and across a variety of procurement process?

-

Table 6. 4: Participants response for question 1

Participant Ref.	Responses
MN1	The participant saw the possibility of using this framework as a tool in their procurement process.
MN2	The participant described the framework as a practical one because it consists of complete risk management components, but the only concern is whether the framework can properly be managed by users.
MN3	The participant described the framework as a good tool, and It could strengthen the procurement risk management activities.
MN4	The participant saw the benefit of practising such framework
MN5	The participant agreed that the framework could support procurement process.
MN6	The participant saw the benefit of using this as a tool in their procurement process.

DISCUSSION: All the participants welcomed the framework as the idea of promoting procurement risk management activities in Libya. Participant Ref.MN2 expresses their main concern in whether the framework can be implemented properly by users.

- Did you find the framework understandable, feasible/non-feasible, clear and concise?

Table 6. 5: Participants response for question 2

Participant Ref.	Responses
MN1	The participant described the framework as comprehensive and clear
MN2	The participant described the framework as comprehensive and clear
MN3	The participant described the framework as Clear and understood
MN4	The participant described the framework as “comprehensive and should not be complicated especially for practitioners”.
MN5	The participant described the framework as clear to understand
MN6	The participant described the framework as clear to understand

DISCUSSION: All the participants embrace the framework as clear to understand.

- To what extent is the framework immediately seen to be of value and why?

Table 6. 6: Participants response for question 3

Participant Ref.	Responses
MN1	The participant saw the value of the framework because it can guide the user to mitigate risks during the procurement process
MN2	The participant admitted that the framework is value added to the risk strategy because it contains a complete guide in helping procurement managers.
MN3	The participant agreed that the framework adds value in mitigating risks not only after risks appears, but also before by helping in setting pro-active plan. (Preventing risk).
MN4	The participant mentioned that the framework provides a full picture which will guide managers to mitigate risks during the procurement process
MN5	The participant agreed that the framework would guide users to mitigate risks during the procurement process.
MN6	The participant agreed the framework is value added because it guides user to mitigate risks during the procurement process

DISCUSSION: All the participants agreed that the framework adds value to the procurement process. Participant MN3 added another value by considering the preventing risk plan that the framework can be of help.

- To what extent is the framework seen as relevant and complete?

Table 6. 7: Participants response for question 4

Participant Ref.	Responses
MN1	The participant agreed that the framework is relevant and complete, but it should be empirically tested in a real process.
MN2	The participant admitted that the framework is complete, however, empirically should be tested in a real procurement process.
MN3	The participant agreed that the framework is relevant to risk management, and should be empirically tested.

MN4	The participant agreed that the framework is complete and comprehensive, and suggested to be examined or prototype form to establish its consistency and likely adaptation.
MN5	The participant claimed that the framework is complete, relevant and reliable. However, it should be empirically tested with a real project.
MN6	The participant stated the framework is complete and could solve procurement issues but more emphasis should be on monitoring process.

DISCUSSION: In general, all the participants agreed that the framework is relevant, reliable, and complete, however, it should be tested to confirm its reliability.

Participant MN6 express their concern regarding the monitoring process.

- What would you suggest should be added to the framework and why?

Table 6. 8: Participants response for question 5

Participant Ref.	Responses
MN1	The participant commented that the concept is fine.
MN2	The participant replied that the framework is good and more risk factors can be added to the registry.
MN3	The participant suggested that the monitoring phase should not be a separate process (in sequence). The monitoring process is a continuing process and should operate any time in the cycle liaising with other components.
MN4	The participant stated that the frame work is good and more risk factors can be added to the registry to make the framework more effective.
MN5	The participant stated that the framework is good and more risk factors can be added to the registry.
MN6	The participant suggested that the monitoring process is a continuous process in monitoring and controlling other phases any time in the cycle.

DISCUSSION: Three of participants (MN2, 4, and 5) agreed that the framework is reliable and more risk factors should be added to the registry.

Also, participants (MN3 and MN6) express their concern regarding the location of the monitoring phase, and they suggest to re-locate in a way to have access to all other processes, this will improve the efficiency of the monitoring and control operation.

6.3 Discussion:

The discussion of the findings obtained from the interview to validate the framework is presented. Based on the reaction of the participants, the idea of the proposed framework to promote risk management activities in Libya was welcomed. However, participant Ref MN2 expresses their main concern in whether the framework can be implemented properly by users. The understanding of the framework was clear to all participants. The value added through the adoption of the framework was evident as all the participants agreed that the framework added value to the procurement process. Meanwhile, participant MN3 added another value by considering the framework for preventing risk plan. In general, all the participants agreed that the framework is relevant, reliable, and complete. However, it should be further tested to confirm its reliability. Participant MN6 express their concern regarding the monitoring process. Three of participants (MN2, 4, and 5) agreed that the framework is reliable as well as the register. Also, participants (MN3 and MN6) express their concern regarding the location of the monitoring phase, and they suggest to re-locate in a way to have access to all other processes, this will improve the efficiency of the monitoring and control operation.

This study set out with the aim to develop and evaluate an approach which uses PRMF to forecast and mitigate the effect of risks on material procurement operations.

The PRMF have been identified and validated using interviews, with focus interviews gaining more clarification on the characteristics of the different risks.

This approach enables procurement managers to prioritise risks based on their influence.

These findings have important implications on the management of procurement operation risks since risks can be prioritised and responses can be planned based on the significance of the risks.

6.4 Summary

This chapter proposed the developed research framework with the two hypotheses that link the relationships between identification, mitigation risk management strategies and risk management performance (outcomes). Developed framework is the overall depiction of risk management method which explains entity relationships during risk management exercise. Each entity of the framework represents an extensive process involved in the supply chain risk management and integrate for the effectiveness of the management activity. The hypotheses were statistically validated and tested. Moreover, the developed framework was tested for validation and reliability by practitioners and procurement managers. Additionally, after thorough validation (via qualitative process) and analysis, various knowledge gaps were identified. These gaps will be mentioned in the conclusion (chapter 7) as recommended for future work research.

Chapter Seven: Conclusion, Recommendation, and Further Study

This chapter is the final part of the research which gives a detailed summary of its major results and inferences (Section 7.1). Section 7.2 is about study highlights as confirmation of novelty; Section 7.3 shows that the objectives of this study were achieved as listed in Chapter 1. Section 7.4 discusses contributions of the study to existing work while Section 7.5 is based on the discussion about the research questions. The limitations and challenges facing material procurement process within the Libyan oil industry is presented in section 7.6. And finally, the recommended further study is proposed in section 7.7.

7.1 Research Summary

This section is a recap of this study's contributions which was embarked upon to answer the research questions and deliver the stated objectives.

