Modelling the Fragility and Resilience of Enterprises

وضع نماذج لهشاشة المؤسسات وقدرتها على الصمود أمام المصاعب

by

AMER MUHAMMAD GOUMAA ALAYA

A thesis submitted in fulfilment

of the requirements for the degree of

DOCTOR OF PHILOSOPHY IN BUSINESS MANAGEMENT

at

The British University in Dubai

Professor Halim Boussabaine

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Date: 19 November 2017

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Abstract

This study attempts to expand the existing literature on modelling enterprise fragility and enterprise resilience and their impact on risk management performance. This research employed a quantitative method to collect data from risk management practitioners. It attempted to investigate the contribution of risk events on inducing enterprise fragility and the contribution of risk attributes on enhancing the enterprise resilience to the risk events that induce enterprise fragility. Severity indexes, exploratory factor analysis and confirmatory factor analysis were conducted to rank and reduce data. Moreover, structural equation models were developed to explore the root-causal relationship that links enterprise fragility and enterprise resilience to risk related managerial performance.

The research findings showed that risk events that induce the fragility of enterprise strategy are grouped into three latent variables: business models and plans, financial and strategic innovations, and globalization and politics. Risk events that induce the fragility of enterprise governance are grouped into three latent variables: risk guidelines, risk auditing and risk communication. Risk events that induce the fragility of enterprise operations are grouped into four latent variables: internal processes, people, systems, and external events. Risk events that induce the fragility of enterprise business units are grouped into two latent variables: failure of business processes and mis-utilization of assets. Risk events that induce the fragility of enterprise projects are grouped into four latent variables: risk monitoring, project scope, risk responding and risk integrating. Attributes that enhance enterprise resilience are grouped into five latent variables: risk governance, risk appetite, risk informed decision-making, risk culture, and risk policies design.

Furthermore, structural equation models have been converged to show that enterprise fragility can impact risk management performance and so can enterprise resilience. The results show acceptable model fitness for the fragility of strategy, the fragility of governance and the fragility of business unit and so is the case for resilience.

This study contributes to knowledge by presenting a conceptual model to assess enterprise fragility, and it incorporates different enterprise levels. This assessment tool will help practitioners to scale how fragile an enterprise is, and so they can anticipate the enterprise robustness and resilience. For future research, it is recommended to develop a resilience or anti-fragility assessment tool in order to show the other side of the coin. In addition, it is recommended to do similar studies on sector levels to consider the specific conditions of each sector.

تهدف هذه الدراسة إلى توسيع نطاق الأدبيات الحالية بشأن هشاشة المؤسسات وقدرتها على الصمود أمام المصاعب وأثرها على أداء إدارة المخاطر. اعتمدت الدراسة على جمع بيانات كمية من ممارسي إدارة المخاطر وتحليلها في محاولة لدراسة تأثير الأحداث الخطرة على المؤسسات وقدرتها على الصمود أمام المصاعب. اعتمد التحليل على إجراء اختبار مؤشرات الشدة والتحليل الاستكشافي والتحليل التأكيدي للمكونات من أجل اختزال البيانات ووضعها في إطار يسهل فهمه. وعلاوة على ذلك، تم تطوير نماذج معادلة هيكلية لاستكشاف فيما اذا كانت هشاشة المؤسسة أو قدرتها على الصمود أمام المصاعب عامل مؤثر على أداء إدارة المخاطر.

وأظهرت النتائج أن الأحداث الخطرة التي تحفز هشاشة استراتيجية المؤسسة يمكن اختزالها في ثلاثة متغيرات كامنة: نماذج الأعمال وخططها، والابتكارات المالية والاستراتيجية، والعولمة و التقلبات السياسية. كما تختزل الأحداث الخطرة التي تحفز هشاشة حوكمة المؤسسات في ثلاثة متغيرات كامنة: إرشادات التعامل مع المخاطر، وتدقيق المخاطر، وإيضاح المخاطر. وتختزل الأحداث الخطرة التي تحفز هشاشة عمليات المؤسسة في أربعة متغيرات كامنة: العمليات الداخلية، والعنصر البشري، ونظم العمليات، بالإضافة إلى الأحداث الخارجية. وتُختزل الأحداث الخطرة التي تحفز هشاشة الوحدة التنظيمية في المؤسسة في متغيرين كامنين هما: فشل العمليات التجارية وسوء استخدام الأصول. وتصنف الأحداث الخطرة التي تحفز هشاشة مشاريع المؤسسة إلى أربعة متغيرات كامنة: رصد المخاطر، ونطاق المشروع، والاستجابة للمخاطر، ودمج المخاطر. وأظهرت النتائج أن السمات التي تعزز قدرة المؤسسة على مواجهة الأحداث الخطرة التي تحفز هشاشة المؤسسات تصنف إلى خمسة متغيرات كامنة: حوكمة المخاطر، ونطاق التعامل مع المخاطر، وبناء القرارات على المعلومات المتعلقة بالمخاطر، وثقافة المخاطر، وتصميم سياسات التعامل مع المخاطر.وقد أظهرت نتائج نماذج المعادلة هيكلية أن هشاشة المؤسسات أو قدرتها على الصمود أمام المصاعب تؤثر على أداء إدارة المخاطر.

وتسهم هذه الدراسة في إثراء المعرفة من خلال تقديم نموذج مفاهيمي لتقييم هشاشة المؤسسة على مختلف مستوياتها. وستساعد أداة التقييم هذه أصحاب الاختصاص على تحديد مدى هشاشة المؤسسة، ومن ثم يمكنهم توقع قوة المؤسسة وقدرتها على الصمود أمام المصاعب. فيما يتعلق في البحوث المستقبلية، فمن المستحسن تطوير أداة لتقييم قدرة المؤسسة على الصمود أو مكافحة الهشاشة من أجل إظهار الجانب الآخر من القصة. وبالإضافة إلى ذلك، يوصى بإجراء دراسات مماثلة على مختلف القطاعات للنظر في الظروف الخاصة بكل قطاع.

Dedication

إلى روح أبي الطاهرة ...

إلى لمسة أمي الحنون ...

إلى زوجتي الحبيبة ...

إلى إخوتي الأعزاء وأخصّ مروان ويوسف ...

إلى أستاذي الفاضل عبد الحليم ...

وأخيراً وليس آخراً إلى أستاذي الفاضل عبدالله الشامسي ...

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List of Abbreviations

ERM	Enterprise risk management
COSO	The Committee of Sponsoring Organizations of the Treadway Commission
SPSS	Statistical Package for Social Sciences
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
SEM	Structural equation modelling
GFI	Goodness of Fit Index
IFI	Incremental fit Index
NFI	Normed Fit Index
CFI	Comparative Fit Index
NNFI	Non-normed Fit Index
RMR	Root Mean Square Residual
TLI	Tucker-Lewis Index
RMSEA	Root Mean Square of Approximation
SRMR	Standardized Root Mean Square Residual
AIC	Akaike Information Criterion
KMO	Kaiser-Meyer-Olkin
OECD	Organisation for Economic Co-operation and Development

CHAPTER ONE

INTRODUCTION

1.1. Introduction

This chapter describes the context and the background information of the research. It also identifies the research problem and scope, research statement, and research significance. The chapter further presents the research questions as well as research aim and objectives. The final section of this chapter provides an overview of the research methodology and the structure of this thesis.

1.2. Research Context and Background Information

Businesses operate in a challenging and ever-changing environment in which risks emerge constantly. Enterprises are subject to different potential disruptions. These may vary in significance and likelihood and on certain occasions they entail a fatal failure of the enterprise. The ability of the enterprise to respond to and recover from any disruptive events is critical to its survival and healthy performance. It is also important to point out that the notion of risk is fundamental to business reward, risks should be managed in an intelligent and effective way by creating a balance between risk and opportunities, that is, taking more risks than expected or fewer risks than needed would affect the efficient achievement of strategic goals (Deloitte 2013). The ultimate endeavour of any enterprise is to continuously search for opportunity while minimising risk to ensure resilience and continuity of operation. Consequently, one of the ultimate strategic goals of any enterprise is to be resilient to disruptions and avoid being caught out of position; therefore, there is a need to move from the reactive status to the proactive opportunity seeking strategy.

Studies have attempted to explore the impact of risk management practices on business financial fragility such as Martínez-Jaramillo et al. (2010), Caballero and Krishnamurthy (2006), Burnside, Eichenbaum and Rebelo (2001), and Diamond and Rajan (2001), yet they are limited as they mainly focus on specific risk management activities – hedging activities and commodity price risk management. These activities do not actually manage the business risks; rather, they transfer them through insurance or other financial products. These activities are not business-wide risk management practices because they do not cover all business units nor do they involve non-financial risk management techniques; moreover, they ignored the intangible value of the enterprise. Risk management activities in the enterprises examined by these studies are mere rough assessment and quantification of risks; they are not based on formal strategies or implementation plans based on developed risk management frameworks. The concept of risk management in these studies does not match the concepts of Enterprise Risk Management (ERM) in its holistic perspective as suggested to this study; therefore, these studies do not answer the research question.

In an extensive search of the academic empirical evidence, Smithon and Simkins (2005) stated that corporate risk management is a value-adding activity. In an analysis of 21 published studies – 9 of them studied financial institutions and 12 studied industrial corporations, Smithon and Simkins (2005) found that financial price risk is reflected in share price behaviour. Moreover, 15 studies – six looked at financial institutions and 9 on industrial Corporations – were examined and it was found that if companies use derivatives to manage financial price risk (such as, changes in interest rates, foreign exchange rates, or commodity prices), there will be an evidence of a change in the sensitivity of their stock returns to those risks. Furthermore, in an analysis of ten empirical studies, Smithon and Simkins (2005) found a relationship between the use of derivatives as risk management techniques and the value of the firm. Moreover, in a study of the overall ERM in 275 insurance firms that operated between 1995 and 2005, Hoyt and Liebenberg (2011) found a statistically significant positive relationship between the firm's economic value and the use of ERM. Furthermore, finance theories suggest that the firm's value can be improved if risks of underinvestment and variability of cash flow are addressed by risk management activities (Froot, Scharfstein & Stein 1993), and a boost in business performance is suggested to be associated with ERM practices (Singh & Kadaba 2005) yet enterprises which financially perform well and have a positive economic value are not necessarily resilient to risk events. None of the above models have taken into consideration the multiple layers of enterprise that go beyond the financial profit or loss. Consequently, there is a need for a holistic model that considers all different fragility drivers including political, social, and behavioural threats on all levels: strategy, governance, operations, business unit and project.

Although both resilience and risk management seek, in principal, efforts to face threats and hazards (Purpura 2013), yet the exact relationship between both disciplines need to be tested empirically (Mitchell & Harris 2012). Risk management can provide 'a window on resilience' because risk and resilience approaches have many characteristics in common, such as: assessment of alternatives to deal with uncertainty, holistic assessment of systems and their interaction, emphasis on capacities to manage hazards or disturbances, and forward looking and proactivity (Mitchell & Harris 2012; Obrist, Pfeiffer & Henley 2010; Berkes 2007). If the inherent similarities between risk and resilience can be reframed, risk management can be at the foundation of resilience. Moreover, in the literature of disaster management, it is established that risk management plays a major role at minimizing the consequences of disasters or hazards on ecological systems, and it enhances the capabilities of the communities and socio-economic systems to recover or 'bounce back' from a disaster (Manyena 2006; Cardona 2004; Lee, Ce Shen & Tran 2008; Obrist, Pfeiffer & Henley 2010; Villanueva 2011; Batica & Gourbesville 2016). Moreover, risk management can be an entry point for operationalizing and measuring resilience (Twigg 2009); however, the story is different with enterprise resilience whose literature lacks the empirical studies to define the relationship between risk management from one side to resilience and fragility from the other side.

The literature suggested that the majority of the studies investigated enterprise resilience and enterprise fragility are conceptual studies (e.g. Paton et al. 2000; Hamel & Välikangas 2003; Starr et al 2003; Riolli & Savicki 2003; Rudolph & Repenning 2002; Fiksel 2003 & 2006; Crichton, Ramsay & Kelly 2009; Gibson & Tarrant 2010; Lengnick-Hall et al. 2011) and case-study focused (e.g., Horne & Orr 1998; Valikangas 2004; Dalziell & McManus 2004, Reinmoeller & van Baardwijk, 2005; McManus et al. 2008; Gulati et al. 2010) and above all they lacked a consistent approach to operationalize enterprise fragility; therefore, there is a need for a theory-based empirical research on the factors that make an enterprise fragile or make it resilient and this justifies the current research. Furthermore, only few studies focussed on developing an objective, reliable and practical assessment model for monitoring organizational resilience (Grecco et al. 2013).

Due to the interdisciplinary nature of "resilience" and "fragility", a complex and immense study is needed to cross the boundaries of disciplines and provide a robust analysis that maps risk, resilience and fragility in an enterprise context. As a result, there is a certain gap in the research related to how enterprise resilience is influenced by risk management practices. That is to say, there is a need to study how non-adherence to risk management makes enterprises caught out of position and fragile to external stimulus. To bridge this gap, there is a need to collect primary data that identifies what types of risks that contribute to the enterprise fragility and what are the enterprise practices that enhance resilience to these events. To identify the best way to evaluate the enterprise resilience or fragility, data should be collected not only from the financial statements of the business, but also from all other operational processes implemented in the different layers of the business. That is to say, this research will adopt an ERM conceptual framework that guides all financial and operational activities in the business in a top-down and a bottom-up interaction among strategic level, governance level, operational level, business unit level and project level of the enterprise.

1.3. Research Statement

This research studies enterprise resilience as a multidimensional dynamic capacity embedded in different organizational levels, routines or processes by which the enterprise orients itself to decisively move forward and establish a setting of collective behaviours and attitudes that devastate the adverse consequences of disruptions and turbulences. This perspective is in alignment with Hall and Beck's argument of resilience as an organization's response to environmental changes in the sense that it encourages the enterprise to develop effective repertoire of routines that ensure complexity reduction and complexity absorption and also to develop the enterprise capabilities of deciding on the most effective options for adaptation or transformation (2016).

This research adopts a transformational view of enterprise resilience which is seen as an inherent attribute of an enterprise or organizational system that focuses on the holistic view of how the system behaves as a whole. This view is in alignment with three-dimension measurement of a system resilience proposed by Walker et al. (2002, p.5) which measures resilience by "[t]he amount of change a system can undergo and still retain the same controls on function and structure … [t]he degree to which the system is capable of self-organization … [t]he degree to which the system expresses capacity for learning and adaptation."

1.4. Research Significance

In an attempt to gauge the maturity of ERM practices in the MENA region, EY and Munich RE conducted a study of the insurance markets in Kingdom of Suadi Arabia (KSA) and the United Arab Emirates (UAE). The results of the study show that 41 per cent of the respondents do not have a risk management department; 40 per cent of the respondents do not have a "formally defined and approved risk appetite statement in place"; 41 per cent of the "insurance companies believe there is a need to improve their overall risk management framework"; 75 per cent of "risk reporting level and measurement are still poor"; and 88 per cent of the respondents have not "fully implemented an IT system to support risk management" (EY & Munich RE, 2015). Although the results of the survey refer to the insurance markets, but they raise a big question about the maturity of ERM in all other sectors and all other countries in MENA region because insurance sector is one of the industries that are most concerned with risk management. If the ERM practices are not up to standards in insurance markets, they are not expected to be so in other industries. The KSA and the UAE can be considered a good sample of the MENA region as they are known to be more advanced than other neighbouring counties in terms of managing businesses and hosting international businesses; therefore, the ERM practices in other MENA countries are not expected to be in a better situation. It was also pointed that current risk management frameworks proved unable to provide an adequate understanding and a timely warning of the financial crisis (Mertzanis 2014). These frameworks do not consider the complexity of the enterprise infrastructure nor do they consider the relationship between risk governance and cognitive resilience; therefore, they should be called into question. There is a need for a more analytical approach to give weight to different sources of risk with the aim of building a robust and adaptable system on both macro and micro levels.

Consequently, this study is highly significant for MENA region since it will shed light on ERM practices and assess the benefits of implementing resilience oriented risk management framework. It may be difficult to identify the source or origin of the fragility factors and tracking of them; however, if the enterprise knows which areas are fragile they can put more resources to enhance anti-fragility and resilience. To build in a basis for studying enterprise fragility, the researcher relied on literature to identify the risk events that are thought to induce enterprise fragility. Therefore, the research focused on the absence of a systematic and agreed upon enterprise fragility or enterprise anti-fragility frameworks. The research addresses this aspect by seeking to clarify the constructs of enterprise fragility since the lack of organized framework could make it more difficult for managers and practitioners to identify and analyse the enterprise fragility or even to suggest possible strategies to enhance the enterprise anti-fragility and enterprise resilience.

1.5. Research Aim and Objectives of the Study

1.5.1. The aim of the research:

The aim of this research is to investigate, extract and model the risk events that induce fragility in enterprises and the attributes that build the resilience of enterprises to fragility.

1.5.2. Research Objectives

- To review literature on risk, fragility and resilience
- To classify and extract latent variables that represent fragility inducing risk events and resilience inducing attributes
- To investigate the influence of fragility inducing risk events and resilience inducing attributes on risk management performance of enterprises
- To develop and test a framework/tool for assessing the fragility of enterprises to risk events

1.5.3. Research Questions

The research purpose of this study is to answer the following questions:

1. What type of risk events which induce the fragility of the enterprise at different organizational levels?
2. What are the risk management attributes that enhance enterprise resilience to fragility-inducing risk events?
3. How to model the influence of fragility inducing risk events on enterprise risk management performance?
4. How to model the influence of resilience inducing attributes on enterprise risk management performance?
5. What framework/tool that can be used to evaluate the enterprise fragility to risk events?

These questions examine the proactive nature of risk management as a foundation of resilience and how it might strengthen enterprise fragility and protects the business from future changing situations. When answered, these questions will reflect the approach of the study, in which the enterprise will be categorized into different layers that cascade from the highest corporate level to the smallest business unit or project.

1.5.4. Hypotheses

The following hypothesises have been designed to help to carry out this investigation. This study is driven by two main constructs

Fragility risk events construct

H01: $\beta 1 = 0$ There is statistically significant association between fragility inducing risk events and enterprise risk management performance

H A1: $\beta 1 \neq 0$ There is no statistically significant association between fragility inducing risk events and enterprise risk management performance

Resilience to fragility risk events construct

H01: $\beta 1 = 0$ There is statistically significant association between resilience to fragility risk events and enterprise risk management performance

H A1: $\beta 1 \neq 0$ There is no statistically significant association between resilience to fragility inducing risk events and enterprise risk management performance.

1.6. Research Methodology

The research methodology is generally outlined in this paragraph. However, the details of the research methodology approach with further argument and empirical support is elaborated in the later methodology chapter.

This research adopts both positivism and interpretivism research paradigms. The researcher is positivist in the sense that he takes a controlled and structural approach in conducting research by identifying a clear research topic, constructing appropriate hypotheses and by adopting a suitable research methodology; moreover, the researcher remains detached from the participants and remain emotionally neutral to make clear distinctions between reason and feeling, to separate science from personal feelings, and to seek objectivity and rationality (Carson et al., 2001). Although the main goal of the researcher is to make time and context free generalizations, yet the researcher admits the interpretivist perspective on reality as multiple and relative (Hudson & Ozanne 1988).

The research reports an analysis of a survey of risk management practitioners with the objective of ascertaining their views concerning the risk events that induce the fragility of the enterprise and the attributes that enhance enterprise resilience to these risk events. The research method comprises a number of tasks and phases. The early phase involves the literature reviews on the subject area to gain more insight into the concepts of risk, fragility and resilience with an overview of risk management frameworks. The next step involves identifying appropriate fragility risk events and resilience to fragility risk events constructs. The risk events were clustered in terms of the different organizational levels. A questionnaire was developed and circulated electronically to practitioners of risk management in the enterprises enlisted in Dubai and Abu Dhabi financial markets. The survey participants were asked to rank how likely a risk event may induce the enterprise fragility and how likely a strategy or a tactic enhances enterprise resilience to risk events that induce fragility.

The data obtained from the completed questionnaire was transferred into a proper tabling and formatting using Microsoft Excel and Statistical Package for Social Science (SPSS) in order to extract relevant statistical data for the research. The data was translated into models using IBM SPSS AMOS (trademark of Amos Development Corporation). The statistical findings of the survey, the overall conclusions and implications of the research were presented in the later chapters.

1.7. Structure of the Thesis

The thesis is divided into 10 chapters.

Chapter 1: aims to present an introduction, purposes and objectives of the research. A theoretical literature review and justification of the significance and importance of the research are outlined in this chapter

Chapter 2: presents a detailed deconstruction of the concepts used in the research. It reviews the common risk management frameworks and enterprise fragility/resilience models. A new framework is proposed to enterprise fragility and resilience for the sake of conducting this research.

Chapter 3: focuses on extracting the risk events that constitutes the variables of enterprise fragility and enterprise resilience. As per the proposed framework, the extracted fragility variables are grouped according to the relevant enterprise level, while enterprise resilience variables are grouped according to the risk management dimensions. This makes the variables more meaningful to the practitioners.

Chapter 4: presents the research methodology for the research. It also elaborates the approach used for the development of the survey design.

Chapter 5: describes the collected data and provides a descriptive analysis of the responses. It also describes how the data was spread.

Chapter 6: describes and presents the results of the factor analysis processes conducted to the responses.

Chapter 7: presents the structural equation models which are drawn based on the results of factors analysis.

Chapter 8: describes the development of an assessment tool for enterprise fragility. It also presents the results of a validation test to the tool in three enterprises.

Chapter 9: presents a discussion of the results that are obtained from analyses conducted throughout the research.

Chapter 10: presents **s**ummary, research contribution and recommendations for further research.

The research design is illustrated in figure 1.1.

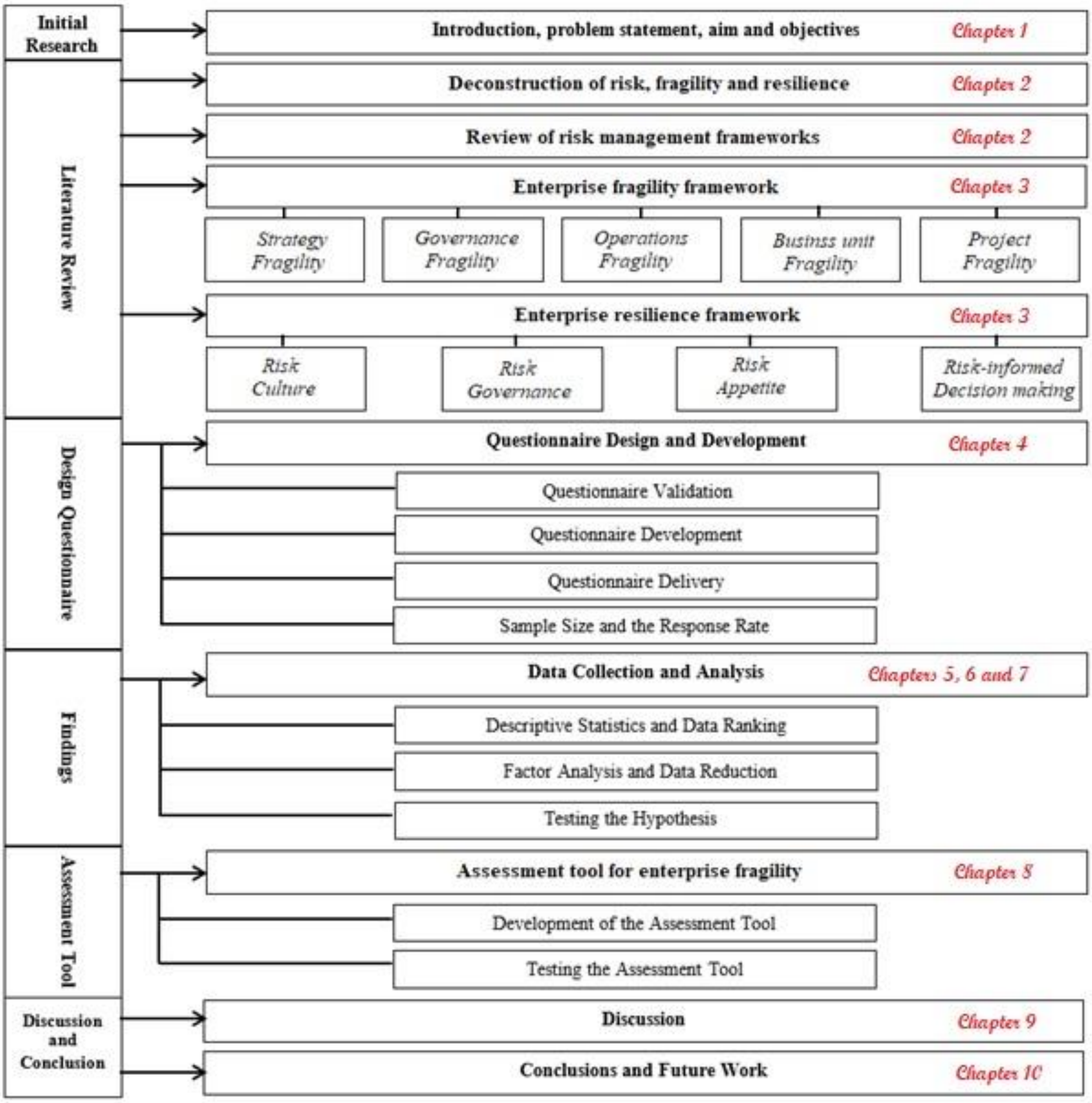


Figure 1.1: Research plan

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents a comprehensive literature review of risk, fragility and resilience. The chapter presents a set of different definitions of the three terminologies and projects the attempts to link them with one another. The three concepts are circumscribed and the relationship between them is defined to steer the direction of the research. Based on the presented mapping, enterprise risk management will be justified as a foundation for enterprise fragility and enterprise resilience. The chapter sheds light on fragility and resilience in the context of enterprise. The chapter then continues with reviewing the studies that attempted to operationalize fragility and other studies that attempted to operationalize resilience. The chapter is concluded by defining the constructs that are used throughout the research – strategy fragility, governance fragility, operations fragility, business unit fragility, project fragility, risk culture, risk governance, risk appetite and risk-informed decision making.

2.2. Concepts of risk and uncertainty

Risk is a complex concept that represents something will happen in the future with a random chance or possibility; therefore, risk has always been associated with making decisions about the actions that should be done to face risks. Since a wide range of investigation fields have been interested in the concept of risk, the terminology of "risk" is often imprecise. Therefore, it is a difficult task to circumscribe the concept of risk and it is usually mistakenly used interchangeably with the concept of uncertainty.

Based on Taleb's (2007) interpretation of uncertainty as 'true randomness' and 'deterministic chaos', uncertainty is interpreted in two different approaches. The first approach associates uncertainty with the difficulty in presuming causes and thus effects are not identified and thus it is the result of 'ontological randomness', while the second approach associates uncertainty with surprises as an 'absolute form of indeterminism' and thus it originates from 'epistemological randomness' (Derbyshire & Wright 2014). In both scenarios, risks are associated and risks disappear only if certainty exists (Cardona 2004). However, these two concepts, risk and uncertainty, have not been deconstructed within clear boundaries although literature presents an extensive analysis of the concepts of risk and uncertainty (Aven & Renn

2009), but the understanding of differences between the two concepts is significant for implementing ERM to create value and maintain resilience.

The disagreement about the concepts of risk and uncertainty can be traced back to the beginning of the twentieth century when Knight (1921) claimed that risk is differentiated from uncertainty in being quantifiable, that is ‘risk’ is a term that refers to a numerically measurable uncertainty, while ‘uncertainty’ is restricted to refer to non-quantitative or statistically immeasurable cases. The prototypical case of risk, in what is called ‘Knightian uncertainty’, is a casino game like roulette or blackjack. Although supported by many proponents especially economists, yet this view has been challenged by many opponents. Hastings (2004) conceptualized uncertainty as something that can be known, unknown, or known to a certain quantifiable degree. Agreeably, Holton (2004) links uncertainty to the state of one’s knowledge regarding the trueness or falseness of a certain proposition. A significant disagreement with Knight’s view was presented by Taleb (2007), who stated that “computable” risks are “laboratory contraptions” (and real life is almost free from absolute probabilities. Moreover, Knight’s prototypical case of risk, i.e. casino games, is criticized by Evans (2012) in the sense that data can be observed about the rules of the game and data can be crunched to reach estimation about the probability of the risk. However, there is a consensus that “uncertainty emanates from a lack of completeness of knowledge” (Boussabaine 2013).

As the two words ‘risk’ and ‘uncertainty’ have not been differently conceptualized, extensive literature has been generated about the definition of risk. Thumbing through the robust literature of risk, a set of definitions can be found; therefore, risk does not have a single well-defined concept. Risk is making decisions under the conditions of “known probabilities” (Knight 1921). Risk is “probability and consequence” (Kaplan & Garrick 1981); risk is the “probability” of an “unwanted outcome” (Graham & Wiener 1995). Risk is “expected harm” (Campbell 2005). Risk is the statistical expectation of an unwanted loss (Willis 2007). The above-mentioned common definitions express risk by means of probabilities or expected values and they do not reflect the impression that the severity of risk as low probability does not equal low risk. Moreover, they see risk as a static concept whose evaluation is based on the unforeseen adverse outcome.

On the other hand, Hansson expresses risk by events, consequences and uncertainties, and he defines risk as a reference “to situations in which it is possible, but not certain, that some undesirable event will occur” (1999, p.539). Similarly, Rosa describes risk as “a situation or event where something of human value (including humans themselves) has been put at stake and where the outcome is uncertain” (1998, p.28). This definition does not only address uncertainties instead of probabilities, but also accommodates both desirable and undesirable features of risk. Rosa's definition can be altered as "risk refers to uncertainty about and severity of the events and consequences (or outcomes) of an activity with respect to something that humans value" (Aven & Renn 2009, p.1) in order to allow a comparison between high and low risks. That is to say, the notion of risk can be symbolized in the form of the following equation: Risk = Probability x consequences (Boussabaine 2013, p.31). Such a definition endorses the dynamic nature of risks and explains how risks are not mere static manifestation of a danger; rather, risk outcomes change due to the dynamic context risks occur in and the actions taken to mitigate them. This definition also shows that risk and vulnerability are not the same thing. Cardona (2004, p.37) defines vulnerability as "an internal risk factor of the subject or the system that is exposed to a hazard and corresponds to its intrinsic predisposition to be affected or to be susceptible to damage", and he defines hazard as "a latent danger or an external risk factor of a system or exposed subject" and thus risk results from the "convolution of hazard and vulnerability".

The multiple perspectives and the interchangeable use of risk, uncertainty and vulnerability concepts in literature might be a significant area of discussion to scholars and academics, yet practitioners are more concerned with the possibility and the significance of the added-value or the potential loss that might result from risks as these have direct effect on business performance, continuity and resilience. Therefore, there is a need for a risk-based resilience framework that enables managers to make significant decisions in relations to all types of risks and fragility concepts. In this study, risk is viewed as a probability that will lead to threatening or promising consequences.

2.3. The concept of fragility

"Fragility is related to how a system suffers from the variability of its environment beyond a certain preset threshold ... [W]hen systems—a building, a bridge, a nuclear plant, an airplane, or a bank balance sheet—are made robust to a certain level of variability and stress but may fail or collapse if this level is exceeded, then they are particularly fragile to uncertainty about the distribution of the stressor, hence to model error, as this uncertainty increases the probability of dipping below the robustness level, bringing a higher probability of collapse" (Taleb & Douady 2013, p.1677). Fragility and vulnerability are not the same thing, rather fragility is a cause of vulnerability. There are three main reasons behind enterprise vulnerability to hazards: physical fragility, enterprise socio-economic fragility and above all a lack of resilience (Cardona 2004); fragility means anti-resilience.

As an outcome to the method or approach through which an enterprise deals with ontological randomness or epistemological randomness, the enterprise will be in a range between the status of 'fragile' or 'anti-fragile'. That is to say, fragility and anti-fragility describe the status of the enterprise preparedness to deal with the consequences of uncertainty. Consequently, the relationship between uncertainty and fragility is not a cause-effect relationship. In other words, it is not uncertainty that causes the enterprise's fragility; rather, it is the inadequate preparedness to uncertainty. This is in agreement with Taleb's (2007) view that the causal constructions are unnecessarily required for being anti-fragile. In other words, the focus is on the outcome rather than the cause. In this research, fragility is attributed to the preparedness of the enterprise to the threatening consequences of risks.

2.4. Review of fragility assessment tools

2.4.1. OECD Growth-Fragility framework

In an attempt to reduce the risks of economic crises and make economies more resilient, the Organisation for Economic Co-operation and Development (OECD) propose a growth-fragility framework (See figure 8.1). The framework attempts to identify possible growth-crisis trade-offs from two perspectives: the extent to which pro-growth policies can make economies more vulnerable to crises and severe recessions; and assessing the impact of risk-mitigating policies on growth. It investigates the impact of various policy settings on average GDP growth on the one hand and either financial crises or exceptionally low GDP growth rates on the other. It provides indications about the areas where policy reforms boost growth and resilience and the ones where reforms can generate trade-offs.

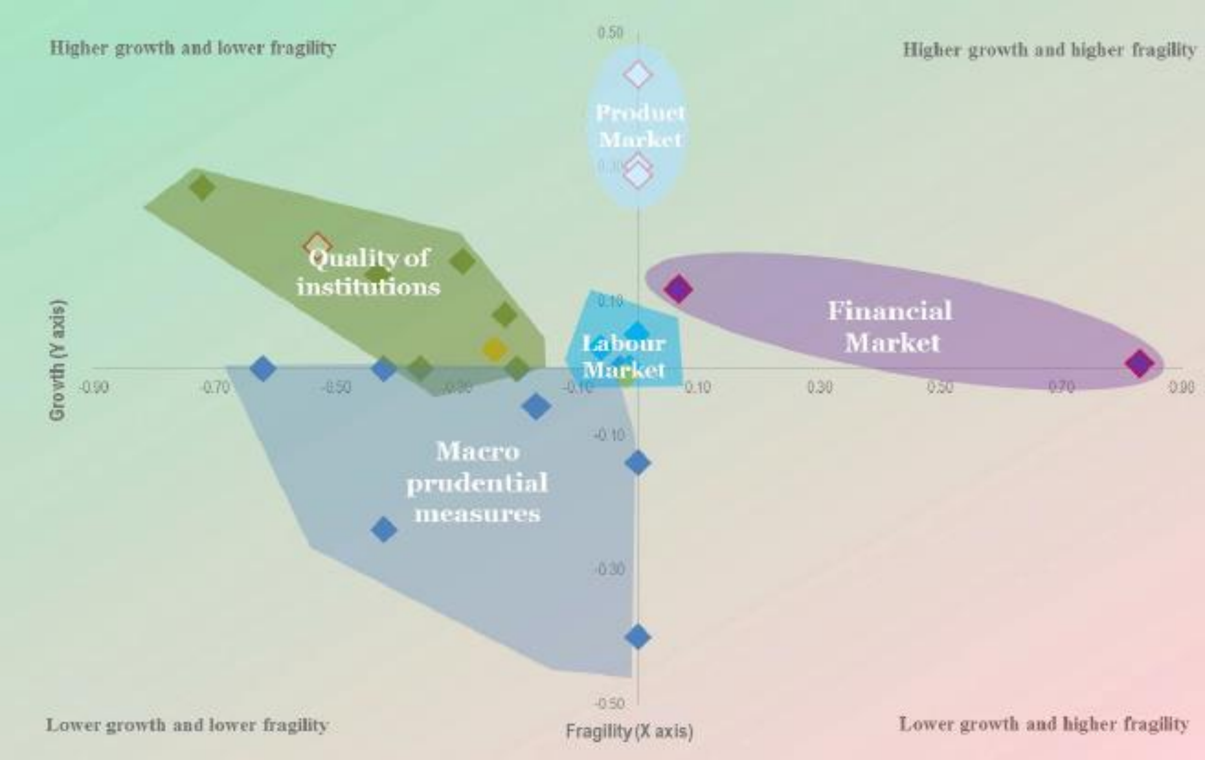


Figure 2.1: Policy areas in a growth-fragility framework (adopted from Loewald et al. 2017)

2.4.2. SEER Model

On the enterprise level, fragility assessment models are not common. A model that barely touches enterprise fragility is suggested by Edgeman (2014) as a modification of a previous model suggested by Edgeman and Eskildsen (2014). It proposes an assessment of the sustainability, excellence, resilience and robustness of the enterprise (SEER). It focuses on the transformation of top line strategies into superior bottom line performance. Six major assessment areas (top line strategy and governance; processes implementation, translation and execution; financial and marketplace performance; sustainability performance, human ecology and capital performance, social-ecological Innovation and general innovation performance) are assessed in terms of maturity criteria on a 0-to-10 scale for each. See figure 8.2.

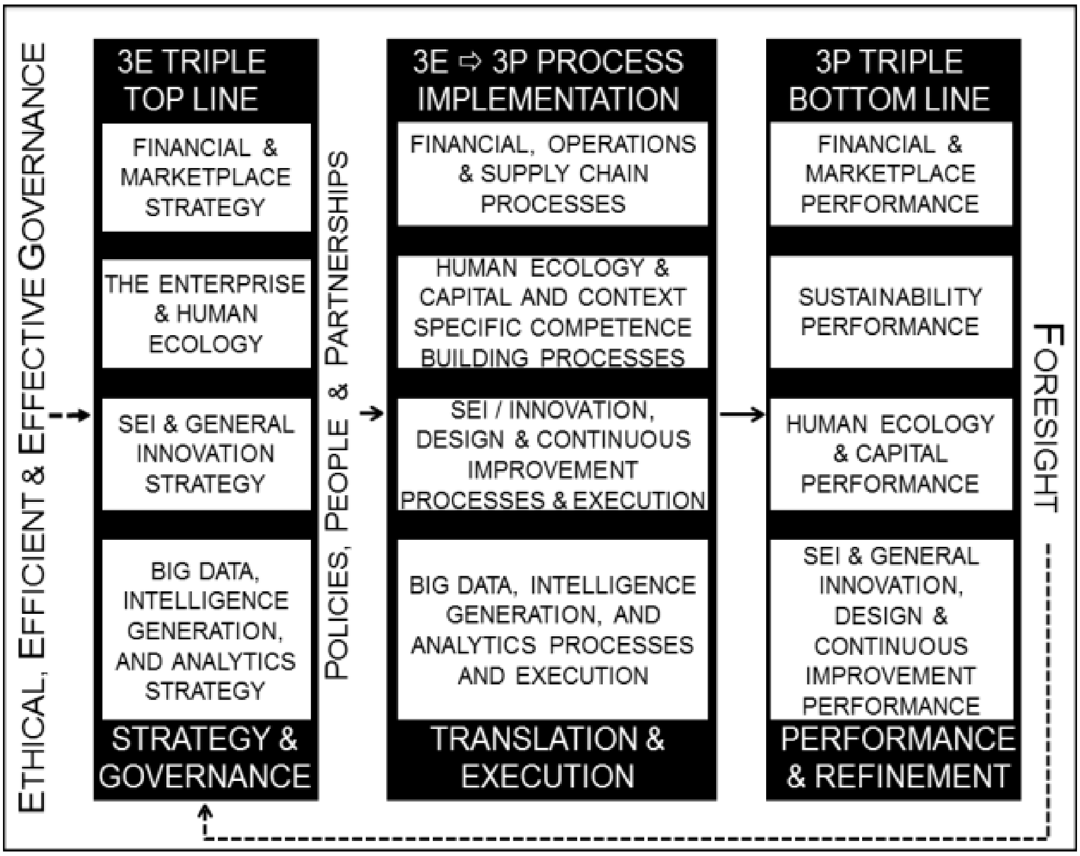


Figure 2.2: Springboard to SEER Model (adapted from Edgeman 2014)

2.4.3. Supply chain fragility model

Stonebraker, Goldhar and Nassos (2009) developed a model to assess corporate sustainability and operational robustness in terms of profitability and costs from a supply chain management perspective. To measure fragility, they propose a set of 6 internal indicators, 4 externalities, and other uncontrollable random events. The internal factors are as follows: physical logistics, behaviour of suppliers, behaviour of customers, information, communication & control systems, product & process design, and people. The externalities are as follows: legal, political & acts of government, behaviour of competitors, financial, accounting, & economics, and environmental impact. Examples of uncontrollable random events are as follows: weather disturbances, terrorism or war. Figure 8.3 shows a representation of the fragility index matrix.