The approach incorporated the two methodologies, quantitative and qualitative to address knowledge gaps and produce experimental research. This study not only investigates the current practice of material procurement risk management among Libyan oil companies, but also proposed a tool (framework) that will support the initiative, if it is implemented, to support material procurement activities in Libya. In addition, the validated knowledge will enhance risk management awareness activities in Libya, especially for the oil industry. The concept of Risk Management (RM) is identified as a way of mitigating the challenges faced by procurement managers affected by risk factors. Therefore, RM has been applied to supply chain management (SCM) activities in relation to activities involved in procurement processes.

7.2 Originality of the Research

The essence of a PhD study is to provide a significant addition to existing knowledge in research which should be based on idea or concept novelty (Baskaran 2008) and (Dwivedi 2003). Cryer (2000) established the different variations to PhD research in terms of originality. This buttressed the points raised in novelty Baskaran (2008) and Dwivedi (2003), that is, creating or inventing new knowledge. This study, therefore, is believed to have met the criteria of study uniqueness, capability, and knowledge contribution as presented in Table 7.1.

Criteria for Research Originality	Evidence in thesis
Evidence of key study	<ul style="list-style-type: none"> ○ Evaluation of risk management among procurement managers in Libya.
Source for quality data	<ul style="list-style-type: none"> ○ Questionnaires and interviews with procurement executives. (NOC)
Use of data	<ul style="list-style-type: none"> ○ Triangulation methodology was implemented in the research, as combination of quantitative and qualitative methods to strengthen the direction of research
Embarking on new experimental study (Innovative results)	<ul style="list-style-type: none"> ○ An empirical study on Libyan oil companies as a potential risk group for the procurement process. ○ PRM Framework
Ability to significantly utilise available idea and resources	<ul style="list-style-type: none"> ○ References on SCRM and procurement perspectives
Setting down a major piece of new information.	<ul style="list-style-type: none"> ○ Expose risk supply and procurement knowledge among the Libyan companies that are practising procurement processes. ○ Help in the prediction of supply risk factors through inferential statistic (Chi-Square test).
Publication	<ul style="list-style-type: none"> ○ 2 Abstracts have been accepted by conferences. ○ One Journal paper is published & one is in progress.
Being cross-disciplinary (Engineering concept and procurement risk management)	<ul style="list-style-type: none"> ○ This thesis is representing engineering concept and procurement risk management.
Making a unique combination (Innovative by-Risk management.	<ul style="list-style-type: none"> ○ Produce empirical study on Libyan oil companies for potential risk during the material procurement process. ○ Develop and validate PRM Framework

Table 7. 1: Summary of Research Originality

7.3 Objectives Accomplished

The contribution presented in this study is the application of risk management knowledge to the developed framework to enhance procurement process activities in Libya. To accomplish the success of the integrated concept proposed in this research, a comprehensive analysis and evaluation of procurement risk factors were presented for both academic and industrial justification. The study effectively presents a procurement risk management-based framework which is validated to provide answers to the research questions and other issues related to material supply issues in Libya.

The research attempted to achieve the objectives highlighted in chapter 1 as listed:

- Reassessed the whole global initiatives of the supply chain and supply chain risk management (SCRM).
- Explored and identified the various risks that propagate within the material supply chain in the oil industry by using questionnaire and interviews.
- Investigated the risk management strategies that Libyan oil companies currently practice that are related to material procurement process within the Libyan oil industry.
- Produced a validated framework on risk management process.

7.4 Contributions to Knowledge

The current research study has contributed to knowledge regarding the following;

- A comprehensive analysis of the existing risk management strategies practice in Libya presented in chapter 4, 5, and 6 above.
- The findings acknowledged the procurement management problems in Libyan oil industry.
- The quantitative data obtained through questionnaire and presented in chapter 4 provides information relating to practice consciousness of risk management strategies and risk factors on procurement process in the Libya oil industry.
- The data in chapter 4 has been enhanced in chapter 5 which demonstrates the qualitative data acquired through semi-structure interviews. Findings in this process show the extent of risk occurrence during the procurement process.
- Finally, chapter 6 unveiled the illustration of the developed framework, which is validated to provide a sequential procedure to mitigate challenges and risks.
- The research entirely has proposed an information management system framework capable of improving procurement process activities. These activities aim to monitor and mitigate the challenges and risk rate through the use of a knowledge-based initiative (framework).

7.5 Research questions and findings

The main aim of this study is to examine the risk management strategies for material procurement to achieve a robust procurement process in Libyan oil industry. In order to meet the target, the research was approached through the following means:

- (1) Identified and analysed various risks in material procurement operations.

(2) Examined the risk strategies for managing these risks

(3) In relations with organisational orientations.

The research adopted a multi-phase mixed method study incorporating two interconnected phases of research. The first phases included the exploratory and analytic study that used questionnaire and interviews. This phase was aimed at the profiling of material procurement and supply risks within the oil industry, (Chapter 4 and 5).

The second phase was also an exploratory study but adopted literature review for the framework development of risk management strategies in order to mitigate material procurement risks and to propose hypotheses regarding the relationships between two risk management strategies and their desired performance outcomes (Chapter 6).

From the literature review in Chapter 2, several research gaps were identified such as:

- In the application of supply chain risks and material procurement risk, where international supply process is more complex than domestic.
- The need for systematic risk analysis because existing risk identification and analysis has tended to provide independent risk concepts without considering interconnectedness and interconnections of risk factors.
- The risk management at a strategic level in consideration of empirical evidence.
- The business contexts were affecting the implementation of risk management strategies.
- The consequences of risk management strategies.

The research questions of this study were developed to address these research gaps, which are as follows:

Q.1 What are the risk areas to be managed in materials procurement process for Libyan oil industry?

Q.2 What are the main risk management strategies to be considered?

Q.3 Can these strategies generate positive performance and outcomes?

Q.4 How can procurement managers effectively manage risks in supply and procurement process?

Risk management process is considered to be involved with risk identification, analysis and mitigation. Q.1 focuses on identification and analysis of procurement risks, while Q.2 aims at mitigation. Figure 7.1 illustrates how the research questions were addressed in each chapter.

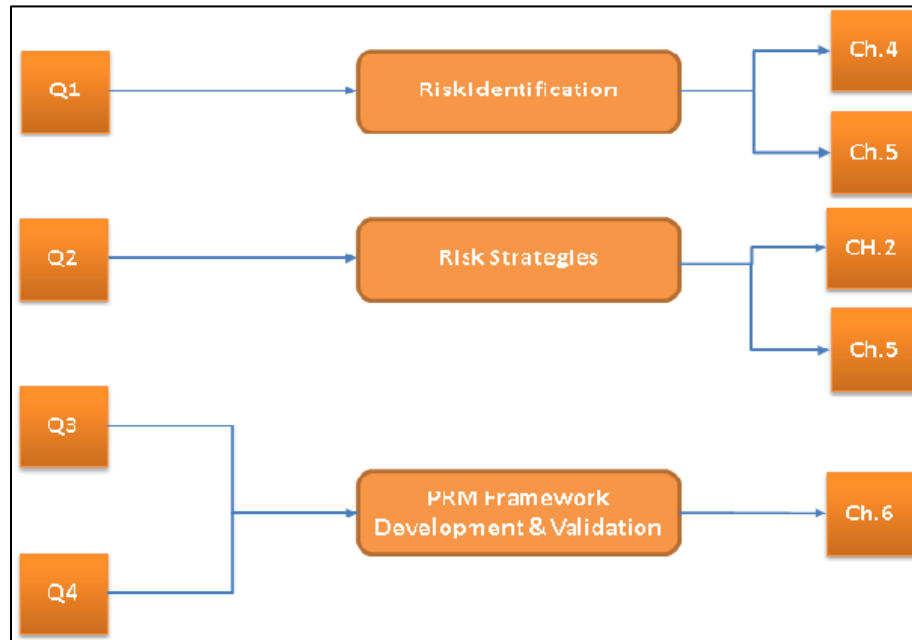


Figure 7. 1: The flows of research questions

7.5.1 Risk Identification

Q.1. What are the risk areas to be managed in materials procurement process for Libyan oil industry?

The result of questionnaire analysis showed the common risk factors between supply chain and material procurement operations and also revealed unique risk factors differentiated from supply chain risks. The result particularly revealed the generation of unique threats to material procurement in terms of the shipping, logistic market and operational practices. Additionally, the distance between trade partners, as well as, long lead-time caused information abnormalities which are essential for smooth procurement operations. Several elements associated with material procurement operations can create new risks areas in inter-organisation relationships. The research question became predominant with the main objective of risk identification and analysis. This is regarding how supply and procurement risks can be understood and what risks must be managed as the main priority.

Based on Sheffi and Rice (2005) claim, the initial occurrence of one risk can cause several waves of other risks to spread through procurement operation. Although the effect of the first risk can be insignificant, the impact of the subsequent can be huge. This research highlighted that information and relationships risks are the main cause of self-enhancing of risk management.

Therefore, it is concluded that managing information and relationships in supply and procurement operations is necessary to break the risk spiral from subsequent risk impact, as well as, to ease the effect of the initial risk.

7.5.2 Risk management strategies

Q.2 what are the main risk management strategies to be considered?

This research developed risk management strategies using information theory that can sufficiently answer to risks associated with relationships and information. To understand the strategies and practices to manage risks in material procurement, the validated framework was further developed and populated by a literature review, case study questionnaire and interviews.

The approach showed four basic strategies that can be selected by managers involved in material procurement operations. These strategies include:

- (1) Building a stable procurement process,
- (2) Leveraging procurement information,
- (3) Leveraging outsourcing contracts and
- (4) Developing collaborative relationships with other parties.

It also proposed risk mitigating practices to serve these strategies. The descriptive analysis of the questionnaire data from 63 managers showed that building a stable procurement process strategy was frequently implemented, which was closely followed by the developing procurement collaboration strategy and the leveraging outsourcing contracts strategy.

7.5.3 Performance and outcomes of risk management strategies.

Q.3 Can these strategies generate positive outcomes?

This research emphasised managers' enablement in the application of risk management strategies. As a result, risk orientation, customer orientation and quality orientation were derived from the literature review, questionnaire, and interviews. The anticipated results of risk management strategies encompassed of robustness and flexibility in the procurement process. Robustness is claimed to be connected with the initial effect of risks with flexibility being related to the effect of succeeding risks.

To ascertain progression relationships between risk management strategies and robustness, the study proposed developed framework in which two hypotheses were tested using SPSS statistical analysis software

7.5.4 Risk management and robust procurement process

Q.4 How can procurement managers effectively manage risks in supply and procurement process?

Chapter 4 and 5 of this study revealed how risk management strategies could effectively provide a robust procurement process. In this process, a stable procurement process strategy was established. This appears in this study findings to be the most effective for the robust procurement process. The proposed strategy is also found to leverage procurement information and executing outsourcing contracts in terms of making significant and positive influences. The presented results demonstrated the strategic priority in implementing risk management strategies if a firm's resources are constrained. Most importantly, the dependence solely on the strategy to leverage outsourcing contracts needs to be treated with caution if cannot be avoided.

7.6. Research Implications & Limitations

A successful implementation of the two phases of risk management strategies provided for material procurement operations implies the means of determining and identifying risks in materials procurement and for the company to effectively mitigate these risks. The research implications are further towards managerial, methodological and theoretical.

7.6.1. Theoretical implications

Theoretical implications for this study can be summarised into six points:

- This research is the first study which has applied four risk management strategies to material procurement. Although there have been studies on supply risk management, their research scope was constrained to a specific mode or a certain phase of risk management, thus lacking a holistic view of risk management (Ghadge *et al.* 2012, Tang and Musa 2011). This research highlighted risks amplified by information and relationship

issues, as well as, illuminating the importance and risk mitigating measures. Also, some unique risks specific to oil material procurement were explored and prioritised by this research.

- This study explores how the consideration of risk management can reshape supply chain management.
- A framework for risk management strategies was suggested based on information processing theory (Galbraith 1963), a rigorous literature review and empirical validation. This framework comprises of two dimensions, namely the treatment of information processing gap and intra-/inter-organisational strategies, which can effectively respond to risks arising from the failure in information and relationships.

The framework was created in the context of material procurement risk management but can also apply to supply chain risk management. In these circumstances, risk management strategies, in this research, expanded discussions on supply chain risk management strategies (Bode *et al.* 2011) and global supply chain risk management strategies (Manuj and Mentzer 2008a; 2008b).

- Several mechanisms behind the implementation of risk management strategies.
The effects on risk management strategy are now empirically validated by a large-scale questionnaire and interview. The findings can be a stepping stone for further research because they suggest corporate features and cultures that a firm need to possess for risk management.
- The results can be applicable to the better understanding of SCM and SCRM.
Many SCM literature emphasised the importance of information and relationships in supply chains but did not have empirical grounds to support the idea in risk management views. This study revealed the crucial roles of information and relationships in risk management, thus will provide theoretical reinforcement for SCRM, supply chain collaboration and supply chain integration. Also, the relationships between organisations and risk management strategies may become the grounds for future research. The constructs used in this research can be easily transformed into SCRM, which can foster empirical research based on the larger-scale questionnaire.