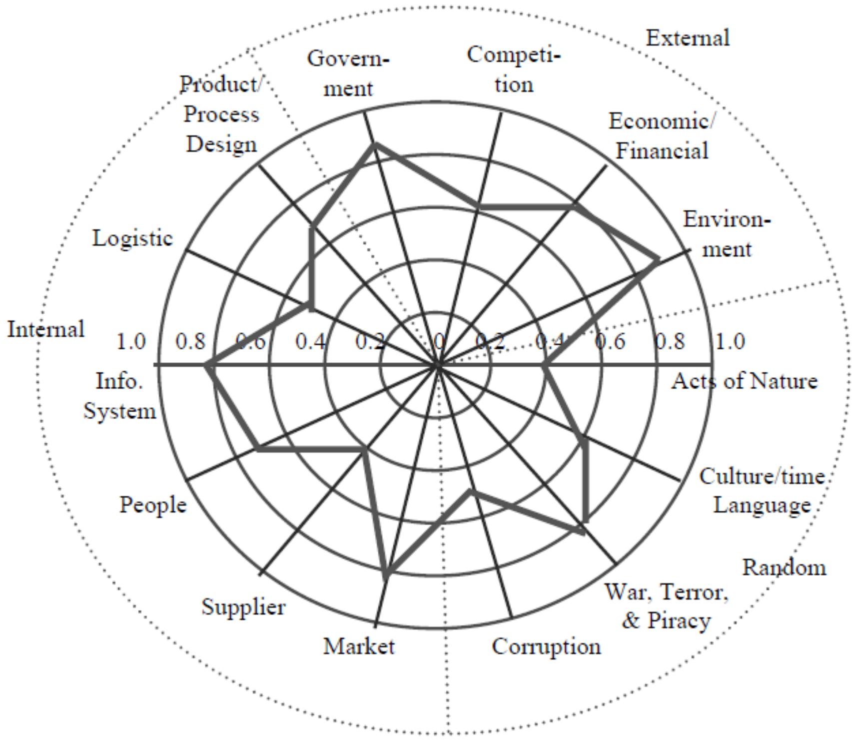


Figure 2.3: Supply chain fragility index matrix (adapted from Stonebraker, Goldhar and Nassos 2009)

2.5. The concept of "resilience"

Although the concept of 'resilience' is widely used and has been gaining a global momentum, yet its deconstruction is a thought-provoking task since it is frequently applied in a number of disciplines such as engineering infrastructure (Reed, Kapur & Christie 2009; Park et al 2013), system engineering (Haimes, Crowther, & Horowitz 2008), crisis management (Boin & McConnell 2007), disaster management (Cutter et al. 2008), social–ecological systems (Walker et al. 2004), psychology (Bonanno 2004; Yates & Masten 2004), and the behavioural sciences (Norris 2011). Therefore, the conceptualization of resilience has become 'dominant' as it significantly contributes to mitigating threats and 'enigmatic' due to the puzzling variety of its practical applications (Prior & Hagmann 201, p.281).

The construct can be traced back to the mechanics literature that was published in the nineteenth century in which 'engineering resilience' was used to describe how the material of steel absorbs shocks and withstand stress (Holling 1996; Alexander 2013). In 1950s, this notion was applied in psychology to describe how schizophrenic patients could withstand shock (Yates & Masten 2004). Another usage of the term emerged in ecology by Holling in the 1970s to capture the system's dynamic and adaptive capacity for 'renewal, re-organization, and development'. He drew a distinction between two different approaches of resilience:

engineering resilience that focuses on "stability near an equilibrium steady state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property" and ecological resilience that focuses on "conditions far from any equilibrium steady state, where instabilities can flip a system into another regime of behaviour – that is, to another stability domain" (Holling 1996, p.33). In other words, engineering resilience reactively focuses on managing risks to build responsive mechanisms for perturbations; therefore, it emphasizes on efficiency, constancy and predictability. On the other hand, ecological resilience proactively focuses on managing both risk and uncertainly to enhance the sustainable functionality of the system through dynamic and continual development, therefore, it emphasizes on persistence, change and unpredictability (Carpenter et al. 2001; Seville et al. 2006).

Despite the difference in focus between the two foundations, yet they commonly conceptualize resilience as the attribute of responding positively to unexpected disturbances and overcoming undesired changes. That is, it focuses on the ability of the underlying system to adjust itself for the purpose of maintaining its essential functions under disturbances and disruptions. Based on those two foundations, scholars from different research domains have developed numerous definitions for the resilience construct coming from an incorporated understanding of the theoretical dimensionality of the construct. A set of definitions of resilience is presented in table 2.1 (adopted from Bhamraa, Daniab & Burnard 2011)

Table 2.1: Definitions of resilience (adopted from Bhamraa, Daniab & Burnard 2011)

Author	Context	Definition
Bodin and Wiman (2004)	Physical systems	The speed at which a system returns to equilibrium after displacement, irrespective of oscillations indicates the elasticity (resilience)
Holling (1973)	Ecological systems	The measure of the persistence of systems and of the ability to absorb change and disturbance and still maintain the same relationships between state variables
Walker *et al.* (2004)	Ecological systems	The capacity of a system to absorb a disturbance and reorganise while undergoing change while retaining the same function, structure, identity and feedback
Gunderson (2000)	Ecological systems	The magnitude of disturbance that a system can absorb before its structure is redefined by changing the variables and processes that control behaviour
Tilman and Downing (1994)	Ecological systems	The speed at which a system returns to a single equilibrium point following a disruption
Walker *et al.* (2002)	Socio–ecological systems	The ability to maintain the functionality of a system when it is perturbed or the ability to maintain the elements required to renew or reorganise if a disturbance alters the structure of function of a system
Carpenter *et al.* (2001)	Socio–ecological systems	The magnitude of disturbance that a system can tolerate before it transitions into a different state that is controlled by a different set of processes
Luthans *et al.* (2006)	Psychology	The developable capacity to rebound from adversity
Bruneau *et al.* (2003)	Disaster management	The ability of social units to mitigate hazards, contain the effects of disasters when they occur and carry out recovery activities that minimise social disruption and mitigate the effects of future earthquakes
Paton *et al.* (2000)	Disaster management	Resilience describes an active process of self righting, learned resourcefulness and growth. The concept relates to the ability to function at a higher level psychologically given an individual's capabilities and previous experience
Coutu (2002)	Individual	Resilient individuals' posses three common characteristics. These include an acceptance of reality, a strong belief that life is meaningful and the ability to improvise
Hamel and Valikangas (2003)	Organisational	Resilience refers to the capacity to continuous reconstruction
Horne and Orr (1998)	Organisational	Resilience is the fundamental quality to respond productively to significant change that disrupts the expected pattern of event without introducing an extended period of regressive
McDonald (2006)	Organisational	Resilience conveys the properties of being able to adapt to the requirements of the environment and being able to manage the environments variability
Hollnagel *et al.* (2006)	Engineering	The ability to sense, recognise, adapt and absorb variations, changes, disturbances, disruptions and surprises

Despite the enormous interest in the concept of resilience, its systematic empirical research is still underdeveloped as its literature has been predominantly conceptual focusing on developing a static knowledge establishment of the theories and concepts (Bhamra et al., 2011). The literature of resilience has generally focused on three main elements: readiness and preparedness, response and adaption, and recovery or adjustment (Ponomarov & Holcomb2009). Enterprises can build adaptive capacity if good practice and lessons learned, from inside and outside the enterprise, are disseminated, shared and implemented and people's skills are developed to be innovative, flexible and agile (The British Standards Institution 2014).

Although 'resilience' is interchangeably used with other constructs such as 'adaptability', 'transformability', 'robustness', and 'redundancy', yet it goes beyond all of them. Adaptability or adoptive capacity is a concept that has been deconstruct as an aspect of resilience (Dalziell and McManus 2004, Fiksel 2006, Erol, Sauser & Mansouri 2010); however, it precisely refers to "the capacity of actors in a system to influence resilience" (Walker et al. 2004, p.4). Transformability is also different from resilience as it refers to the "capacity to create a fundamentally new system when ecological, economic, or social (including political) conditions make the existing system untenable (Walker et al. 2004, p.5). Moreover, robustness is different from resilience as it refers to "the degree of insensitivity of a system's performance to errors in the assumptions of design parameters and variations in the operational environment that may result in adverse operating conditions" (Haimes, Crowther & Horowitz 2008, p.291). Furthermore, although redundancy is commonly suggested to create resilience (Dalziell & McManus 2004; Sheffi & Rice 2005), yet 'redundancy' is different from resilience as it "refers to the ability of certain components of a system to assume the functions of failed components without appreciably affecting the performance of the system itself" (Haimes, Crowther & Horowitz 2008, p.290)

These concepts are not only interrelated with resilience but also interrelated with one another. For example, redundancy can be a means to increase a system's adaptive capacity (Dalziell & McManus 2004; Haimes, Crowther & Horowitz 2008). Overall, resilience can be enhanced by increasing the adaptive capacity of the system (Dalziell & McManus 2004, Walker et al. 2004), by increasing the robustness of the system (Haimes, Crowther & Horowitz 2008), by increasing the transfomabilit of the system (Walker et al. 2004), and by increasing redundancy (Sheffi & Rice 2005; Haimes, Crowther & Horowitz 2008).

This study considers resilience from the point of view of ecological resilience that focuses on sustaining the dynamism and functionality of the system by managing risk, uncertainty and fragility.

2.6. ERM to map risk, fragility and resilience

Uncertainty is the mutual factor among the three concepts: risk, fragility and resilience. Because enterprises cannot terminate uncertainty, they are always vulnerable to be hit by disruptions. If an enterprise is fragile, it will suffer the damage of the disruption; however, if the enterprise is anti-fragile, it will resist the disruption and become resilient. Therefore, anti-fragility is the first step towards reducing vulnerability and building a resilient enterprise. The relationship between the three constructs is illustrated in figure 2.4. Uncertainty can be categorized into diminishable uncertainty and undiminishable uncertainty. The first emerges from known unknowns, while the later emerges from unknown unknowns. This uncertainty is translated into a set of risks that vary in terms of significance and likelihood, but are usually handled within risk appetite boundaries. When risks are mitigated, they show the status of the enterprise that ranges between fragility and anti-fragility. When fragility is eliminated and anti-fragility is enhanced, enterprise becomes resilient.

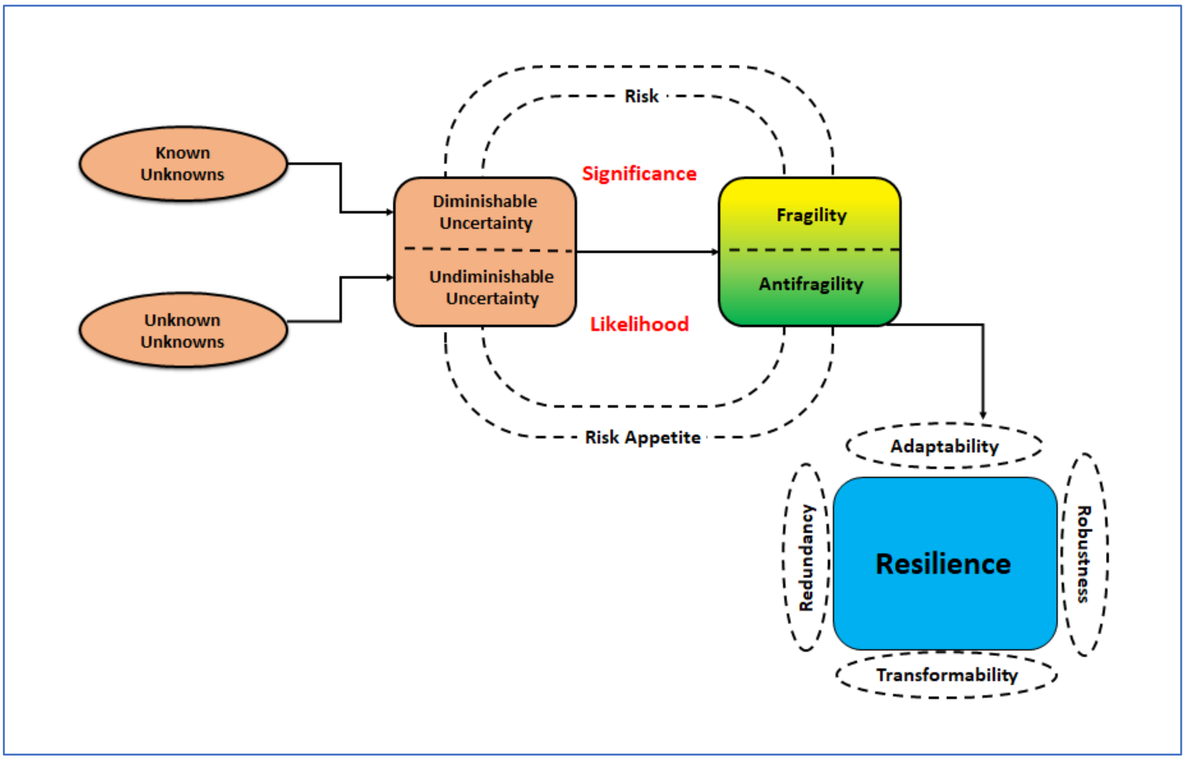


Figure 2.4: Mapping risk, fragility and resilience

One of the major difficulties managers face while building resilient enterprises is the inability of translating resilience principles into the tangible constructs of daily operational processes and transferring resilience concepts from post-disaster management to day-to-day functions. Risk management can be utilized to evaluate and improve enterprise resilience as risk management techniques generally focus on the probability and outcomes of ontological uncertainties (Dalziell & McManus 2004) and thus risk management can help to define the relationships between resilience and vulnerability at different enterprise levels (Paton et al. 2000). That is, to develop resilience in the enterprise system, there should be a focus on reducing three drivers: uncertainty, risk and vulnerability (Herbane, Elliott & Swartz, 2004, Burnard & Bhamra, 2011, Winnard, et al., 2014). Enterprise resilience can be successful when the internal and external threats are thoroughly understood and a proper response is recognized by employees (Herbane, Elliott & Swartz, 2004). Knowledge about disturbances can reduce uncertainty and undesired risks can be treated by lowering their likelihood (Burnard & Bhamra, 2011). Vulnerability can be reduced if the exposure to system disturbances has been mitigated its sensitivity is reduced through enhanced range of available responses (Bhamra et al., 2011). Therefore, by mitigating disruption risks an enterprise will manage to develop multidimensional resilience mechanisms which are distinguished with adaptability, transformability, robustness, and redundancy. It is needed to map risk and fragility through risk management because this will help “i) extend the current risk conceptualisation and treatment frameworks to include the black swan risk, ii) develop a new generation of risk assessment and decision support methods that place more emphasis on the black swan risk and iii) better understand what analysis captures and what lies within the management domain” (Aven 2015, p.83). It is suggested to map both, risk and fragility, with resilience to enable the organization from adding value and utilizing opportunities out of disruptions (Bosetti, Ivanovic & Munshey 2016).

2.7. Fragility in the context of business/enterprise

In literature, ‘fragility’ has been commonly conceptualized in reference to the fragility of financial systems, states/communities, market or economy; however, the literature about enterprise fragility is not well developed.

Similar to the literature of disaster management, the literature of financial management is rich in models that attempted to measure or index financial fragility. For example, Foley (1987) developed a model of financial fragility that is based on an interaction between corporate debt accumulation and investment spending. Greenwald and Stiglitz (1993) suggested that when the firm's net worth goes down, the financial fragility and the risk of bankruptcy go up. Jarsulic (1996) developed a model of accumulation and growth with debt, with income distribution playing a crucial role in the dynamics of effective demand and financial instability. Chiarella et al. (2001) developed a model based on the destabilizing debt effect of capital accumulation arising from the creditor–debtor relation between asset-owing households and firms. Crosbie and Bohn (2003) suggested that financial fragility is measured by the enterprise distance-to-default.

Similarly, only few studies have tried to explore the fragility of supply chain. Jüttner, Peck and Christopher (2003) stated that the concept of supply chain vulnerability is still in its "infancy". Christopher and Lee (2004) suggest that the vulnerability of a supply chain can be reduced if supply chain confidence is enhanced through visibility and control – sharing information among the members of the supply chain and controlling supply chain operations. A significant study of the supply chain fragility conducted by Stonebraker, Goldhar and Nassos (2009) outlines an integrated model for organizing and managing the data gathering and analysis required to assess overall supply chain fragility. They focused on four supply chain fragility drivers: increasing complexity of products, processes, and technologies; increasing structural complexity of supply chains; increasing diversity and global nature of business systems; and the environmental costs and impacts of extended supply chains.

None of the above models have taken into consideration the multiple layers of enterprise that go beyond the financial profit or loss. Consequently, there is a need for a holistic model that considers all different fragility drivers including political, social, and behavioural threats on all levels: strategy, governance, operations, business unit and project.

The majority of ecological fragility studies and financial fragility studies highlighted the stress testing exercises to assess fragility; however, stress testing is not enough to assess fragility as this tool often pay little attention to how the impact would change in case of different scenarios. Moreover, stress tests with poorly designed scenarios or based on inappropriate methods can be misleading and one could miss the convexities/non-linearities that can lead to serious fragilities (Taleb et al. 2012).

Based on a literature review, Stonebraker, Goldhar and Nassos (2009, p.169) suggests six characteristics for supply chain fragility measures: "(1) ability to compare the current state and progress of different entities, including plants, companies, industries, cities, and states against a benchmark, standard, target, or goal … (2) ability to use cardinal scales of performance as an indicator of improvement over time against a target or benchmark … (3) ability to provide absolute measures, relative measures, and indexed measures for various applications… (4) ability to facilitate reactive as well as proactive and sequential as well as simultaneous responses … (5) ability to support a cost-benefit analysis to identify Pareto-like most critical efforts … and (6) ability to consider elasticities of substitution between different types of capital and resources".

2.8. Resilience in the context of business/enterprise

The fundamental concept of resilience as the capability to return to pre-disturbance status after a disruption can be applied to the context of an organization or an enterprise in the sense that it describes the organizational responses to disruptions and the organization's ability to withstand turbulence and adapt to the new risks (Starr et al. 2003).

Definitions of organizational resilience come from two different perspectives. First, organizational resilience can be simply seen as the organizational ability to rebound from adverse situations that hit the organization unexpectedly and come back to normal functionality (Horne & Orr 1998, Mallak 1998, Rudolph & Repenning 2002, Fiksel 2003, Gittell et al 2006, Vogus & Sutcliffe 2007, Zhang & Liu 2012). As it can be seen in table 2.2, some definitions of organizational resilience focused mainly on the ability to bounce back and so it is defined in a way similar to resilience in the physical sciences, i.e. a material can be resilient only if it is able to regain its original condition after being put under stress. From this rebound-oriented perspective, resilience relies on coping and resuming strategies that can bring performance back to its normal status by limiting dysfunctional behaviors.

Table 2.2: Definitions of organizational resilience

The capacity of a system to tolerate disturbances while retaining its structure and function	Fiksel, 2003
The maintenance of positive adjustment under challenging conditions such that the organization emerges from those conditions strengthened and more resourceful.	Vogus & Sutcliffe 2007
Organizational resilience is the competence of an organization to anticipate external shocks and disruptions, and to recover swiftly with a sufficiently rich variety of safeguards and responses.	Oh & Teo 2009

Organizational resilience is a multidimensional construct at the organizational level that describes the organizational adaptation to adversity.	Zhang & Liu 2012

Literature offers another perspective to define organizational resilience in which resilience is emphasized as not only the ability to bounce back but also a capability of development and creation new opportunities (Coutu, 2002; Lengnick-Hall, Beck & Lengnick-Hall 2011, Hamel & Valikangas 2003, Bhamraa, Daniab & Burnard 2011, McManus et al 2007, Dalziell & McManus 2004, WPC 2015) See table 2.3. This perspective focuses on leveraging unexpected changes to utilize opportunities and resolve adverse effects simultaneously. Hence, the enterprise will have the dynamic capability to arise stronger from each complex and challenging situation with a vast repertoire of actions that enable it to face any future disruptions.

Table 2.3: Definitions of organizational resilience as bounce back ability

The ability to dynamically reinvent business models and strategies as circumstances change, to continuously anticipate and adjust to changes that threaten their core earning power – and to change before the need becomes desperately obvious	Hamel & Valikangas 2003
A firm's ability to effectively absorb, develop situation-specific responses to, and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten organization survival.	Lengnick-Hall, Beck & Lengnick-Hall 2009
Resilience is an organisation's capacity to anticipate and react to change, not only to survive, but also to evolve	PWC 2015 adapted from the British Standards Institution (BSI) and the International Standards Organisation (ISO)
Resilience is the emergent property of organizational systems that relates to the inherent and adaptive qualities and capabilities that enables an organization's adaptive capacity during turbulent periods	Bhamraa, Daniab & Burnard 2011
Resilience is a function of an organisation's: • situation awareness, • management of keystone vulnerabilities and • adaptive capacity in a complex, dynamic and interconnected environment.	McManus et al 2007

the overarching goal of a system to continuing to function to the fullest possible extent in the face of stress to achieve its purpose	Dalziell & McManus 2004
The ability of an organization's business operations to rapidly adapt and respond to internal or external dynamic changes—opportunities, demands, disruptions or threats	IBM seven Essentials
The "ability of an organization to anticipate, prepare for, and respond and adapt to incremental change and sudden disruptions in order to survive and prosper."	British Standard, (BSI) BS65000 (2014) defines "organisational resilience"

2.8.1. Operationalization of Organizational /Enterprise Resilience

For the purpose of surveying the literature of organizational/enterprise resilience, this chapter presents a review of key organizational resilience studies published in peer reviewed journals in the last two decades. Table 2.4 presents a review of the studies in order to contribute to the theoretical building of enterprise resilience and mainly the development of a proper measurement to this construct.

Table 2.4: Review of organizational resilience studies

Study	**Industry/ Discipline**	**Method**	**Theoretical underpinning**	**Findings/conclusion**
Mallak 1998	Hospitals	Survey	Not specified	To generate a resilient workforce, there are six factors that that are listed as follow: avoidance, role dependence, source reliance, source access, and goal-directed solution-seeking.
Horne and Orr 1998	Hospitals	Case study	Systems theory	The following seven tributaries of resiliency behaviour assessment: community, competences, connections, commitment, communication, coordination and consideration help enterprises to detect resiliency factors that are included in processes and people and they also develop whole-systems that focus on commitments, connections and competencies in response to essential changes. Such information can be utilised efficiently in HR applications like, Organization alignment, Organizational learning, Cooperative culture awareness, and Strategic planning.
Paton et al. 2000	Environmental	Theoretical/ conceptual	Not specified	To perceive the connection between each of resilience and vulnerability at various levels (dispositional, cognitive, and organizational) a risk management framework can be applied.

				The framework, as well, proposes ways for recovery and development throughout extenuating distress risk and the following three components represents its foundation stone: 1. Cognitive resilience; coherence, meaning, and training 2. Environmental resilience; group dynamics, organizational characterizations, and managerial behaviour 3.Dispositional vulnerability and resilience.
Rudolph and Repenning 2002	Aviation	Case study	grounded theory	The study tried to identify the relationship between minor events and the failure of an organizational system by building a mathematical model. It also offered theoretical perceptions to investigate the reasons behind the organisational crises, and it suggested effective ideas and proposals in order for stopping such problematic happenings.
Starr et al 2003	Generic	Theoretical/ conceptual	Not specified	To connect business strategy with business resilience and continuity planning by developing an integrated risk mitigating program that is based on the firm's needs and actual earnings motivations, the enterprise resilience audit can be utilized; however, it can be put into action by following the listed procedures: 1. Resilience profiling and baselining (i.e., comparing resiliency profiles with an optimal level of resilience) 2.Enterprise topology and earnings-driver classification (i.e., identifying key earning drivers and associated risks) 3. Resilience strategy (i.e., developing a new resilience program).
Riolli and Savicki 2003	Informati on System	Theoretical/ conceptual	Not specified	The study proposes a resilience model that helps organizations to discover and capitalize on self-generating resilience to face the crises by applying HR policies and creating flexible and applicable organizational culture strategies. It is based on 1. Work environment 2. Specific information system contexts 3. Intra- and extra-organizational factors 4. The cognitive appraisal processes 5. Impact of individual differences 6. Influence of social support 7. Influence of coping processes 8. Individual and organizational outcomes 9. Relevant variables associated with stress process.

Hamel and Valikangas 2003	Generic	Theoretical/ conceptual		The strategic alignment with the environment and the agile reorganization of resources to withstand disturbances enable companies to successfully change. To do so, there are four main challenges that can face companies; cognitive challenge (i.e., conquering denial), strategic challenge (i.e., valuing variety), Political challenge (i.e., liberating resources), and Ideological challenge (i.e., embracing paradox).
Valikangas 2004	Generic	Theoretical/ conceptual	Not specified	To achieve resiliency development, there are four main steps that are: thinking again of forming management principles like decision-making process, creating a variety of strategic options like, experiential strategies or business models, testing resources allocation like, funding for new opportunities, and effective corporate governance like, principles to safeguard against wrongdoing. That is, leveraging resilience helps remaining sustainable and competitive and it also helps in reducing the economic and social costs that are related to any failure or decline.
Dalziell and McManus 2004	Generic	Theoretical/ conceptual	Systems theory	Throughout ensuring enough redundancy in the system to propose continual function, or by enhancing the capability and the quickness of the system to develop and adjust to any new arising situations resilience can be empower by enhancing the adaptive capacity
Reinmoeller and van Baardwijk (2005)	Generic	Quantitative Longitudina l Daya	Evolutionary theory	The utilization of a portfolio of Innovation Strategies in order to develop resilience and widen the similarity of successful adaptations in various contexts is a serious need for organizations. It suggests four innovation strategies. 1. Knowledge management which means using and leveraging what already known. 2. Exploration which refers to creating new, internal ideas and resources like R and D. 3. Cooperation which implies leveraging and exchanging resources across companies like outsourcing. Entrepreneurship, which implies generating new resources, ideas, applications that are external to the firm like developing new businesses.

Fiksel 2003, 2006	Energy	Case study	System theory	The following properties: Diversity which refers to the availability of multiple forms and behaviours, Efficiency which means to perform by using the least resource in consumption, Adaptability which demands firms to be flexible in changing in accordance to new pressures, Cohesion which means having unifying forces or connections are essential properties for a system. Additionally, firms should do their best to own a long-term resilience by detecting system for functions and boundaries, launching system demand, choosing suitable technologies, developing a system design, appraising and antedating performance, and inventing practical tool for system development.
Gittell et al 2006	Airlines	Quantitative Data	relational theory	Resilience in airline industry can be explained by the preservation of relational and financial reserves and the existence of viable business models.
Seville et al 2006	Generic	Case study	Not specified	The functional areas of resilience progress are 1. Readiness or preparedness 2. Alleged vulnerability which is based on the firm's organizational planning for hazardous happenings 3. Investment prioritization, resource placement, and legal and contractual atmospheres.
McManus et al 2007 and McManus et al 2008	Generic	Case study	Not specified	The study introduced a simplified process to augment the performance according to three elements of organizational resilience. These elements are: 1. Situation awareness, which refers to the degree of a firm's understanding and awareness of the whole operating environment. 2. Management of source vulnerabilities, which indicates to the organizational, operational, and managerial aspects that participate negatively during a crisis situation. Adaptive capacity pictures the ability of a firm's suitable and on time decision making through measuring the cultures and the dynamics of that firm. Facilitated resilience management process assists firms to evaluate and expand organizational resilience, collecting information about other companies in relation to weaknesses and strengths; thus, related strategies can be improved to develop

				organizational resilience in order for facing crisis situations. Therefore, the points to be highlight in the process of improving resilience levels are perception of stockholders parts and responsibilities, hazardous happenings, consequences and recovery of priorities which is considered as situational awareness and refers to the level of planning and application which is stated above as management of keystone vulnerabilities that demands a silo mentality, communication and connection with stakeholders, lack of flexibility and innovative decision making ability, which is stated as adaptive capacity.
Vogus and Sutcliffe 2003, 2007	Generic	Theoretical/ conceptual	Not specified	Resilience is the result of the practices that enhance competence, flexibility, convertibility, malleability, structure, curative effectiveness, as well as mediate jolts and enhance growth. The mechanism of resilience depends on affective, cognitive, relational, and structural processes.
Somers 2009	Municipal public works departme nts	Quantitative Data	Organization al theory	The study suggested a scale for measuring hidden resilience in firms. It proposes are six factors for it which are: goal-directed solution, risk avoidance, capability of filling different roles, perception of critical situations, depending on information source and accessing to resources.
Lengnick-Hall, Beck and Lengnick-Hall 2009	Human Resources Managem ent	Theoretical/ conceptual	Not specified	Employees with strategic human resources management can have abilities to achieve organizational resilience. Developing certain cognitive competencies, behavioural traits, and contextual conditions can develop an organization’s capacity for resilience.
Crichton, Ramsay and Kelly 2009	Generic	Case study	Not specified	Organizations should observe incidents that happen outside their sectors and use the repeated themes to discover the resilience of their emergency plans. A group of best practices can be suggested strongly to develop the learning process from what is happening in organizations.

Oh and Teo 2009	Generic	Quantitative Data	Not specified	The study came by with the result that the organization's IT-enbaled ERM capabilities can lead to organizational resilience. The commitment of the organization and the IT assets are essential in generating IT-enabled ERM capabilities.
Gulati et al. (2010)		Case study; Financial Data analysis	Not specified	It proposes a categorization process for firms based on the strategic shifts and resources allocation in between both of prerecession and the recession years and the resulted resilience responses. There are four types of firms that are identified in this context: prevention-focused, promotion- focused, pragmatic-focused, and progressive-focused projects, and the best performing firm is the latter one as it is closer to customer needs.
Gibson and Tarrant 2010	Generic	Theoretical/ conceptual	Not specified	The study suggests three resiliency models: 1. The integrated resilience functions model, 2. The composite resilience model, and 3. The resilience triangle model. These models acknowledged various and interrelated elements of resilience. Resilience is linked to some strategies that develop the infrastructure and the information and knowledge (soft and hard) of organization abilities. For building resilience, there are four strategic methods: developing the sturdiness of the company to face unpredictability (resistance strategies), making sure that all key functions, resources, information, and infrastructure (reliability strategies), offering choices to everyday operational approaches (redundancy strategies), and adapting to odds and sudden hazards (flexibility strategies).
Erol, Sauser and Mansouri 2010	Generic	Theoretical/ conceptual	Not specified	It suggests an investigation framework for 'extended enterprise resilience' which is based on the enterprise characteristics that are related to agility, flexibility, adaptability, and connectivity. This framework is based on two major enablers for enterprise resilience. These facilitators are: 1. related to ability of the enterprise to link people, systems, information and processes in a way that will make the enterprise own a deeper connection and be more respondent to the dynamics of its environment,

				competitors and stakeholders. 2. The alignment of information technology with business goals.
Lengnick-Hall, Beck and Lengnick-Hall (2011)	Human Resource Management	Theoretical/ conceptual	Not specified	Based on HR policy, the organizational, cognitive, behavioural and contextual capacity of resilience can be developed. The HR policy includes: 1. HR principles 2. HR policies 3. Desired employee contributions. Resilience is a collective, different –level attribute that stemmed from capabilities and actions of individuals, and units among a firm's essential interrelationships among HR systems, resilience, associated strategic capabilities, and performance.
Burnard and Bhamra 2011	Generic	Theoretical/ conceptual	organisational theory and complex systems theory	It proposes a conceptual framework of a resilient organisational response. It addresses two aspects within the response of an organisation to disruptive events: detection and activation. It also suggests two sub-frameworks for those two features.
Zhang and Liu 2012	Generic	Theoretical/ conceptual	Not specified	It identifies four dimensions of adaptive capacity: (1) learning to live with uncertainty and change by allowing and/or encouraging small scale disturbance events before there is a buildup of pressures leading, inevitably, to some sort of collapse; (2) supporting and promoting diversity and highlighting the positive connection between diversity and redundancy; (3) combining different types of knowledge; and (4) maintaining opportunities for self-organization in the direction of sustainability.
Grecco et all 2013	Radio-pharmaceuticals	Case study	Fuzzy Set Theory	It proposes a method for resilience assessment in organizations based on leading safety performance indicators. It considers six principles of resilience engineering: Top-level commitment, learning culture, flexibility, just culture, awareness, and preparedness.
Sahebjamni, Torabi and Mansouri 2015	Generic	Case study	Not specified	It proposes a framework that integrates business continuity and disaster recovery planning for efficient and effective resuming and recovering of critical operations after being disrupted. It addresses decision problems at all strategic, tactical and operational levels.

As presented in Table 2.4., although a reasonable number of studies have been conducted in the area of organizational/enterprise resilience, yet most of them have been conceptual and have not relied on empirical data. These studies highlighted a variety of resilience themes such as: resilience models and frameworks (Paton et al. 2000, Riolli & Savicki 2003, Sutcliffe & Vogus 2003, Vogus & Sutcliffe 2007, Gulati 2010, Gulati et al. 2010, Lengnick-Hall et al. 2011), resilience principles or characteristics (Gibson & Tarrant 2010; Coutu 2002; Fiksel, 2003, 2006; Dalziell & McManus 2004, Seville et al. 2006); resilience assessment (Horne & Orr 1998, Mallak 1998; Starr et al. 2003), resilience strategies (Reinmoeller & van Baardwijk, 2005, Gulati et al. 2010), resilience challenges (Hamel & Välikangas, 2003), yet only few of them focus on developing an objective, reliable and practical assessment model for monitoring organizational resilience (Grecco et al. 2013).

2.8.2. Resilience Attributes and Strategies

Resilience is not a static trait or a single aspect trait; rather it is a multidimensional outcome that results from a set of conditions and can be founded upon effective risk management of interrelated organizational aspects (Gibson & Tarrant 2010). To create a resilient workforce, Mallak (1998) suggested six factors including: goal-directed solution-seeking, avoidance, critical understanding, role dependence, source reliance, and resource access. A group of other studies adopted a system-based approach to deconstruct resilience such as Fiksel's (2003), Dalziell and McManus 's (2004) and McManus et al. (2008). The focus in these studies lies on the interdependencies among system agents when developing resilience capabilities. Therefore, they highlighted fundamental organizational characteristics such as: diversity, efficiency, adaptive capacity, cohesion, situation awareness, and management of keystone vulnerability.

Having investigated the annual reports of 10 Dutch companies for twenty years, Reinmoeller and van Baardwiji (2005) suggest that a company should maintain a dynamic balance among a portfolio of four (knowledge management, exploration, cooperation, and entrepreneurship) in order to be resilient and maximize the probability of successful adaptation to different disruptive events. Likely, Gulati et al. (2010) attempted to classify companies based on their strategy shifts before and after the economic recession. The authors suggested four classifications: progressive-focused, prevention-focused, promotion-focused, and pragmatic-focused and concluded that the companies which were progressive-focused and maintained close ties with customer needs significantly outperformed their counterparts, that is, leveraging resilience capabilities help firms to keep their competitiveness. Alternatively, Gibson and Tarrant (2010) suggested that resistance strategies (the robustness of a firm to withstand volatility), reliability strategies - ensuring the availability of key functions, resources information, and infrastructures, redundancy strategies (providing alternatives to daily operational approaches), and flexibility strategies (adapting to extreme circumstances and sudden shock) enhance organizational capabilities to achieve effective resilience development. However, Hamel and Välikangas (2003) argue that organizational strategies deteriorate with time and firms that applying the old business models find it relatively difficult to adapt with the continually-changing business environment; therefore, firms need a regular review of their strategies in terms of four dimensions: replication, supplantation, exhaustion, and evisceration in order to enhance rapid and effective renewal in the face of disruptive environments.

2.8.3. Resilience Assessment

In an attempt to define the application of resilience in human recourse management practices, Horne and Orr (1998) identified seven streams of resiliency behavior assessment (community, competences, connections, commitment, communication, coordination, consideration) to enable enterprises to explore and identify resiliency factors embedded in people and processes, and to develop organizational systems that are based on competencies, commitments and connections in response to significant change. Information about these themes can be put into effective use through the following human resources applications: strategic planning, organization alignment, corporate culture awareness and organizational learning. Similarly, Lengnick-Hall et al. (2011) suggested that organizational resilience can be developed through strategic human resources management policies, practices, and activities. They propose a consideration of the interrelationships between four factors: human resources systems, organizational resilience, strategic capabilities, and competitive performance.

To achieve resilience, enterprises should have a proper resilience measurement which offer simple yet effective methodologies based on common terminologies and well-defined metrics (Dalziell & McManus 2004). McManus et al. (2008) developed a facilitated resilience management process for assessing an organization's overall resilience profile and for identifying a company's strengths and weaknesses so relevant strategies can be developed for improving organizational resilience in the face of crisis situations. Starr et al (2003, p.8-9) highlights the importance of the enterprise resilience audit to establish linkage between business strategy to resilience and business continuity planning through the development of an integrated risk mitigation program based on company needs and actual earnings drivers. A procedure of four steps are suggested: 1. Enterprise topology and earnings-driver classification (i.e., identifying key earning drivers and associated risks) 2. Resilience profiling and baselining (i.e., comparing resiliency profiles with an optimal level of resilience) 3. Resilience strategy (i.e., developing a new resilience program).

This research adopts that argument that an enterprise is conceptualized as a complex system that is composed of a network of linkages that are interconnected nonlinearly (Comfort et al. 2001 & Crichton et al. 2009). Due to this interconnection, a cause and effect behaviour emerges among the different agents of the system creating a complex loop of the agents' feedback (Bhamra, Dani & Burnard 2011). When the complexity of the enterprise system increases due to the high impact of disruptions, the performance of the system adversely loses its capacity of analysing and processing the amount and range of information needed to enhance the coordination among the agents' exchanged responses, that is, it loses the integration of the decisions taken on the multiple levels of the enterprise system. That is to say, due to the highly complexity and dynamism of enterprises, measuring enterprise resilience is not a matter of simply identifying cause and effect relations (Dalziell & McManus 2004) rather, it is need a well-established system that creates a balance between anticipation or preparedness and resilience, and this requires a strategy that reduces risk in uncertain environments and tackle the increased environmental and system complexity (Comfort et al. 2001). A resilient enterprise is a strategic initiative that changes the way an enterprise operates to enhance competitiveness, reduce vulnerability and increase flexible responsiveness (Sheffi & Rice 2005), and this can be achieved by effectively exchanging the system's agents feedback to enhance the enterprise's adaptive capacity and its ability to cope with, adapt and recover after a disruption (Gallopin 2006).

2.9. Risk management frameworks

Risk management can be deconstructed as a systematic set of culture, processes and structure to logically identify, analyze and either accept or mitigate uncertainties aiming to utilize opportunities or avoid threats (Cooper et al. 2005, Fraser & Simkins 2010). Besides being too broad, risk field is interconnected with plenty of other fields; therefore, it is very difficult to project all its sides and objectives in one paper.

In the beginning of the third millennium, the first set of risk management standards was developed in the USA which is *IEEE Standard 1540-2001: Standard for Software Life Cycle Processes – Risk Management in the USA*. Then many other standards and guidelines were developed such as *JIS Q2001:2001(E): Guidelines for Development and Implementation of*

Risk Management System in Japan, *AS/NZS 4360:2004: Risk Management in Australia and New Zealand*, and the *Orange Book of the HM Treasury and IRGC Risk Governance Framework in UK*. Different standards were also proposed by professional bodies like AIRMIC, ALARM, PRAM and IRM. The different terminologies used by these different sets led to different risk management processes (Raz & Hillson 2005).

For example, the Australian and New Zealand Standard for Risk Management AS/NZS 4360 proposed a seven-step process as shown in Figure 2.5. The process is composed of: establishing the context of risk, identifying risks, analyzing risks, evaluating risks, communication and consultation across stakeholders, and monitoring and controlling risks events (1999).

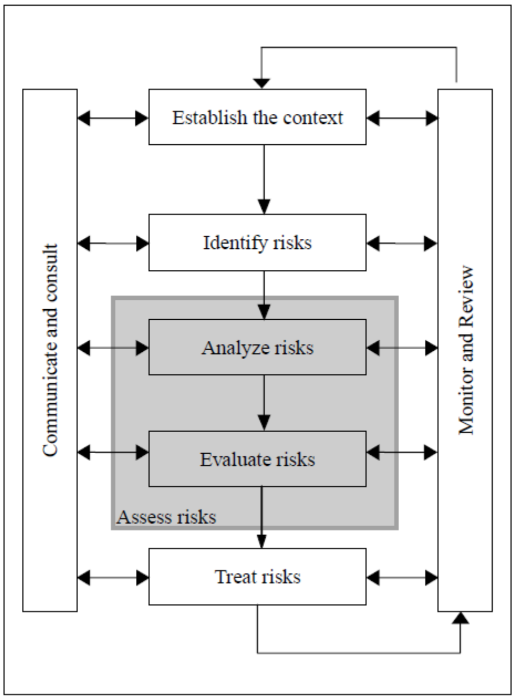


Figure 2.5: Risk Management Process (The Australian and New Zealand Standard for Risk Management AS/NZS 4360)

Unlike the model proposed by The Australian and New Zealand Standard for Risk Management AS/NZS 4360, *the Orange Book of the HM Treasury* proposes a strategic risk management model which is projected in a non-linear process that urges the balance between different ‘interwoven’ elements (2004). As seen in Figure 2.6., core risk management process (reviewing and reporting risks, identifying risks, assessing risks, and addressing risks) interact within a risk environment or context that includes several stakeholders.

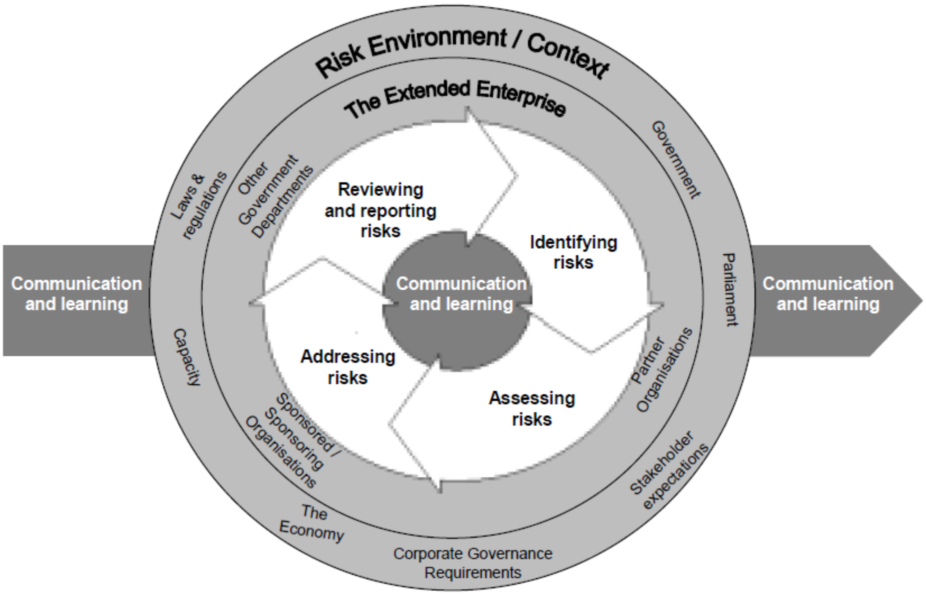


Figure 2.6: The Risk Management Model (The Orange Book: Management of Risk–Principles and Concepts, 2004)

Having different guidelines might result from the different levels of complexity that business environments have, or there could be a political reason. Anyway, these guidelines or standards share more or less the same key phases of risk management process – risk identification, risk analysis, risk evaluation and risk treatment – even though they use different terminologies or different sub-phases. A common aspect of these guidelines is the perception of risk as being harmful or undesired so they must be avoided or mitigated although risk taking is fundamental for economic reward. Such misjudgement could be a result of the absence of a well-defined fragility framework. In other words, if a clearly defined fragility model is available for the decision makers, they would be able to decide if a risk is a potential threat or a potential reward and thus they can make the right decisions how to deal with this risk. A performance related fragility framework might be the solutions to identify the rewards behinds risks and to optimize performance in a manner that treats threatening risks or fragility drivers and consequently enhances enterprise resilience.