7.6.2 Methodological implications

Three methodological implications are listed as follows:

1. This work combined empirical and analytical research techniques to capture the real shape of material procurement risks. The creative combination of the qualitative and quantitative mixed method maximised the explanation power of the proposed risk structure because it analysed the empirically-driven elements in a systematic manner. It is different from previous research which used elements from the literature review. The findings have graphically and systematically demonstrated the interactions of risks, which can provide empirical evidence to the concept of the risks within material procurement process.
2. N-vivo the qualitative data analysis (QDA) computer software was adopted to investigate the type of risks most frequent within procurement process and ranked it depending on their severity. N-vivo has not been used very often in SCRM research which was mainly led by qualitative studies. This research can guide for future research which will use this technique in the context of risk management.
3. This research covered all risk management phases using a multi-phase research method. It showed the applications of both qualitative and quantitative research methods within positivism paradigm by merging advantages that each method owns. In particular, the linkages between different methods were clearly suggested to figure out a holistic risk management approach. Managers can follow the series of research methods proposed in this research to find out critical risks in their organisations' procurement operations, the current status of their risk management practices and the future directions for mitigating critical risks.

7.6.3 Managerial implications

Managerial implications can also be drawn from this study as follow:

- The profile of material procurement risks will enable managers to anticipate and proactively deal with potential risks. The risks mentioned in this research are not completely exhaustive but still very meaningful because they are explored by practitioners

from specific industry involved in material procurement. Although material procurement process might be a small portion of the entire supply chain, its importance cannot be underestimated because material procurement operations are often the weakest link in the supply chain due to lack of information and control.

- Risk sources such as outsourcing and number of risk factors can provide a guideline to managers in investigating risks of their daily procurement operations. With individual or collective efforts, they can explore risk factors residing in each category. In this way, they can reach the root causes of their current and future disruptions, which can be the foundation of their risk management.
- This study highlighted the importance of the relationships with trade partners and procurement service providers because they play a great role not just in amplifying procurement risks but also in monitoring and mitigate it.
In particular, to develop collaboration are highlighted as the primary risk management strategies. Managers can investigate their definition of relationships reflecting the risk management practices proposed in this study, and thus achieve positive risk management performance.
- Companies involved in material procurement can evaluate the current status of their risk management efforts with the risk management strategies and practices suggested in this study, and then benchmark some of them. The four strategies (Building a stable procurement process, leveraging procurement information, leveraging outsourcing contracts and developing procurement collaboration) will provide practical ideas as to how companies can reduce risks. It will also be important for companies to reach a compromise on their direction of risk management with their trade and procurement partners.
- The research suggests that companies should carefully consider risk management strategies because their effects on risk management vary slightly. In general, the strategies to build a stable procurement process and to develop procurement collaboration are effective to fulfil robustness.
- Organisational orientations were emphasised in this research to enhance risk management strategies leading to risk management capabilities. Customer focus and awareness is a good starting point for a firm to consider possible risk areas and their consequences in the procurement process. From the customer's point of view, companies can easily detect risks undermining their operations and have strong rationale to rectify the issues despite the needs for financial investment and top management's supports.

Disruption awareness within an organisation also provides a chance to review the material procurement process and enables companies to develop robust inter-firm relationships. Quality orientation does not just augment the operational performance of a firm's procurement but also increases information processing capacity by initiating necessary investment in the procurement quality.

Companies striving for risk management culture can implant these orientations first to achieve effective material procurement both in operational performance and in risk management performance.

7.7 Limitations and Recommendations Future Research

The limitations of this study will open opportunities for future research relating to risk management.

- As the proposed framework is designed to be used as a template, the process of risk identification, monitoring and analysis can be imitated in other supply chain applications, such as warehousing or procurement in other industries. Since this study focused only on oil materials procurement out of a variety of applications in supply chain management, the findings may be very specific to the oil contexts. The application of the same research process to other areas will broaden the knowledge on supply chain risk management.
- The variation in the construction of focus groups may result in more rich knowledge. This study started with a number of stakeholders, then focus on service providers group without mixing up the participants. Mixed group, however, may facilitate further discussions about risk factors which the same group of people may overlook because they just take them for granted.
Moreover, although this study invited participants from service providers and end-users, other participants in the supply chain, such as logistics service providers, terminal operators and customs may also be invited to future research to provide a more comprehensive picture of material procurement risks.
- Cross-validation of the structural framework can be possible by widening the geographical scope of the research. This study investigated risk management by companies in Libya. Even though Libyan companies are a good sample to test the framework when their volume of material trade and procurement is considered, cross-

validation of the framework by other geographical areas will determine the general application of the research framework and findings. In particular, a comparative analysis between countries with small and large material trade volume will provide fresh insight into the development of risk management initiatives.

- Verification based on the current research framework will be a great potential area for the future research.
- Compared to other types of frameworks in this area, the limitation of the proposed framework according to the validation of the framework is that the monitoring and control strategy should be a continuous process at every stage of the risk management procurement operation rather than cycle loop.
- Risk performance measured by risk occurrence or risk impact can be incorporated into the future research framework. This research investigates risk factors during the procurement process because they can represent the desired outcomes from risk management. However, to precisely evaluate the effectiveness of risk management strategies, it will be necessary to investigate whether the strategies have reduced the risk level or not. The problem was that the risk level was not just dependent on the degree of risk management but also relied on the complexities that a procurement company inherently possesses, which generated a poor framework-fit of the initial research framework.

Lastly, future research may consider risk analysis using Agent-Based Modelling and Simulation (ABMS) to analyse the behaviour of procurement stakeholders, risk management strategies and risk level to confirm the positive effects of risk management on risk management performance.

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Appendices 1: Questionnaire

Evaluation of Supply Chain Risk Management in Materials Procurement - A case Research of Libyan Petroleum Industry

Page 1: Introduction

The oil industry is one of the most important industries in the world as it provides the energy that is needed by almost all industries in many countries.

Therefore, procurement equipment, and materials for this industry is very delicate process, as it contains and associates various types of supply risks.

Aims: This questionnaire aims to collect data from suppliers , contractors (service providers) and end user managers in oil companies who engage in procurement operations for equipment and materials .

Owner /End -User companies, have to identify and manage risk factors that affect the procurement project to reduce the frequency and impact of supply risks hence increase the company's performance.

The result of this research should help in secure the procurement processes from failure and to ensure stability for the oil industry.

This ongoing PhD. research uses the themes of supply risk management and procurement management as a vehicle to implement this target.

This questionnaire should take 10-15 min.

Thank you for your time,

Mohamed F. Laradi

(Under supervision of Dr.Anthony Olomolaiye)

Coventry University, United Kingdom

* Data Protection:

All data collected in this questionnaire will be held anonymously and securely, no personal questions. Data will be used for the purpose of this research and will be destroyed later.

1By ticking the box, I consent to be a participant in this research. *Required*



I Agree

Page 2: Company General Information

2What kind of organisation is you currently working for?



Material Supplier



Contractor, service provider, third party



Owner/ end user

3Which country is you currently operating from?

4How would you classify your organisation in terms of size?

Page 3: Company and Respondent

5How many years have you been practicing equipment ,material procurement and procurement process?

- ☐ < 5 years
- ☐ 6 - 10 years
- ☐ 11 - 15 years
- ☐ 16- 20 years
- ☐ >21 yers

6What is the value of procurement operations you are authorised to execute or normally carry out?

- ☐ \$10,000-50,000
- ☐ \$51,000-100,000
- ☐ \$101,000-250,000
- ☐ \$251,000-500,000\$
- ☐ >\$500,000

7Is your company ISO certified ?

- ☐ Yes
- ☐ No
- ☐ Don't Know

Page 4: Risk Management

8Do you practice the following activities during procurement processes?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question?

	Every time	Almost every time	Sometimes	Almost never	Never
Risk Identification	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Risk Registration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Risk Analysis / Assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Risk Mitigation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Risk Monitoring & Control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Definitions

Risk Identification: Identifying risks using e.g. consulting experts, brainstorm sessions.

Risk Registration: Recording the list of risks .

Risk Analysis: Estimating probability and impact of the risk.

Risk Mitigation : Actions taken to reduce risks effects .

Risk Monitoring and Control: Observation of results /action .

Page 5Risk Identification

9How frequently do you practice the following statements?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question? View in tableless mode

	Every time	Almost every time	Sometimes	Almost never	Never
We are informed about possible risks in our supplier network.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

We are constantly searching for short-term risks in our supplier network.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In risk analysis , we define early warning indicators.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Risk Analysis/Assessment

10 Do you practice the following activities ?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question?

	Every time	Almost every time	Sometimes	Almost never	Never
During risk analysis for suppliers , we look for the possible sources of supply risks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
During risk analysis for suppliers , we evaluate the probability of supply risks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
During risk analysis for supplier, we analyse the possible impact of supply risks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
During risk analysis for	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

suppliers, we evaluate the urgency of our supply risks.					
During risk analysis for all suppliers, we classify and prioritise our supply risks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Risk Mitigation

11How frequently do you practice the following activities?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question? [View in tableless mode](#)

	Every time	Almost every time	Sometimes	Almost never	Never
During risk analysis for suppliers , we demonstrate possible reaction strategies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
During risk analysis for suppliers ,we evaluate the effectiveness of possible reaction strategies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supply Risk Management is an important activity in our company.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Risk Monitoring , Control and Continuous Improvement

12Do you agree with the following statements?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question? [View in tableless mode](#)

	Strongly Agree	Agree	Nether Agree or Disagree	Disagree	Strongly Disagree
We control our risk management methods in Procurement and Supply Management and adapt these to changing conditions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
We control the progress for critical supply risks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
We control our activities for identifying and analysing supply risks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Risk Performance

13 Do you agree with the following statements in regards to your organisation?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question?

	Strongly Agree	Agree	Nether Agree or Disagree	Disagree	Strongly Disagree
Our employees are experienced in solving occurrence of supply risks.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Our risk management processes in procurement are very professionally designed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

We managed to minimise the frequency of occurrence of supply risks over the last three years.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
We managed to minimise the impact of occurrence of supply risks over the last three years.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14 Do you agree the following is an advantage of outsourcing*?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question?

	Strongly Agree	Agree	Nether Agree or Disagree	Disagree	Strongly Disagree
Improved time-scales	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reduced risk exposure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reduced cost	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Improved administration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Quality of service improvements	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Risk sharing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

* Outsourcing is the process where end-user request an external organisation (e.g.contractor) to execute the procurement process on their behalf.

15 When disruption occurs , Is there a proactive plan to be executed?

- ☐ Yes
- ☐ No



Don't Know

16 Do you agree the following statements are benefits of using Risk management ?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question? [View in tableless mode](#)

	Strongly Agree	Agree	Nether Agree or Disagree	Disagree	Strongly Disagree
Secure project time frame	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Better use of resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cost savings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Time savings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Following international standards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sustainability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17 Do you agree the following risks often occur during procurement processes?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question? [View in tableless mode](#)

	Strongly Agree	Agree	Nether Agree or Disagree	Disagree	Strongly Disagree
Unreliable Suppliers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shortage of suppliers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Financial Issues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Logistic Issue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inappropriate Inventory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Raw material price fluctuation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Government Issue (Tax,regulation,...)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lack of communication with supplier	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lack of technical experts within our organisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

18 Do you agree the following risks usually occur during procurement implementation?

Please don't select more than 1 answer(s) per row.

Having trouble with the format of this question? [View in tableless mode](#)

	Strongly Agree	Agree	Nether agree or disagree	Disagree	Strongly Disagree
* Un-clear scope of work	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Un-clear material specifications	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Lack of suppliers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Suppliers operations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Contract Terms & Conditions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Lack of resources	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Lack of expertise	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
* Financial stability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Definitions :

* Un-clear scope of work: Plan and target is wrong or not easy to understand .

* Un-clear specifications : Material specifications are not accurate or wrong

- * Lack of suppliers: Risk due to type of product /dealing with high value and technologically advanced product (product constraint)
- * Suppliers Operations: Inflexible, low performance and quality of service, delay, capacity constraints, operation of sub-supplier,shipping/transportation and inventory.
- * Contract Terms & Conditions: Inaccurate terms
- * Lack of Resources: IT , communication, equipment, facilities .
- * Lack of Expertise: Lack of knowledge , experience and the ability to cope with project rectifications.
- * Financial Stability: Price fluctuation, low budget, currency exchange, un schedule instalment,cash flow management.

19 Do you agree these issues are drivers of supply chain risk management in your company? *

Please select all that apply

Having trouble with the format of this question?

	Strongly Agree	Agree	Nether Agree or Disagree	Disagree	Strongly Disagree
Government regulations/legislation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gaining competitive advantage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Customer perception of company's image	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organisation's values	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cost reduction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Avoidance of problems with stakeholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Industry regulatory compliance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pressure / encouragement by customers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Deregulation of the downstream oil industry	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supply chain integration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Strategic issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
------------------	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

a Please enter any comments or additional risks you think are important and have not been mentioned in this questionnaire.

B Thank you again for your time. If you have any comment please write it down . If you would like to receive a copy of results from this research, please provide me with your e-mail address

• Finish

Powered by BOS Copyright Questionnaire contact details

Appendices 2-A: Interview Informed Consent

Informed Consent

Dear Sir / Madam,

I am a PhD. student at the Engineering and Computing faculty in Coventry University; I am interested in Material Procurement and Risk Management. My research investigates type of risks that your organisation faces during execution procurement process.

You have been asked to participate in this interview to describe experiences in your working life at the organisation, in particular describing the risks you think are apparent in the supply chain. I will ask questions that are related to supply risk.