2.10. Risk Classification

Translating risk management into actions requires a breakdown of risks into classes and subclasses. The nature of various risks and the variety of businesses make it so difficult to classify risks in two or three categories only.

From a project management perspective, The Orange Book: Management of Risk–Principles and Concepts (2004), illustrates risks in a hierarchy of three levels – on the top is strategic risk; programme risk is on the middle level; on the base is project and operational risk. Based on its level, risk can also be categorized into the following two categories: macro-level risk – caused by external factors such as political, economic, natural, or social changes; micro-level risk – operational or technical risks caused by internal factors (Kardes et al. 2013). Alternatively, risks can be categorized as: technical risks, delivery risks, supplier risks, project structure risks, client quality risks, and out-of-area location risks (Cooper et.al 2005). Moreover, risks in projects are commonly classified into different clusters like: financial risk, technical risk, commercial risk, execution risk, and contractual or legal risk (Pinto 2007).

Similarly, Pritchard (2015) classifies risks into five facets: technical, programmatic – "associated with obtaining and using applicable resources and activities that can affect project direction", supportability - environment related, cost, and schedule. Such classification might fit the purposes of project risk management only and it cannot be applicable to non-projectized organizations. From an insurer's viewpoint, risks are classified and sub-classified into three classes: pure risk versus speculative risk, Diversifiable risk versus non- diversifiable risk, personal risk versus enterprise risk (Rejda & McNamara, 2014).

None of the different risk classification approaches that literature provides seems more feasible than the others; rather, practitioners can select or create any scheme that reflects an organization's risk management needs. Risks are identified using different methods; some of the most common methods are: brainstorming, Delphi technique, examination of post-project reports, benchmarking, checklists, interviews and focus group discussions, personal observation, prompt lists, prototyping, work breakdown structure analysis, influence diagrams, cause-and-effect diagrams, failure mode and effect analysis, system or process flow chart, hazard and operability study, fault trees, technology readiness levels, taxonomies, testing and modelling and SOWT analysis (Hillson 2002, Lindenaar et al. 2004, Cooper et al. 2005, Pinto 2007, Ahmed et al. 2007, Raz & Hillson 2005, PMBoK 2013). Risk managers can develop and expand a list of risks that can be framed into a business risk model. Figure 2.7 shows a sample of business risk model.

STRATEGIC RISKS

External Factor Risks

- Industry risk
- Economy risk
- Competitor risk
- Legal and regulatory change risk
- Customer needs and wants risk

Internal Factor Risks

- Reputation risk
- Strategic focus risk
- Parent company support risk
- Patenttrademark protection risk

OPERATIONS RISKS

Process Risks

- Supply-chain risk
- Customer satisfaction risk
- Cycle-time risk
- Process execution risk

Compliance Risks

- Environmental risk
- Regulatory risk
- Policy and procedures risk
- Litigation risk

People Risks

- Human resources risk
- Employee turnover risk
- Performance incentive risk
- Training risk

FINANCE RISKS

Treasury Risks

- Interest rate risk
- Foreign exchange risk
- Capital availability risk

Credit Risks

- Capacity risk
- Collateral risk
- Concentration risk
- Default risk
- Settlement risk

Trading Risks

- Commodity price risk
- Duration risk
- Measurement risk

INFORMATION RISKS

Financial Risks

- Accounting standards risk
- Budgeting risk
- Financial reporting risk
- Taxation risk
- Regulatory reporting risk

Operational Risks

- Pricing risk
- Performance measurement risk
- Employee safety risk

Technological Risks

- Information access risk
- Business continuity risk
- Availability risk
- Infrastructure risk

Figure 2.7: A sample of business risk model adopted from (Moeller, 2007)

2.11. Enterprise Risk Management

Casualty Actuarial Society Committee on Enterprise Risk Management (2003) defines ERM as “the discipline by which an organization in an industry assesses, controls, exploits, finances, and monitors risks from all sources for the purpose of increasing the organization’s short- and long-term value to its stakeholders.” Moreover, as defined by The Committee of Sponsoring Organizations of the Treadway Commission (COSO), ERM as “a process, effected by an entity’s board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives” (COSO 2004). Enterprise risk management (ERM) is “a management process that identifies, define, quantifies, compares, prioritizes, and treats all of the material risks facing an organization, whether or not it is insurable” (Leimberg et al. 2002)

It is assured by the above-mentioned definitions that the ultimate goal of enterprise risk management is to maximize the firm’s and the shareholders’ value. Moreover, both definitions highlight the holistic approach of risk management and recommend the use of risk management activities in all layers of the business and reject the inefficient ‘silo’ perspective of traditional risk management. Unlike the traditional risk management, ERM does not consider risk is a pure potential loss or hazard that the organization should be insured against; on the contrary, ERM looks for any potential value that can be added to the organization if risks are properly managed.

It has always been a controversy if past lessons would be enough to understand future challenges. Therefore, there is a need to adopt a risk-based enterprise resilience approach that questions all assumptions including the unquestionable fundamental ones.

2.11.1. The Committee of Sponsoring Organizations of the Treadway Commission’ Enterprise Risk Management (COSO ERM) Framework

COSO ERM is a three-dimensional model or framework for understanding enterprise risk. The first dimension consists of eight vertical components or layers (internal environment, objective setting, event identification, risk assessment, risk response, control activities, information and communication and monitoring) which are called risk components. The second dimension consists of four vertical columns covering key risk objectives (strategic, operations, reporting, and compliance). The third dimension consists of four layers categorizing the organizational units into subsidiary, business unit, division and entity level (Moeller 2007). See Figure 2.8.

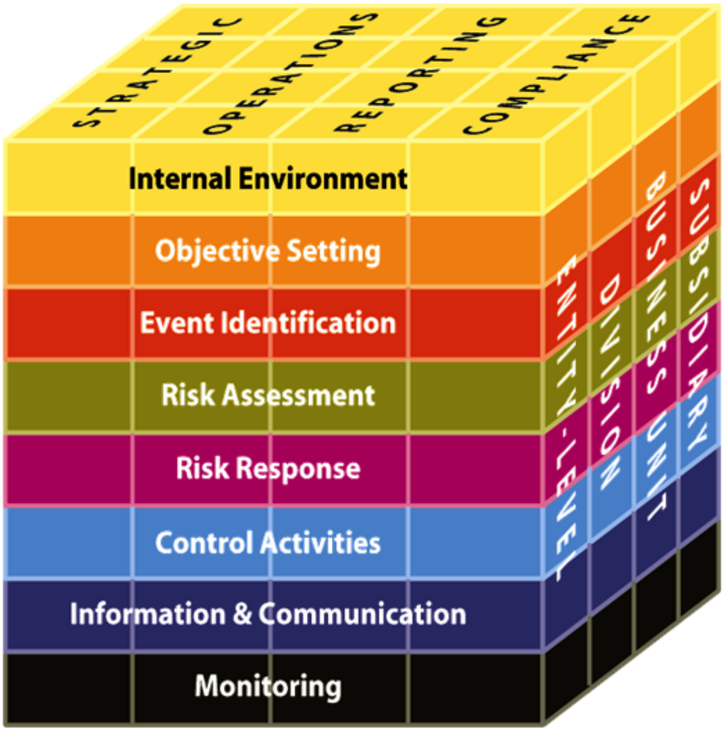


Figure 2.8: The Committee of Sponsoring Organizations' Enterprise Risk Management (COSO ERM) Framework (adopted from Moeller, 2007)

One of the strengths of COSO ERM Framework is that it does not consider ERM as a static set of rules that do not cope with the dynamic nature of continuously-change risks; rather, it describes ERM as a process that requires a timely review and evaluation on all levels of the organization (Cendrowski & Mair 2009).

2.11.2. ISO 31000:2009, Risk management – Principles and guidelines,

"ISO 31000:2009, *Risk management – Principles and guidelines*, provides principles, framework and a process for managing risk. It can be used by any organization regardless of its size, activity or sector. Using ISO 31000 can help organizations increase the likelihood of achieving objectives, improve the identification of opportunities and threats and effectively allocate and use resources for risk treatment. … Organizations using it can compare their risk management practices with an internationally recognised benchmark, providing sound principles for effective management and corporate governance" (ISO, 2012).

ISO 31000:2009 is based on the classical functional approach of management ‘plan, organize, direct, control’. This approach conceptualizes risk as a clearly-defined and measured aspect of management and depicts risk management system as implementation of a continual improvement process based on measurable indicators that can be integrated with performance assessment and be applied in all business levels (Lalonde & Boiral, 2012). However, several basic principles underlying the ISO 31000 standard are poorly aligned with the strategic practices of organizations (Wooten & James, 2008, Lalonde & Boiral, 2012). Leitch (2010) considers that the terminology used in ISO 31000:2009 is too vague or ambiguous and this affects the managers’ decisions.

2.12. Enterprise fragility-resilience model

Although recent risk frameworks provide a systematic approach to identifying and assessing the nature, scope, and impact of a wide range of threats and they went further than reactive efforts by including more preventive approaches, yet they tend to adopt a very technical approach to risk management, focus on environmental and economic risks, and pay insufficient attention to the political dimensions of risk, especially in fragile and conflict-affected settings (Bosetti, Ivanovic & Munshey 2016).

Resilience aims to better anticipation of undesired events (Munoz, Vidal-Gomel & Bourmaud 2015), but current risk management frameworks proved unable to provide an adequate understanding and a timely warning of the financial crisis (Mertzanis 2014). These frameworks do not consider the complexity of the enterprise infrastructure nor do they consider the relationship between risk governance and cognitive resilience; therefore, they should be called into question. There is a need for a more analytical approach to give weight to different sources of risk with the aim of building a robust and adaptable system on both macro and micro levels.

Accordingly, in this research, there will be an attempt to project a comparative anatomy of business layers (strategic level, governance level, operational level, business unit level and project level). The five enterprise layers are crossed with four aspects of risk-based resilience drivers: risk governance, risk culture, risk appetite and risk-informed decision making. See figure 2.9. The following section will outline the constructs of the model, while the detailed drivers will be presented in chapter 3.

Figure 2.9: Enterprise fragility-resilience model

It is suggested that the fragility of the enterprise emerges from the fragility of the enterprise strategy, the fragility of the enterprise governance, the fragility of operations, the fragility of business units and the fragility of the projects. Moreover, it is suggested that enterprise resilience is fostered by risk culture, risk governance, risk appetite and risk-informed decision making. According to ISO 31000 (2009) principles and guidelines, risk culture, risk appetite, risk communication, and the integration of risk management within the firms' processes are drivers that highly contribute to the excellence of the enterprise. Similarly, the British Standards Institution (2014) gives high weight to governance and accountability, leadership and culture to contribute to enterprise resilience.

2.12.1. Fragility of enterprise strategy

From a dynamic theory perspective, strategy is the central reason behind the success or failure of enterprises since it sets the causes of superior performance in the short term, and it creates the competitive positions in the long term (Porter 1991). The fragility of strategy is usually associated with organizational vulnerabilities and technological shocks (Hill & Zeller 2008).

2.12.2. Fragility of enterprise governance

In principal, enterprise governance refers to the accountability structure that rules compliance, performance and responsibility (Fahy, Weiner & Roche 2005), but it can also be viewed as "an organizational competence – a coherent whole of organizational skills, knowledge and technology – anchored in the competencies of employees" (Hoogervorst 2009, p.13). That is, enterprise governance is not setting the hierarchy of the enterprises; rather it is the employee's capabilities of dealing with responsibilities.

2.12.3. Fragility of enterprise operations

According to Basel Committee on Banking Supervision, operational risk is defined as "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events. This definition includes legal risk, but excludes strategic and reputational risk" (as cited in McNeil, Frey & Embrechts 2015, p.504). For the purpose of exploring the operational fragility of enterprises, the research will categorizes operational fragility drivers into four clusters: operational internal processes, people, operational systems and external events.

2.12.4. Fragility of enterprise business units

It is vital that each business unit knows its contribution to the core business objectives and core business processes; otherwise, the enterprise will lose the strategic alignment between different organizational functions and business processes will have high potential to fail (Lok et al 2005). Therefore, business units should not be isolated from one another; rather, business units should be integrated with one another to create value to the stakeholders and this can be achieved through proper communication, flexibility, and responsiveness (Khosravi 2016).

2.12.5. Fragility of enterprise projects

If compared to 'project vulnerability', the term 'project fragility' is not common in the literature of project management or enterprise management. The drivers of project fragility will be aligned with project failure factors and the factors that cause the ineffectiveness of project management.

2.12.6. Risk culture and enterprise resilience

In enterprises, a strong risk culture is reflected in the attitudes, behavioural and managerial norms and this determines the way in which employees identify, assess and act on challenges and risks confronted (Atkinson 2013); thus, to a large degree, risk culture determines how an enterprise manages risk when it is under stress (Delloitte 2013); consequently, a strong risk culture is generally thought to be valuable to enterprise as it is believed to strengthen the enterprise resilience (Fritz-Morgenthal, Hellmuth & Packham 2016), while weak risk culture adversely affects performance (Clarke & Varma 1999).

The aftermath of the 2008 financial crisis showed that effective risk culture, besides other corporately integrated ERM mechanisms, added value to the enterprise performance and helped to enhance economic advantages (Bezzina et al. 2014) since there are significant relationships between the risk culture and the stress test scores, in the sense that better stress test result corresponds to a better risk culture (Fritz-Morgenthal, Hellmuth & Packham 2016). Therefore, it is vital to build a culture in which it is normal to consider resilience within decision making (The British Standards Institution 2014) and take those valuable risks an enterprise is able to bear (Fritz-Morgenthal, Hellmuth & Packham 2016).

Risk culture can be achieved through leadership, involvement, learning, accountability and communication (Hopkin 2017). To embed a strong risk culture, it is suggested to: use common risk language and concepts, communicate about risk using appropriate channels and technology, develop training programs for risk management, identify and train 'risk champions', provide success stories and identify quick wins, align risk management techniques with company culture, and develop a knowledge-sharing system (KPMG 2001, Moeller 2007).

2.12.7. Risk governance and enterprise resilience

Risk governance involves "the translation of the substance and core principles of governance to the context of risk and risk-related decision-making" (van Asselt & Renn 2011, p.431). The ability of enterprise risk governance to cope with the complexity and ambiguity of future uncertainties and their impact on the enterprise performance has become a major concern to scholars and practitioners alike (Klinke & Renn 2012).

Enterprises can enhance resilience if decision making processes are driven by well-defined systems of rules and made within acceptable parameters of cost, risk and speed; that is, when talented employees are accountable for their decisions, opportunities can be utilized and risks will be mitigated (The British Standards Institution 2014). To enhance enterprise resilience, governance strategies should be operationalized in a manner that makes the components of the system fits for one another with the emphasis on adaptation and flexibility (Welsh 2014). Non-hierarchical adaptive and integrative risk governance systems are more resilient and consequently they are less vulnerable (Klinke & Renn 2012).

2.12.8. Risk appetite and enterprise resilience

The enterprise's risk appetite is argued in much of the literature to be a central aspect of ERM and a key to its success (Lundqvist 2014). According to the Orange Book (2004), the risk appetite is "a series of boundaries, appropriately authorised by management, which give each level of the organisation clear guidance on the limits of risk which they can take, whether their consideration is of a threat and the cost of control, or of an opportunity and the costs of trying to exploit it". Similarly, ISO 31000 (2009) defines risk appetite as the "amount and type of risk that an organisation is willing to pursue or retain". Therefore, risk appetite is related to credit risk, operational risk, market risk, etc., and it normally influences, to a large extent, how risk is priced (Boussabaine 2013).

Risk appetite is an emotional trait and it is not a right or wrong matter (Evans 2012) and there is uncertainty about the exact level of a risk appetite threshold (Polasky et al 2011), yet resilient enterprises should define rough boundaries that involve choices about what risks are acceptable, and risk appetite and tolerances should be clearly understood with alerts in place to ensure the decision makers are alerted when risk thresholds are exceeded (Farrell & Gallagher 2015). In a resilient enterprise, risk tolerances in all levels should align with the level and types of risk the enterprise is willing to accept in pursuit of its strategy. Any variations from the tolerance threshold should be reported and monitored (Kinman 2012).

2.12.9. Risk-informed decision making and enterprise resilience

Risk informed decision-making is intended to make alternatives selecting more informed through better understanding of the information obtained from risk and uncertainty (Dezfuli, Maggio & Everett 2010). Although the embeddedness of ERM in managers' decision making is both 'complex' and 'elusive' (Power 2009), yet one of the major decision-making deficiencies in enterprises is the inability to make informed risk and reward decisions (Moran 2014); therefore, ERM should not be lapsed to 'rule-based compliance' (Arena, Arnaboldi & Azzone 2010); on the contrary, managers should embed the management of risk in all business processes decisions (Atkinson 2013). ERM should be a key influence in every decision that an enterprise takes especially those operating on industries with high level of uncertainty (Theriou & Aggelidis 2014).

Resilient enterprises usually distribute decision making power among employees and equip them with the skills that help them make sound risk decisions that serve the enterprise's mission (Sheffi & Rice 2005). Decision-support capabilities should be aligned in order to uncover and adjust continually changing risks, endure disruptions to its primary earnings drivers, and create advantages over less adaptive competitors (Starr, Newfrock & Delurey 2003). Decision makers should consider the impact of all strategies and decisions on a risk informed bases, both at the time decisions are taken and on an on-going basis (The British Standards Institution 2014). Therefore, Risk responsibilities should be incorporated into individual activities with the focus on relatedness between risk assessment, risk decision making and risk communication (Byrd III & Cothern 2000).

2.13. Summary

This chapter reviewed the literature of risk, fragility, resilience as well as risk management. Having deconstructed these three concepts, this chapter defines the relationship between them. Uncertainty, diminishable and undiminishable, can be mitigated by risk management in order to reduce fragility and enhance anti-fragility and consequently become resilient. The chapter highlighted how fragility and resilience are operationalized in the context of enterprise. The chapter was concluded by defining the constructs that are used throughout the research – fragility of strategy, fragility of governance, fragility of operations, fragility of business unit, fragility of project, risk culture, risk governance, risk appetite and risk-informed decision making. The following chapter will present in detail all the risk events and attributes that constitute the above-mentioned constructs.

CHAPTER THREE

CONCEPTUAL FRAMEWORK

3.1. Introduction

Having reviewed literature of fragility, resilience and risk management performance in the previous chapter, this chapter gives a detailed description of the attributes of risk management performance, the risk events that induce enterprise fragility and the attributes that enhance enterprise resilience as well. This chapter presents a diagram of the conceptual framework on which this research is based. Moreover, it develops the hypotheses that will answer the research questions. Overall, this chapter assumes that both enterprise fragility and enterprise resilience are associated with risk management performance.

3.2. Conceptual framework

Based upon the review of relevant literature and the critical analysis of the existing enterprise fragility and enterprise resilience frameworks presented in chapter two, it is proposed that the following conceptual model can improve operationalization of resilience by illustrating the link between risk management performance and enterprise fragility and enterprise resilience. This model suggests that risk management performance is dependent on enterprise fragility resulted from risk-events inducing the fragility of strategy, risk-events inducing the fragility of governance, risk-events inducing the fragility of operations, risk-events inducing the fragility of business unit and risk-events inducing the fragility of project. It also suggests that risk management performance is dependent on the enterprise resilience to fragility risk events that emerges from risk culture, risk appetite, risk governance and risk-informed decision making.

3.3. Hypothesis development

In this research, enterprise fragility drivers and enterprise resilience drivers are the main determinant of managerial performance. The dimensions are described in the following sections and illustrated in figure 3.2 and 3.3.

3.3.1. Risk management performance

When decision making is based on risk, managers should identify what need to be known (Dezfuli, Maggio & Everett 2010), identify what measures matter the most, turn data into actionable information (Giniat 2011; Sikula et al. 2015; Larson & Chang 2016; Alade 2017), link risks to performance (Chitakornkijsil 2009; Abdali et al. 2013), and use risk-informed metrics to track performance (Daggett et al. 2017). See table 3.1.

Table 3.1: Attributes of risk management performance

<table>
<tr><th colspan="2">Attributes of risk management performance</th></tr>
<tr><td>Identify what need to be known</td><td rowspan="5">(Dezfuli, Maggio & Everett 2010)
(Giniat 2011)
(Sikula et al. 2015)
(Larson & Chang 2016)
(Alade 2017)
(Chitakornkijsil 2009)
(Abdali et al. 2013)
(Daggett et al. 2017)</td></tr>
<tr><td>Identify what measures matter the most</td></tr>
<tr><td>Turn data into actionable information</td></tr>
<tr><td>Link risks to performance</td></tr>
<tr><td>Use risk-informed metrics to track performance</td></tr>
</table>

3.3.2. Risk events inducing the fragility of enterprise

It is assumed that risk events inducing the fragility of enterprise can be grouped into risk events inducing the fragility of strategy, risk events inducing the fragility of governance, risk events inducing the fragility of operations, risk events inducing the fragility of business units, and risk events inducing the fragility of projects. See figure 3.1.

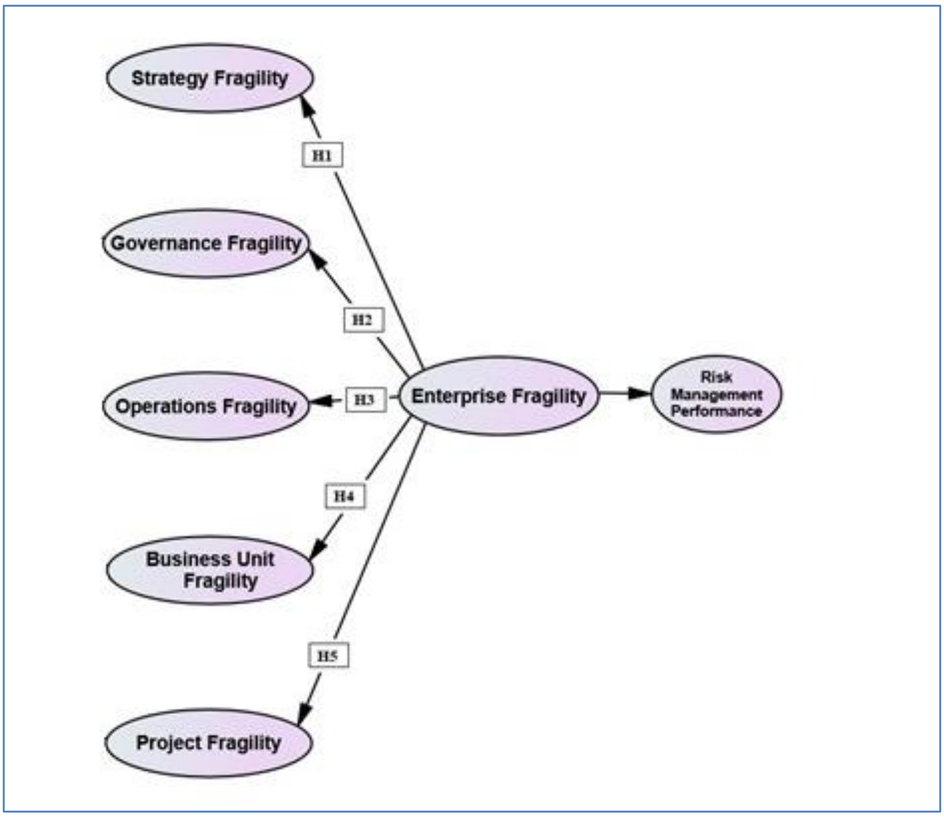


Figure 3.1: Research Hypotheses of Enterprise Fragility and Risk Management Performance

3.3.2.1.The fragility of strategy

The fragility of enterprise strategy can be induced by a set of risk events such as: inability to catch up with new innovations (Sebora & Theerapatvong 2010; Wonglimpiyarat 2010, Castellacci 2015; Lochhead 2017), disruption in the political changes (Liu et al. 2008, Birkmann et al. 2010, Christopher et al. 2011, Ekpenyong, Umoren & Ntiedo 2010), influence of globalization (Manuj & Mentzer 2008, Milani & Park 2015, Asongu, Koomson & Tchamyou 2017), negative media and news affecting the reputation (Aula 2010; Nicolo 2015; Bhat & Agrawal 2015; Stepashkin & Khusnoiarov 2015; Gatzert, Schmit & Kolb 2015), inadequate assessment of organization capabilities (Xun, Goldsby & Holsapple 2009; Ghilic-Micu, Mircea & Stoica 2010; Sanfelice 2014), inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies (Neiger & Churilov 2003; Rubio-Loyola et al. 2006; Koellner et al. 2008), inaccurate strategic positioning (Cinquini & Tenucci 2010; Xie et al. 2011; Kochetova-Kozloski & Messier 2011; Theriou & Aggelidis 2014), overoptimistic or vague projections (Lovallo & Sibony 2006; Patil, Grantham, & Steele 2012), inefficient strategy execution (Sheehan 2010; Heesen 2012; Malik & Holt 2013; Sabourin 2015), lack of feasible strategic support and action plans (Gates 2006; Smyth 2016), unawareness of market economic changes (Baek, Bandopadhyaya & Du 2005; Pearce II & Michael 2006; Tarasi et al. 2011; Zhang et al. 2013); unawareness of new technology (Wonglimpiyarat 2010; Trent & Monczka 2003), unawareness of legislation implications (Power 2004 Mügge 2011 Vinnari & Skærbæk 2014), misapplication of business models (Keen & Qureshi 2006; Wells 2013 Johnson et al. 2013; Shetinina, Zadorozhnyaya & Petimko; 2013 Taran; Boer & Lindgren 2015), financial uncertainty (Stockhammer & Grafl 2010; Nishimura 2015; Asongu, Koomson & Tchamyou 2017), and emerging aggregated risks (Linkov et al. 2014; Embrechts, Wang & Wang 2015). See table 3.2.

Table 3.2: Risk events inducing strategy fragility

Unable to catch up with new innovations	(Sebora & Theerapatvong 2010) (Wonglimpiyarat 2010) (Castellacci 2015) (Lochhead 2017)
Disruption in the political changes	(Birkmann et al. 2010) (Christopher et al. 2011) (Ekpenyong, Umoren & Ntiedo 2010) (Liu et al. 2008)
Influence of Globalization	(Manuj & Mentzer 2008) (Milani & Park 2015) (Asongu, Koomson & Tchamyou 2017)
Negative media and news affecting the reputation	(Aula 2010) (Nicolo 2015) (Bhat & Agrawal 2015) (Stepashkin & Khusnoiarov 2015)
Inadequate assessment of organization capabilities	(Ghilic-Micu, Mircea, & Stoica 2010) (Xun, Goldsby & Holsapple 2009) (Sanfelice 2014)
Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies	(Neiger & Churilov 2003) (Rubio-Loyola et al. 2006) (Koellner et al. 2008)
Inaccurate strategic positioning	(Kochetova-Kozloski & Messier 2011)

	(Cinquini & Tenucci 2010) (Xie et al. 2011) (Theriou & Aggelidis 2014)
Overoptimistic or vague projections	(Lovallo & Sibony 2006) (Patil, Grantham & Steele 2012)
Inefficient strategy execution	(Sheehan 2010) (Heesen 2012) (Malik & Holt 2013) (Sabourin 2015)
Lack of feasible strategic support and action plans	(Smyth 2016) (Gates 2006)
Unawareness of market economic changes	(Baek, Bandopadhyaya & Du 2005) (Pearce II & Michael 2006) (Tarasi et al. 2011) (Zhang et al. 2013)
Unawareness of new technology	(Trent & Monczka 2003) (Wonglimpiyarat 2010)
Unawareness of legislation implications	(Power 2004) (Mügge 2011) (Vinnari & Skærbæk 2014)
Misapplication of business models	(Keen & Qureshi 2006) (Wells 2013) (Johnson et al. 2013) (Shetinina, Zadorozhnyaya & Petimko, 2013) (Taran, Boer & Lindgren 2015)
Financial uncertainty	(Nishimura 2015) (Stockhammer & Grafl 2010) (Asongu, Koomson & Tchamyou 2017)
Emerging aggregated risks	(Linkov et al. 2014) (Embrechts, Wang & Wang 2015)

H1: strategy fragility will be positively related to managerial performance

3.3.2.2.The fragility of governance

The fragility of enterprise governance can be induced by a set of risk events such as: fluctuation of policies and regulations (Howlett & Cashore 2009; Duit et al. 2010), violation of policies and regulations (Cavallari 2012; Dafikpaku & Mcmi 2011; Hrbackova 2016), inadequate communication of objectives and targets (Crowe & Meade 2007; Wilkes, Yip & Simmons 2011; Khandelwal 2001), inadequate mechanism for internal control (Spira & Page 2003; Zhihua 2007; Doyle, Ge & McVay 2007; Kanellou & Spathis 2011; Hrbackova 2016); unavailability of timely risk information (Linsley & Shrives 2005; Ballou, Heitger & Stoel 2011; Mark & Krishna 2008), inadequate risk assessment methods (Aven 2015; Mestchian, Makarov & Mirzai 2005), inadequate risk reporting systems (Epstein & Rejc 2006; Grody, Hughes & Toms 2010; Chaudhuri & Ghosh 2016), inadequate risk pricing policies (Xiang et al. 2012; Hussein 2014; Gatzert & Kolb 2014; Boussabaine 2013), inadequate risk management reviewing processes (Hrbackova 2016), inadequate risk accountability system (Boussabaine 2013), inadequate external auditing processes (Sobel & Reding 2004; Kanellou & Spathis 2011), non-compliance with environmental guidelines (Turk 2009; Alexandru & Spineanu-Georgescu 2011; Srinivasan, Mukherjee & Gaur 2011; Teriö & Kähkönen 2011; Ong 2015), non-compliance with fiscal and monetary guidelines (Kopits 2014; Rosman & Abdul Rahman 2015), non-compliance with mandatory reporting obligations (Ong 2015; Rosman & Abdul Rahman 2015; Jeffrey & Perkins 2014). See table 3.3.

Table 3.3: Risk events inducing Governance Fragility	
Fluctuation of policies and regulations	(Duit et al. 2010) (Howlett & Cashore 2009)
Violation of policies and regulations	(Cavallari 2012) (Dafikpaku & Mcmi 2011) (Hrbackova 2016)
Inadequate communication of objectives and targets	(Khandelwal 2001) (Crowe & Meade 2007) (Wilkes, Yip & Simmons 2011)
Inadequate mechanism for internal control	(Spira & Page 2003) (Zhihua 2007) (Doyle, Ge & McVay 2007) (Kanellou & Spathis 2011) (Eulerich, Velte & Theis 2015) (Hrbackova 2016)
Unavailability of timely risk information	(Linsley & Shrives 2005) (Mark & Krishna 2008) (Ballou, Heitger & Stoel 2011)
Inadequate risk assessment methods	(Aven 2015) (Mestchian, Makarov & Mirzai 2005)
Inadequate risk reporting systems	(Epstein & Rejc 2006) (Grody, Hughes & Toms 2010) (Chaudhuri & Ghosh2016)
Inadequate risk pricing policies	(Xiang et al. 2012.) (Boussabaine 2013) (Hussein 2014) (Gatzert & Kolb 2014)
Inadequate risk management reviewing processes	(Hrbackova 2016)
Inadequate risk accountability system	(Boussabaine 2013)
Inadequate external auditing processes	(Sobel & Reding 2004)

	(Kanellou & Spathis 2011)
Noncompliance with environmental guidelines	(Turk 2009) (Alexandru & Spineanu-Georgescu 2011) (Srinivasan, Mukherjee & Gaur 2011) (Teriö & Kähkönen 2011) (Ong 2015)
Noncompliance with fiscal and monetary guidelines	(Kopits 2014) (Rosman & Abdul Rahman 2015)
Noncompliance with mandatory reporting obligations	(Ong 2015) (Rosman & Abdul Rahman 2015) (Jeffrey & Perkins 2014)

H2: Governance fragility will be positively related to managerial performance

3.3.2.3.The fragility of operations

The risk events that induce the fragility of operations can be clustered into four groups: internal operational processes, people-related events, operational system events, and external events.

The fragility of operations can be induced by a set of internal operation risk events such as: inadequate execution of operational plans (Dulisse 2015; Havlícek & Schlossberger 2013; Schubert et al. 2015), inadequate evaluation of operational plans (Dulisse 2015; Schubert et al. 2015), excessive implementation requirements(Patil, Grantham & Steele 2012), misalignment with stakeholders (Asif et al. 2010; Garengo, Biazzo & Bititci 2005; Jahansoozi 2006), contractual risks (Teach 1997; Mani, Barua & Whinston 2012; Ikediashi et al. 2012), inaccurate pricing of services/products ((Eicher & Ruder 2007; Lynn & Shambju 2012; Shukla, Naim & Yaseen 2009; Zhang & Burke 2011), non-compliance with client requirements (Teach 1997; Gumerov et al. 2015; Kamara 2017), Ineffective communication with clients (Agrawal, Sengupta & Shanker 2009) (Dejonckheere et al., 2004; Machuca & Barajas, 2004; Ouyang, 2007; Wu & Katok, 2006), unexpected change of customer requirements (Teach 1997; Lee, Padmanabhan & Whang, 2004; Kim et al., 2006; Marquez, 2010; Taylor 2016), unmaintained customer relationships (Teach 1997; Marquez, 2010; Taylor 2016). See table 3.4.

Table 3.4: Risk events inducing the fragility of internal operational processes	
Inadequate execution of operational plans	(Havlícek & Schlossberger 2013) (Dulisse 2015) (Schubert et al. 2015)
Inadequate evaluation of operational plans	(Dulisse 2015) (Schubert et al. 2015)
Excessive implementation requirements	(Patil, Grantham & Steele 2012)
Misalignment with stakeholders	(Asif et al. 2010) (Garengo, Biazzo & Bititci 2005) (Jahansoozi 2006)
Contractual risks	(Teach 1997) (Mani, Barua & Whinston 2012) (Ikediashi et al. 2012)
Inaccurate pricing of services/products	(Eicher & Ruder 2007) (Lynn & Shambju 2012) (Shukla, Naim, & Yaseen 2009) (Zhang & Burke 2011)
Non-compliance with client requirements	(Teach 1997) (Gumerov et al. 2015) (Kamara 2017)
Ineffective communication with clients	(Agrawal, Sengupta & Shanker 2009) (Dejonckheere et al., 2004) (Machuca & Barajas, 2004) (Ouyang, 2007) (Wu & Katok, 2006)
Unexpected change of customer requirements	(Teach 1997) (Lee, Padmanabhan & Whang, 2004) (Kim et al., 2006) (Marquez, 2010) (Taylor 2016)

Unmaintained customer relationships	(Teach 1997) (Marquez, 2010) (Taylor 2016)

The fragility of operations can be induced by a set of people-related risk events such as: fraud or corruption (McNeil, Frey & Embrechts 2015), unhappy work environment (Sewell & Gilbert 2015; Bolton 2015), turnover of key talents (Ribeiro & Semedo 2014; Bolton 2015), inadequate talent configuration and management (Teach 1997; Ribeiro & Semedo 2014; Bolton 2015), inappropriate behaviour - discrimination/harassment (Moeller 2007; Okechukwu et al. 2014; Amin 2016; Gatzert, Schmit & Kolb 2015). See table 3.5.

Table 3.5: Risk events inducing the fragility of people-related operations	
Fraud or corruption	(Le et al. 2014) (McNeil, Frey & Embrechts 2015)
Unhappy work environment	(Sewell & Gilbert 2015) (Bolton 2015)
Turnover of key talents	(Ribeiro & Semedo 2014) (Bolton 2015)
Inadequate talent configuration and management	(Teach 1997) (Ribeiro & Semedo 2014) (Bolton 2015)
Inappropriate behaviour (discrimination/harassment)	(Moeller 2007) (Okechukwu et al. 2014) (Amin 2016) (Gatzert, Schmit & Kolb 2015)

The fragility of operations can be induced by a set of operational system-related risk events such as: hardware/software failure (McNeil, Frey & Embrechts 2015), disruption in communication channels (Machuca & Barajas 2004; Ouyang 2007; Wu & Katok 2006; Lee, Padmanabhan & Whang 2004), cyber-attack/ Malware or virus/ ISP disruption (Kelic et al. 2013; Edgeman 2014; Torabi, Giahi & Sahebjamnia 2016), data Disclosure (Kim & Leem

2005), data integrity failure (Cárdenas et al. 2011; Kim & Leem 2005; O'Donnell 2005), data Reporting failure(Kim & Leem 2005; Borges et al. 2017), inadequate technological innovative ability (Fan & Yuan 2016), inadequate technical transformation ability (Fan & Yuan 2016; Jinlan & Shurong 2010; Zhang & Geng 2012). See table 3.6.

Table 3.6: Risk events inducing the fragility of operational systems

Hardware/software failure	(McNeil, Frey & Embrechts 2015)
Disruption in communication channels	(Machuca & Barajas, 2004) (Ouyang, 2007) (Wu & Katok, 2006) (Lee, Padmanabhan & Whang 2004)
Cyber-attack/ Malware or virus/ ISP disruption	(Kelic et al. 2013) (Edgeman 2014) (Torabi, Giahi & Sahebjamnia 2016)
Data Disclosure	(Kim & Leem 2005) (Oktay et al 2014) (Sen & Borle 2015)
Data integrity failure	(Cárdenas et al. 2011) (Kim & Leem 2005) (O'Donnell 2005)
Data Reporting failure	(Kim & Leem 2005) (Borges et al. 2017)
Inadequate technological innovative ability	(Fan & Yuan 2016)
Inadequate technical transformation ability	(Fan & Yuan 2016) (Jinlan & Shurong 2010) (Zhang & Geng 2012)

The fragility of operations can be induced by different external risk events such as : market volatility (Teach 1997; Claessens et al. 2010; Chabi-Yo 2012), credit availability (Claessens et al. 2010; Ali & Daly 2010; Gaiotti 2013), interest rate level (Ihrig et al. 2010; Pal

& Mittal 2011; Ben Omrane & Savaşer 2017), prepayment/extension availability (Claessens et al. 2010), equity price fluctuation (Teach 1997; Claessens et al. 2010; Kurov & Stan 2017); foreign exchange rate fluctuation (Ihrig et al. 2010 Pal & Mittal 2011; Forbes, K., 2016; Ben Omrane & Savaşer 2017; Kurov & Stan 2017), inflation escalation(Ihrig et al. 2010; Pal & Mittal 2011; Forbes, K., 2016), tax rate uncertainty (Ihrig et al. 2010; Claessens et al. 2010; Pal & Mittal 2011), cost volatility (Tsai et al., 2008; Shukla, Naim, & Yaseen, 2009; Zhang & Burke 2011), outsourcing failure (Christopher & Peck 2004; Manuj & Mentzer 2008; Liu et al. 2008; Tsai et al. 2008; Marquez 2010), infrastructure uncertainty (Christopher & Peck 2004; Hoyos, Morales & Akhavan-Tabatabaei 2015), misalignment of interests with suppliers (Christopher & Peck 2004; Manuj & Mentzer 2008; Marquez, 2010; Taylor 2016); service/products obsolescence (Taylor 2016; Marquez 2010; Srinivasan, Mukherjee & Gaur 2011), and the scarcity of complementary services/products (Pellegrin-Boucher, Le Roy & Gurău 2013; Xia, Xiao & Zhang 2013; Ende, Jaspers & Rijsdijk 2013). See table 3.7.