The interview is confidential and your anonymity will be maintained throughout my project. I will not include any information in my thesis or any papers subsequently written about the study that will identify you.

Your participation in this interview is completely voluntary .You may refuse to participate in this interview or discontinue participation at any time.

The interview will last approximately 30-45 minutes. I would like to electronically record your responses to my questions so I can listen carefully to what you have to say and take notes. I will destroy the electronic recording of this interview as soon

as my thesis is completed. If you do not want me to record your responses, then I will just take notes.

If you have any questions about this project, you may contact me on laradim@uni.coventry.ac.uk.

Interview questions

1. What is the challenging risks you most frequently facing during the procurement process? Why they are the most important ones?

2. Is there any reason why these risks appear frequently?
3. What is the impact, of these risks?
4. Can these risks be reduced / managed?
5. Do you use any system for documenting incidents, tools, software or contingency plans to monitor or mitigate the consequences of these risks?
6. Are you satisfied regarding the performance of your procurement team in terms of managing /mitigating risks? Can this performance be increased (i.e. Training)?

Thanks,,,

Name of Researcher: **Mohamed Laradi**

Coventry University

ID: 2819637

Signature of researcher:

Date

Appendices 2-B: Interview Consent Templet Form
Participant Consent Form

Ref.No.

Research Title:

“Evaluation of Supply Chain Risk Management for Material Procurement in Libyan Oil Industry”

Please tick

1. I confirm that I have read and understood the participant information sheet provided by the researcher for the above research and have had the opportunity to ask questions.

☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.

☐

3. I understand that all the information I provide will be treated in confidence

☐

4. I understand that all the information I provided will be destroyed by the researcher by the end of research period and can be used only for research purpose.

☐

5. I agree to be filmed & recorded as part of the research interview process.

☐

6. I agree to take part in the research project



Name of participant

Signature of participant:

Date

Name of Researcher: **Mohamed Laradi**

Coventry University

ID: 2819637

Signature of researcher:

Date

Appendices 3: Screen shot of N-Vivo (Interview data analysis)

Laradi.nvp - NVivo Starter

FILE HOME CREATE DATA ANALYZE QUERY EXPLORE LAYOUT VIEW

Document Memo Node Case

Sources Nodes Cases

Look for Search In Find Now Clear

Nodes

Nodes

Name	Sources	References	Created O	Created By	Modified O	Modified
Challenging and Risks during procurement	0	0	08/08/2016	LARADI	12/08/201	LARADI
Clone Part	7	8	12/08/2016	LARADI	13/08/201	LARADI
Delay	8	8	12/08/2016	LARADI	13/08/201	LARADI
Oil Fluctuation Price	3	4	12/08/2016	LARADI	13/08/201	LARADI
Security	1	1	12/08/2016	LARADI	13/08/201	LARADI
Product discrepancy	1	1	12/08/2016	LARADI	12/08/201	LARADI
Reason for risks appear frequently	0	0	12/08/2016	LARADI	12/08/201	LARADI
Hard to identify clone (Experience)	7	7	12/08/2016	LARADI	13/08/201	LARADI
No control on the oil market price	1	1	12/08/2016	LARADI	13/08/201	LARADI
Goods Transhipment	3	3	12/08/2016	LARADI	13/08/201	LARADI
Impact of the risks	0	0	12/08/2016	LARADI	12/08/201	LARADI
Problems to the machine	6	6	12/08/2016	LARADI	13/08/201	LARADI
Penalties	6	6	12/08/2016	LARADI	13/08/201	LARADI
Cancel projects	1	1	12/08/2016	LARADI	13/08/201	LARADI
Reduced risks and managed	0	0	12/08/2016	LARADI	12/08/201	LARADI
Select supplier	6	6	12/08/2016	LARADI	13/08/201	LARADI
Clear required specifications to supplier	4	4	12/08/2016	LARADI	13/08/201	LARADI
Original parts	6	6	12/08/2016	LARADI	13/08/201	LARADI
Add budget	1	1	12/08/2016	LARADI	13/08/201	LARADI
Expertise	5	5	12/08/2016	LARADI	13/08/201	LARADI
Monitoring system	0	0	12/08/2016	LARADI	12/08/201	LARADI
Record for supplier's performance (Form)	9	9	12/08/2016	LARADI	13/08/201	LARADI

Sources Nodes Classifications Collections Queries Folders

LARADI 30 Items

Appendices 4: Sample of Risk Record & Supply Evaluation Form

NWD Procurement Risk Register							
Risk Name & Description	Current Controls	Impacts	Risk Assessment			Risk Treatment	Responsibility / Due Date
			Likelihood	Consequence	Risk Rating		
<i>Example:</i> Insufficient funding	none	Delays to purchasing	C Possible	4 Major	High	Ensure funding approvals obtained at start of project	

NWD Vendor performance Evaluation Form							
Vendor	Product Quality	On Time Delivery	Documentation Quality	Development Costs	Development Time	Cost per Unit	Transactional Efficiency
Vendor #1							
Vendor #2							
Vendor #3							
Vendor #4							
Vendor #5							
Vendor #6							
Vendor #7							
Vendor #8							
Vendor #9							
Vendor #10							

- 1 – Unsatisfactory
- 2 – Acceptable
- 3 - Exceptional

Appendices: 5. Framework Validation.

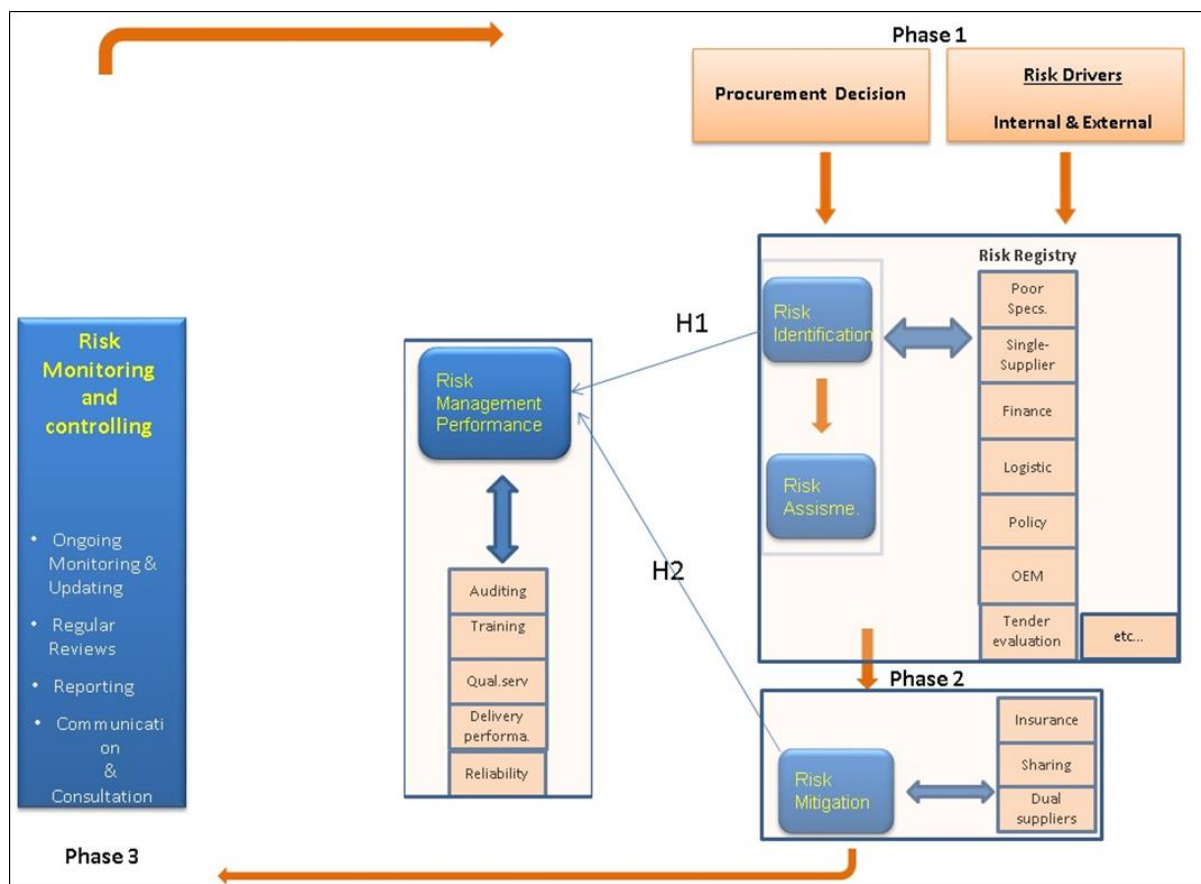
Dear Participant,

The second aim of this research is to develop and validate Procurement Risk Management Framework which should support procurement managers in dealing with risks during the procurement process.

Please find below the developed framework which been developed during this research, kindly read the brief description and answer the 5 questions to validate it.

Thank you for your participation,

Mohamed F. Laradi



Phase I:

After the material procurement decision is taken, internal and external risks start threatening the process.

Risk Identification:

A process where manager must identify types of risks that been stored in the risk registry such as: poor specifications, single supplier, finance issue Etc.

Risk Assessment:

The main aims of the stage is to provide managers with analysis and results in form of information.

Phase II

Risk Mitigation:

After receiving the analysis results from risk analysis phase, managers can take a decision in order to mitigate the specified risks.

Phase III

Risk Monitoring:

Continuous monitoring process is required to recognise new potential risks, check the occurrence (or potential occurrence) of already identified risk, review the effectiveness of mitigation measures, documentation, reports and adjustment of the risk management plan where necessary.

Risk Performance:

This administration process performs the output of the previous processes and what's needed in order to increase the performance. (i.e. Training, Auditing, Improvement...etc.)

Please evaluate and validate this framework by answering these questions

Thank you,,

Mohamed Laradi

Participant Responses

MN.. 1.6

1. Do you see opportunity to apply this framework on your projects and across a variety of procurement process?

Yes, there is good chance to use this framework as a tool in our procurement projects.

2. Did you find the framework understandable, ; feasible/non-feasible ,clear and concise?

Clear to understand

3. To what extent is the framework immediately seen to be of value and why?

The frame work is seen to be of value, because it can guide you to mitigate risks during the procurement process

4. To what extent is the framework seen as relevant and complete?

It looks complete; however, it should be empirically tested with real project. I will use it in the next project.

5. What would you suggest should be added to the framework? and why?

The participant commented that the concept is fine,

MN.. 2-6

1. Do you see opportunity to apply this framework on your projects and across a variety of procurement process?

It looks practical framework, yes, it can be used as a tool in our procurement process as it consists of complete risk management components. The only concern weather the framework can properly managed.

2. Did you find the framework understandable; feasible/non-feasible, clear and concise?

Yes, it is comprehensive and clear.

3. To what extent is the framework immediately seen to be of value and why?

The framework add value to the procurement process from the end user prospective, because it consists of complete risk strategies that will lead procurement managers in mitigate risks during their procurement process.

4. To what extent is the framework seen as relevant and complete?

It looks complete, because it contain all risk management steps . however it should be empirically tested with real procurement process. I will use it in my next project.

5. What would you suggest should be added to the framework? and why?

The frame work is good and more risk factors can be added to the registry.

MN.. 3-6

1. Do you see opportunity to apply this framework on your projects and across a variety of procurement process?

Yes, there is good chance to use this framework as a tool in our procurement projects. It could strengthen the procurement risk management activities.

2. Did you find the framework understandable; feasible/non-feasible ,clear and concise?

Yes , Clear and understood

3. To what extent is the framework immediately seen to be of value and why?

The frame work is seen to be of value, because it provides a clear guide line to be follow in order to monitor the procurement process and it also can be used to prevent risks before appearance.

4. To what extent is the framework seen as relevant and complete?

It is relevant to risk management; however, It has to be empirically tested.

5. What would you suggest should be added to the framework? and why?

I suggest the monitoring phase should not be separate. Monitoring process is continues monitoring process liaising all the time with other components.

MN.. 4-6

1. Do you see opportunity to apply this framework on your projects and across a variety of procurement process?

Yes indeed, I can see the benefit of practicing such framework

2. Did you find the framework understandable, ; feasible/non-feasible ,clear and concise?

The framework is comprehensive and should not be complicated especially for practitioners.

3. To what extent is the framework immediately seen to be of value and why?

The frame work is seen to be of value, because it provide a full picture will guide you to mitigate risks during the procurement process

4. To what extent is the framework seen as relevant and complete?

It looks complete and comprehensive; however, I suggest to be tested or prototype form to ascertain its reliability and possible modification.

5. What would you suggest should be added to the framework? and why?

The frame work is good and more risk factors can be added to the registry to make the framework more effective.

MN.. 5-6


1. Do you see opportunity to apply this framework on your projects and across a variety of procurement process?
Yes, there is good chance to use this framework as a supporting tool for our procurement projects.
2. Did you find the framework understandable; feasible/non-feasible, clear and concise?
Clear to understand
3. To what extent is the framework immediately seen to be of value and why?
The frame work is seen to be of value, because it will guide you to mitigate risks during the procurement process
4. To what extent is the framework seen as relevant and complete?
It looks complete, relevant and reliable, however it should be empirically tested with real project. I will use it in the next project.
5. What would you suggest should be added to the framework? and why?
The frame work is good however more risk factors can be added to the registry.