Table 3.7: Risk events inducing the fragility of external-events-related operations

Market volatility	(Teach 1997) (Claessens et al. 2010) (Chabi-Yo 2012) (McNeil, Frey & Embrechts 2015)
Credit availability	(Claessens et al. 2010) (Ali & Daly 2010) (Gaiotti 2013) (McNeil, Frey & Embrechts 2015)
Interest rate level	(Ihrig et al. 2010) (Pal & Mittal 2011) (Ben Omrane & Savaşer 2017)
Prepayment/extension availability	(Claessens et al. 2010)
Equity price fluctuation	(Claessens et al. 2010) (Kurov & Stan 2017)
Foreign exchange rate fluctuation	(Ihrig et al. 2010) (Forbes, K., 2016)

	(Pal & Mittal 2011) (Ben Omrane & Savaşer 2017) (Kurov & Stan 2017)
Inflation escalation	(Ihrig et al. 2010) (Pal & Mittal 2011) (Forbes, K., 2016)
Tax rate uncertainty	(Ihrig et al. 2010) (Claessens et al. 2010) (Pal & Mittal 2011)
Cost volatility	(Tsai et al., 2008) (Shukla, Naim, & Yaseen 2009) (Zhang & Burke 2011)
Outsourcing failure	(Christopher & Peck 2004) (Manuj & Mentzer 2008) (Liu et al. 2008) (Tsai et al., 2008) (Marquez, 2010)
Infrastructure uncertainty	(Christopher & Peck 2004) (Hoyos, Morales & Akhavan-Tabatabaei, 2015)
Misalignment of interests with suppliers	(Christopher & Peck 2004) (Manuj & Mentzer 2008) (Marquez, 2010) (Taylor 2016)
Service/products obsolescence	(Taylor 2016) (Marquez, 2010) (Srinivasan, Mukherjee & Gaur 2011)
The scarcity of complementary services/products	(Pellegrin-Boucher, Le Roy & Gurău 2013) (Xia, Xiao & Zhang 2013) (Ende, Jaspers & Rijsdijk 2013)

H3: Operations fragility will be positively related to managerial performance

3.3.2.4.The fragility of business units

The fragility of business units can be induced by different risk events such as: fixed assets mis-utilization inadequate (Hastings 2009; Laue et al 2014), fund management ability (Huang et al. 2015; Fan & Yuan 2016; Ruggiero & Lehkonen 2017), inadequate business unit supervision ability (Bunderson & Sutcliffe 2003; Cooper 2013), red-tape risk (Valackienė & Virbickaitė 2011; Kotey & Sorensen 2014), failure to follow business processes (Lok et al 2005; Schultz, Bierstaker & O'Donnell 2010; Hrbackova 2016), failure to integrate with business processes (Lok et al 2005; Khosravi 2016), lack of cost control (Pajares & Lopez-Paredes 2011; Caniëls, Gelderman & Vermeulen 2012), lack of resources (Fagan 1991; Christopher & Peck 2004; Manuj & Mentzer 2008) and improper planning for daily operations (Asfe et al. 2014; Hsu & Chen 2014; Cui et al. 2016). See table 3.8.

Table 3.8: Risk events inducing the fragility of business units

Risk events inducing the fragility of business units	
Fixed assets mis-utilization	(Hastings 2009) (Laue et al 2014)
Inadequate fund management ability	(Huang et al. 2015) (Fan & Yuan 2016) (Ruggiero & Lehkonen 2017)
Inadequate business unit supervision ability	(Bunderson & Sutcliffe 2003) (Cooper 2013)
Red-tape risk	(Valackienė & Virbickaitė 2011) (Kotey & Sorensen 2014)
Failure to follow processes	(Lok et al 2005) (Schultz, Bierstaker & O'Donnell 2010) (Hrbackova 2016)
Failure to integrate with business processes	(Lok et al 2005) (Ferri-Reed 2014) (Khosravi 2016)
Lack of cost control	(Caniëls, Gelderman & Vermeulen 2012) (Pajares & Lopez-Paredes 2011)

Lack of resources	(Fagan 1991) (Christopher & Peck 2004) (Manuj & Mentzer 2008) (Aureli & Salvatori 2013)
Improper planning for daily operations	(Asfe et al. 2014) (Hsu & Chen 2014) (Cui et al. 2016)

H4: Business unit fragility will be positively related to managerial performance

3.3.2.5.The fragility of projects

The fragility of projects in enterprises can be induced by a set of risk events such as: inadequate project requirements (Sumner 2000; Boardman Liu et al. 2008; Thamhain 2013; Eigbe, Sauser & Felder 2015), inadequate scope of control (Patil, Grantham & Steele 2012; Irimia-Diéguez, Sanchez-Cazorla & Alfalla-Luque 2014), inadequate project management ability (Fan & Yuan 2016), inadequate project risk culture building (Zeng et al. 2015), inadequate change management ability (Tatsiopoulos 2003; Fraser, Schoening-Thiessen & Simkins 2008; Crawford & Nahmias 2010; Ahmad & Shamsudin 2013), inadequate procurement management ability (Moeller 2007); Inadequate project monitoring (Raz & Hillson 2005; Sanchez et al. 2009; Boussabaine 2013; Marcelino-Sádaba et al. 2014), user's rejection of the product/service (Marquez, 2010; Srinivasan, Mukherjee & Gaur 2011; Taylor 2016), failure to record/archive lessons learned (Sumner 2000; Vogus & Sutcliffe 2007; White 2009; Yu et al. 2015), disengagement of executives with the project (Smyth 2016), lack of re-alignment between strategic and project objectives (Srivannaboon & Milosevic 2006), conflict between key stakeholders (Ward & Chapman 2003; Shrivastava & Rathod 2017), lack of integrating cost and time management (Jung, Moon & Kim 2011; El-Omari & Moselhi 2011), Lack of project risk identification (Moeller 2007; Thamhain 2013) lack of identifying risk triggers (Boussabaine 2013; Cozmei & Şerban 2014) lack of risk quantification (Grant & Pennypacker 2006, Wu & Olson 2009); lack of existing risk documentations on all processes and standards (Raz & Michael 2001; Grant & Pennypacker 2006; Moeller 2007; Boussabaine 2013), lack of using performance indices to measure project risk (Vandevoorde & Vanhoucke 2006; Vanhoucke 2012), Lack of immediate response to risks as they arise (Moeller 2007), Lack of processes for tracking project risks (McDowell 2001), lack of contingency risk plans (Raz & Michael 2001), (De Meyer, Loch & Pich 2002; Kerzner 2017), lack of using risk assessment and project performance status in decision making (Pillai, Joshi & Rao 2002); lack of information on risk triggers (Boussabaine 2013; Cozmei & Şerban 2014; Curkovic, Scannell & Wagner 2013). See table 3.9.

Table 3.9: Risk events inducing the fragility of projects

Inadequate project requirements	(Sumner 2000) (Boardman Liu et al. 2008) (Thamhain 2013) (Eigbe, Sauser & Felder 2015)
Inadequate scope of control	(Patil, Grantham & Steele 2012) (Irimia-Diéguez, Sanchez-Cazorla & Alfalla-Luque 2014)
Inadequate project management ability	(Fan & Yuan 2016)
Inadequate project risk culture building	(Zeng et al. 2015)
Inadequate change management ability	(Tatsiopoulos 2003) (Fraser, Schoening-Thiessen & Simkins 2008) (Crawford & Nahmias 2010) (Ahmad & Shamsudin 2013)
Inadequate procurement management ability	(Moeller 2007)
Inadequate project monitoring	(Raz & Hillson 2005) (Sanchez et al. 2009) (Boussabaine 2013) (Marcelino-Sádaba et al. 2014)
User's rejection of the product/service	(Marquez, 2010) (Srinivasan, Mukherjee & Gaur 2011) (Taylor 2016)
Failure to record/archive lessons learned	(Sumner 2000) (Vogus & Sutcliffe 2007) (White 2009)

	(Yu et al. 2015)
Disengagement of executives with the project	(Smyth 2016)
Lack of re-alignment between strategic and project objectives	(Srivannaboon & Milosevic 2006)
Conflict between key stakeholders	(Ward & Chapman 2003) (Shrivastava & Rathod 2017)
Lack of integrating cost and time management	(Jung, Moon & Kim 2011) (El-Omari & Moselhi 2011)
Lack of project risk identification	(Moeller 2007) (Thamhain 2013)
Lack of identifying risk triggers	(Boussabaine 2013) (Cozmei & Şerban 2014)
lack of risk quantification	(Grant & Pennypacker 2006) (Wu & Olson 2009)
Lack of existing risk documentations on all processes and standards	(Raz & Michael 2001) (Grant & Pennypacker 2006) (Moeller 2007) (Boussabaine 2013)
Lack of using performance indices to measure project risk	(Vandevoorde & Vanhoucke 2006) (Vanhoucke 2012)
Lack of immediate response to risks as they arise	(Moeller 2007) (Lloyd-walker, Mills & Walker 2014)
Lack of processes for tracking project risks	(McDowell 2001)
Lack of contingency risk plans	(Raz & Michael 2001) (De Meyer, Loch & Pich 2002) (Kerzner 2017)
Lack of using risk assessment and project performance status in decision making	(Pillai, Joshi & Rao 2002) (Hartono et al. 2014) (Sundararajan & Tseng 2017)
Lack of information on risk triggers	Boussabaine 2013) (Cozmei & Şerban 2014)
Lack of risk information collection	(Curkovic, Scannell & Wagner 2013)

H5: Project fragility will be positively related to managerial performance

3.3.3. Enterprise Resilience

To be resilient to the risk events inducing fragility, the enterprise should develop anti-fragility attributes and these can be clustered into risk culture, risk governance, risk appetite and risk-informed decision making. See figure 3.2.

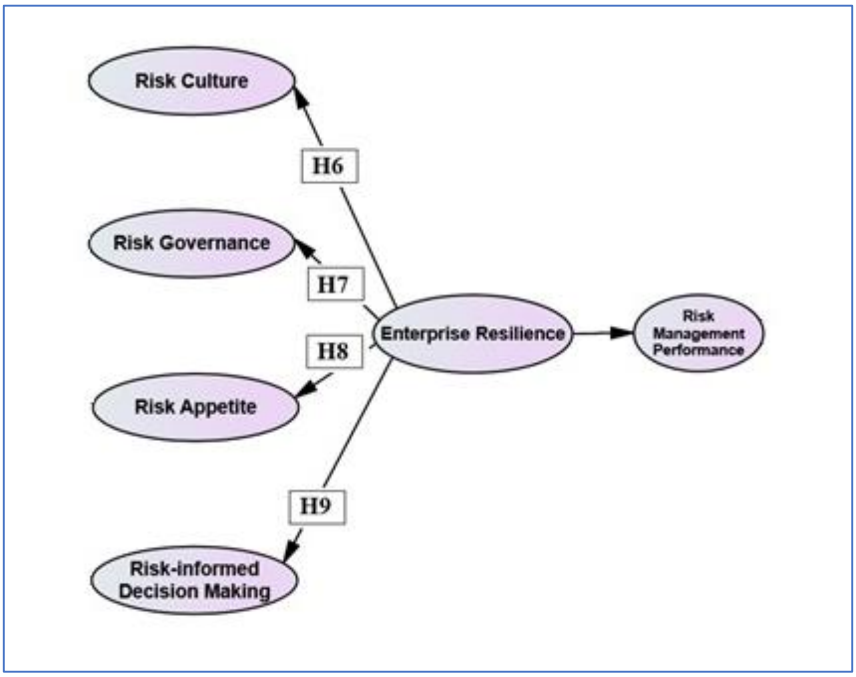


Figure 3.2: Research Hypotheses of Enterprise Resilience and Risk Management Performance

3.3.3.1.Resilience attributes to risk culture

Risk culture can contribute to the enterprise resilience if the following attributes are achieved: existence of thorough risk culture across entire organization; risk norms are embedded through various corporate processes; risk norms are embedded through various governance processes; existence of risk skill-enhancement program for key roles; existence of common vocabulary for different risks; using business-specific scenarios and stress tests to understand risks and opportunities; and using business-specific scenarios and early indicators to understand risks and opportunities (Clarke & Varma 1999; Christopher & Peck 2004; Moeller 2007; Hopkin 2017; Fritz-Morgenthal, Hellmuth & Packham 2016; Bezzina et al. 2014; Atkinson 2013). See table 3.10.

Table 3.10: Attributes of risk culture	
Existence of thorough risk culture across entire organization	(Clarke & Varma 1999) (Christopher & Peck 2004) (Moeller 2007) (Hopkin 2017) (Atkinson 2013) (Bezzina et al. 2014) (Fritz-Morgenthal, Hellmuth & Packham 2016)
Risk norms are embedded through various corporate processes	
Risk norms are embedded through various governance processes	
Existence of risk skill-enhancement program for key roles	
Existence of common vocabulary for different risks	
Using business-specific scenarios and stress tests, to understand risks and opportunities	
Using business-specific scenarios and early indicators to understand risks and opportunities	

H6: Risk culture will be positively related to managerial performance

3.3.3.2.Resilience attributes to risk governance

Risk governance can contribute to the enterprise resilience if the following attributes are achieved: ERM mandate of the risk function is clearly defined; robust design risk organization across entire organization; appropriation of top management; existence of clear allocation of responsibilities between risk taking and controlling units; risks are communicated via appropriate channels and technology; risk ownership and accountability are well defined; the organization has a risk management organizational structure with clear reporting lines; formal organizational risk reports are regularly reviewed; existence of risk models as support tool for business decisions; existence of key intelligence risks indicators; and provision of clarity and responsibility on taking actionable measures (van Asselt & Renn 2011; Klinke & Renn 2012; Welsh 2014, KPMG 2001). See table 3.11.

Table 3.11: Attributes of risk governance	
Enterprise Risk Management mandate of the risk function is clearly defined	(van Asselt & Renn 2011) (Klinke & Renn 2012) (Welsh 2014)
Robust design risk organization across entire organization	
Ensure appropriation of top management	

Existence of clear allocation of responsibilities between risk taking and controlling units	(KPMG 2001)
Risks are communicated via appropriate channels and technology	
Risk ownership and accountability is well defined	
The organization has a risk management organizational structure with clear reporting lines	
Formal organizational risk reports are regularly reviewed	
Existence of risk models as support tool for business decisions	
Existence of key intelligence risks indicators	
Provision of clarity and responsibility on taking actionable measures	

H7: Risk governance will be positively related to managerial performance

3.3.3.3.Resilience attributes to risk appetite

Risk appetite can contribute to the enterprise resilience if the following attributes are achieved: existence of policies on risk ownership Policies on risk appetite (how much risk can be taken) existence of guidelines on risk taking capacity (how much risk can be comfortably taken), existence of guidelines on trade-offs between risk taking and the corresponding cost, existence of guidelines on actions to transform company risk profile (Lundqvist 2014;Boussabaine 2013; Evans 2012; Polasky et al 2011; Farrell & Gallagher 2015; Kinman 2012). See table 3.12.

Table 3.12: Attributes of risk appetite	
Existence of policies on risk ownership	(Lundqvist 2014) (Boussabaine 2013) (Evans 2012) (Polasky et al 2011) (Farrell & Gallagher 2015) (Kinman 2012)
Policies on risk appetite (how much risk can be taken)	
Existence of guidelines on risk taking capacity (how much risk can be comfortably taken)	
Existence of guidelines on trade-offs between risk taking and the corresponding cost	
Existence of guidelines on actions to transform company risk profile	

H8: Risk appetite will be positively related to managerial performance

3.3.3.4. Resilience attributes to risk-informed decision making

Making decisions based on risk can contribute to the enterprise resilience if the following attributes are achieved: business decision making is embedded on risk, major strategic decisions are embedded on risk before deployment, core business processes are designed and executed on a risk-informed basis, core business operations are designed and executed on a risk-informed basis, risk responsibilities are incorporated into individual activities, and the minimum process functionality requirements are well identified (Starr, Newfrock & Delurey 2003; Sheffi & Rice 2005; Power 2009; Arena, Arnaboldi & Azzone 2010; Atkinson 2013; Theriou & Aggelidis 2014; Moran 2014). See table 3.13.

Table 3.13: Attributes of risk-informed decision making

Business decision making is embedded on risk	(Starr, Newfrock & Delurey 2003) (Sheffi & Rice 2005) (Power 2009) (Arena, Arnaboldi & Azzone 2010) (Atkinson 2013) (Theriou & Aggelidis 2014) (Moran 2014)
Major strategic decisions are embedded on risk before deployment	
Core business processes are designed and executed on a risk-informed basis	
core business operations are designed and executed on a risk-informed basis	
Risk responsibilities are incorporated into individual activities	
The minimum process functionality requirements are well identified	

H9: Risk-based decision making will be positively related to managerial performance

3.4. Summary

This chapter presented in detail the attributes that constitute the constructs of enterprise fragility, enterprise resilience and risk-related managerial performance. The chapter also outlined nine hypotheses that define the relationship between the three constructs. This chapter bridged the literature review which was presented in chapter one and the research methodology that will be presented in chapter four.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1. Introduction

This chapter presents the research methodologies that have been deployed to answer the research questions and achieve the research objectives. The first section describes the different approaches and methods that are usually used when conducting research, while the second section provides a detailed description of how the concepts are translated into researchable entities and the rationale behind the design of the research. The chapter is concluded by the ethical considerations that were practiced while conducting the research.

4.2. Research Strategy

Business Research is usually conducted in two main approaches: deductive or inductive. In the deductive approach, the researcher attempts to deduct a hypothesis based on pre-established knowledge about a theoretical consideration and then tests it; in the inductive approach, on the other hand, the theory is inducted as an outcome of the research through drawing generalizations out of observations (Bryman & Bell 2015). This research adapts a deductive approach as this approach is best suited when the researcher aims to examine if the observed phenomena can fit with what previous research expected (Wiles et al 2011).

Due to the deductive nature of the research, this study would be based on a quantitative approach informed by a positivist philosophy. The difference between qualitative approaches and quantitative approaches is related to the distinction between data deduction and data induction (Gibbs 2002). The quantitative approach is validated through a set of standard statistical tests (Goddard & Melville, 2004). To satisfactorily and logically answer the research questions, the researcher should incorporate a set of statistical tests and a number of modeling techniques. This requires the availability of data from a large number of participants to get a statistically accepted result. However, there is a need to an in-depth qualitative literature review as a first step of translating concepts into researchable entities.

4.3. Research Design

A research design provides “a framework for the collection and analysis of data”. The research is designed to understand the causal connection between enterprise fragility and risk management performance and the causal connection between enterprise resilience and risk management performance with a sample and then to generalize it to all enterprises. To ensure the quality of the research through the enhancement of reliability, validity, and replication, the research will adapt a cross-sectional social survey design, which entails“ the collection of data on more than one case (usually quite a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually many more than two), which are then examined to detect patterns of association” (Bryman & Bell 2015, p.62). The research method used in this research is self-completion questionnaire as it is the most feasible instrument to reach a large sample of practitioners and researchers. This method would help to reduce the researcher’s subjectivity or bias, to ensure the anonymity of the participants, and to reach a large sample size. However, the drawback of using this method will be the researcher’s inability to observe how the data is filled and this gives a room for some participants to fill the data without paying high attention. Moreover, the researcher cannot get any further feedback or follow–up on the answers received.

4.4. Research Plan

The main purpose of this study is to model enterprise resilience and enterprise fragility. It aims to provide decision makers with the tools to make strategic and tactical decisions that protect the enterprise, strengthen fragile areas and enhance resilient areas. Therefore, it requires in-depth literature review that would pave the way to a quantitative research process, which in turn would generate the two models. Through an intensive qualitative literature review, a conceptual framework of risk-oriented enterprise fragility and risk-oriented enterprise resilience is designed. The framework is used to profile the risk events that contribute to the fragility of the enterprise and the attributes that contribute to enterprise resilience. A questionnaire was conducted to develop two models: one to assess the fragility of the enterprise to risk events and another model to assess the resilience of the enterprise based on risk management practices. Based on the enterprise fragility model, a tool is developed to assess the enterprise fragility. The tool is validated in three enterprises.

4.4.1. Initial Research

In the first stage of the research plan, the research context is introduced and the research problem is identified. It also presents the research questions and the research objectives. This part also highlights the gap in literature as well as the significance of the study. This stage aims to put the researcher on track to establish the viewpoint that would be discussed in the later parts.

4.4.2. Literature Review

In order to generate a conceptual framework for the study, there is a need to survey the literature for the purpose of linking theoretical backgrounds and finding patterns that can be in conjunction with prototyping methods. Based on the generated conceptual framework, qualitative data was collected from literature to identify the profiles of the fragility risk events and enterprise resilience attributes. This is aimed to explore the environments in which risk managers work as this helps to answer the research questions and gives a clue about the type of information they need in order to make sound decisions under uncertainty. The purpose of the qualitative literature review is exploratory in nature as it is a means to scrutinize data about risk management, fragility and resilience. The qualitative data analysis is associated with different processes: data reduction, data display, and data verification (Miles & Huberman 1984). The module presented by Miles and Huberman (1984) is applied in this study. To reduce the collected data, a screening process was implemented aiming to identify any kind of potential frequencies or potential missing data. This led to a reconfiguration of data and this allowed for a sort of data to be transformed or singled out. Then, the data was displayed in an organized way that paved the way to draw inferences, conclusions or patterns. Finally, data was verified via an observation of the inferences and patterns already produced. There was also test of the “plausibility”, “sturdiness”, and “conformability” (Miles & Huberman 1994, p.11) of these drawn conclusions.

4.4.3. Questionnaire design and development

In a research project, data can be collected from two sources: primary – researcher’s raw evidence, or secondary – based on others’ raw evidence (Sapsford & Jupp 2006). The research collected primary data. Besides the scarcity of secondary data in the area of enterprise fragility, the collection of primary data helps the research to focus on this specific topic and investigate the specific insight of the research. In order to test the stakeholder's validation of the final framework, a questionnaire was conducted in the United Arab Emirates to collect data from a statistically significant sample. The questionnaire was distributed to the enterprises registered in Dubai Financial Market and Abu Dhabi financial market. This aimed to ensure that the sampled enterprises are from various sectors but they all adhere to the regulations of the financial markets. The researcher targeted at least one hundred fully completed questionnaires to be valid for the research. Ferguson and Cox (1993) suggest that one hundred responses would be enough to run indicative analysis. The questionnaire was re-distributed to larger sample since the number of fully completed questionnaires did not reach one hundred. The questionnaire was distributed online to save time and to cover different locations. The questionnaire is developed based on the factors identified in chapter 3. It is divided into three parts: fragility risk events, resilience attributes, managerial performance, and demographics. See appendix 4.1.

The questionnaire begins with an introduction through which the researcher introduces himself and the purpose of the research. The introduction also ensures the ethics followed in dealing with the data collected by this questionnaire. Moreover, it shows the contact information of the researcher and his director of studies.

The questionnaire consists of three main sections. In the first section, the participants are asked to rate how likely a set of risk events contribute to the fragility of the enterprise. This section is subdivided into five subsections: fragility of strategy, fragility of governance, fragility of operations, fragility of business unit and fragility of projects. While in the second section, the participants are asked to rate how likely a set of attributes contribute to the resilience of the enterprise. This section is subdivided into four subsections: risk culture, risk governance, risk appetite and risk-informed decision making. The structure of those sections is shown in figure 4.1 and 4.2.

4.4.4. Pilot study

The questionnaire was pre-tested on 30 respondents with the purpose of improving upon the questions. Reliability, validity and variability tests were conducted to ensure that the measurement tool produces stable and consistent results and they measure what it is purported to measure. Based on the pilot study, the below three questions were misunderstood by the respondents and then were deleted.

- How likely do you believe that **ERM** can add value to your organization's success?

- Please rate the potential of **identifying risk** as a source of value creation across in your business?
- Please rate how likely i**dentifying and assessing risks** help organisations to recover quickly from all events that disrupts business.

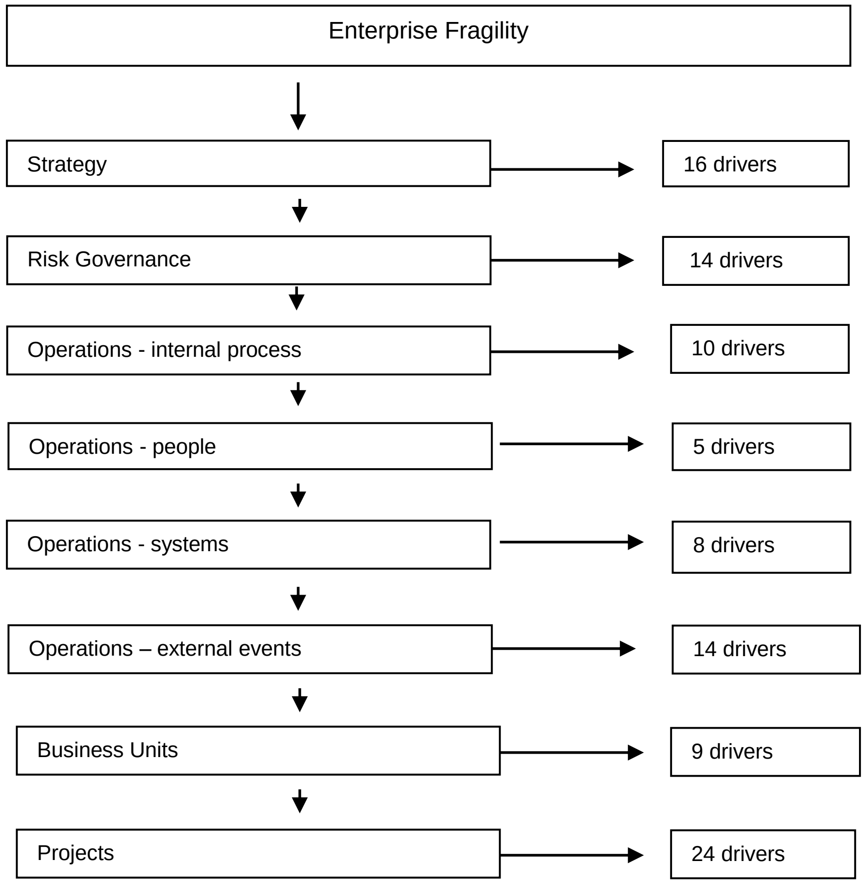


Figure 4.1: Questionnaire structure of fragility risk events

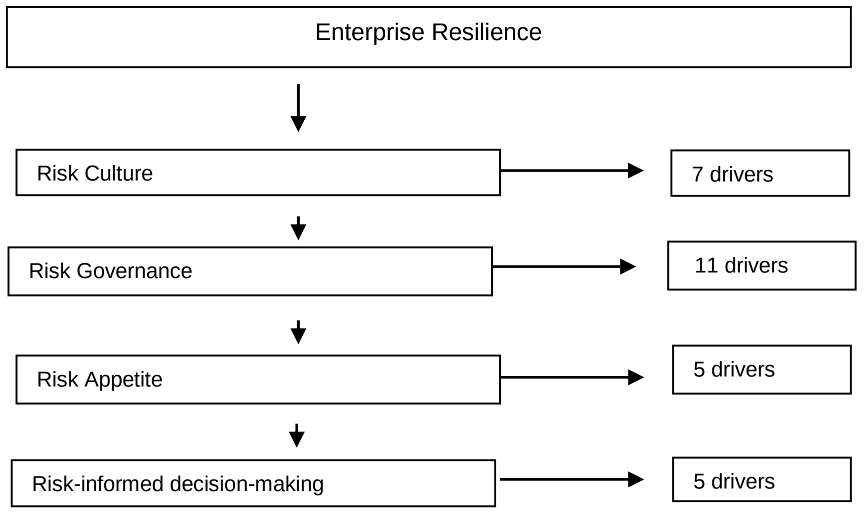


Figure 4.2: Questionnaire structure of resilience attributes

The first two sections were measured on a 5-point Likert-type scale. Participants were requested to rate each factor attribute based on its likelihood of contribution. There should be a selection of one of the following alternatives: ‘very likely’, ‘likely’, ‘neutral’, ‘unlikely’ and ‘very unlikely’. See a sample in table 4.1. The 5-point Likert-type scale is easy to construct and easily grasped by the participants; moreover, it is directly translated to a numerical measurement that can be used in statistical analysis (Li 2013). A scoring system of 1 to 5 is assigned to the responses. See table 4.2.

Table 4.1: Sample of the questionnaire items

Please rate how likely the risk events stated below contribute to the fragility of the enterprise strategies	Very likely	Likel y	Neutral	Unlikel y	Very unlikely
Unable to catch up with new innovations					
Disruption in the political changes					
Influence of Globalization					
Negative media and news affecting the reputation					
Inadequate assessment of organization capabilities					
Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies					
Inaccurate strategic positioning					
…..					

Table 4.2: Questionnaire scoring system

Very likely	Likely	Neutral	Unlikely	Very Unlikely
5	4	3	2	1

In the third section, participants were asked general questions about themselves and the enterprise they work for. They were asked about the period they spent in their current enterprise, their level of seniority, the size of their enterprise, the industry they work in as well as their ERM practices. Moreover, participants were asked how often they link risk with managerial performance. See table 4.3

Table 4.3: Link between risk and managerial performance

Please rate how often you use the following to manage your risks and performance.	**Very Frequently**	**Frequently**	**Occasionally**	**Rarely**	**Very Rarely**
a) Only what need to be known is identified					
b) Only measures that matter most are identified					
c) Data turned into actionable information					
d) Risks are linked to performance					
e) Risk-informed metrics are used to track performance					

4.4.5. Data collection and analysis

The questionnaire generated demographics about participants and these characteristics might function as moderator variables. Using SPSS, the quantitative data collected from the questionnaire was described, tested and analysed. In addition to descriptive statistics, factor analysis, reliability tests, correlation tests, and severity indices were utilized to interpret data. In chapter five, descriptive statistics will be summarized and projected in suitable graphs such as tables, pie charts, bar charts, etc. in order to make them more readable and easily understood. IMOS will be used to do structural equation modelling for fragility and resilience in chapter 7. In chapter 8, the model of enterprise fragility will be translated into an assessment tool. The same chapter will show how the developed tool was sent to top risk managers in three enterprises asking them to assess their enterprises as per the suggested model.

4.4.5.1.Factor Analysis

Factor analysis is usually used to identify a small number of factors that explain most of the variance observed in a much larger number of variables (Morgan et al. 2004; Punch 2005). Having many variables often makes it difficult to understand the data. Factor analysis technique can reduce the number of variables without losing too much of the information the original variables provide (Field 2013, Punch 2005). This technique can also be used for other purposes such as the establishment of underlying dimensions between measured variables and latent constructs, thereby allowing the formation and refinement of theory, and it also provides construct validity evidence of self-reporting scales (Hair et al. 1998). This technique has two types: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

Broadly speaking, EFA is heuristic since the researcher has no expectations of the number or nature of the variables and he/she aims to explore the main dimensions in the data to generate a theory, or model from a relatively large set of latent constructs. Contrarily, in CFA the researcher attempts to test pre-set assumptions based on a proposed theory or model regarding the number of factors, and which factor theories or models best fit (Schreiber et al. 2006). The latent components and variables are extracted by using the principal components method in SPSS. The components are then formed into a set of matrices that present the correlations between two or more different variables. The factor analysis process starts by finding a component that includes a linear combination of variables accounting for as much variation in the original variables as possible. After that, the process continues to find the other components that account for as much of the remaining variation as possible and each should be uncorrelated with any other previous component. The process ends after all the relevant components have been found containing as much as original variables. Usually, it can be seen that a few components account for most of the variation, and these components can be considered to replace the original variables (Punch, 2006; Morgan, et al., 2004; Field, 2005). Therefore, in the results presented in the following section, the most important fragility risk events and resilience attributes have been extracted and treated as representative of the whole set of factors. The degree of significance of each risk event and anti-fragility attribute varies according to its likelihood and impact on fragility and resilience respectively. It can be said that some variables can be influential in comparison with others. Chapter 6 will discuss a few variables that present the characteristics for risk events inducing enterprise fragility and attributes contributing enterprise resilience.

First, the components extracted by principle component analysis using varimax rotation will be presented. The components were set according to a series of correlations among different fragility risk events and among different resilience attributes. For each group of factors, a total variance table, a scree plot of data and rotated component matrix table are presented. Then, a diagram will be present the model produced by CFA. The total variance table shows the correlation between factors. The first column shows the components and the next three columns present three sets of results. The first column shows Initial Eigenvalues, which are related to the Eigenvalue of the correlation matrix and indicate which components can remain in the analysis. The next column shows Extraction Sum of Squared Loadings which describes the sum of the squared loadings for the non-rotated attributes. The last column shows Rotation Sums of Squared Loadings, which presents the rotated attributes' solution. Factor analysis was considered for the components with Eigenvalues of more than one, whilst those with Eigenvalues of less than 1 were excluded (Punch, 2005; Field, 2005). The initial Eigenvalues and rotated were used to confirm the variation explained by each extracted value creation component. The scree plot is proposed in order to provide a graphical picture of the Eigenvalue for each component extracted in SPSS. The chart line shows the slope is reducing, while it is moving towards the components that have an Eigenvalue of less than 1. The scree plot shows the place where a sharp change in angle occurs, and this is considered to be the point where Eigenvalues of less than 1 are placed, where the flattened part of the curve is plotted (Morgan et al 2004). In contrast, the curve's sharp slope indicates where the Eigenvalues with a value of larger than 1 are located. The rotated component matrix table shows the extraction of a rotated component matrix in order to find out which factors are having the highest level of influence by presenting the matrix loading scores. The degree of influence of each factor can be seen by using varimax rotation, and this distinguishes the factors with the highest level of influence. It is suggested that attribute loadings with an absolute value greater than 0.45 should be interpreted (hair et al 1998, Morgan et al. 2004, Field 2005). The method is used to extract the most effective factors of each component. That is the factors with the highest scores and correlation values are chosen for each component.

CFA is conducted when the researcher uses a hypothesized model to estimate a population covariance matrix that is compared with the observed covariance matrix. Technically, the researcher wants to minimize the difference between the estimated and observed matrices. The graphic representation is the hypothesized model that is tested to see how well it fits the observed data. The numbers "1" in the diagram indicate that the regression coefficient has been fixed to 1. Coefficients are fixed to a number to minimize the number of parameters estimated in the model. Values other than 1 can be chosen and will not change the overall fit of the model, but rather, affect the variance of the error. The model is mainly described with Chi-square value, Degrees of freedom and Probability level. However, Chi-square value on its own is not an inadequate indicator because as with any inferential procedure, large samples, which are required in order to obtain robust, reliable parameter estimates, more likely produce large chi-square values, which produce statistical significance. Therefore, there is a need to examine additional indices of model fit. For example, researchers examine indices such as the Goodness of Fit Index (GFI), the Incremental Fit Index (IFI), the Normed Fit Index (NFI), the Comparative Fit Index (CFI), the Non-normed Fit Index (NNFI, also known as the Tucker-Lewis Index or TLI), the Root Mean Square of Approximation (RMSEA), the Root Mean Square Residual (RMR), the Standardized Root Mean Square Residual (SRMR), and the Akaike Information Criterion (AIC), to name but a few. The fit indices have differing scales and norms for indicating model adequacy (Hu and Bentler 1999, Yu 2002, Schreiber et al. 2006).

Regarding the overall theoretical model fit analysis, as indicated by Bagozzi and Yi (1988), one single indicator or criterion cannot determine the model goodness of fit; therefore, there should be a consideration of different testing results of the overall model. In relation to the validity of approximate, there is a great deal of debate about which indicator to be used (Marsh et al. 2004). In a review of 194 confirmatory factor analysis studies (1,409 factor models) published in American Psychological Association journals from 1998 to 2006, Jackson and Gillaspy (2009) stated the most frequently reported fit measures reported in the studies were Chi-square ($\chi 2$), CFI, RMSEA, and TLI (89.2%, 78.4%, 64.9%, and 46.4 respectively); while the ratio of reporting other fit measures ranged between 1.5% to 34% of studies under review. In a review of CFA and SEM articles published in The Journal of Educational Research between 1989 and 2004, Schreiber et al. stated that "[i]n general, the authors prefer the TLI, CFI, and RMSEA for one-time analyses" (2006, p.327)

The overall model fit to data is traditionally measured by the Chi-Square value. It "assesses the magnitude of discrepancy between the sample and fitted covariances matrices" (Hu & Bentler 1999). When the test has an insignificant result at a 0.05 level, the model has a good fit (Barrett 2007). A major limitation of this test is its sensitivity to sample size, that is, a small sample size does not help the test distinguish between good fitting models and poor fitting models (Jöreskog & Sörbom 1993). The impact of this limitation can be minimized by using relative/normed chi-square ($\chi 2/df$) (Wheaton et al's 1977). The cut-off of accepted ($\chi 2/df$) ratio is a debateable point and it may range from 2.0 (Tabachnick & Fidell 2007) to 5.0 (Wheaton et al 1977). In general, 2.0 to 3.0 is generally accepted ratio (Schreiber et al. 2006).

Moreover, another recommended test is root mean square error of approximation (RMSEA). This test is recommended due to its ability for a confidence interval to be calculated around its value (MacCallum et al. 1996). Root mean square error of approximation (RMSEA) measure ranges from zero to positive infinity, with a value of zero indicating exact model fit, and the larger the value the poorer the model fit. A value of less than 0.08 was originally suggested to indicate a reasonable error of approximation and less 0.05 was suggested to indicate a close fit (Browne & Cudeck 1993). MacCallum et al. (1996) suggested 0.01 for excellent fit, 0.05 for good fit and 0.08 for mediocre fit. Recently, it has been generally agreed (Hooper et al. 2008, Chen et al. 2008) that a cut-off value close to 0.06 (Hu & Bentler 1999) or an upper limit of 0.07 (Steiger 2007) is recommended. However, this cut-off point cannot be taken as "golden rules of thumb," because of its "limited generalizability to mildly misspecified models" (Marsh et al. 2004).

Furthermore, one more test that can help to assess the overall model fit is The Tucker-Lewis Index (TLI). TLI index (also called the non-normed fit index or NNFI) is an incremental fit index that depends on the average size of the correlations in the data. The scale of this test ranges from 0.0 to 1.0 and the higher value the better fit. Values greater than 0.9 was originally recommended to indicate a good fit, and later Hu and Bentler (1999) suggested 0.95 and higher as an indicator of a good fit. However, Marsh, Hau and Wen argued that (TLI > .90) is "overly demanding in relation to a normative criterion of appropriateness based on the best existing psychological instruments. Hence, the new, more demanding cutoff values proposed by Hu and Bentler (1998, 1999) appear to be largely unobtainable in appropriate practice" (2004, p.326).

In addition, the overall model fit can be assessed through The Comparative Fit Index (CFI). Based on the Normed-fit index (NFI) model that compares the $\chi 2$ value of the model to the $\chi 2$ of the null model, Bentler in 1990 introduced CFI to test small sample size (Hooper et al. 2008). The scale of this test ranges from 0.0 to 1.0 and the higher value the better fit. Values greater than 0.9 was originally recommended to indicate a good fit; however, it has been recently suggested to recognized 0.95 to indicate a good fit (Hu & Bentler 1999).

4.4.5.2.Structural Equation Modelling

Structural equation modelling (SEM) is a method used in social sciences to test a proposed model based on testing hypotheses of causal influences (Snoj et al. 2004) and it has been widely used in empirical studies (Lee 2007). SEM is more powerful than other multivariate analysis technique as it incorporates latent variables into the analysis and considers the correlated independents, measurement error and multiple latent independents (Byrne 2001, p.3-4), and it also can help to improve statistical estimation, identify the measurement error, and gives rise to the interdependent nature of the structural model (Hair et al. 2006, p.711-718). SEM is done through two stages. The first stage is to do a confirmatory factor analysis for each construct, while the second stage is to estimate SEM for the conceptual model. The generated model is evaluated in terms of statistical significance and measures of fit and it can be modified if needed (Anderson & Gerbing 1988).

For the purpose of evaluating the CFA and SEM models, four indicators will be considered: CMIN/DF, TLI, CFI and RMSEA. The measures of fit for the CMIN/DF are evaluated in the context of suggested minimum of 2.0 (Hair et al. 2006). The measures of fit for the TLI and the CFI are evaluated in the context of suggested minimum threshold values of 0.9. The measures of RMSEA is evaluated in the context of suggest minimum of 0.8. The statistical significance of coefficients is evaluated in terms of the results of a hypothesis test with the null hypothesis that the true coefficient is zero using a significance level of 1%. The SMCC is evaluated in terms of the minimum value of 0.3 as the minimum standard suggested by Jőreskog, Sőrbom and Lisrel (1983). At the construct level, the latent variable's composite reliability (CR) is calculated to for the validity purpose suggesting the internal consistency of the composite indicators (Fornell & Larker 1981) and the result evaluated in the context of 0.60 standards for acceptability (Bagozzi & Yi 1988).

4.4.5.3.Assessment tool for enterprise fragility

As will be presented in chapter 8, enterprise fragility indicators will be identified and highlighted in each component based on the refinement and data reduction and then the components are grouped into clusters based on their relation to each other. This assessment tool is based on a scoring system for the indicators, weighting them based on the confirmatory factor analysis, compute the scoring, plotting the result, testing the tools, and finally implications and discussion.

4.5. Ethical Considerations

Throughout the whole research process, the researcher observed all ethical considerations, especially the three ethics principals: respect for persons, beneficence and justice. The ethical research guidelines issued by the British University in Dubai were observed. Furthermore, the researcher ensured the following points are enhanced. First is confidentiality. The anonymity of all parties involved in the study will be guaranteed before, during and after the research. Privacy of participants is highly maintained and data is stored safely without any access to non-authorized parties. The authorized parties were specified prior to the commencement of the study. Second is transparency. The purpose of the study and the risks associated with it should be declared to all parties involved prior to the commencement of the study. A detailed letter about the purpose of the study, the research methodology and risks associated with the research were issued to the organizations involved in the study to get their voluntarily-granted approval and consent about the research. This study entails research which can be considered a medium to high risk due to the significantly adverse effects of the release of data; therefore, all potential adverse effects on participants were declared prior to conducting the study with a complete plan on how they will have been addressed. Third is honesty, throughout the whole research all data, tests, methods, and results are reported honestly and transparently. The researcher is neutral against all results and findings. Finally, participants in the study were not vulnerable to any physical or psychological harm or being disadvantaged in terms of education; rather, the full benefits of their participation is available for them.

4.6. Summary

This chapter presented the research methodologies that have been deployed to answer the research questions and achieve the research objectives. The chapter defined the research strategy, the research design, and the research plan. It also presented a detailed description of how the data is collected and analysed. The chapter was concluded by the ethical considerations that were practiced while conducting the research.

CHAPTER FIVE

DESCRIPTIVE STATISTICS AND DATA RANKING

5.1. Introduction

Based on a qualitative review of the risk management, business fragility and business resilience literatures and previous research works, the questionnaire was designed, validated by academics and practitioners and then commissioned among risk management practitioners. The practitioners came from three managerial levels (middle management, senior management and top management), involved in risk management practices. The data was coded and entered on SPSS. The findings obtained from the questionnaire are statistically described and ranked in this chapter, while a further inferential statistical test results will be reported chapters 6 and 7.

5.2. Participants

One hundred and twenty-four questionnaires were distributed to the enterprises enlisted in Dubai financial market (50 enterprises) and Abu Dhabi Financial Market (64 enterprises) asking for it to be distributed to managers who are familiar with risk practices. Fifty three complete responses were collected. Therefore, 200 questionnaires were distributed to other enterprises that are similar in size and sector to the enterprises enlisted in the Dubai financial market and Abu Dhabi Financial Market, and 76 complete responses were collected. The obtained data were entered to SPSS and organized to be analysed. In this chapter, descriptive statistics of the data is presented to provide a visual description of the findings aiming for a proper exploration of the data. Moreover, data is ranked in terms of significance to pave the way for further analysis and discussions that will be presented next chapters.

As seen in figure 5.1, the findings showed 18 participants (14%) were working in insurance sector, 17 participants (13%) were working in engineering sector, 16 participants (12%) were working in banking sector, and 15 participants (12%) were working in telecommunication sector, 14 participants (11%) were working in public services sector, 13 participants (10%) were working in manufacturing sector, 9 participants (7%) come from each of construction and real estate or energy sectors, while 11 participants (8.5%) were working in other sectors.

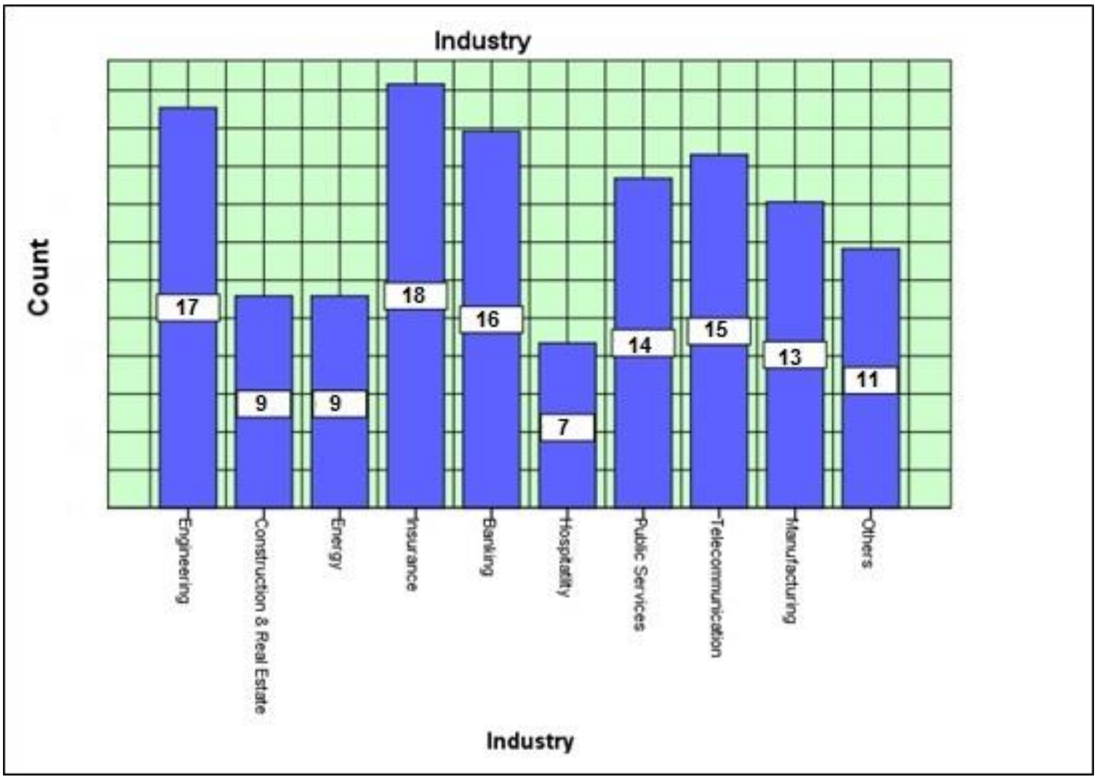


Figure 5.1: Enterprises Industry

Less than one fifth of the participants work for enterprises with 100 employees or less; more than a quarter of them work for enterprise whose employees are between 101 and 300; while more than half of the participants work for enterprises with more than 300 employees. The majority of participants (46.5%) are senior managers, less than a quarter of the participants are top managers and less than a third of them are middle managers. See Figure 5.2 and 5.3.

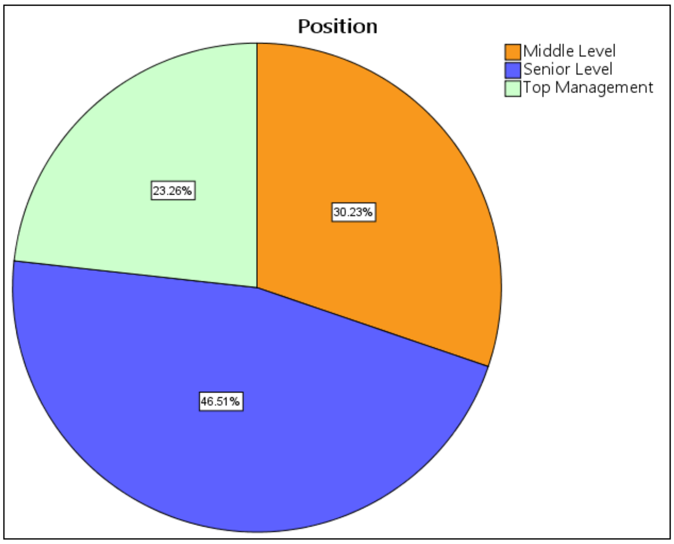


Figure 5.2: Participants Position

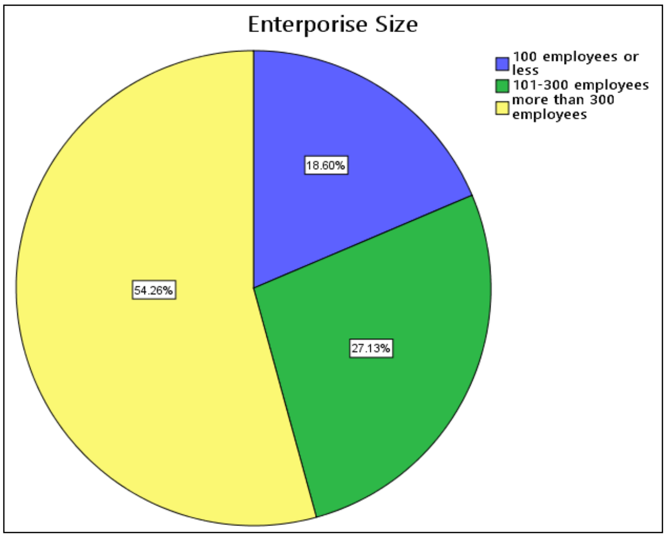


Figure 5.3: Enterprise Size

In an attempt to provide a self-evaluation of risk management practices in the enterprises surveyed, participants were asked three more questions about their enterprises.

The responses to the question about the methods that participants use to measure risk effects show that more than a quarter of participants do not use a systematic method to measure the effects of risks. Almost one third of the participants uses risk matrix. 19%, 15% and 8% use check list, scoring systems, and Monte Carlo Simulation, respectively. See figure 5.4.

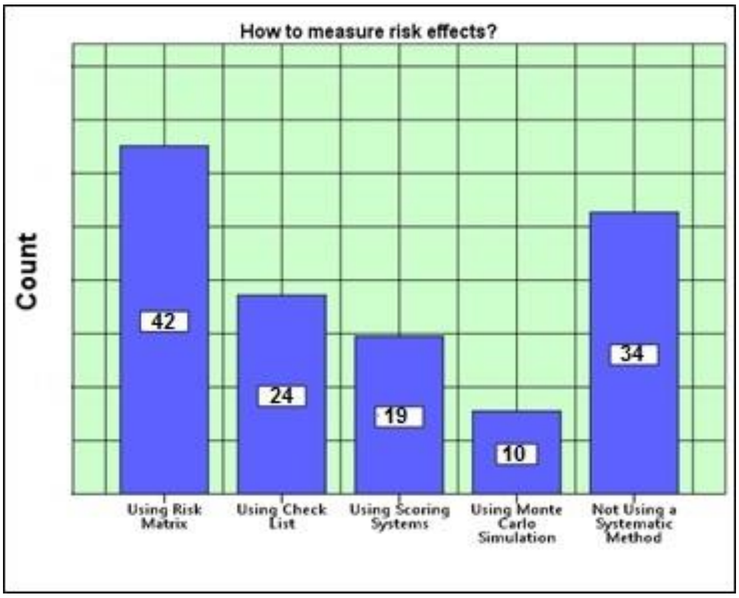


Figure 5.4: Measuring Risk Effects

When the participants were asked whether monitoring the effectiveness of risk management in their enterprise is an integral part of routine management reporting, the responses showed that three quarters of the participants believe that the effectiveness of risk management in their enterprise is an integral part of routine management reporting, while almost 17% and 7% are either not sure of the answer or they disagree with the statement, respectively. See figure 5.5.

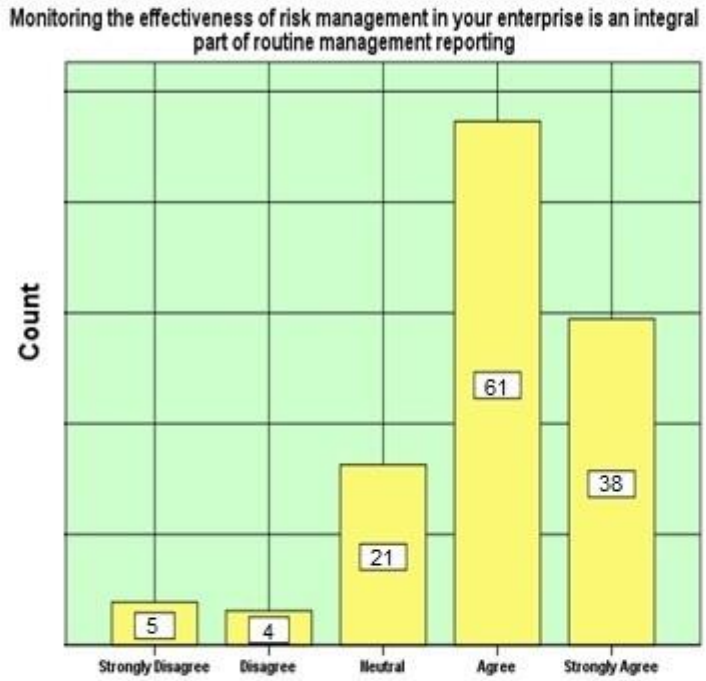


Figure 5.5: Monitoring the effectiveness of risk management

The responses of this question are cross tabulated with the participants' industry as can be seen in figure 5.6. Insurance, engineering and telecommunication sectors outperform other industries in monitoring the effectiveness of enterprise risk management practices; while manufacturing sector showed the least developed practices.

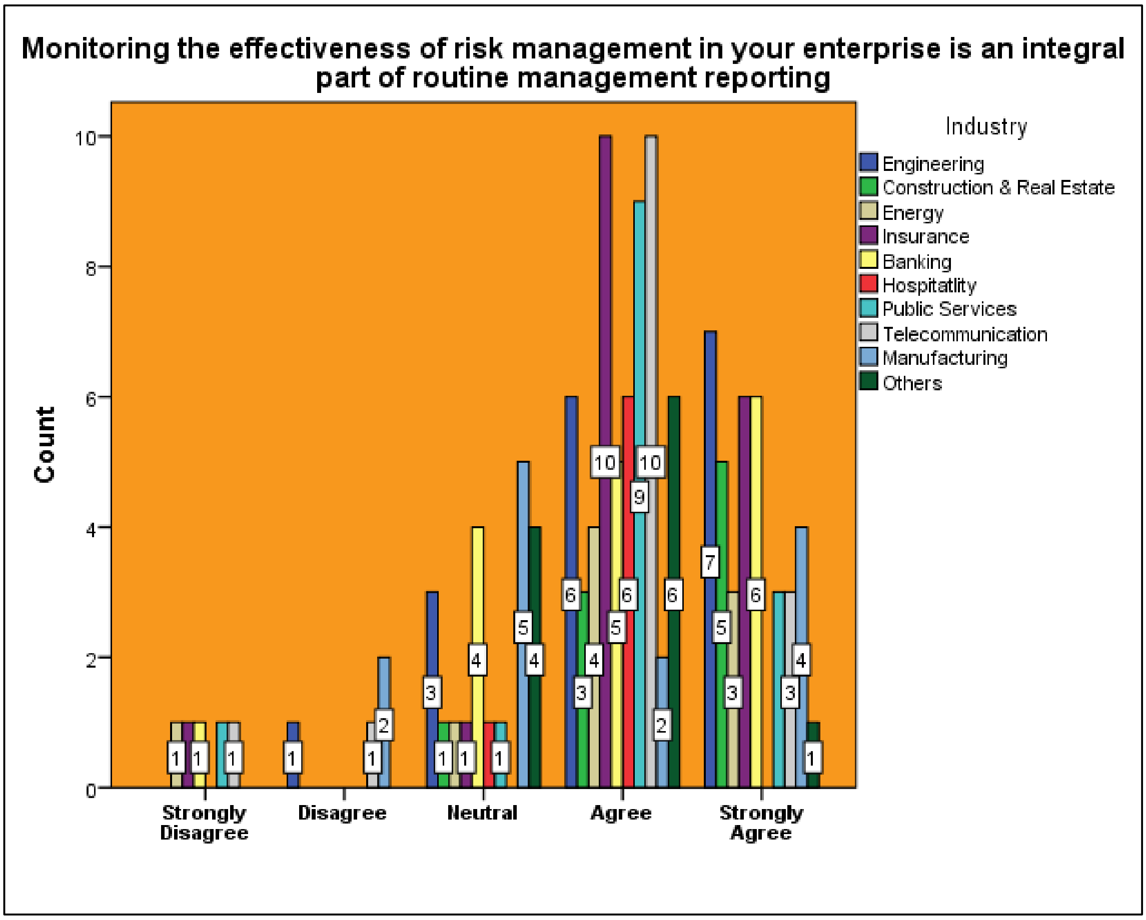


Figure 5.6: Monitoring the effectiveness of risk management cross tabulated with industry

Note: the number on the bars indicates the frequency of the response

When the participants were asked about how far the enterprise's senior management is receptive to all communication about risks, including bad news, the responses showed that almost two thirds of participants agree that their enterprise's senior management is receptive to all communication about risks, including bad news. While almost 18% and 15% are either not sure of the answer or they believe that their enterprise's senior management is not receptive to all communication about risk, respectively. See figure 5.7.

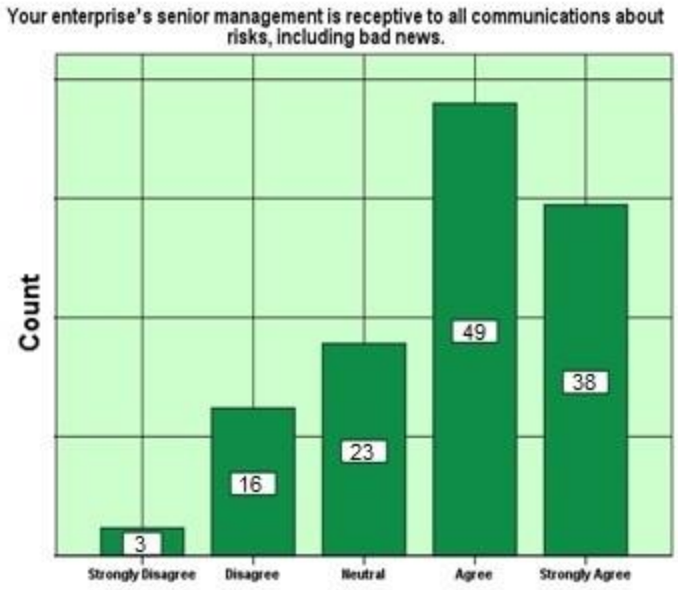


Figure 5.7: Management reception of communication about risk

The responses of this question are cross tabulated with the participants' industry as can be seen in figure 5.8. Insurance and banking sectors outperform other industries in the receipt of communication about risk; while manufacturing sector showed the least developed practices.

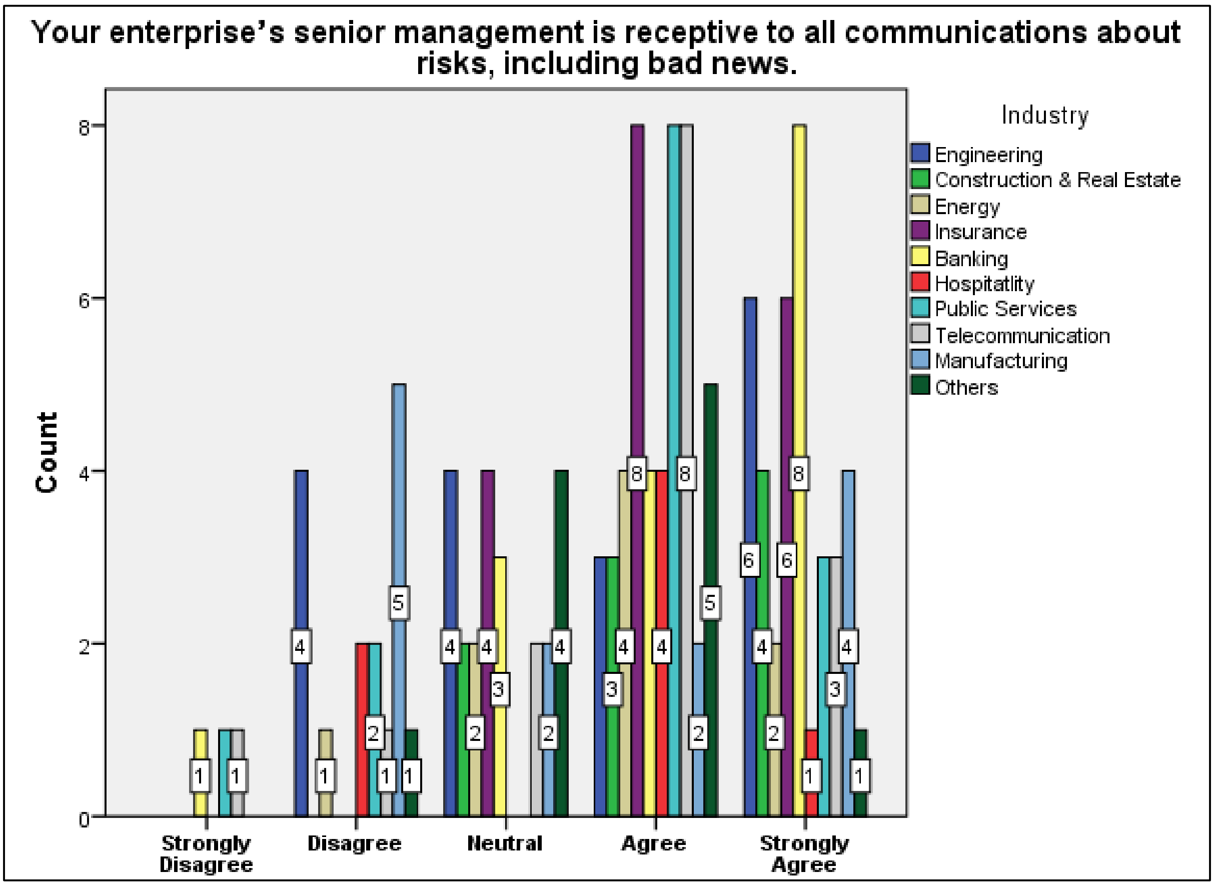


Figure 5.8: Management reception of communication about risk cross tabulated with industry

Note: the number on the bars indicates the frequency of the response

When the participants were asked to evaluate how far risk management practices are developed in the enterprise they work for. The responses showed that more than 70% of the enterprises are above basic level – almost a quarter of the enterprises practice reasonably well-developed risk management; less than a third showed well developed practices while a tenth showed best practices. While 25% and 2% consider their enterprise's risk management practices are reasonably well developed, basic and non-existent, respectively. See figure 5.9.

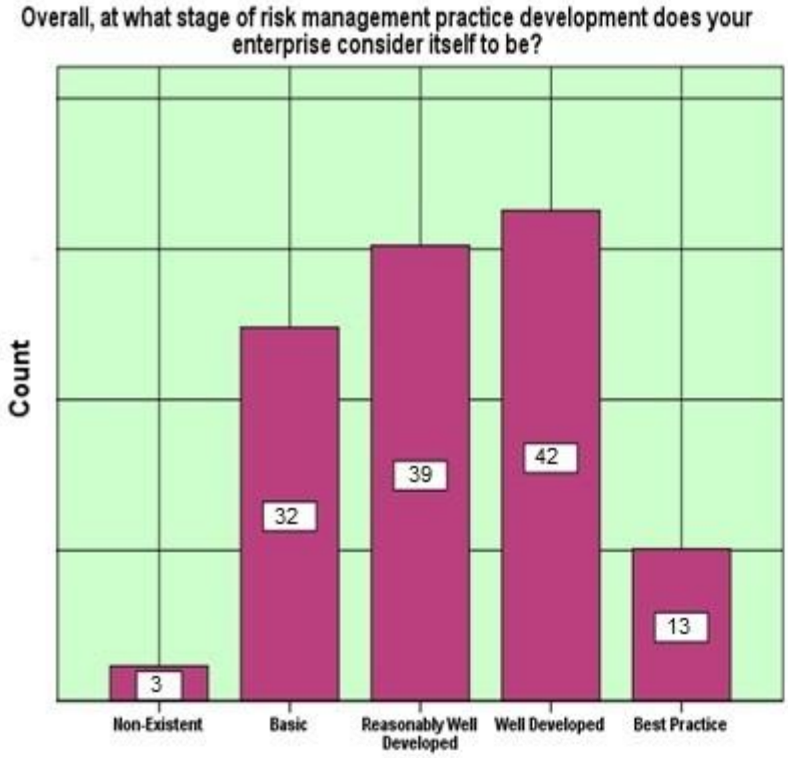


Figure 5.9: The development of risk management practices

The responses of this question are cross tabulated with the participants' industry as can be seen in figure 5.10. Banking and insurance sectors outperform other industries in practicing well-developed risk management; while manufacturing sector showed the least developed practices.

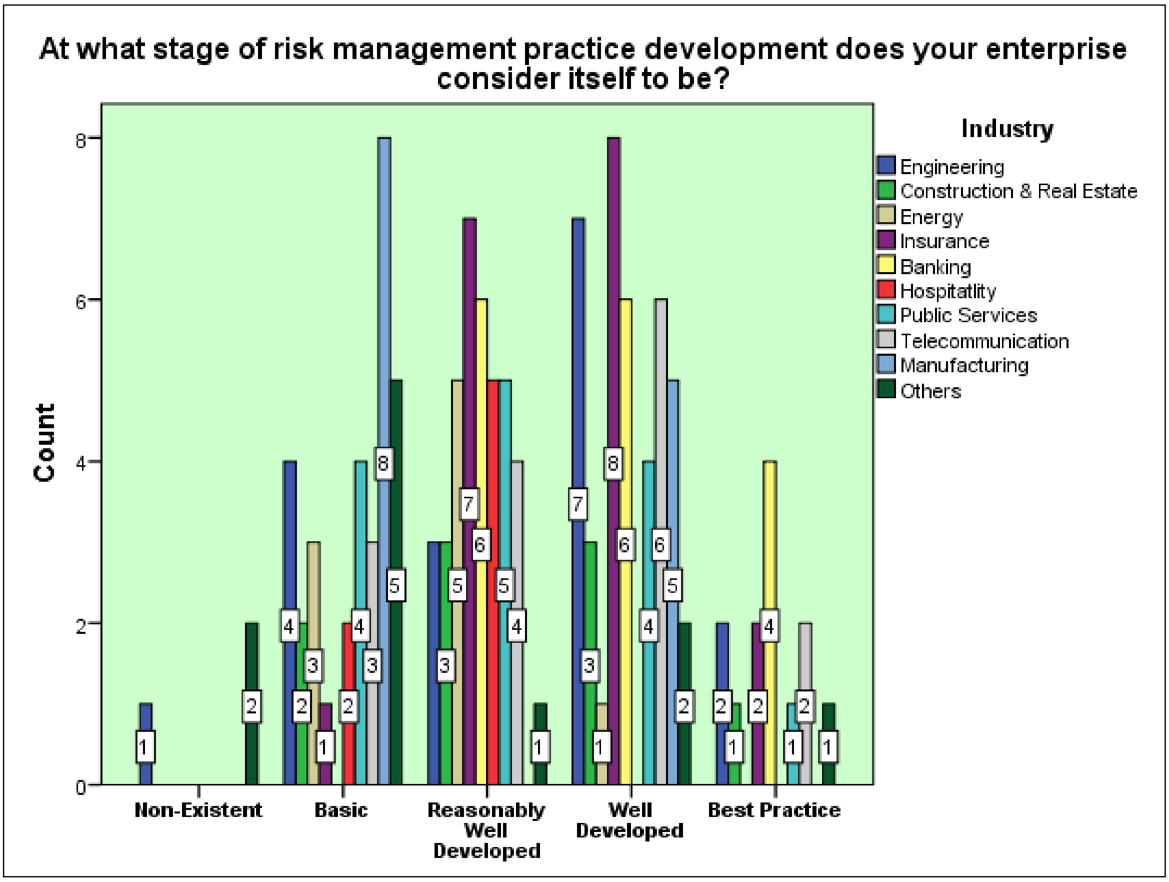


Figure 5.10: Evaluation of risk management practice cross tabulated with industry

Note: the number on the bars indicates the frequency of the response

5.3. Data ranking

This chapter presents a raking analysis to the data obtained from the questionnaire survey, using the SPSS and Microsoft Excel. The method of evaluation and ranking is based on statistical analysis such as (Field, 2005; Morgan et al, 2004; Punch, 2006):

- The average weighted mean
- Standard deviation
- Coefficient of variation
    - The ratio of standard deviation as a percentage (%) of the mean.
    - For comparing the relative variability of various responses.
    - The lower variation coefficient, the better is the variability.
- Severity index
    - Ranking of the indicators according to their significance.
    - The higher percentage (%), more significance is the factor.

As a result of the participants' scale, the risk events inducing enterprise fragility and enterprise resilience attributes were ranked based on their significance. This ranking helps group this huge set of factors and helps understand the commonality among them with the purpose of figuring out common trends or themes.

5.3.1. Analysis and ranking

A mean weighted rating for each factor is computed to indicate the importance of each indicator, using the equation 5.1 below.

Mean weighted rating **= [∑ (R*F)] / n** equation (5.1)

Where;

R = rating of each risk factor (1,2,3,4,5)

F = frequency of responses

n = total number of responses (n = 129)

Severity index (S.I) measure is to rank the indicators according to their significance. Equation 5.2 presents how S.I is calculated:

S.I. = { [∑(W*F)] / n } * 100 % equation (5.2)

Where;

W = weight of each rating (1/5, 2/5, 3/5, 4/5, 5/5)

F = frequency of responses

n = total number of responses (n = 129)

The ratio of standard deviation (SD) as a percentage of the mean, is called Coefficient of variation (COV) and is for comparing relative variability of responses.

COV = (S / M) * 100 % equation (5.3)

Where;

S = standard deviation

M = weighted mean sample

A list of risks derived from the literatures was provided to the participants who were asked to rate how likely each risk may contribute to the fragility of the enterprise using the Likert scale of 1-5 (1- very unlikely; 2 unlikely; 3- neutral; 4- likely; 5-very highly likely). Similarity, a list of risk management factors was provided to participants who were asked to rate how likely each factor may contribute to the enterprise resilience using the Likert scale of 1-5 (1- very unlikely; 2 unlikely; 3- neutral; 4- likely; 5-very highly likely).

5.3.2. Rating and ranking of risk events inducing enterprise fragility

Overall, the average weighted mean for the fragility factors varies from 2.736 to 4.512, with the overall mean of 3.991. The severity indices range within 16% (GR11) to 58 % (GR8). The spread of the data is large and this indicates a relative change in opinions among the participants. This can be due to the differences among the sectors. Some risk events are more significant to some industries than other industries.

The top 30 ranked risk events were dominated by the events from the strategy risks where the highest ranked factor was (GR8 Inadequate risk pricing policies) with a mean of 4.062 and severity indices of 58 %. An overall examination of the first 30 ranked risk events indicates that all first 30 ranked risk events have a minimum mean value of 4.062 (which is higher than the overall mean of 3.991) and minimum severity indices of 44.58 %. This means that the first 30 ranked fragility inducing risk events seem to be important as viewed by the participants.

5.3.3. Risk events inducing the fragility of strategy

In the strategy level, 9 risk events out of 16 are ranked in the first 30 highest ranked fragility-inducing risk events. The risk events inducing the fragility of strategy have an overall mean in the range of 3.884 to 4.512. The severity indices are in the range of 31% - 54%. Factor SR4 (Negative media and news affecting the reputation) is ranked the most important fragility factor for the strategy level and has an overall rank of third out of 100 indicators, and the severity index of 54.346%. See figure 5.11 and appendix 5.4. With the advanced technology that facilitates social media, the reputation of the enterprise in the online environment has become an essential success factor (Floreddu, Cabiddu & Evaristo 2014). Nowadays, the infamous reputation of an enterprise can go viral in hours through social media and other mobile communication tools.

Figure 5.11: Ranking of risk events inducing the fragility of enterprise strategy

5.3.4. Risk events inducing the fragility of governance

In the governance level, 6 risk events out of 14 are ranked in the first 30 highest ranked fragility inducing risk events. The risk events inducing the fragility of governance have an overall mean in the range of 2.736 to 4.256. The severity indices are in the range of 16% - 58%. Factor GR8 (Inadequate risk pricing policies) is ranked the most important risk event for the governance level and has an overall rank of first out of 100 indicators, and the severity index of 58.008%. See figure 5.12 and appendix 5.5.

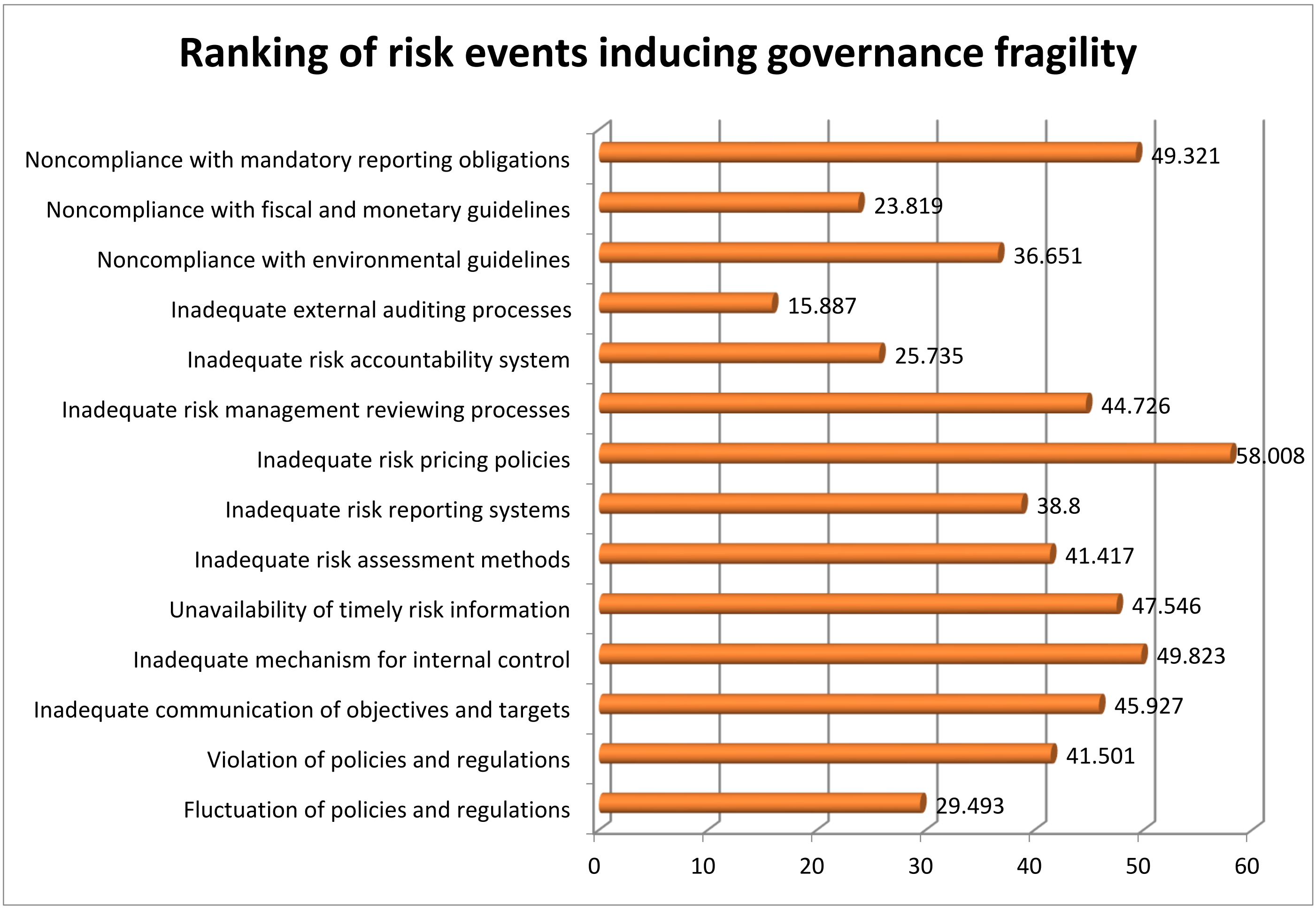


Figure 5.12: Ranking of risk events inducing the fragility of enterprise governance

5.3.5. Risk events inducing the fragility of operations

In the operations level, only 4 risk events out of 37 are ranked in the first 30 highest ranked fragility drivers. The operations fragility drivers have an overall mean in the range of 3.496 to 4.426. The severity indices are in the range of 25% - 54%. Factor ORP1 (Fraud or corruption) is ranked the most important fragility factor for the operations level and has an overall rank of second out of 100 indicators, and the severity index of 54.349%. See figure 5.13 and appendix 5.6.

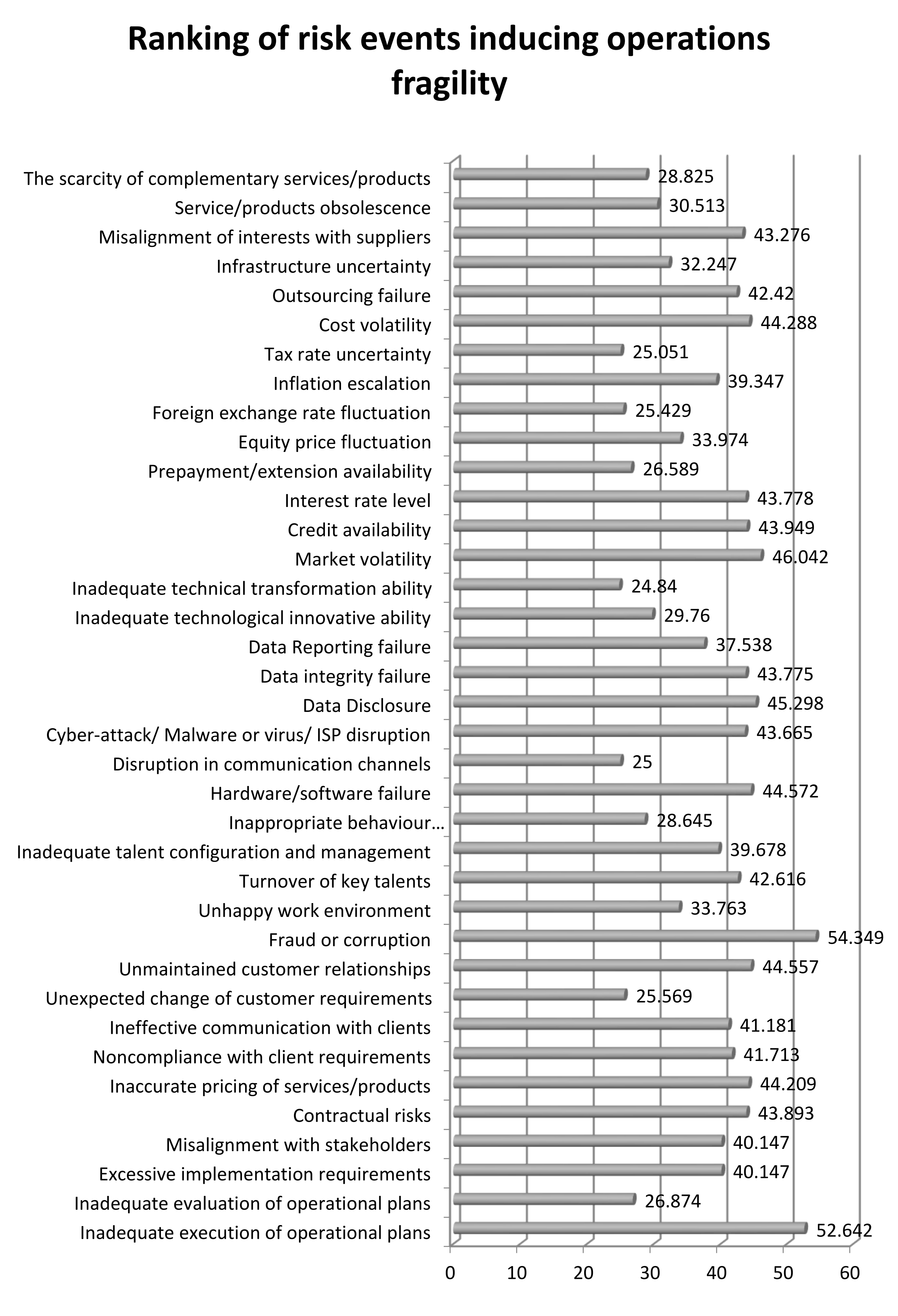


Figure 5.13: Ranking of risk events inducing the fragility of enterprise operations

5.3.6. Risk events inducing the fragility of business units

In the business unit level, 3 drivers out of 9 are ranked in the first 30 highest ranked fragility drivers. The business unit fragility drivers have an overall mean in the range of 3.496 to 4.426. The severity indices are in the range of 29% - 48%. Factor BUR7 (Lack of cost control) is ranked the most important fragility factor for the business unit level and has an overall rank of eleventh out of 100 indicators, and the severity index of 48.836%. See table figure 5.14 and appendix 5.7.

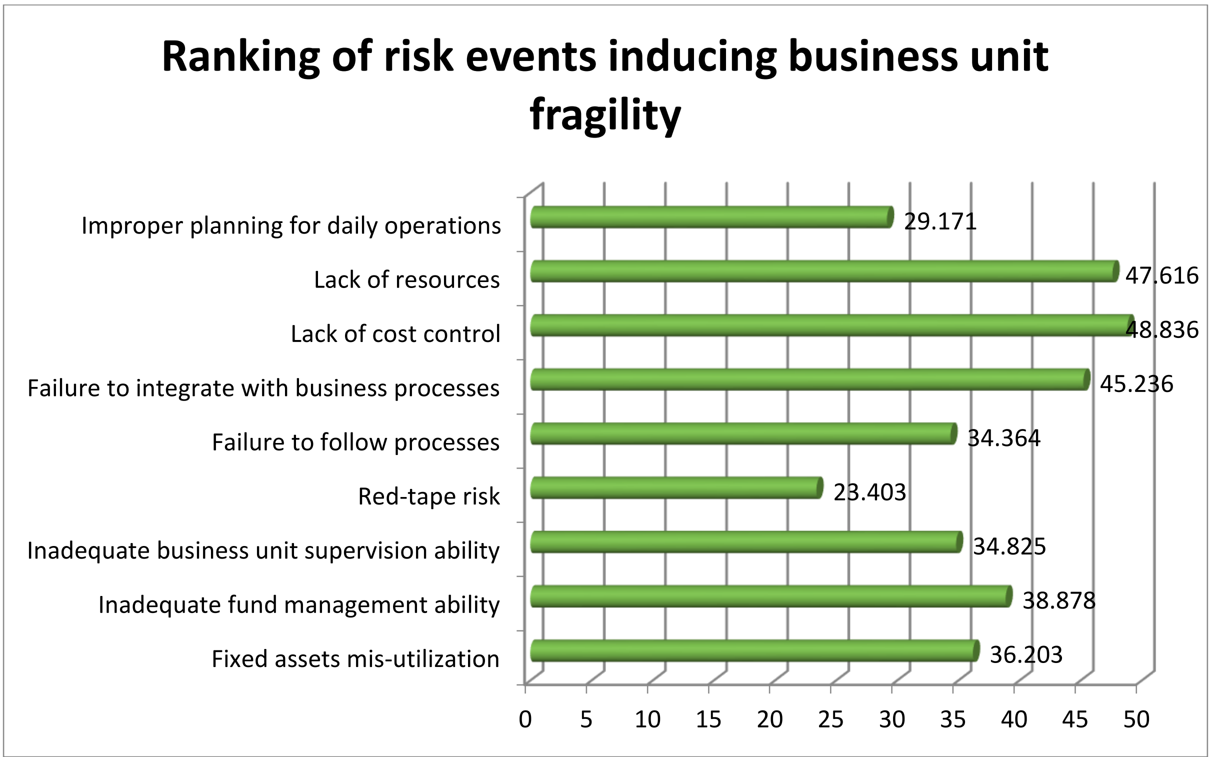


Figure 5.14: Ranking of risk events inducing the fragility of enterprise business units

5.3.7. Risk events inducing the fragility of enterprise projects

In the project level, 8 risk events out of 24 are ranked in the first 30 highest ranked fragility drivers. The risk events inducing the fragility of enterprise projects have an overall mean in the range of 3.442 to 4.318. The severity indices are in the range of 23% - 49%. Factor PR5 (Inadequate change management ability) is ranked the most important fragility-inducing risk event for the project level and has an overall rank of tenth out of 100 indicators, and the severity index of 49.245%. See figure 5.15 and appendix 5.8.