MN... 6-6

1. Do you see opportunity to apply this framework on your projects and across a variety of procurement process?
Yes, I can see the benefit of using this framework re is good chance to use this framework as a tool in our procurement projects.
2. Did you find the framework understandable, ; feasible/non-feasible ,clear and concise?
Clear to understand
3. To what extent is the framework immediately seen to be of value and why?
The frame work is seen to be of value, because it will guide you to mitigate risks during the procurement process
4. To what extent is the framework seen as relevant and complete?

The framework could help in solving procurement process but more emphasis should be on monitoring process.
5. What would you suggest should be added to the framework? and why?
I suggest that monitoring phase should not be separate process (in sequence). Monitoring process is a continuous process and should operate any time in the cycle liaising with other components.

Appendices 6: Sample of Request of quotation (RFQ)

 Mabruk Oil Operations		مبروك للعمليات النفطية				
Quotation Request						
P.R(s). No.:M5290-13		Enquiry No. : M0086-14 Enquiry Date : 10/03/2014				
Vendor Details : Address : _____ Contact : _____ Email : _____ Tel : _____ Fax : _____		Closing Date : 20/03/2014 Number of Items : 1 Final Destination : _____ / LIBYA Forwarding Agent : _____ Payment Terms : 30 Days Net Freight Terms : DDP <small>MOO General Terms and Conditions MAB/PMD/PROC./2012/0002 Applies</small>				
<small>This Quotation Request includes the present document as well as the General Conditions of Purchase and Shipping instructions</small>						
ITEM	DESCRIPTION	PART NO.	MANUFACTURE	VOCABULARY	UNIT	QTY
1	ELECTRICAL MOTOR 0,75kW 400V 50 Hz 3PH	1106362	EUROMOTORI	14.303.001.0750	PCE	2.00
*** Nothing Follows ***						
Mabruk Oil Operations, Libyan Branch Dhat EL Imad Complex, Tower 4, Floor 3 P.O. Box 91171, Tripoli Libya. Commercial Registration N° 25636 Tel : (218.21) 3350401, 3/6, Fax : (218.21) 3350415 / 3350402 / 3350558				مبروك للعمليات النفطية، فرع ليبيا، مجمع ذات العمد برج 4 كائنات 3، ص.ب. 91171، طرابلس، ليبيا رقم السجل التجاري 25636 هاتف 3350558 / 3350402 / 3350415 (فكس) 218.21 (3350401 3/6)		

Appendices 7: Sample of purchasing order (PO)



AKAKUS OIL OPERATIONS

19-Dec-2013

Local Purchase Order

Purchase Order 04/Dec/2013	P.O. No.: P131362
Vendor Name and Address AXIS Contact: www.axitec@aol.com AXIS Technology. Libya. GSPLAJ Gergaresh. Reem Al Bawadi Business Tripoli Libya P.O.Box 74960 Email +21821 484-1518 +21821 483-2430	Shipping Marks شركة أكاكوس للعمليات النفطية Location: AOO El Sharara Store PO P131362 PR OP131362
مرکز التكلفة 0301-2999-..... تاريخ التسليم 12/02/2014 طريقة الدفع NET 60 DAYS Freight Terms: DOOR TO DOOR	Total Order LDN 329,603.40 العملة دينار ليبي Number of 3

Additional Information

-PO as per your Offer Ref No: AX-AK-13/ 362R, Dated 16/09/2013.

Line البنء	Maximo	Qty الكمية	Unit الوحدة	Description الوصف	Unit Cost سعر الوحدة	Total المجموع
1	68387	7	EACH	Material: PRX3 F27 PRM3 110V/70X2 140A, -P/N: S9278132.	28,890.00	202,230.00
2	68388	2	EACH	Monitoring. PCM2. Charging Rectifier. Kraft PRX3. -P/N: S9229100.	900.00	1,800.00
3	68389	7	EACH	UPS PW9130i5000T-XL. -P/N: S9925178.	16,660.00	116,620.00
				Total Material:		320,650.00
4	SHIP	1		Other Shipping	5,690.00	5,690.00
5	TAX	1		Tax	3,263.40	3,263.40
				Total Other Charges:		8,953.40
				Grand Total: المجموع الكلى		329,603.40

Recommended **أوصى بها من قبل**

A. Abujarad

Approved By: **أعتمدت من قبل**

M. Gonzalez

AKAKUS Oil Operations (Tripoli)
 El-Tahaddi Street (Off Airport Road)
 P.O. Box: 91987
 Telephone: (00218)21-4802630/39 Ext: 7320 Fax:

شركة أكاكوس للعمليات النفطية
صندوق بريد
التهاتف **بريد مصور**

Distribution: Original: Vendor Copy: Materials Copy: Accounts

PO/reports/roi/rpotlarb_act.1.41627.445787037_112733024.roi

Page 1 of 1

Appendices 8: Sample of Procurement Terms and Conditions



HAROUGE OIL OPERATIONS GENERAL PROCUREMENT TERMS AND CONDITIONS

MATERIALS AND EQUIPMENTS

1. Quotations must clearly show this enquiry reference number.
2. Please ensure that all quotations have the following details clearly shown on the first page of the quotation, failure to do so will result in the quotation being rejected
 - a. Currency must be in Euro or GBP or US\$.
 - b. Total quotation Lump Sum Value.
 - c. Delivery point, CIF Ras Lanuf INCOMTERMS 2010. With option to Tripoli or Benghazi.
 - d. Validity of Quotation.
 - e. Lead time for delivery.
 - f. Note: Partial offer will not be accepted.
 - g. Origin of Materials, specific country shall be identified.

Note: block descriptions such as 'Europe' or 'European Union' is not acceptable.
 - h. Brand/model and manufacturer (s) name.
 - i. Offering (Genuine) or (OEM).
 - j. Applicable Warranty Period.
3. Quotations must have minimum (120) day validity from bid closing date.
4. Quotations must show line item prices, unit of measure, line item quantity extended price and total value for all items.
5. Quotations must be for brand new products and country of origin for each line item, failure to give this information may result in your bid being rejected. We may in the event of an order require a Certificate of origin or Conformity from the manufacturer. Please confirm you can comply.
6. Any literature, drawings, brochures etc, referenced within your bid must be attached to your quotation.
7. We reserve the right to inspect goods at any stage of manufacture prior to dispatch.
8. **All parts must be brand new and genuine:**

The Supplier is obliged to verify whether the equipment/parts ordered under this contract (procurement) are subject to a national export/transit license according to supplier's home country regulations. The supplier must state the result of this verification in the order confirmation and is responsible for obtaining the export license in accordance with applicable national regulations of his home country. If a required license is not granted by the national authorities, Harouge Oil Operations reserves the right to cancel this order without any additional cost to Harouge Oil Operations.