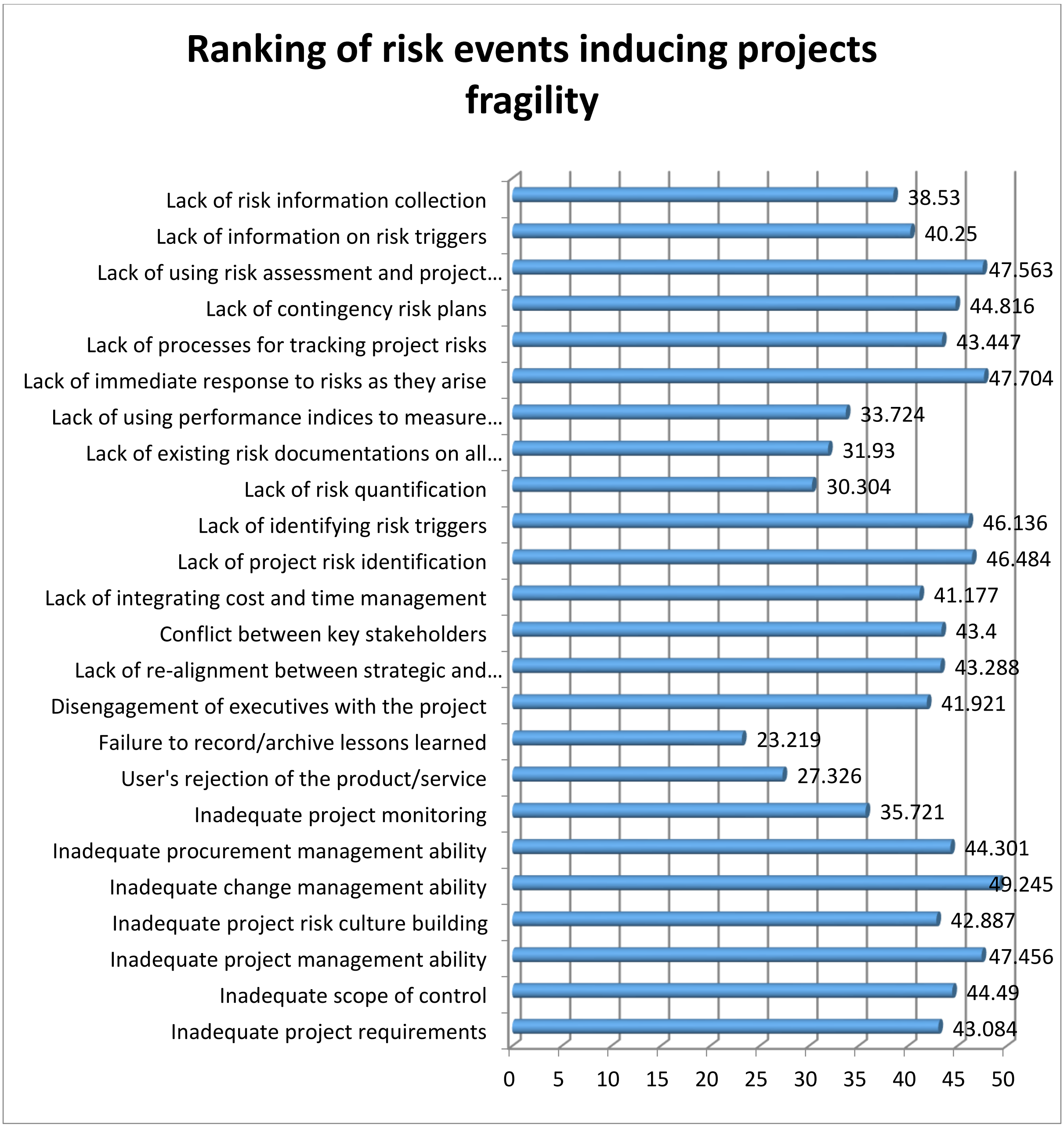


Figure 5.15: Ranking of risk events inducing the fragility of enterprise projects

5.3.8. Rating and ranking of enterprise resilience attributes

Over all, the average weighted mean for the resilience drivers varies from 3.659 to 4.465, with the overall mean of 4.171. The severity indices range within 27% (RGR5) to 55 % (RDMR2). The spread of the data is not large and this indicates that the opinions of the participants do not vary a lot. This is due to the significance of resilience for all enterprises regardless of the industry.

The top 14 ranked resilience attributes were dominated by the attributes from the resilience of risk governance where the highest ranked attribute was RDMR2 (Major strategic decisions are embedded on risk before deployment) with a mean of 4.465 and severity index of 54.4 %. An overall examination of the highly ranked resilience attributes indicates that all first 14 ranked attributes have a minimum mean value of 4.263 (which is higher than the overall mean of 4.171) and minimum severity index of 46.27 %. This means that the first 14 ranked resilience attributes seem to be important as viewed by the participants. See figure 5.16. More details are available in appendices 5.9, 5.10, 5.11, and 5.12.

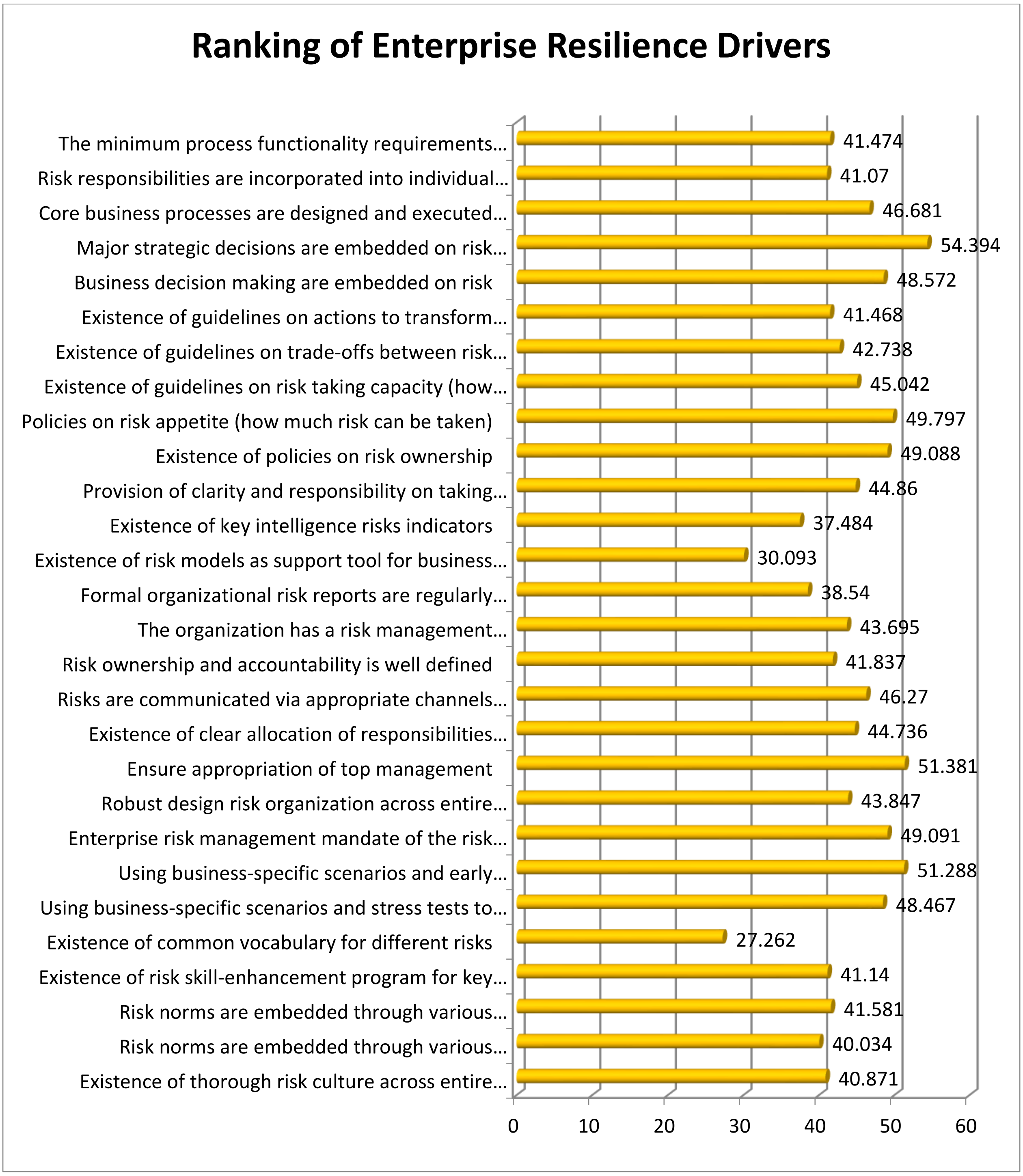


Figure 5.16: Ranking of enterprise resilience attributes

5.3.8.1. Resilience attributes to risk culture

In the risk culture category, only 2 attributes out of 7 are ranked in the first 14 highest ranked resilience drivers. The resilience attributes to risk culture have an overall mean in the range of 3.659 to 4.279. The severity indices are in the range of 30% - 46%. Attribute RCR1 (Existence of thorough risk culture across entire organization) is ranked most important resilience factor for the risk culture category and has an overall rank of the tenth out of 28 attributes, and the severity index of 46.270%.

5.3.8.2. Resilience attributes to risk governance

In the risk governance category, 6 attributes out of 11are ranked in the first 14 highest ranked resilience attributes. The resilience attributes to risk governance have an overall mean in the range of 3.736 to 4.395. The severity indices are in the range of 27% - 51%. Attribute RGR10 (Existence of key intelligence risks indicators) is ranked the most important resilience attributes for the risk governance category and has an overall rank of second out of 28 indicators, and the severity index of 51.381%.

5.3.8.3.Resilience attributes to risk appetite

In the risk appetite category, 3 attributes out of 5 are ranked in the first 14 highest ranked resilience attributes. The resilience attributes to risk appetite have an overall mean in the range of 4.178 to 4.372. The severity indices are in the range of 41% - 50%. Factor RAR2 (Policies on risk appetite - how much risk can be taken) is ranked the most important resilience attribute for the risk appetite category and has an overall rank of fourth out of 28 attributes, and the severity index of 49.797%.

5.3.8.4.Resilience attributed to risk-informed decision-making.

In the risk decision making category, 3 drivers out of 5 are ranked in the first 14 highest ranked resilience attributes. The resilience attributes to risk-informed decision-making have an overall mean in the range of 4.101 to 4.465. The severity indices are in the range of 41% - 54%. Attribute RDMR2 (Major strategic decisions are embedded on risk before deployment) is ranked the most important resilience attribute for the risk-informed decision-making category and has an overall rank of first out of 28 attributes, and the severity index of 54.394%.

5.4. Correlation Results

SPSS was used to run a bivariate correlation test between risk management performance and the five areas of fragility: strategy, governance, operations, business units and projects. The results showed statistically-significant association between risk management performance and the fragility of strategy; risk management performance and the fragility of governance; risk management performance and the fragility of operations; risk management performance and the fragility of business units; and risk management performance and the fragility of projects. See table 5.1.

Table 5.1: Results of correlations tests – fragility and risk management performance

Correlations

		Governance Fragility	Operations Fragility	Business unit Fragility	Project Fragility	Performance
Strategy Fragility	Correlation Coefficient	.653**	.532**	.503**	.571**	.288**
	Sig. (2-tailed)	.000	.000	.000	.000	.001
	N	129	129	129	129	129
Governance Fragility	Correlation Coefficient		.693**	.559**	.599**	.371**
	Sig. (2-tailed)		.000	.000	.000	.000
	N		129	129	129	129
Operations Fragility	Correlation Coefficient			.592**	.582**	.263**
	Sig. (2-tailed)			.000	.000	.003
	N			129	129	129
Business unit Fragility	Correlation Coefficient				.616**	.314**
	Sig. (2-tailed)				.000	.000
	N				129	129
Project Fragility	Correlation Coefficient					.301**
	Sig. (2-tailed)					.001
	N					129

**. Correlation is significant at the 0.01 level (2-tailed).

A similar bivariate correlation test was conducted between risk management performance and the attributes of resilience: risk culture, risk governance, risk appetite and risk-informed decision making. The results showed statistically-significant association between risk management performance and resilience attributes to risk culture; risk management performance and resilience attributes to risk governance; risk management performance and resilience attributes to risk appetite; and risk management performance and resilience attributes to risk-informed decision making. See table 5.11.

Table 5.2: Results of correlations tests – resilience and risk management performance

Correlations					
		Risk culture	Risk governance	Risk-informed decision making	Risk appetite
Risk-based Performance	Correlation Coefficient	.310**	.329**	.349**	.223*
	Sig. (2-tailed)	.000	.000	.000	.011
	N	129	129	129	129
Risk culture	Correlation Coefficient		.502**	.452**	.389**
	Sig. (2-tailed)		.000	.000	.000
	N		129	129	129
Risk governance	Correlation Coefficient			.605**	.650**
	Sig. (2-tailed)			.000	.000
	N			129	129
Risk-informed decision making	Correlation Coefficient				.617**
	Sig. (2-tailed)				.000
	N				129
**. Correlation is significant at the 0.01 level (2-tailed).					
*. Correlation is significant at the 0.05 level (2-tailed).					

5.5. Summary

This chapter was aimed to describe and rank the data collected through a questionnaire. This helped the research to indicate which fragility-inducing risk events and resilience attributes are the most significant. The ranking was based on severity index, average weighted mean and standard deviation of each factor. This chapter provided a description of the data to show the agreement or disagreement in the responses that practitioners provided. It also presented the results of bivariate correlation tests between the constructs. More details about inferences and conclusions are presented in the next chapters.

CHAPTER SIX

FACTOR ANALYSIS

6.1. Introduction

This chapter presents the results of the factor analysis and data reduction processes. The first section describes the processes used to generate the latent variables, the second section explains the results of confirmatory factor analysis. The analysis and findings in this research are of a survey distributed among mangers and practitioners who are involved in the field of risk management from different sectors in the UAE. Based on descriptive statistics and data ranking processing in Chapter 5, it is concluded that some fragility factors are more likely to influence enterprise fragility than other factors, and some resilience factors are more significant in enterprise resilience if compared with other factors. A number of fragility factors with the highest degree of likelihood can be considered as representative of the whole set of data affecting enterprise fragility; similarly, a number of resilience factors with the highest degree of significance can be considered as representative of the whole set of data affecting enterprise resilience. Therefore, the most significant latent variables are extracted and treated as representative of the whole set of fragility indicators and resilience indicators.

Based on the variables' relationship and correlation, the outcome of the data reduction is presented in a few latent clusters that represent the original large. At the end of the day, a more clear and manageable understanding of fragility clusters and resilience clusters and their implications will be instrumental in assessing and evaluating enterprise fragility and enterprise resilience.

6.2. Factor analysis process

The factor analysis technique is applied to investigate if there is an underlying relationship between the different factors within a questionnaire. The existence of 100 fragility factors and 28 resilience factors in this survey makes it difficult to handle the analysis, therefore factor analysis and data reduction are considered as an important process to decrease the number of variables in order to handle the task more efficiently. Factor analysis can help solve the problem of multicollinearity when conducting multiple regressions test with a large number of variables by combining variables that are collinear. This process is basically based on identifying variables that correlate highly with a group of other variables, but simultaneously do not correlate with variables outside of that group. When two or more variables are correlated, it can be proposed that these variables share to a certain extent a common factor and this factor can explain the correlation between them (Hair et al. 1998). By reducing a data set from a group of interrelated variables into a smaller set of factors, factor analysis explains the maximum amount of common variance in a correlation matrix using the smallest number of explanatory concepts (Field 2013). The process of the analysis is shown in Figure 6.1 and 6.2.

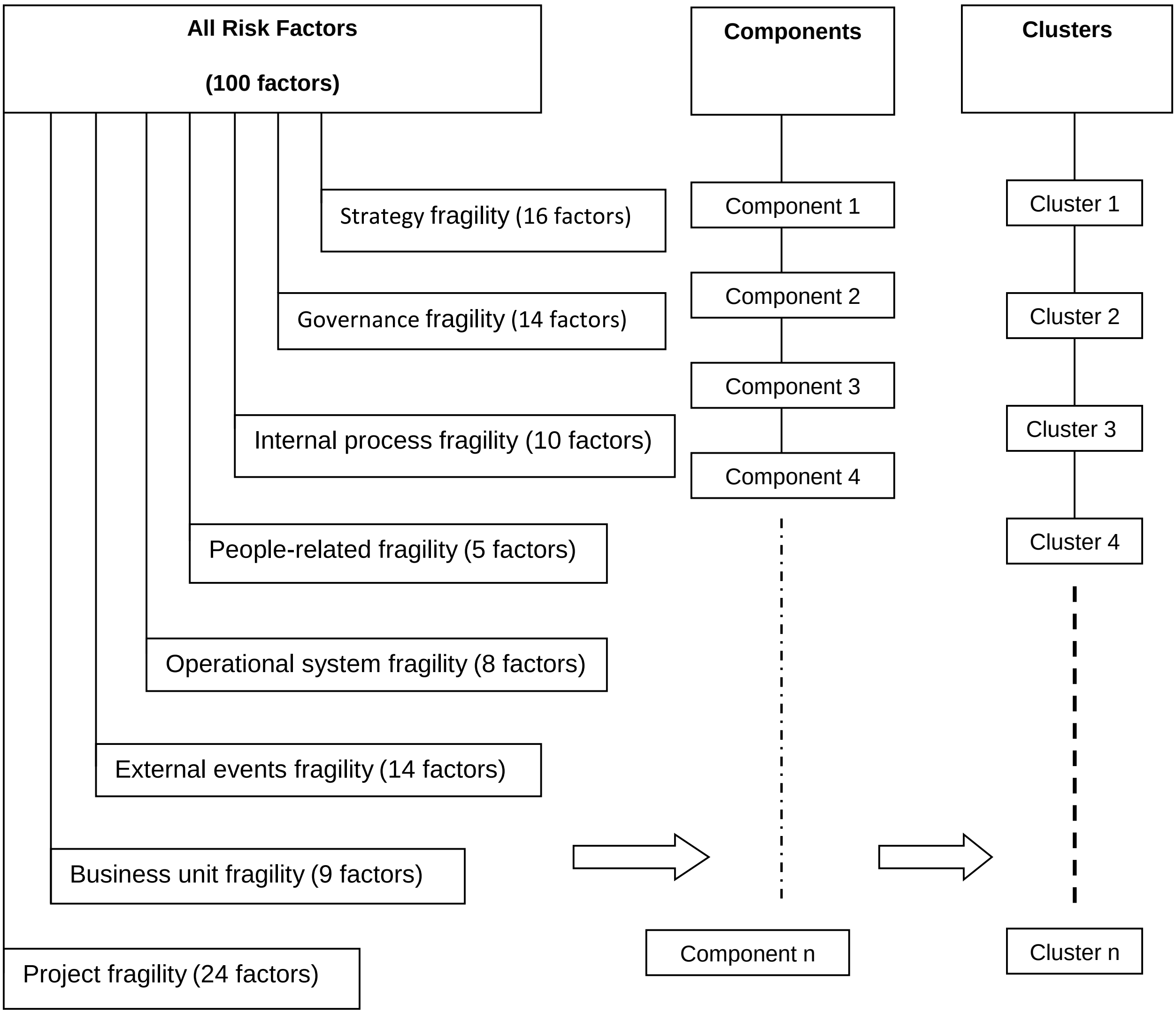


Figure 6.1: The process of data reduction and factor analysis for fragility factors

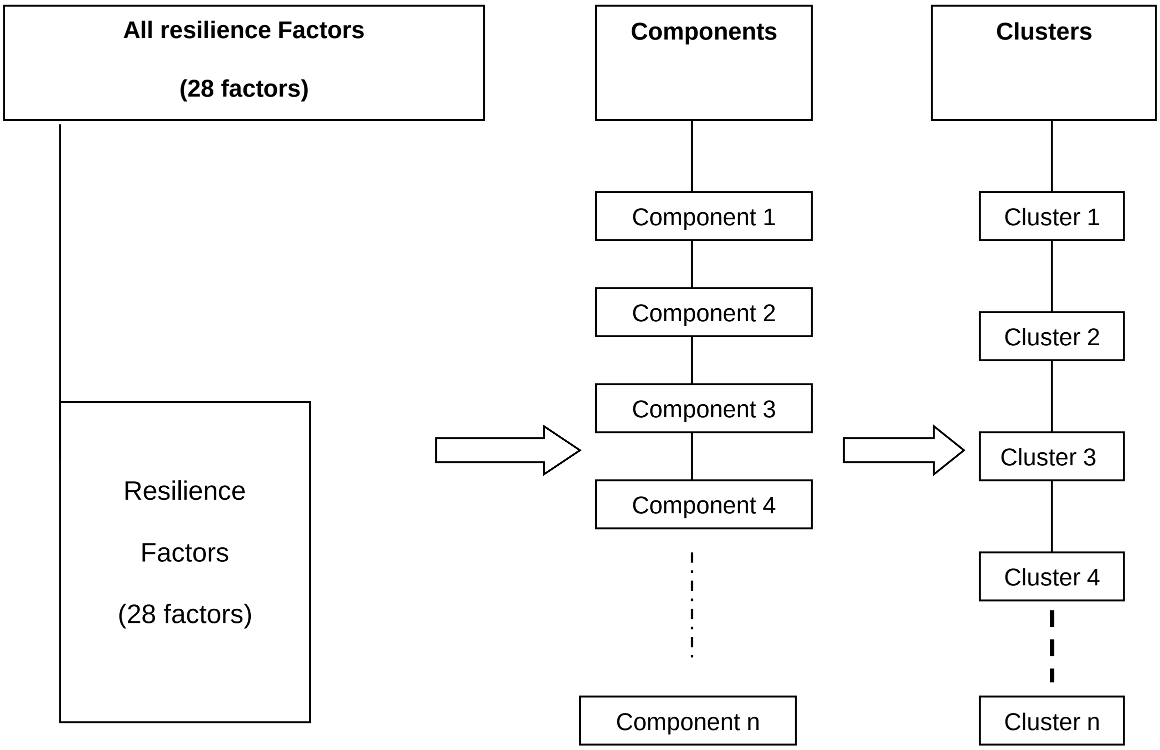


Figure 6.2: The process of data reduction and factor analysis for resilience factors

There are two major types of factor analysis: Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA). For undertaking these analyses of the data, SPSS, AMOS and Microsoft Excel were used to remove redundant data from the list of factors in order to achieve a manageable subset of components that present the majority of fragility factors and resilience factors and explore if any hidden latent components are available.

6.3. KMO and Bartlett test

Before conducting factor analysis, two statistical tests were conducted. The first test, Kaiser-Meyer-Olkin (KMO), measures sampling accuracy, in order to indicate the proportion of variance of the variables that might be caused by underlying factors. High values close to 1.0 in the KMO test indicate that a factor analysis is useful for the data; however, if the value is less than 0.50, this indicates that the results of the factor analysis will not be very useful. The second test is to check the presence of correlations by Bartlett Test of Sphericity, which tests the hypothesis that the correlation matrix is an identity matrix; a small significance level of less than 0.05 indicates that a factor analysis can be conducted (Field, 2005; Morgan et al., 2004). The results are shown in Table 6.1 below:

Table 6.1: Results of KMO and Bartlett tests

Groups of factors	Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	Bartlett's Test of Sphericity (Significance value)
Strategy fragility	.823	.000
Governance fragility	.824	.000
Operational Internal Processes fragility	.803	.000
People-related operational fragility	.800	.000
Operational systems fragility	.750	.000
External events operational fragility	.768	.000
Business Unit fragility	.816	.000
Project fragility	.857	.000
Resilience factors	.881	.000
Risk management performance	.705	.000

It can be seen from the above table that the KMO values are close to 1, which means that the factor analysis is likely to be appropriate and acceptable. A value close to 1 indicates that the patterns of correlations are relatively compact, and so factor analysis will provide distinct and reliable factors (Hair et al. 1998, Field 2005). Kaiser (1974) recommends accepting values greater than 0.5 as acceptable. Precisely, KMO values between 0.5 and 0.7 are good, between 0.7 and 0.8 are great, and above 0.8 are superb.

Bartlett's test measures the null hypothesis (H0 > 0.05), which shows that the original correlation matrix is an identity matrix. Therefore, factor analysis needs some relationships between variables and the significance value to be ($p< 0.05$). By considering the significance level of 0.05, Bartlett's test shows the values of p for both the likelihood of fragility impact and importance of the resilience factors are highly significant. This test shows that the correlation matrix is not an identity matrix, so there are some relationships between the variables. If the population correlation matrix resembles an identity matrix then it means that every variable correlates very badly with all other variables, i.e. all correlations coefficients are close to zero (Field 2005; Morgan et al 2004). Both KMO and Bartlett tests have demonstrated that factor analysis is appropriate for these data.

6.4. Reliability test

Reliability analysis takes place as part of practical validation in order to check whether the properties of a measurement scale and the items that compose the scale are reliable. Low reliability shows that the items that make up the scale do not correlate strongly enough; thus, they might not be measuring the same construct domain. As a measure of reliability, Cronbach's Alpha was calculated to check the consistency of the research items and to identify the unreliable items that need to be excluded from the scale. Based on George and Mallory's (2003) measures, Cronbach's Alpha is assessed as follows in Table 6.2.

Table 6.2: measure of reliability (adopted from George and Mallory, 2003)

Cronbach's Alpha	Internal Consistency
> 0.90	Excellent
0.80 - 0.89	Good
0.70 - 0.79	Acceptable
0.60 - 0.69	Questionable
0.50 - 0.59	Poor
< 0.50	Unacceptable

The reliability of the data has been checked for the fragility factors and resilience factors by using Cronbach's test. The Cronbach's Alpha values for all factors are between 0.80 and 0.89 except for two groups: one is 0.744 and another is 0.917, which shows that the components have significantly good internal consistency, as shown in the following table, Table 6.3.

Table 6.3: Results of Cronbach's reliability test

Groups of factors	**Cronbach's Alpha**
Strategy fragility	.852
Governance fragility	.851
Operational Internal Processes fragility	.829
People-related operational fragility	.744
Operational systems fragility	.811
External events operational fragility	.834
Business Unit fragility	.849
Project fragility	.917
Resilience factors	.941
Risk management performance	.761

6.5. Factor Analysis Results

The following sections in this chapter will present and discuss the methodology for factor analysis and data reduction. Harman's single factor test was used to test Common method bias (CMB) to ensure that variations in responses are caused by the actual predispositions of the respondents that the instrument attempts to uncover rather than the instrument. The test is the most widely used in the literature (Podsakoff et al. 2003). The results did not show any substantial CMB presence in the data as much of the variance could not be explained by a single factor.

6.5.1. Factor analysis for strategy fragility factors

As seen in table 6.4 that shows the analysis of the importance of strategy fragility factors, just four components carry an Eigenvalue of more than 1 and account for nearly 60.85% of the variance, that is the result of the selected four components present 60.85% of the whole variance. Consequently, these four components can be considered to be representative of all 16 strategy fragility factors included in this study.

Table 6.4: Exploratory factor analysis for strategy fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.327	33.292	33.292	5.327	33.292	33.292	3.032	18.952	18.952
2	1.970	12.313	45.604	1.970	12.313	45.604	2.858	17.861	36.813
3	1.336	8.350	53.954	1.336	8.350	53.954	2.336	14.601	51.414
4	1.104	6.898	60.852	1.104	6.898	60.852	1.510	9.438	60.852
5	.936	5.848	66.700						
6	.900	5.625	72.325						
7	.749	4.684	77.008						
8	.666	4.161	81.169						
9	.505	3.157	84.326						
10	.494	3.090	87.417						
11	.449	2.804	90.220						
12	.398	2.487	92.707						
13	.352	2.202	94.909						
14	.312	1.949	96.858						
15	.269	1.678	98.536						
16	.234	1.464	100.000						

As can be seen from figure 6.3, the curve starts to slightly flatten out and become horizontal after component 4 and that the point of interest was defined between components 3 and 5, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

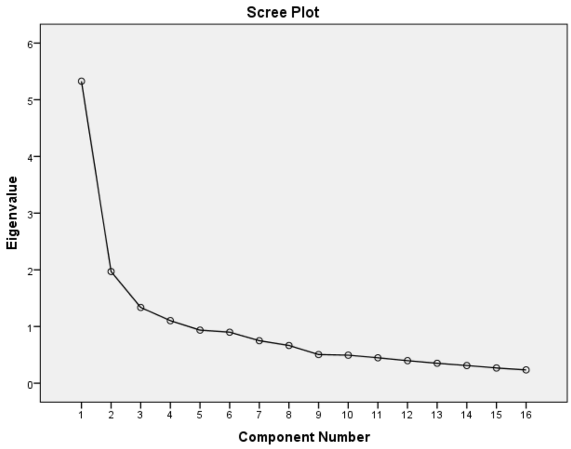


Figure 6.3: Scree plot of exploratory factor analysis for strategy fragility factors

As indicated in the table 6.5, factors SR13, SR10, SR14, SR12 and SR8 have greater influence on component 1 compared to other components. Similarly, factors SR15, SR16, SR1, SR7, SR9 and SR11 have greater influence on component 2 compared to other components. Factors SR6, SR5, and SR2 have greater influence on component 3 compared to other components. Whereas factors SR3 and SR4 have greater influence on component 4 compared to other components.

Table 6.5: Extractions of components - strategy fragility

	Component			
	1	2	3	4
SR13	.815			
SR10	.756			
SR14	.662			
SR12	.485			
SR8	.478			
SR15		.729		
SR16		.705		
SR1		.661		
SR7		.612		
SR9		.577		
SR11		.484		
SR6			.837	
SR5			.676	
SR2			.553	
SR3				.779
SR4				.690

After applying factor analysis and data reduction to the strategy fragility factors, the questionnaire's 16 factors are reduced to four components, which are shown in table 6.6. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.4 and Table 6.5.

Table 6.6: Strategy fragility factors aggregated to component following rotation

fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	5.327	33.292	18.952	.815	SR13	Unawareness of legislation implications
				.756	SR10	Lack of feasible strategic support and action plans
				.662	SR14	Misapplication of business models
				.485	SR12	Unawareness of new technology
				.478	SR8	Overoptimistic or vague projections
Component 2	1.970	12.313	17.861	.729	SR15	Financial uncertainty
				.705	SR16	Emerging aggregated risks
				.661	SR1	Unable to catch up with new innovations
				.612	SR7	Inaccurate strategic positioning
				.577	SR9	Inefficient strategy execution
				.484	SR11	Unawareness of market economic changes
Component 3	1.336	8.350	14.601	.837	SR6	Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies
				.676	SR5	Inadequate assessment of organization capabilities
				.553	SR2	Disruption in the political changes
Component 4	1.104	6.898	9.438	.779	SR3	Influence of Globalization
				.690	SR4	Negative media and news affecting the reputation

Strategy fragility factors can be organised into three latent constructs

Business Models and Plans (Cluster 1): It comprises one component and represents 18.952% of the total variance explained. This cluster is made up of five factors and they relate to the inadequacy of business models, business projections and implications, and business technology. Strategists have generally referred to "business model" as "the logic of the firm, the way it operates and how it creates value for its stakeholders." This definition does not draw a clear distinction between “strategy” and “business model” although they are different in the sense that “business model” can be a considered “a reflection of the firm’s realized strategy” (Casadesus-Masanell & Ricart 2009). A more accurate conceptualization of the term is suggested by Zott, Amit and Massa (2011, p. 1019) as “a system of interdependent activities that transcends the focal firm and spans its boundaries.” Although scholars do not agree upon the exact deconstruction of the concept, yet it has been generally agreed that “business model” is dealt with in a holistic view of a system level and above all it explains how the firm creates and captures value (Casadesus-Masanell & Ricart 2009; Zott, Amit & Massa 2011).

Financial and strategic innovations (Cluster 2): It comprises one component and represents 17.861%of the total variance explained. This cluster is made up of six factors and they relate to the enterprise’s unawareness of innovations and changes in financial, economic or strategic situations. The innovation strategy has a crucial positive impact on the financial performance of the companies (Ezzi & Jarboui 2016). Strategic innovations helped firms to develop and sustain competitive advantages and assisted firms to survive financial and economic crisis (Naidoo 2010; Laperche, Lefebvre & Langlet 2011). Similarly, financial uncertainty can be a significant reason behind the ineffectiveness of strategic innovations since these innovations bring many unknowns (Koen et al. 2010) and the way the firms responds to financial uncertainty is crucial to its ability to achieve strategic goals (Mosley, Maronick & Katz 2012).

Globalization and Politics (Cluster 3): It comprises two components and represents 24.039% of the total variance explained. The two components have been merged in one cluster due to the interrelationship between globalization and political changes (Pierson and Tormey 1999; LiPuma & Lee 2004). This cluster is made up of five factors and they relate to the enterprise’s uncertainty of the organizational goals and capabilities to withstand, global, political and reputational adversity. Globalization risks are not only related to the enterprise external factors (such as: interest rates, exchange rates, competition), but also they influence internal processes and consequently they impact enterprise strategies, organizational structure, as well as organizational culture (Lopatina 2012).

Businesses cannot avoid trending toward globalization and this provides them with the chance to advantage of economic scale, and strategic partnering; however, globalization results in the multiplication of risk failure impact (Campbell 2015). Political instability is a serious risk that affects the enterprise on both strategic and operational level due to the increased dependence on global outsourcing and the interdependencies among national economies (Tang & Musa 2011; Kleindorfer & Saad 2005) and above all the effect of political identity issues on aggravation of global economic crises (Pierson & Tormey 1999; Roe & Siegel 2011; Akopova & Akopov 2012).

As illustrated in figure 6.4, Amos successfully estimated the variances and covariances in the model of strategy fragility factors. SR4 factor was deleted because the regression weight is not significantly different from zero at the 0.05 level (two-tailed). The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed) except for one parameter which is significantly different from zero at the 0.01 level. See appendix 6.1.

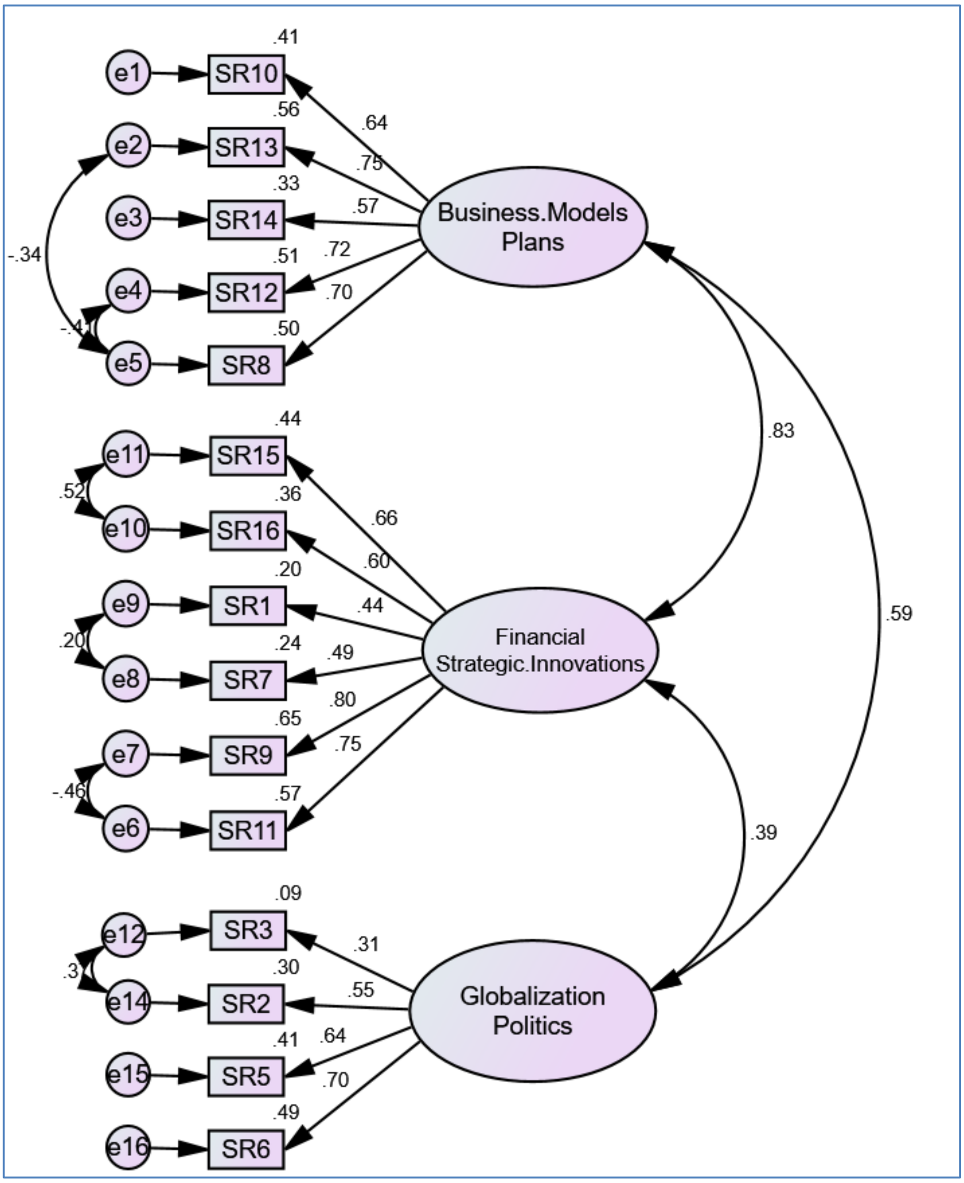


Figure 6.4: Confirmatory factor analysis of strategy fragility factors

In regards to the overall model fit, the absolute fit indicator CMIN = 145.028, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.790 is within the acceptable range. In addition, TLI = 0.875, CFI = 0.903, and RMSEA = 0.079 are acceptable standard values. Overall, the theoretical model fit is acceptable.

In conclusion, three different variables can be identified to represent strategy fragility: Business Models and Plans, financial and strategic innovations, and globalization and politics. These sub-variables are summarized in table 6.7.

Table 6.7: Latent variables of strategy fragility

Variable	Factor Code	Factor Statement
Variable 1 (business models and plans)	SR13	Unawareness of legislation implications
	SR10	Lack of feasible strategic support and action plans
	SR14	Misapplication of business models
	SR12	Unawareness of new technology
	SR8	Overoptimistic or vague projections
Variable 2 (financial and strategic innovations)	SR15	Financial uncertainty
	SR16	Emerging aggregated risks
	SR1	Unable to catch up with new innovations
	SR7	Inaccurate strategic positioning
	SR9	Inefficient strategy execution
	SR11	Unawareness of market economic changes
Variable 3 (globalization and politics)	SR6	Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies
	SR5	Inadequate assessment of organization capabilities
	SR2	Disruption in the political changes
	SR3	Influence of Globalization

6.5.2. Factor analysis for governance fragility factors

As seen in table 6.8 that shows the analysis of the importance of governance fragility factors, just three components carry an Eigenvalue of more than 1 and account for nearly 58.84% of the variance, that is the result of the selected three components present 58.84% of the whole variance. Consequently, these three components can be considered to be representative of all 14 governance fragility factors included in this study.

Table 6.8: Exploratory factor analysis for governance fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.154	36.812	36.812	5.154	36.812	36.812	3.873	27.664	27.664
2	1.908	13.630	50.442	1.908	13.630	50.442	2.517	17.981	45.645
3	1.176	8.397	58.840	1.176	8.397	58.840	1.847	13.195	58.840
4	.972	6.942	65.782						
5	.803	5.736	71.518						
6	.726	5.185	76.704						
7	.625	4.462	81.166						
8	.545	3.894	85.060						
9	.498	3.559	88.619						
10	.416	2.970	91.589						
11	.347	2.478	94.067						
12	.313	2.234	96.301						
13	.298	2.131	98.432						
14	.219	1.568	100.000						

As can be seen from figure 6.5, the curve starts to slightly flatten out and become horizontal after component 3 and that the point of interest was defined between components 2 and 4, where the curve connects the points, which is the point where Eigenvalues of less than 1 are placed.

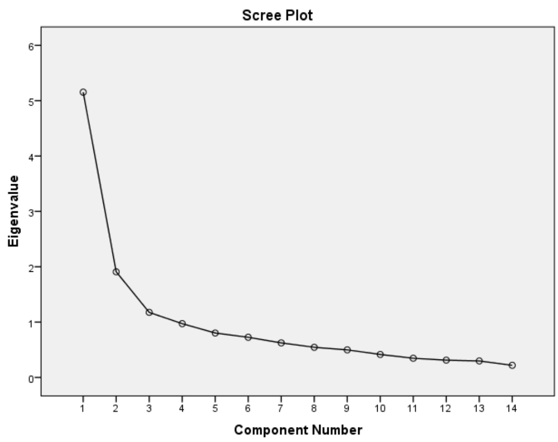


Figure 6.5: Scree plot of exploratory factor analysis for governance fragility factors

As indicated in table 6.9, factors GR6, GR5, GR9, GR7, GR10, GR8, and GR4 have greater influence on component 1 compared to other components. Similarly, factors GR14, GR12, GR11, and GR13 have greater influence on component 2 compared to other components. Whereas factors GR2, GR1 and GR3 have greater influence on component 3 compared to other components.

Table 6.9: Extractions of components - governance fragility

	Component		
	1	2	3
GR6	.817		
GR5	.755		
GR9	.740		
GR7	.735		
GR10	.699		
GR8	.637		
GR4	.613		
GR14		.776	
GR12		.747	
GR11		.734	
GR13		.643	
GR2			.735
GR1			.730
GR3			.668

After applying factor analysis and data reduction to the governance fragility factors, the questionnaire’s 14 factors are reduced to three components which are shown in table 6.10. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors, which are extracted from Table 6.8 and Table 6.9.

Table 6.10: Governance fragility factors aggregated to component following rotation

fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	5.154	36.812	27.664	.817	GR6	Inadequate risk assessment methods
				.755	GR5	Unavailability of timely risk information
				.740	GR9	Inadequate risk management reviewing processes
				.735	GR7	Inadequate risk reporting systems
				.699	GR10	Inadequate risk accountability system
				.637	GR8	Inadequate risk pricing policies
				.613	GR4	Inadequate mechanism for internal control
Component 2	1.908	13.630	17.981	.776	GR14	Noncompliance with mandatory reporting obligations
				.747	GR12	Noncompliance with environmental guidelines
				.734	GR11	Inadequate external auditing processes
				.643	GR13	Noncompliance with fiscal and monetary guidelines
Component 3	1.176	8.397	13.195	.735	GR2	Violation of policies and regulations
				.730	GR1	Fluctuation of policies and regulations
				.668	GR3	Inadequate communication of objectives and targets

Governance fragility factors can be organised into three latent constructs

Risk guidelines (Cluster 1): it comprises one component and represents 27.664% of the total variance explained. This cluster is made up of seven factors and they relate to risk guidelines and policies. Although literature is rich of generically accepted risk management standards such as COSO, ISO/DIS 31000, or AS/NZS4360, yet these frameworks are quite theoretical, and they lack specific risk guidelines that develop, implement and maintain the risk management system and here comes the role of organizational policies (Dequae 2009).

Risk auditing (Cluster 2): it comprises one component and represents 17.981% of the total variance explained. This cluster is made up of four factors and they relate to risk auditing and compliance. Risk auditing is one of the most important processes that enhance enterprise governance (Law 2011) and protect the enterprise from fraud and business failure risks (Messier 2010). It usually helps to understand the environment of the enterprise and how value is created the best way (Curtis & Turley 2007)

Risk Communication (Cluster 3): it comprises one component and represents 13.195% of the total variance explained. This cluster is made up of three factors and they relate to risk communication. Risk communication is an important aspect of resilient communities and systems (Radovic & Mercantini 2015) because it makes the connection between the vulnerabilities and closing the loop of accountability (Campbell 2015). An insightful disclosure of risk in terms of both quantity and quality is essential to fulfill the demands of the stakeholders, but it should be done within communication regulations and policies (Beretta & Bozzolan 2004). When risks and risk appetite are communicated, informed and integrated as part of the enterprise strategic objectives, risk management frameworks become more effective and risk culture will be properly built (Hopkin 2017).

As illustrated in figure 6.6, Amos successfully estimated the variances and covariances in the model of governance fragility factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See appendix 6.2.

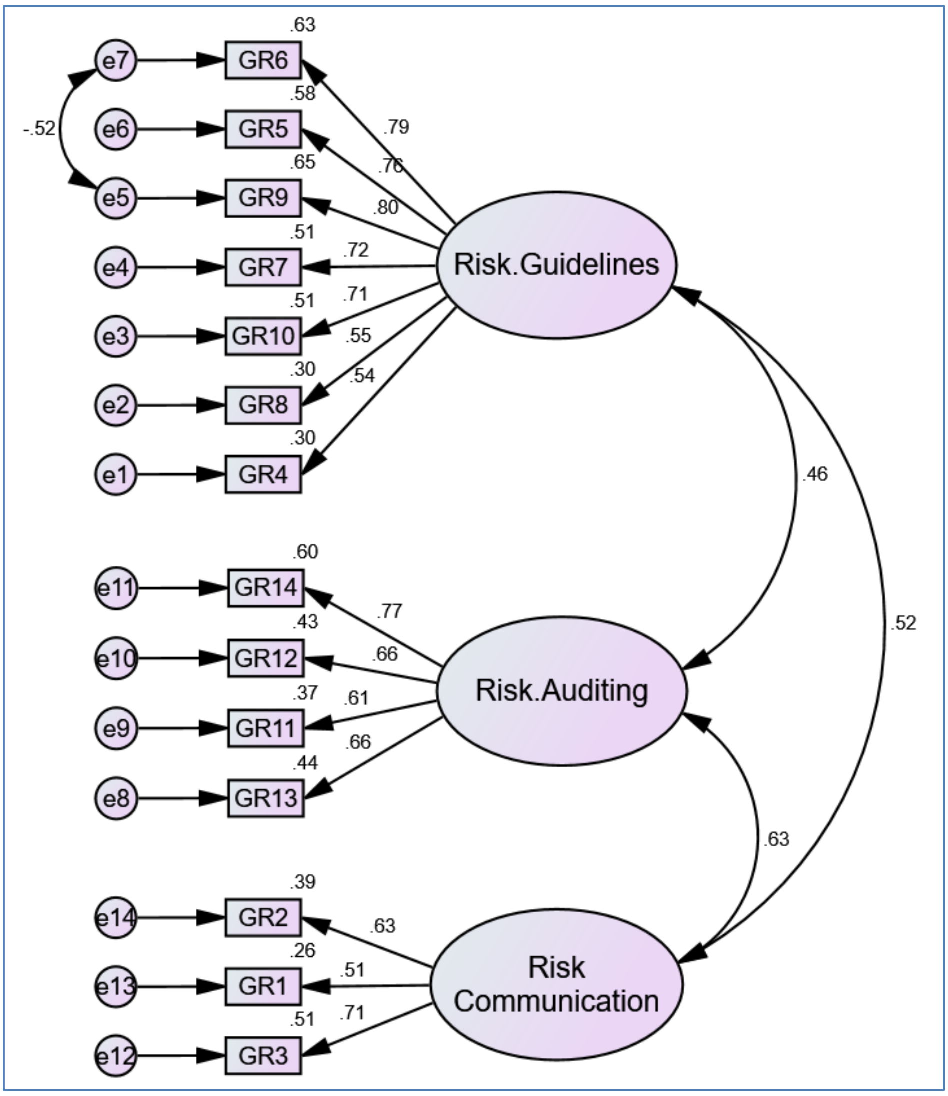


Figure 6.6: Confirmatory factor analysis of governance fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 131.361, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.799 is within the acceptable range. In addition, TLI = 0. 886, CFI = 0 .909, and RMSEA = 0.079 are acceptable standard values. Overall, the theoretical model fit is acceptable.

In conclusion, three different variables can be identified to represent governance fragility: risk guidelines risk auditing, and risk communication. These sub-variables are summarized in table 6.11.

Table 6.11: Latent variables of governance fragility

Variable	Factor Code	Factor Statement
Variable 1 (risk guidelines)	GR6	Inadequate risk assessment methods
	GR5	Unavailability of timely risk information
	GR9	Inadequate risk management reviewing processes
	GR7	Inadequate risk reporting systems
	GR10	Inadequate risk accountability system
	GR8	Inadequate risk pricing policies
	GR4	Inadequate mechanism for internal control
Variable 2 (risk auditing)	GR14	Noncompliance with mandatory reporting obligations
	GR12	Noncompliance with environmental guidelines
	GR11	Inadequate external auditing processes
	GR13	Noncompliance with fiscal and monetary guidelines
Variable 3 (risk communication)	GR2	Violation of policies and regulations
	GR1	Fluctuation of policies and regulations
	GR3	Inadequate communication of objectives and targets

6.5.3. Factor analysis for the fragility factors of operational internal processes

As seen in table 6.12 that shows the analysis of the importance of operational internal processes fragility factors, just three components carry an Eigenvalue of more than 1 and account for nearly 65.86% of the variance, that is the result of the selected three components present 65.86% of the whole variance. Consequently, these three components can be considered to be representative of all 10 operational internal processes fragility factors included in this study.

Table 6.12: Exploratory factor analysis for the fragility factors of operational internal processes

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.180	41.800	41.800	4.180	41.800	41.800	2.776	27.760	27.760
2	1.313	13.126	54.925	1.313	13.126	54.925	2.628	26.281	54.041
3	1.093	10.931	65.857	1.093	10.931	65.857	1.182	11.816	65.857
4	.877	8.773	74.629						
5	.636	6.363	80.992						
6	.571	5.714	86.706						
7	.413	4.132	90.838						
8	.380	3.802	94.640						
9	.294	2.945	97.585						
10	.242	2.415	100.000						

As can be seen from figure 6.7, the curve starts to slightly flatten out and become horizontal after component 3 and that the point of interest was defined between components 2 and 4, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

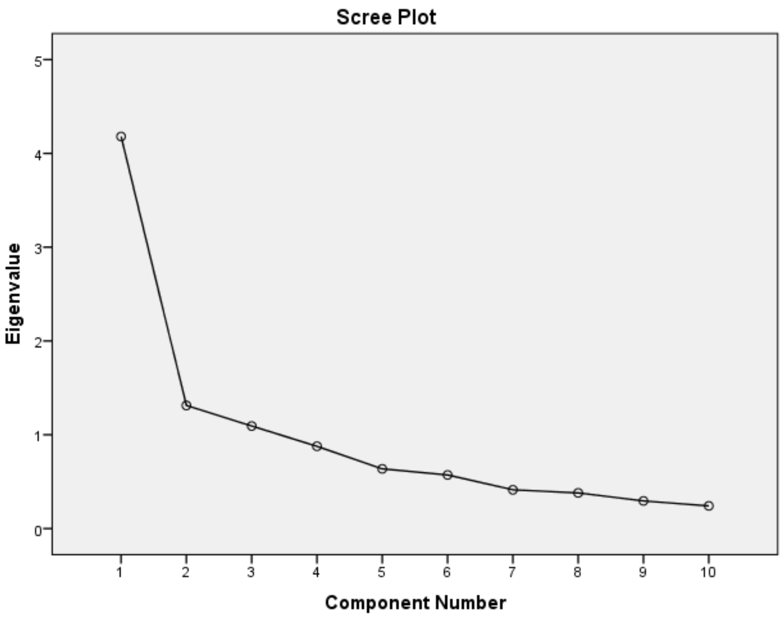


Figure 6.7: Scree plot of exploratory factor analysis for operational internal process fragility factors

As indicated in table 6.13, factors ORIP7, ORIP4, ORIP8, and ORIP9 have greater influence on component 1 compared to other components. Similarly, factors ORIP1, ORIP2, ORIP5, ORIP110 and ORIP6 have greater influence on component 2 compared to other components. Whereas, factor ORIP3 does have high influence on neither component 1 nor component 2.

Table 6.13: Extractions of components - the fragility factors of operational internal processes

	Component		
	1	2	3
ORIP7	.797		
ORIP4	.772		
ORIP8	.748		
ORIP9	.645		
ORIP1		.873	
ORIP2		.763	
ORIP5		.724	
ORIP10		.560	
ORIP6		.501	
ORIP3			.922

After applying factor analysis and data reduction to the operational internal processes fragility factors, the questionnaire's 10 factors are reduced to two components which are shown in table 6.14. ORIP 3 was added to component 1 having done a reliability test and the value of Cronbach's Alpha for the factors of the component 1 is .732. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.12 and Table 6.13.

Table 6.14: the fragility factors of operational internal processes aggregated to component following rotation

fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	5.273	52.731	39.576	.797	ORIP7	Noncompliance with client requirements
				.772	ORIP4	Misalignment with stakeholders
				.748	ORIP8	Ineffective communication with clients
				.645	ORIP9	Unexpected change of customer requirements
Component 2	1.313	13.126	26.281	.873	ORIP1	Inadequate execution of operational plans
				.763	ORIP2	Inadequate evaluation of operational plans
				.724	ORIP5	Contractual risks
				.560	ORIP10	Unmaintained customer relationships
				.501	ORIP6	Inaccurate pricing of services/products
Component 3	1.093	10.931	11.816	.922	ORIP3	Excessive implementation requirements

The fragility factors of operational internal processes can be organised into two latent constructs.

Alignment with stakeholders (Cluster 1): it comprises one component and represents 39.876% of the total variance explained. This cluster is made up of four factors and they relate to alignment with stakeholders. Internal operational processes should be integrated with the demands of both primary and secondary stakeholders (Asif et al. 2010). These demands vary from one stakeholder into another and thus internal operations processes should be carefully engineered to meet these demands as they are a sensitive measurement of business performance (Garengo, Biazzo & Bititci 2005). Transparency can be a tool to build trust between the enterprise and its stakeholders and this helps reduce the effect of disruptions (Jahansoozi 2006).

Execution and evaluation of internal operational processes (Cluster 2): it comprises two components and represents 38.079% of the total variance explained. This cluster is made up of six factors and they relate to execution and evaluation of internal operational processes. While implementing internal operational processes, enterprises should achieve flexibility, agility and efficiency; otherwise, operations will have a higher risk of failure and might not leverage all the business capabilities and enhance the enterprise's competitiveness. Moreover, these internal operational processes must be compliant with a set of multiple and overlapping regulatory requirements (McGill & Sheppey 2005).

As illustrated in figure 6.8, Amos successfully estimated the variances and covariances in the model of operational internal processes fragility factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed) except for one parameter which is significantly different from zero at the 0.01 level (two-tailed). See Appendix 6.3.

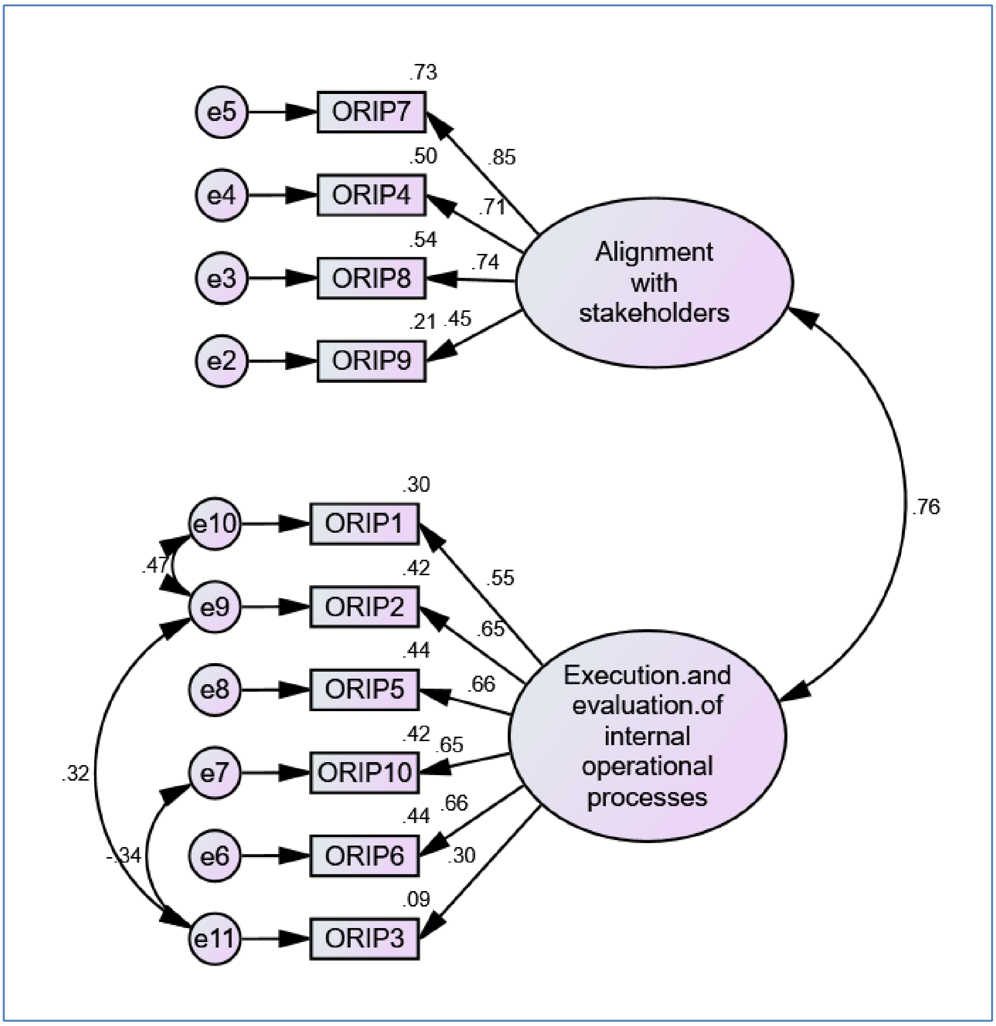


Figure 6.8: Confirmatory factor analysis of internal operational processes fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 52.736, ($p < 0.01$) reached the 1% significant level, and the normal CMIN/DF = 1.7 is within the acceptable range. In addition, TLI = 0.929, CFI = 0 .951, and RMSEA = 0.074 are acceptable standard values. Overall, the theoretical model fit is acceptable.

In conclusion, two variables can be identified to represent the fragility factors of internal operational processes: alignment with stakeholders, and execution and evaluation of internal operational processes. These sub-variables are summarized in table 6.15.

Table 6.15: Latent variables of the fragility factors of operational internal processes

Cluster	Factor Code	Factor Statement
Cluster 1 (Alignment with stakeholders)	ORIP7	Noncompliance with client requirements
	ORIP4	Misalignment with stakeholders
	ORIP8	Ineffective communication with clients
	ORIP9	Unexpected change of customer requirements
Cluster 2 (execution and evaluation of internal operational processes)	ORIP1	Inadequate execution of operational plans
	ORIP2	Inadequate evaluation of operational plans
	ORIP5	Contractual risks
	ORIP10	Unmaintained customer relationships
	ORIP6	Inaccurate pricing of services/products
	ORIP3	Excessive implementation requirements

6.5.4. Factor analysis for operational people-related fragility factors

As seen in table 6.16 that shows the analysis of the importance of operational people related fragility factors, just one component carry an Eigenvalue of more than 1 and account for nearly 50.29% of the variance, that is the result of the selected component presents 50.29% of the whole variance. Consequently, this component can be considered to be representative of all 5-operational people related fragility factors included in this study.

Table 6.16: Exploratory factor analysis for operational people-related fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.515	50.293	50.293	2.515	50.293	50.293
2	.848	16.953	67.246			
3	.603	12.061	79.307			
4	.582	11.640	90.947			
5	.453	9.053	100.000			

As can be seen from figure 6.9, the curve starts to slightly flatten out and become horizontal after component 1 and that the point of interest was before component 2, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

Figure 6.9: Scree plot of exploratory factor analysis for people related operational fragility factors

As indicated in table 6.17, factors ORP4, ORP3, ORP2, OPR 5and ORP1 have great influence on one component.

Table 6.17: Extractions of components - operational people-related fragility factors

	Component
	1
ORP4	.804
ORP3	.772
ORP2	.733
ORP5	.689
ORP1	.509

After applying factor analysis and data reduction to the operational people related fragility factors, the questionnaire's 5 factors are reduced to one component which is shown in table 6.18. The table shows the percentages of variance of this component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.16 and Table 6.17.

Table 6.18: Operational people-related fragility factors aggregated to component following rotation

fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	fragility factors aggregated to component following rotation		
			Factor loading score	Factor Code	Factor Statement
Component 1	2.515	50.293	.804	ORP4	Inadequate talent configuration and management
			.772	ORP3	Turnover of key talents
			.733	ORP2	Unhappy work environment
			.689	ORP5	Inappropriate behaviour (discrimination/harassment)
			.509	ORP1	Fraud or corruption

Operational people-related fragility factors form one latent cluster: It comprises one component and represents 50.293 % of the total variance explained. This cluster is made up of five factors and they relate to untalented or corrupted human resources. People related operations risks are vital for the fragility of operation since these risks have high potential to aggregate with other operational risks: internal processes, information technology systems and external events. People are in charge of interpreting and responding to circumstances so they have a high impact on processes regardless of how formalized these processes are, and when critical people are not available, operational processes failure is highly possible (Sscandizzo 2005).

As illustrated in figure 6.10, Amos successfully estimated the variances and covariances in the model of operational people-related risk factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See Appendix 6.4.

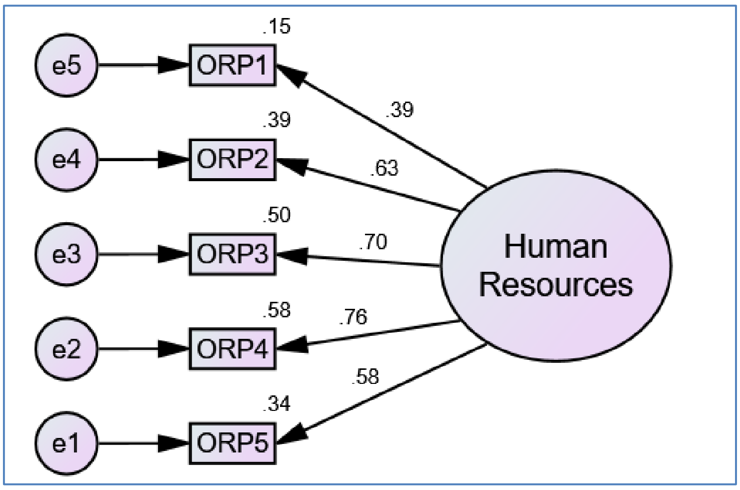


Figure 6.10: Confirmatory factor analysis of operational people-related fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 1.069, ($p > 0.05$) did not reach the 1% significant level, and the normal CMIN/DF = 0.21 is within the acceptable range. In addition, TLI = 1.061, CFI = 1.000, and RMSEA = 0.000 are acceptable standard values. Overall, the theoretical model fit is acceptable.

In conclusion, people related operational fragility factors can form one variable. These sub-variables are summarized in table 6.19.

Table 6.19: Latent variables of the operational people-related fragility factors

variable	Factor Code	Factor Statement
variable 1 (human resources)	ORP4	Inadequate talent configuration and management
	ORP3	Turnover of key talents
	ORP2	Unhappy work environment
	ORP5	Inappropriate behaviour (discrimination/harassment)
	ORP1	Fraud or corruption

6.5.5. Factor analysis for operational systems fragility factors

As seen in table 6.20 that shows the analysis of the importance of operational systems fragility factors, just two components carry an Eigenvalue of more than 1 and account for nearly 64.15% of the variance, that is, the result of the selected two components presents 64.15% of the whole variance. Consequently, these two components can be considered to be representative of all 8 operational system fragility factors included in this study.

Table 6.20: Exploratory factor analysis for operational systems fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.590	44.880	44.880	3.590	44.880	44.880	2.749	34.368	34.368
2	1.542	19.271	64.151	1.542	19.271	64.151	2.383	29.783	64.151
3	.890	11.124	75.275						
4	.638	7.970	83.246						
5	.476	5.947	89.192						
6	.383	4.782	93.974						
7	.273	3.409	97.383						
8	.209	2.617	100.000						

As can be seen from figure 6.11, the curve starts to slightly flatten out and become horizontal after component 2 and that the point of interest was defined between components 1 and 3, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

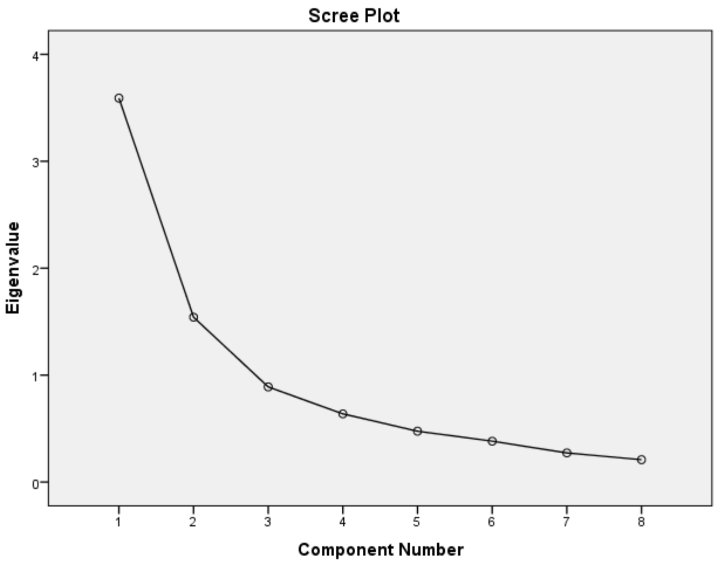


Figure 6.11: Scree plot of exploratory factor analysis for operational system fragility factors

As indicated in table 6.21, factors ORS4, ORS3, ORS5 and ORS1 have greater influence on component 1 compared to the other component. Whereas, factors ORS8, ORS7, ORS6 and ORS2 have greater influence on component 2 compared to the other component.

Table 6.21: Extractions of components - operational systems fragility factors

	Component	
	1	2
ORS4	.804	
ORS3	.800	
ORS5	.765	
ORS1	.726	
ORS8		.913
ORS7		.845
ORS6		.640
ORS2		.518

After applying factor analysis and data reduction to the operational systems fragility factors, the questionnaire's 8 factors are reduced to two components which are shown in table 6.22. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.20 and Table 6.21.

Table 6.22: operational systems fragility factors aggregated to component following rotation

Fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	Fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	3.590	44.880	34.368	.804	ORS4	Data Disclosure
				.800	ORS3	Cyber-attack/ Malware or virus/ ISP disruption
				.765	ORS5	Data integrity failure
				.726	ORS1	Hardware/software failure
Component 2	1.542	19.271	29.783	.913	ORS8	Inadequate technical transformation ability
				.845	ORS7	Inadequate technological innovative ability
				.640	ORS6	Data Reporting failure
				.518	ORS2	Disruption in communication channels

Operational systems fragility factors can be organised into two latent constructs.

Failure of systems (Cluster 1): It comprises one component and represents 34.368% of the total variance explained. This cluster is made up of four factors and they relate to failure of systems to protect data. Enterprises are nowadays a complex network of technological systems that not only connects the internal stakeholders, but also it is interconnected with certain external stakeholders like suppliers or customers. Thus, the enterprise should ensure that these systems are both robust and resilient as far as possible since the fragility of these systems puts the whole business at risk although it does not usually entail high costs to the attackers (Linkov et al. 2013; Zhu & Basar 2011; Spekman & Davis 2004; Cheng, Yang, & Lin 2004)

Technological innovative capabilities (Cluster 2): It comprises one component and represents 29.783% of the total variance explained. This cluster is made up of four factors and they relate to inadequate technological transformation and innovative capabilities. "The concept of technological innovation refers to any incremental or radical change in technology embodied in product and process; moreover, it includes the change in value activities such as service and administration" (Sher & Yang 2005). To enhance performance, enterprises should always exploit the new technology and keep pace with the radical technological innovations that shake the market (Hill & Rothaermel 2003) and thus they should develop innovative capabilities. These capabilities are positively associated with financial performance measured by returns on assets (Sher & Yang 2005). These innovative capabilities are influenced by the interrelationships among intellectual, organizational and social capitals in the organization (Subramaniam & Youdnt 2005)

As illustrated in figure 6.12, Amos successfully estimated the variances and covariances in the model of operational system fragility factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See appendix 6.5.

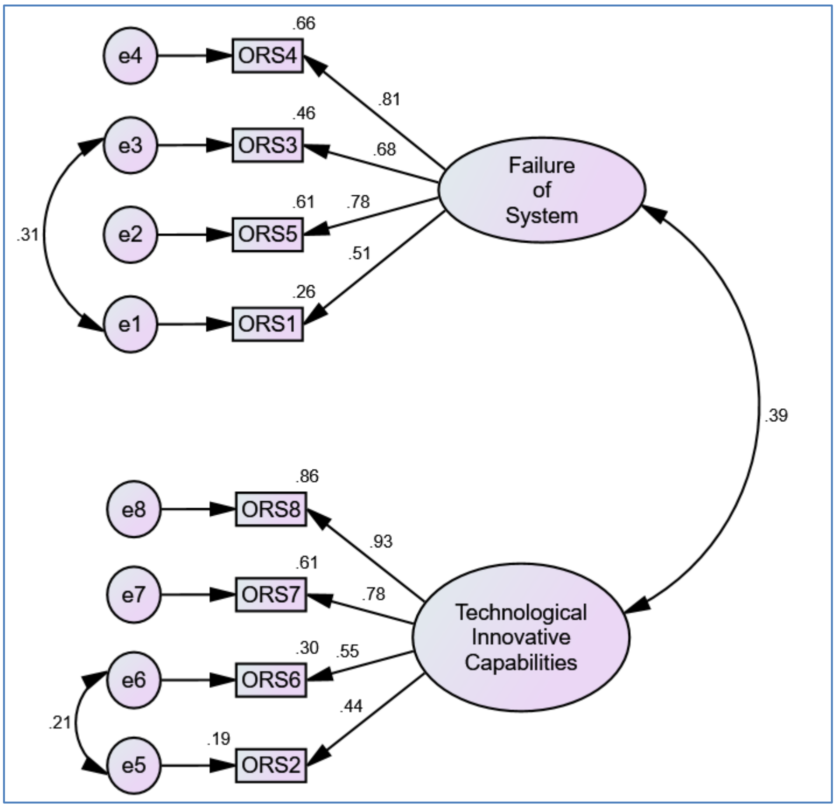


Figure 6.12: Confirmatory factor analysis of operational system fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 86.247, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 5.073 is not within the acceptable range. In addition, TLI = 0.722, CFI = 0.831, and RMSEA = 0.178 are not acceptable standard values. Overall, the theoretical model fit is not acceptable. This could be due to the inappropriate selection of the risk events that constitute the fragility of operation systems. It is possible that the mixture of data items and system items was not grasped well by the participants.

In conclusion, two variables may be identified to represent the fragility factors of operational systems: failure of systems, and technological innovative capabilities. These sub-variables are summarized in table 6.23.

Table 6.23: Latent variables of operational systems fragility factors

Variable	**Factor Code**	**Factor Statement**
Variable 1 (failure of systems)	ORS4	Data Disclosure
	ORS3	Cyber-attack/ Malware or virus/ ISP disruption
	ORS5	Data integrity failure
	ORS1	Hardware/software failure
Variable 2 (technological innovative capabilities)	ORS8	Inadequate technical transformation ability
	ORS7	Inadequate technological innovative ability
	ORS6	Data Reporting failure
	ORS2	Disruption in communication channels

6.5.6. Factor analysis for operational external events fragility factors

As seen in table 6.24 that shows the analysis of the importance of operational external events fragility factors, just four components carry an Eigenvalue of more than 1 and account for nearly 67.20% of the variance, that is, the result of the selected four components presents 67.20% of the whole variance. Consequently, these four components can be considered to be representative of all 14 operational external events fragility factors included in this study.

Table 6.24: Exploratory factor analysis for operational external events fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.560	32.572	32.572	4.560	32.572	32.572	2.505	17.889	17.889
2	2.097	14.979	47.551	2.097	14.979	47.551	2.398	17.129	35.018
3	1.682	12.011	59.562	1.682	12.011	59.562	2.355	16.825	51.843
4	1.069	7.634	67.196	1.069	7.634	67.196	2.149	15.352	67.196
5	.779	5.567	72.763						
6	.749	5.349	78.112						
7	.599	4.279	82.391						
8	.549	3.920	86.311						
9	.456	3.256	89.567						
10	.367	2.623	92.189						
11	.326	2.327	94.517						
12	.287	2.051	96.568						
13	.274	1.959	98.527						
14	.206	1.473	100.000						

As can be seen from figure 6.13, the curve starts to slightly flatten out and become horizontal after component 4 and that the point of interest was defined between components 3 and 5, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

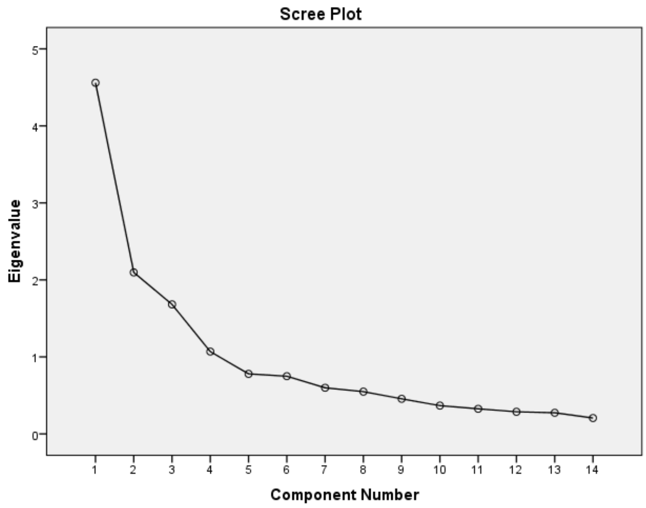


Figure 6.13: Scree plot of exploratory factor analysis for operational external event fragility factors

As indicated in table 6.25, factors OREE14, OREE13, OREE8, OREE11 and OREE6 have greater influence on component 1 compared to other components. Factors OREE7, OREE15 and OREE9 have greater influence on component 2 compared to other components. Factors OREE10, and OREE12 have greater influence on component 3 compared to other components. Whereas, factors OREE2, OREE4, OREE3, and OREE1 have greater influence on component 4 compared to other components.

Table 6.25: Extractions of components - operational external events fragility factors

	Component			
	1	2	3	4
OREE14	.806			
OREE13	.756			
OREE8	.634			
OREE11	.582			
OREE6	.517			
OREE7		.834		
OREE5		.733		
OREE9		.501		
OREE10			.818	
OREE12			.786	
OREE2				.863
OREE4				.731
OREE3				.588
OREE1				.501

After applying factor analysis and data reduction to the operational external event fragility factors, the questionnaire's 14 factors are reduced to four components which are shown in table 6.26. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.24 and Table 6.25.

Table 6.26: Operational external events fragility factors aggregated to component following rotation

Fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	Fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	4.560	32.572	17.889	.806	OREE14	The scarcity of complementary services/products
				.756	OREE13	Service/products obsolescence
				.634	OREE8	Tax rate uncertainty
				.582	OREE11	Infrastructure uncertainty
				.517	OREE6	Foreign exchange rate fluctuation
Component 2	2.097	14.979	17.129	.834	OREE7	Inflation escalation
				.733	OREE5	Equity price fluctuation
				.501	OREE9	Cost volatility
Component 3	1.682	12.011	16.825	.818	OREE10	Outsourcing failure
				.786	OREE12	Misalignment of interests with suppliers
Component 4	1.069	7.634	15.352	.863	OREE2	Credit availability
				.731	OREE4	Prepayment/extension availability
				.588	OREE3	Interest rate level
				.501	OREE1	Market volatility

Operational external events fragility factors can be organised into three latent constructs.

Volatility of market conditions (Cluster 1): it comprises two components and represents 34.714% of the total variance explained. This cluster is made up of seven factors and they relate to the volatility of non-financial market conditions. Market conditions - such as competitive intensity, price sensitivity, and demand uncertainty, product/service obsolescence or the scarcity of complimentary products/services - have a major influence on the enterprise operations in the sense that market conditions might force an adjustment in the product/service price (Ahmadi, Iravani & Mamani 2015; Ingenbleek, Frambach & Verhallen 2013), product/service features, innovation strategies or cost effectiveness (Bloch & Metcalfe 2017); consequently, market conditions influence different organizational outcomes (Chari et al 2014).

Volatility of costing and pricing (Cluster 2): it comprises one component and represents 17.129% of the total variance explained. This cluster is made up of three factors and they relate to the volatility of costing and pricing. Costing and pricing are subject to volatility since they are affected by different external events such as failure of outsourcing (Gunasekaran et al 2015), supply and demand mismatch (Hendricks & Singhal 2014), and high inflation rates (Nakamura et al 2016).

Volatility of financial macro-economic conditions (Cluster 3): it comprises one component and represents 15.352% of the total variance explained. This cluster is made up of four factors and they relate to the volatility of financial macro-economic condition. There is a positive relationship between financial recessions and the volatility of macro-economic conditions in the sense that the news about any of the two variables will lead to increase in the other and thus the volatility of financial macro-economic is an indicator of the financial recession (Ben Omrane & Savaşer 2017). Monetary policy uncertainty is one of the main factors that defines the landscape of any market, and any macroeconomic news about the monetary policy highly affects the volatility of stock market, foreign exchange, and crude oil markets and these in turn will affect all businesses in the market (Kurov & Stan 2017).

As illustrated in figure 6.14, Amos successfully estimated the variances and covariances in the model of operational external events fragility factors. This is a modified version of the model after the deletion of the parameters whose load is too low. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See appendix 6.6.

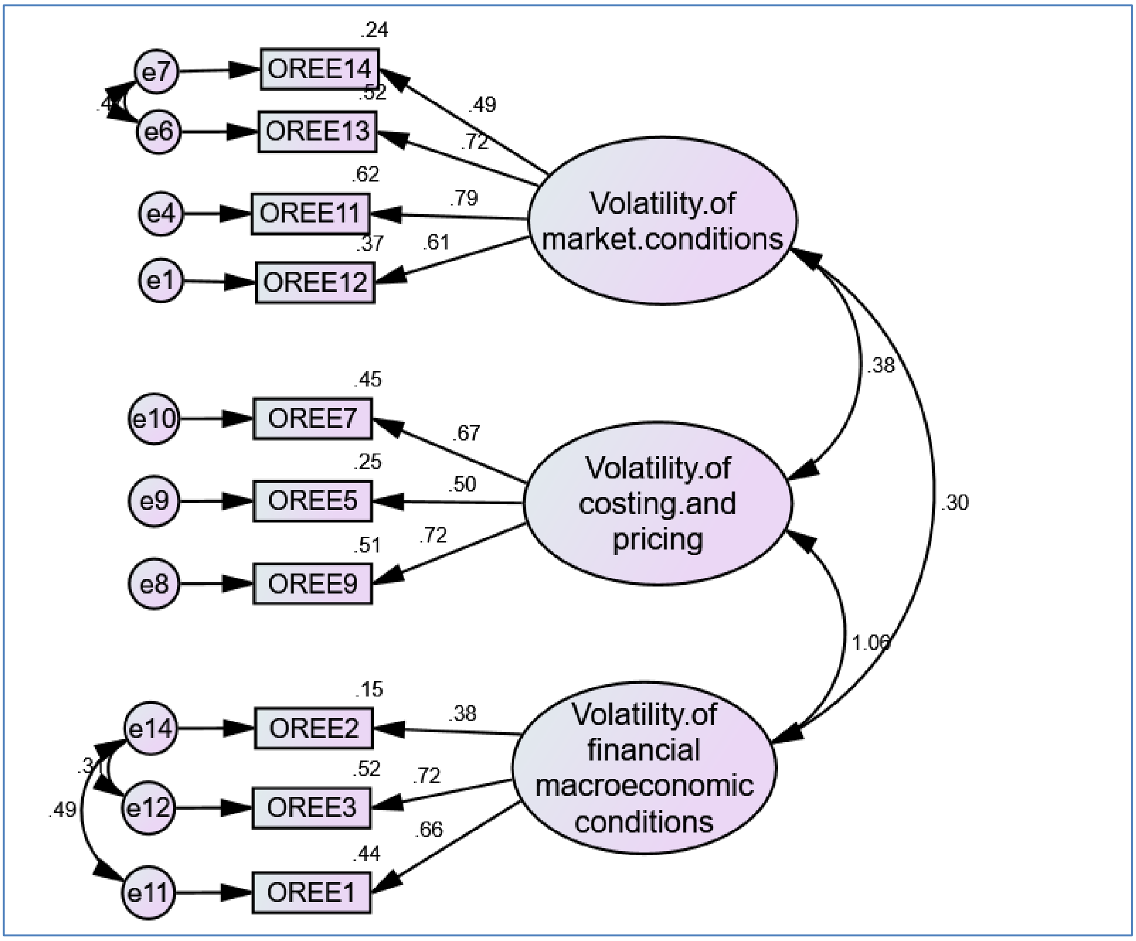


Figure 6.14: Confirmatory factor analysis of operational external event fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 42.007, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.449 is within the acceptable range. In addition, TLI = 0.951, CFI = 0.968, and RMSEA = 0.059 are acceptable standard values. Overall, the theoretical model fit is acceptable.

In conclusion, three variables may be identified to represent the fragility factors of operational systems: failure of systems, and technological innovative capabilities. These sub-variables are summarized in table 6.27.

Table 6.27: Latent variables of operational external events fragility factors

Cluster	Factor Code	Factor Statement
Cluster 1 (volatility of market conditions)	OREE14	The scarcity of complementary services/products
	OREE13	Service/products obsolescence
	OREE11	Infrastructure uncertainty
	OREE12	Misalignment of interests with suppliers
Cluster 2 (volatility of costing and pricing)	OREE7	Inflation escalation
	OREE5	Equity price fluctuation
	OREE9	Cost volatility
Cluster 3 (volatility of financial macro-economic conditions)	OREE2	Credit availability
	OREE3	Interest rate level
	OREE1	Market volatility

6.5.7. Factor analysis for business unit fragility factors

As seen in table 6.28 that shows the analysis of the importance of business unit fragility factors, just two components carry an Eigenvalue of more than 1 and account for nearly 60.72% of the variance, that is, the result of the selected two components presents 60.72% of the whole variance. Consequently, these two components can be considered to be representative of all 9 business unit fragility factors included in this study.

Table 6.28: Exploratory factor analysis for business unit fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.169	46.318	46.318	4.169	46.318	46.318	2.935	32.610	32.610
2	1.296	14.400	60.718	1.296	14.400	60.718	2.530	28.108	60.718
3	.980	10.884	71.602						
4	.686	7.624	79.226						
5	.485	5.388	84.614						
6	.462	5.128	89.742						
7	.404	4.487	94.229						
8	.290	3.222	97.451						
9	.229	2.549	100.000						

As can be seen from figure 6.15, the curve starts to slightly flatten out and become horizontal after component 2 and that the point of interest was defined between components 1 and 3, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

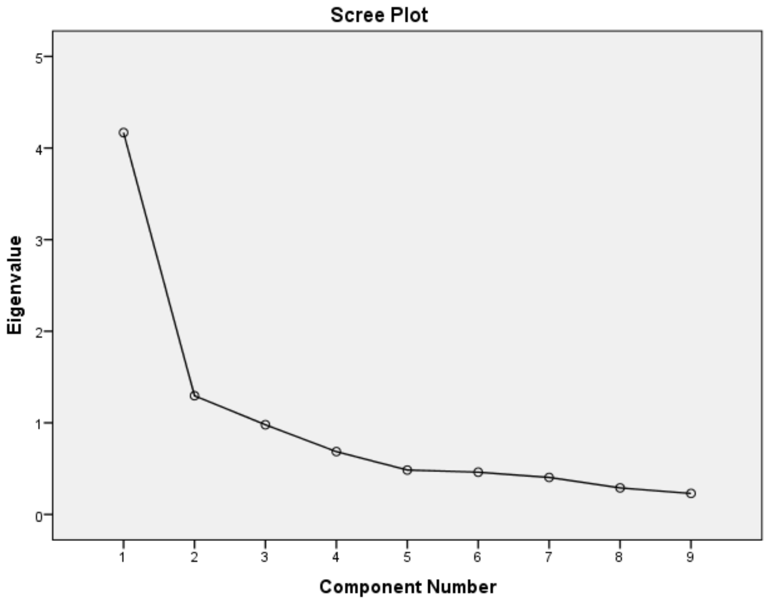


Figure 6.15: Scree plot of exploratory factor analysis for business unit fragility factors

As indicated in table 6.29, factors BUR9, BUR5, BUR4, BUR6 and BUR3 have greater influence on component 1 compared to the other component. Whereas, factors BUR1, BUR2, BUR7, and BUR8 have greater influence on component 2 compared to the other component.

Table 6.29: Extractions of components - business unit fragility factors

	Component	
	1	2
BUR9	.832	
BUR5	.814	
BUR4	.760	
BUR6	.636	
BUR3	.619	
BUR1		.811
BUR2		.761
BUR7		.758
BUR8		.551

After applying factor analysis and data reduction to the business unit fragility factors, the questionnaire’s 9 factors are reduced to two components which are shown in table 6.30. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.28 and Table 6.29

Table 6.30: Business unit fragility factors aggregated to component following rotation

Fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	Fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	4.169	46.318	32.610	.832	BUR9	Improper planning for daily operations
				.814	BUR5	Failure to follow processes
				.760	BUR4	Red-tape risk
				.636	BUR6	Failure to integrate with business processes
				.619	BUR3	Inadequate business unit supervision ability
Component 2	1.296	14.400	28.108	.811	BUR1	Fixed assets mis-utilization
				.761	BUR2	Inadequate fund management ability
				.758	BUR7	Lack of cost control
				.551	BUR8	Lack of resources

Business unit fragility factors can be organised into two latent constructs

Failure of business processes (Cluster 1): it comprises one component and represents 32.610% of the total variance explained. This cluster is made up of five factors and they relate to failure of business processes. It is vital that each business unit knows its contribution to the core business objectives and core business processes; otherwise, the enterprise will lose the strategic alignment between different organizational functions and business processes will have high potential to fail (Lok et al 2005). Therefore, business units should not be isolated from one another; rather, business units should be integrated with one another to create value to the stakeholders and this can be achieved through proper communication, flexibility, and responsiveness (Khosravi 2016).

Mis-utilization of Assets (Cluster 2): it comprises one component and represents 28.108% of the total variance explained. This cluster is made up of four factors and they relate to mis-utilization of assets. The effectiveness of assets is obtained from three factors: availability, utilization and quality. Availability and quality have no use if assets are misutilized (Hastings 2009). Therefore, there is a need to embed a comprehensive asset management framework in the enterprise to enhance the integration of technology, information and human factors on both operational and strategic levels (Laue et al 2014).

As illustrated in figure 6.16, Amos successfully estimated the variances and covariances in the model of business unit fragility factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See appendix 6.7.

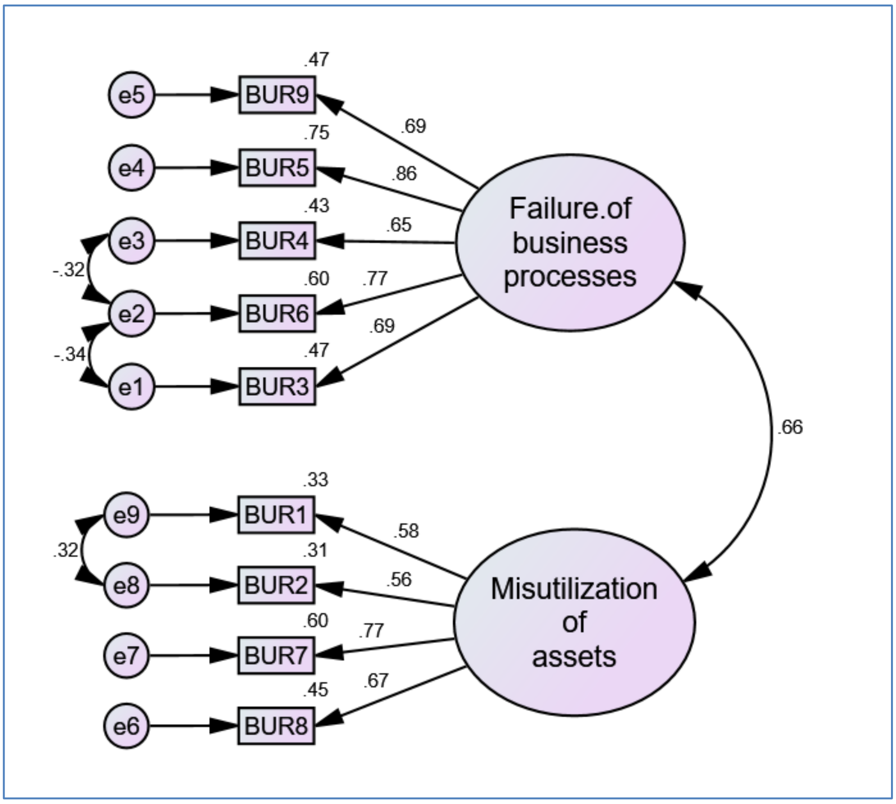


Figure 6.16: Confirmatory factor analysis of business unit fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 61.021, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 2.653 is within the acceptable range. In addition, TLI = 0.869, and RMSEA = 0. 114 are not acceptable standard values, while CFI = 0.916 is acceptable. Overall, the theoretical model fit can be accepted.

In conclusion, two variables may be identified to represent the fragility factors of operational systems: failure of systems, and technological innovative capabilities. These sub-variables are summarized in table 6.31.

Table 6.31: Latent variables of business unit fragility factors

Variable	**Factor Code**	**Factor Statement**
Variable 1 (Failure of business processes)	BUR9	Improper planning for daily operations
	BUR5	Failure to follow processes
	BUR4	Red-tape risk
	BUR6	Failure to integrate with business processes
	BUR3	Inadequate business unit supervision ability
Variable 2 (mis-utilization of assets)	BUR1	Fixed assets mis-utilization
	BUR2	Inadequate fund management ability
	BUR7	Lack of cost control
	BUR8	Lack of resources

6.5.8. Factor analysis for project fragility factors

As seen in table 6.32 that shows the analysis of the importance of project fragility factors, five components carry an Eigenvalue of more than 1 and account for nearly 63.19% of the variance, that is, the result of the selected four components presents 63.19% of the whole variance. Consequently, these five components can be considered to be representative of all 24 project fragility factors included in this study.

Table 6.32: Exploratory factor analysis for project fragility factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.567	35.694	35.694	8.567	35.694	35.694	4.169	17.370	17.370
2	2.685	11.187	46.882	2.685	11.187	46.882	3.584	14.933	32.303
3	1.665	6.938	53.820	1.665	6.938	53.820	3.074	12.808	45.111
4	1.368	5.699	59.518	1.368	5.699	59.518	2.194	9.142	54.253
5	1.110	4.626	64.144	1.110	4.626	64.144	2.145	8.936	63.188
6	1.019	4.248	68.392						
7	.906	3.774	72.166						
8	.763	3.180	75.345						
9	.715	2.978	78.323						
10	.635	2.647	80.971						
11	.601	2.506	83.477						
12	.546	2.277	85.754						
13	.470	1.959	87.713						
14	.424	1.767	89.479						
15	.363	1.511	90.991						
16	.334	1.393	92.384						
17	.312	1.300	93.684						
18	.281	1.171	94.855						
19	.256	1.068	95.923						
20	.245	1.020	96.943						
21	.233	.969	97.912						
22	.197	.821	98.733						
23	.186	.776	99.509						
24	.118	.491	100.000						

As can be seen from figure 6.17, the curve starts to slightly flatten out and become horizontal after component 5 and that the point of interest was defined between components 3 and 4, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

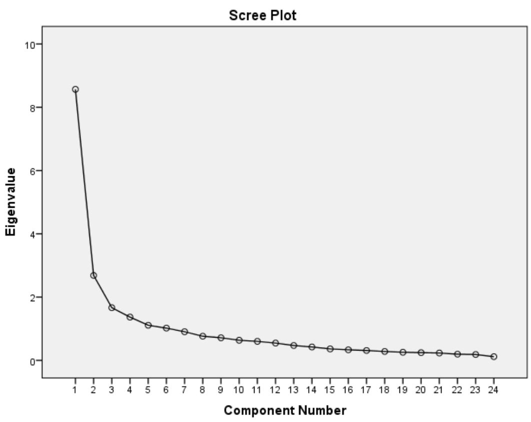


Figure 6.17: Scree plot of exploratory factor analysis for project fragility factors

As indicated in table 6.33, factors PR17, PR7, PR8, PR16, PR9, PR23, PR18 and PR13 have greater influence on component 1 compared to other components. Factors PR2, PR6, PR4, PR3, PR5 and PR1 have greater influence on component 2 compared to other components. Factors PR19, PR20, PR24, PR21 and PR22 have greater influence on component 3 compared to other components. Factors PR11, PR10 and PR12 have greater influence on component 4 compared to other components. Whereas, factors PR15 and PR14 have greater influence on component 5 compared to other components.

Table 6.33: Extractions of components - project fragility factors

	Component				
	1	2	3	4	5
PR17	.804				
PR7	.796				
PR8	.704				
PR16	.668				
PR9	.636				
PR23	.611				
PR18	.580				
PR13	.467				
PR2		.774			
PR6		.750			
PR4		.730			
PR3		.702			
PR5		.592			
PR1		.592			
PR19			.698		
PR20			.690		
PR24			.668		
PR21			.665		
PR22			.490		
PR11				.734	
PR10				.701	
PR12				.613	
PR15					.783
PR14					.704

After applying factor analysis and data reduction to the project fragility factors, the questionnaire's 24 factors are reduced to five components which are shown in table 6.34. The table shows the percentages of variance of each component, Eigenvalue, loading score and the fragility factors which are extracted from Table 6.32 and Table 6.33.

Table 6.34: Project fragility factors aggregated to component following rotation

Fragility component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	Fragility factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	8.567	35.694	17.370	.804	PR17	Lack of existing risk documentations on all processes and standards
				.796	PR7	Inadequate project monitoring
				.704	PR8	User's rejection of the product/service
				.668	PR16	Lack of risk quantification
				.636	PR9	Failure to record/archive lessons learned
				.611	PR23	Lack of information on risk triggers
				.580	PR18	Lack of using performance indices to measure project risk
				.467	PR13	Lack of integrating cost and time management
Component 2	2.685	11.187	14.933	.774	PR2	Inadequate scope of control
				.750	PR6	Inadequate procurement management ability
				.730	PR4	Inadequate project risk culture building
				.702	PR3	Inadequate project management ability
				.592	PR5	Inadequate change management ability
				.592	PR1	Inadequate project requirements
Component 3	1.665	6.938	12.808	.698	PR19	Lack of immediate response to risks as they arise
				.690	PR20	Lack of processes for tracking project risks
				.668	PR24	Lack of risk information collection
				.665	PR21	Lack of contingency risk plans
				.490	PR22	Lack of using risk assessment and project performance status in decision making
Component 4	1.368	5.699	9.142	.734	PR11	Lack of re-alignment between strategic and project objectives
				.701	PR10	Disengagement of executives with the project
				.613	PR12	Conflict between key stakeholders
Component 5	1.110	4.626	8.936	.783	PR15	Lack of identifying risk triggers
				.704	PR14	Lack of project risk identification

Project fragility factors can be organised into four latent constructs.

Risk monitoring (Cluster 1): It comprises one component and represents 17.370 % of the total variance explained. This cluster is made up of six factors and they relate to risk monitoring. Two factors of the first component (PR8 and PR9) are merged with cluster four because they relate to risk integrating. Risk Monitoring is the continual review of risks and their controls (Baccarini & Archer 2001) in which the status of identified risks is observed and new risks are identified to review the effectiveness of agreed responses and help achieve the deliverables of the project (Hillson 2002).

Project Scope risks (Cluster 2): It comprises two components and represents 23.869% of the total variance explained. This cluster is made up of eight factors and they relate to project scope issues. Project scope is one of the project characteristics that affects all dimensions of risk and the larger the scope of the project the greater the risks (Shrivastava & Rathod 2017, Wallace, Keil & Rai 2004). If not defined well, the project scope might result in conflicts among stakeholders and other risks such as scope creep (Chen, Law & Yang 2009) and ill-defined deliverables (Sumner 2000).

Risk responding (Cluster 3): It comprises one component and represents 12.808% of the total variance explained. This cluster is made up of five factors and they relate to risk responding. After identifying and assessing risks, project managers should implement appropriate risk responses aiming to reduce the likelihood of occurrence of risk events and/or lower the negative impact of those risks. To ensure proper responses to identified risks, there must be suitable risk response strategies, which integrates cost, time and quality (Zhang & Fan 2014). To be anti-fragile, these strategies must be constantly monitored to cope with the dynamic nature of project risks.

Risk integrating (Cluster 4): It comprises one component plus two factors from cluster 1 and represents more than 9.142% of the total variance explained. This cluster is made up of five factors and they relate to risk integrating. Managing risks in silo-based activities with little integration or aggregation will increase the fragility of projects (Farrell & Gallagher 2015); therefore, there is a need for a quantitative measure of the risk interdependence (Zhang 2016). Integrating risks will help the enterprise avoid the duplication to risk management expenditure and outlay (Hoyt & Liebenberg
2011)

As illustrated in figure 6.18, Amos successfully estimated the variances and covariances in the model of project fragility factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See appendix 6.8.

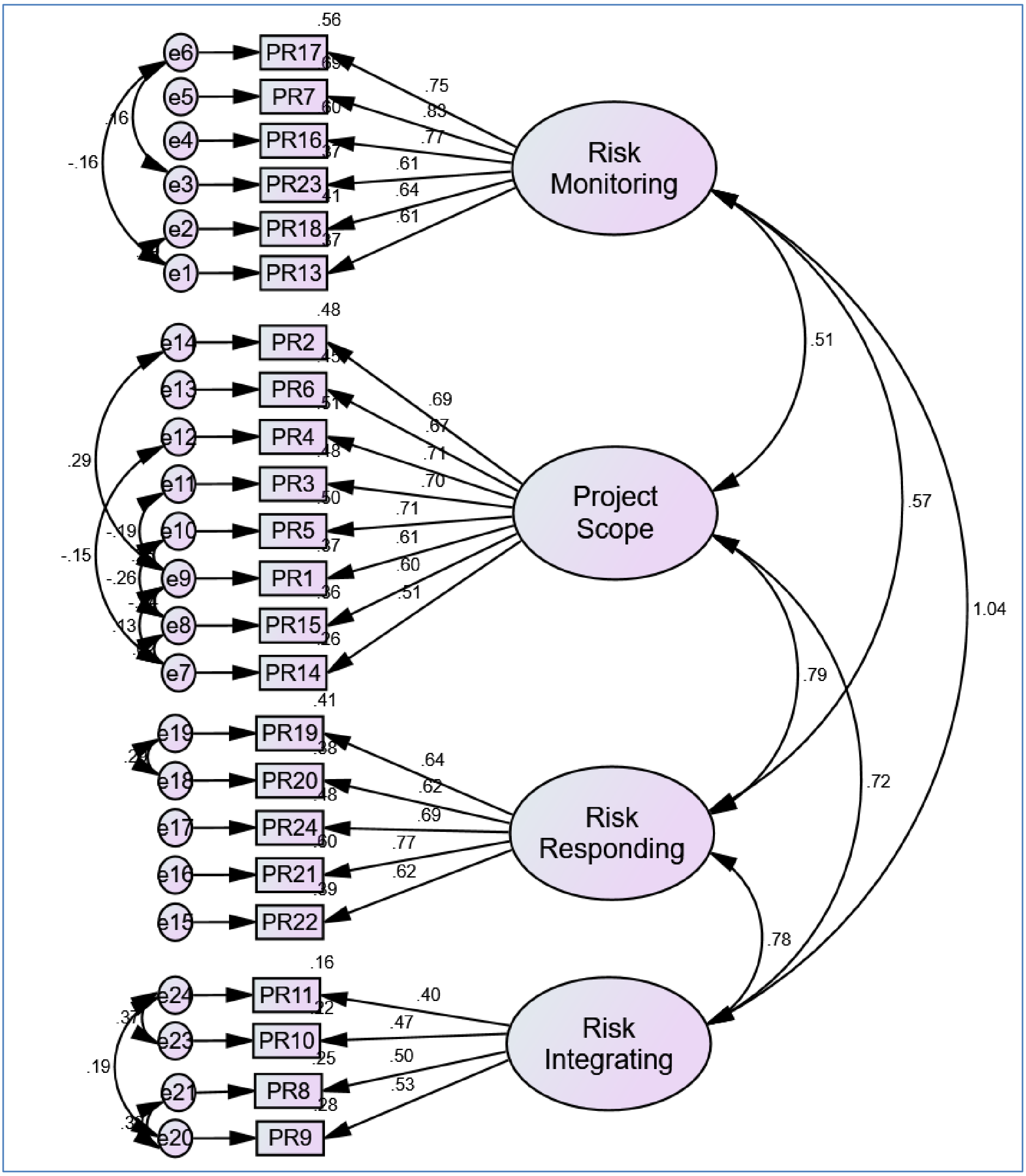


Figure 6.18: Confirmatory factor analysis of project fragility factors

In regard to the overall model fit, the absolute fit indicator CMIN = 461.185, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 2.207 is within the acceptable range. In addition, TLI = 0.789, CFI = 0. 826, and RMSEA = 0.097 are not acceptable standard values. Overall, the theoretical model is barely acceptable. An explanation of this can be related to the sample as it contained non-projectized enterprises like banks or insurance enterprises.

In conclusion, four variables may be identified to represent the fragility factors of projects: risk monitoring, project scope, risk responding and risk integrating. These sub-variables are summarized in table 6.35.

Table 6.35: Latent variables of project fragility factors

Variable	Factor Code	Factor Statement
Variable 1 (risk monitoring)	PR17	Lack of existing risk documentations on all processes and standards
	PR7	Inadequate project monitoring
	PR16	Lack of risk quantification
	PR23	Lack of information on risk triggers
	PR18	Lack of using performance indices to measure project risk
	PR13	Lack of integrating cost and time management
Variable 2 (project scope issues)	PR2	Inadequate scope of control
	PR6	Inadequate procurement management ability
	PR4	Inadequate project risk culture building
	PR3	Inadequate project management ability
	PR5	Inadequate change management ability
	PR1	Inadequate project requirements
	PR15	Lack of identifying risk triggers
	PR14	Lack of project risk identification
Variable 3 (risk responding)	PR19	Lack of immediate response to risks as they arise
	PR20	Lack of processes for tracking project risks
	PR24	Lack of risk information collection
	PR21	Lack of contingency risk plans
	PR22	Lack of using risk assessment and project performance status in decision making
Variable 4 (risk integration)	PR11	Lack of re-alignment between strategic and project objectives
	PR10	Disengagement of executives with the project
	PR12	Conflict between key stakeholders
	PR8	User's rejection of the product/service
	PR9	Failure to record/archive lessons learned

6.5.9. Factor analysis for resilience attributes

As seen in table 6.36 that shows the analysis of the importance of resilience attributes, seven components carry an Eigenvalue of more than 1 and account for 70.4% of the variance, that is the result of the selected seven components present 70.4% of the whole variance.

Consequently, these seven components can be representative of all 28 resilience factors included in this study.

Table 6.36: Exploratory factor analysis for resilience attributes

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.340	40.500	40.500	11.340	40.500	40.500	3.847	13.739	13.739
2	1.961	7.004	47.504	1.961	7.004	47.504	3.094	11.050	24.789
3	1.444	5.158	52.662	1.444	5.158	52.662	2.994	10.693	35.482
4	1.350	4.823	57.485	1.350	4.823	57.485	2.882	10.294	45.776
5	1.264	4.516	62.001	1.264	4.516	62.001	2.636	9.415	55.192
6	1.194	4.263	66.263	1.194	4.263	66.263	2.256	8.056	63.248
7	1.158	4.137	70.400	1.158	4.137	70.400	2.003	7.153	70.400
8	.869	3.102	73.503						
9	.722	2.578	76.081						
10	.704	2.513	78.594						
11	.629	2.245	80.839						
12	.615	2.196	83.035						
13	.515	1.839	84.875						
14	.504	1.800	86.675						
15	.484	1.727	88.402						
16	.444	1.584	89.986						
17	.394	1.406	91.392						
18	.337	1.203	92.595						
19	.313	1.120	93.714						
20	.269	.959	94.673						
21	.268	.956	95.630						
22	.245	.875	96.505						
23	.220	.785	97.290						
24	.188	.670	97.959						
25	.183	.652	98.611						
26	.157	.561	99.173						
27	.123	.438	99.610						
28	.109	.390	100.000						

As can be seen from figure 6.19, the curve starts to slightly flatten out and become horizontal after component 7 and that the point of interest was defined between components 6 and 8, where the curve connects the points, which is considered to be the point where Eigenvalues of less than 1 are placed.

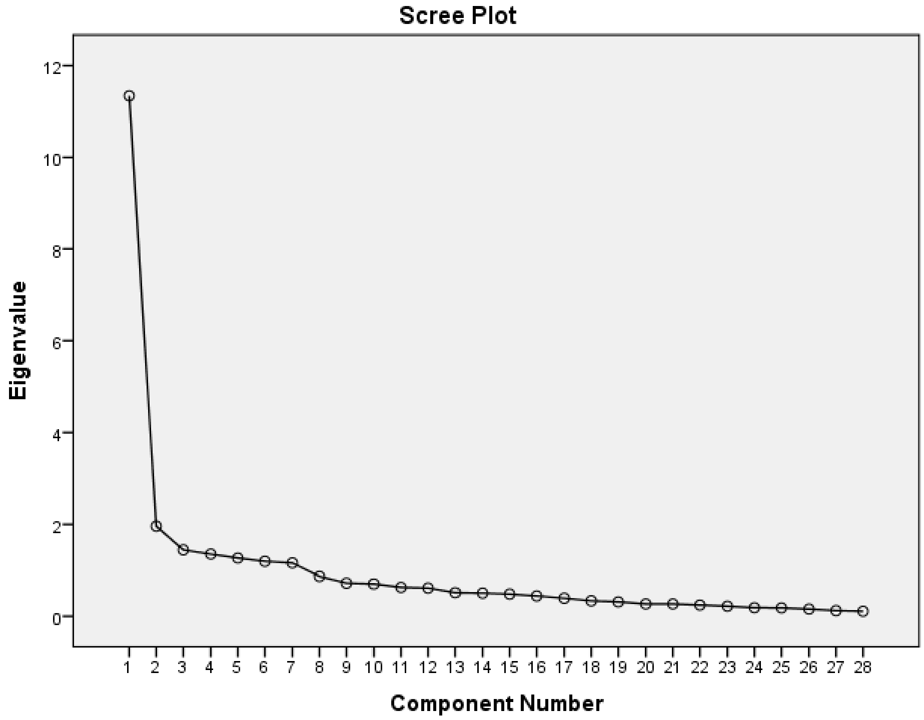


Figure 6.19: Scree plot of exploratory factor analysis for resilience factors

As indicated in table 6.37, factors RGR7, RGR6, RGR10, RGR8, RDMR2 and RGR11 have greater influence on component 1 compared to other components. Factors RAR4, RAR2, RAR5, RAR3 and RAR4 have greater influence on component 2 compared to other components. Factors RDMR5, RDMR4, RDMR1 and RGR9 have greater influence on component 3 compared to other components. Factors RCR4, RCR3, RCR1 and RCR2 have greater influence on component 4 compared to other components. Factors RGR1, RGR2, RAR1 and RDMR3 have greater influence on component 5 compared to other components. Factors RCR6, RCR7 and RCR5 have greater influence on component 6 compared to other components. While factors RGR5 and RGR3 have greater influence on component 7 compared to other components.

Table 6.37: Extractions of components – resilience attributes

	Component						
	1	2	3	4	5	6	7
RGR7	.801						
RGR6	.737						
RGR10	.673						
RGR8	.662						
RDMR2	.483						
RGR11	.444						
RAR4		.736					
RAR2		.669					
RAR5		.664					
RAR3		.596					
RGR4		.446					
RDMR5			.782				
RDMR4			.778				
RDMR1			.629				
RGR9			.501				
RCR4				.746			
RCR3				.735			
RCR1				.720			
RCR2				.647			
RGR1					.750		
RGR2					.721		
RAR1					.552		
RDMR3					.510		
RCR6						.860	
RCR7						.793	
RCR5						.500	
RGR5							.803
RGR3							.736

After applying factor analysis and data reduction to the resilience factors, the questionnaire's 28 factors are reduced to seven components which are shown in table 6.38. The table shows the percentages of variance of each component, Eigenvalue, loading score and the resilience factors which are extracted from Table 6.34 and Table 6.35.

Table 6.38: Resilience attributes factors aggregated to component following rotation

Resilience component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	Resilience factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	11.340	40.500	13.739	.801	RGR7	The organization has a risk management organizational structure with clear reporting lines
				.737	RGR6	Risk ownership and accountability is well defined
				.673	RGR10	Existence of key intelligence risks indicators
				.662	RGR8	Formal organizational risk reports are regularly reviewed
				.483	RDMR2	Major strategic decisions are embedded on risk before deployment
				.444	RGR11	Provision of clarity and responsibility on taking actionable measures
Component 2	1.961	7.004	11.050	.736	RAR4	Existence of guidelines on trade-offs between risk taking and the corresponding cost
				.669	RAR2	Policies on risk appetite (how much risk can be taken)
				.664	RAR5	Existence of guidelines on actions to transform company risk profile
				.596	RAR3	Existence of guidelines on risk taking capacity (how much risk can be comfortably taken)
				.446	RGR4	Existence of clear allocation of responsibilities between risk taking and controlling units
Component 3	1.444	5.158	10.693	.782	RDMR5	The minimum process functionality requirements are well identified
				.778	RDMR4	Risk responsibilities are incorporated into individual activities
				.629	RDMR1	Business decision making are embedded on risk
				.501	RGR9	Existence of risk models as support tool for business decisions
Component 4	1.350	4.823	10.294	.746	RCR4	Existence of risk skill-enhancement program for key roles
				.735	RCR3	Risk norms are embedded through various governance processes
				.720	RCR1	Existence of thorough risk culture across entire organization
				.647	RCR2	Risk norms are embedded through various corporate processes
Component 5	1.264	4.516	9.415	.750	RGR1	Enterprise risk management mandate of the risk function is clearly defined
				.721	RGR2	Robust design risk organization across entire organization
				.552	RAR1	Existence of policies on risk ownership
				.510	RDMR3	Core business processes are designed and executed on a risk-informed basis
Component 6	1.194	4.263	8.056	.860	RCR6	Using business-specific scenarios and stress tests to understand risks and opportunities
				.793	RCR7	Using business-specific scenarios and early indicators to understand risks and opportunities
				.500	RCR5	Existence of common vocabulary for different risks
Component 7	1.158	4.137	7.153	.803	RGR5	Risks are communicated via appropriate channels and technology
				.736	RGR3	Ensure appropriation of top management

Resilience factors can be organised into five latent constructs.

Risk governance (Cluster 1): it comprises two components and represents 20.892%of the total variance explained. This cluster is made up of eight factors and they relate to risk governance. Risk governance concerns with the decisions different stakeholders make to deal with complex risks associated with uncertainty (van Asselta & Renn 2014). To enhance enterprise resilience, governance strategies should be operationalized in a manner that makes the components of the system fits for one another with the emphasis on adaptation and flexibility (Welsh 2014).

Risk Appetite (Cluster 2): It comprises one component and represents 11.050 % of the total variance explained. This cluster is made up of five factors and they relate to risk appetite. Resilient enterprises should define a threshold that involves choices about what risks are acceptable. The 'risk appetite' should infuse in all enterprise functions throughout all business levels (Atkinson 2013). Although there is often uncertainty about the exact level of a threshold (Polasky et al 2011), yet risk appetite and tolerances should be clearly understood with alerts in place to ensure the decision makers are made aware when risk thresholds are exceeded (Farrell & Gallagher2015)

Risk decision making (Cluster 3): It comprises one component and represents 10.693% of the total variance explained. This cluster is made up of four factors and they relate to risk decision making. Resilient enterprises usually distribute decision making power among employees and equip them with the skills that help make sound risk decisions that serve the enterprise's mission (Sheffi & Rice 2005). Security and resilience considerations have to be taken into account in designing the business processes and woven into the fabric of business decision making (Sheffi 2005). In a resilient enterprise, decision-support capabilities should be aligned in order to uncover and adjust continually changing risks, endure disruptions to its primary earnings factors, and create advantages over less adaptive competitors (Starr, Newfrock & Delurey 2003).

Risk culture (Cluster 4): It comprises one two components and represents 18.35% of the total variance explained. This cluster is made up of seven factors and they relate to risk culture. Based on its risk profile, an enterprise should build a culture of awareness and sensitivity to security in order to reduce the probability and impact of disruptions (Sheffi 2005). A strong risk culture must be both resilient and robust (Atkinson 2013). The aim of a good risk culture is not to avoid taking risks in general, since this would make the enterprise lose opportunities. Instead, risk culture is about taking those valuable risks an enterprise is able to bear, to assess and, as a result, manage these risks in a way appropriate for the benefits of stakeholders (Fritz-Morgenthal, Hellmuth & Packham 2016). Therefore, strong risk culture is a significant indicator of the enterprise's healthy performance (Levy, Lamarre & Twining 2010).

Risk policies design (Cluster 5): it comprises one component and represents 9.415% of the total variance explained. This cluster is made up of four factors and they relate to risk policies design. Folke (2006) asserts that the implication for policy is profound, requiring a shift away from policies based on steady-state thinking and the design of policies that stimulate adaptive responses to change in the short- and longterm. To enhance resilience, risk policies need to be sensitive to the various principles of complexity such as feedback, nonlinearity, unpredictability, renewal cycles, memory in the system, and the significance of windows of opportunity during which innovative changes can be made to the system (Berkes & Ross 2013); therefore, developing appropriate policies for resilience demands the development of more sophisticated and agile governance networks (Bristow and Healy 2014)

As illustrated in figure 6.20, Amos successfully estimated the variances and covariances in the model of project risk factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See Appendix 6.9.

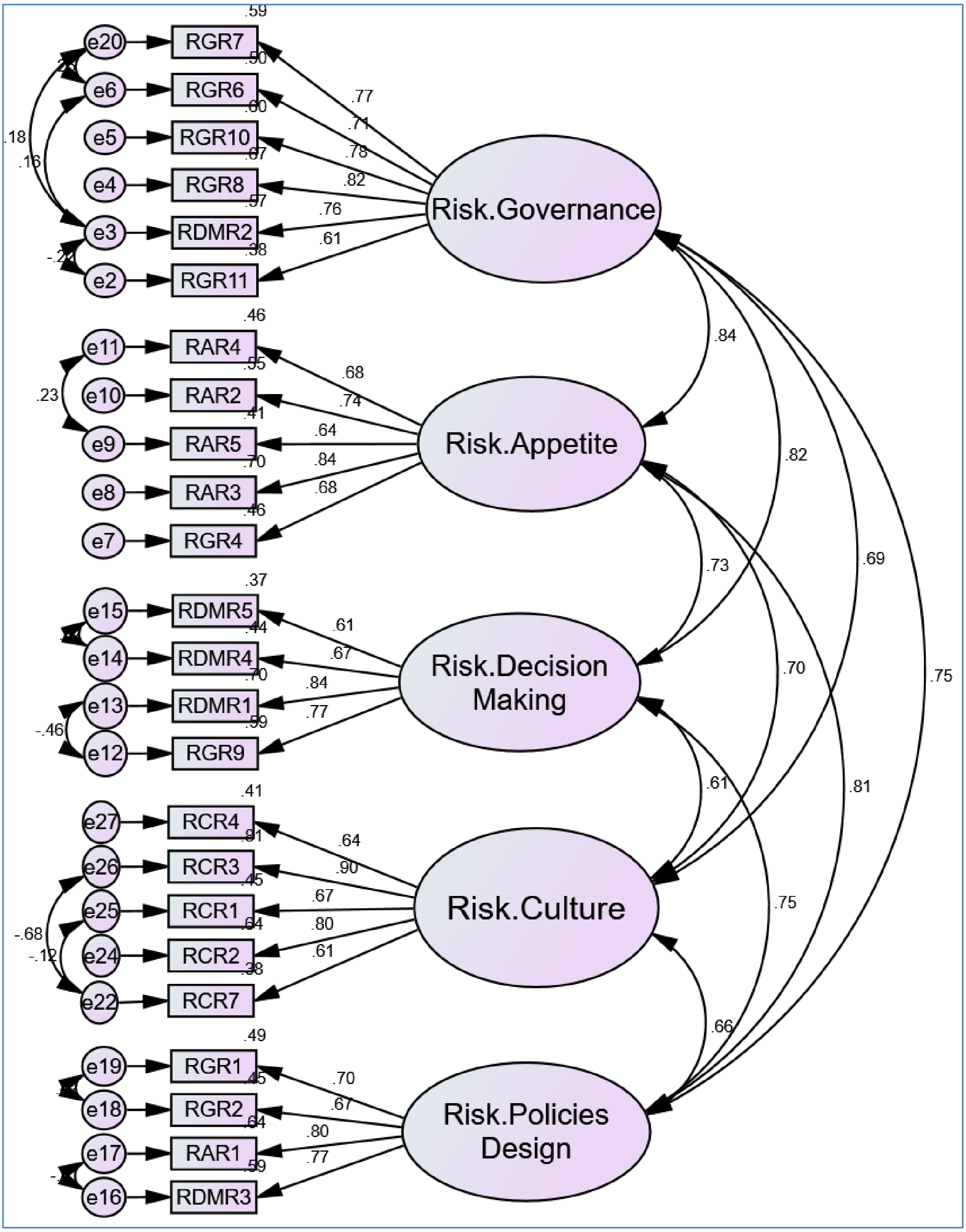


Figure 6.20: Confirmatory factor analysis of resilience factors

In regards to the overall model fit, the absolute fit indicator CMIN = 377.221, ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.633 is within the acceptable range. In addition, TLI = 0.899, CFI = 0.916, and RMSEA = 0.070 are acceptable standard values. Overall, the theoretical model is acceptable.

In conclusion, five variables may be identified to represent resilience factors: risk governance, risk appetite, risk-informed decision making, risk culture and risk policies design. These sub-variables are summarized in table 6.39.

Table 6.39: Latent variables of resilience attributes

Variable	Factor Code	Factor Statement
Variable 1 Risk Governance	RGR7	The organization has a risk management organizational structure with clear reporting lines
	RGR6	Risk ownership and accountability is well defined
	RGR10	Existence of key intelligence risks indicators
	RGR8	Formal organizational risk reports are regularly reviewed
	RDMR2	Major strategic decisions are embedded on risk before deployment
	RGR11	Provision of clarity and responsibility on taking actionable measures
	RGR5	Risks are communicated via appropriate channels and technology
	RGR3	Ensure appropriation of top management
Variable 2 Risk Appetite	RAR4	Existence of guidelines on trade-offs between risk taking and the corresponding cost
	RAR2	Policies on risk appetite (how much risk can be taken)
	RAR5	Existence of guidelines on actions to transform company risk profile
	RAR3	Existence of guidelines on risk taking capacity (how much risk can be comfortably taken)
	RGR4	Existence of clear allocation of responsibilities between risk taking and controlling units
Variable 3 Risk-informed decision making	RDMR5	The minimum process functionality requirements are well identified
	RDMR4	Risk responsibilities are incorporated into individual activities
	RDMR1	Business decision making are embedded on risk
	RGR9	Existence of risk models as support tool for business decisions
Variable 4 Risk culture	RCR4	Existence of risk skill-enhancement program for key roles
	RCR3	Risk norms are embedded through various governance processes
	RCR1	Existence of thorough risk culture across entire organization
	RCR2	Risk norms are embedded through various corporate processes
	RCR6	Using business-specific scenarios and stress tests to understand risks and opportunities
	RCR7	Using business-specific scenarios and early indicators to understand risks and opportunities
	RCR5	Existence of common vocabulary for different risks
Variable 5 Risk policies design	RGR1	Enterprise risk management mandate of the risk function is clearly defined
	RGR2	Robust design risk organization across entire organization
	RAR1	Existence of policies on risk ownership
	RDMR3	Core business processes are designed and executed on a risk-informed basis

6.5.10. Factor analysis for risk management performance factors

As seen in table 6.40 that shows the analysis of managerial performance factor, two components carry an Eigenvalue of more than 1 and account for 75.05% of the variance, that is the result of the selected two components present 75.05% of the whole variance. Consequently, these two components can be representative of all 5 resilience factors included in this study.

Table 6.40: Exploratory factor analysis for risk management performance factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.593	51.867	51.867	2.593	51.867	51.867	2.084	41.686	41.686
2	1.159	23.182	75.049	1.159	23.182	75.049	1.668	33.363	75.049
3	.520	10.409	85.458						
4	.381	7.620	93.078						
5	.346	6.922	100.000						

As can be seen from figure 6.21, the curve starts to slightly flatten out and become horizontal after component 2 and that the point of interest was defined between components 1 and 3, where the curve connects the points, which is the point where Eigenvalues of less than 1 are placed.

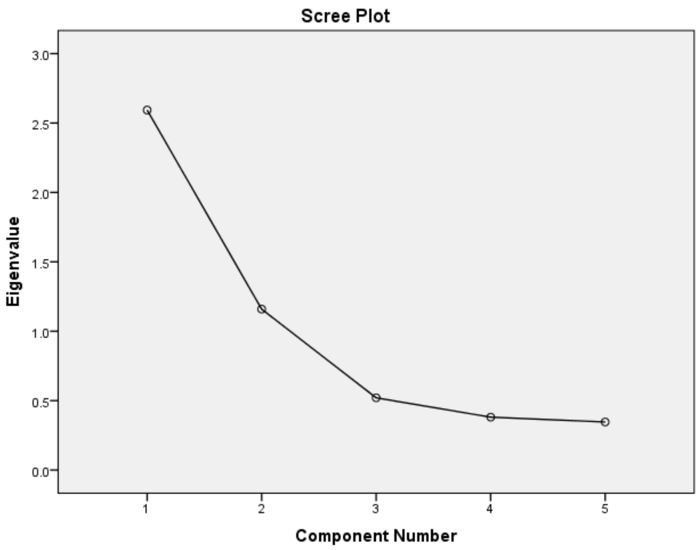


Figure 6.21: Scree plot of exploratory factor analysis for resilience factors

As indicated in table 6.41, factors Perform3, Perform4 and Perform5 have greater influence on component 1 compared to the other component. Factors Perform1 and Perform2 have greater influence on component 2 compared to the other component

Table 6.41: Extractions of components – risk management performance factors

	Component	
	1	2
Perfor4	.869	
Perfor5	.867	
Perfor3	.720	
Perfor1		.897
Perfor2		.866

After applying factor analysis and data reduction to the performance factors, the questionnaire's 5 factors are reduced to two components which are shown in table 6.42. The table shows the percentages of variance of each component, Eigenvalue, loading score and the factors which are extracted from Table 6.40 and Table 6.41.

Table 6.42: Risk management performance factors aggregated to component following rotation

Resilience component	Extracted eigenvalue	Extracted sum of squared loadings: variance %	Rotation sum of squared loadings: variance %	Resilience factors aggregated to component following rotation		
				Factor loading score	Factor Code	Factor Statement
Component 1	2.593	51.867	41.686	.869	Perfor4	Risks are linked to performance
				.867	Perfor5	Risk-informed metrics are used to track performance
				.720	Perfor3	Data turned into actionable information
Component 2	1.159	23.182	33.363	.897	Perfor1	Only what need to be known is identified
				.866	Perfor2	Only measures that matter most are identified

Managerial performance factors can be organised into two latent constructs.

The practice of risk management (Cluster 1): it comprises one component and represents 41.686 %of the total variance explained. This cluster is made up of three factors and they relate to the practice of risk managers.

Risk intelligence (Cluster 2): it comprises one component and represents 33.363 % of the total variance explained. This cluster is made up of two factors and they relate to risk intelligence and how much information managers know about risks.

As illustrated in figure 6.22, Amos successfully estimated the variances in the model of managerial performance factors. The regression weight for all parameters is significantly different from zero at the 0.001 level (two-tailed). See Appendix 6.10.

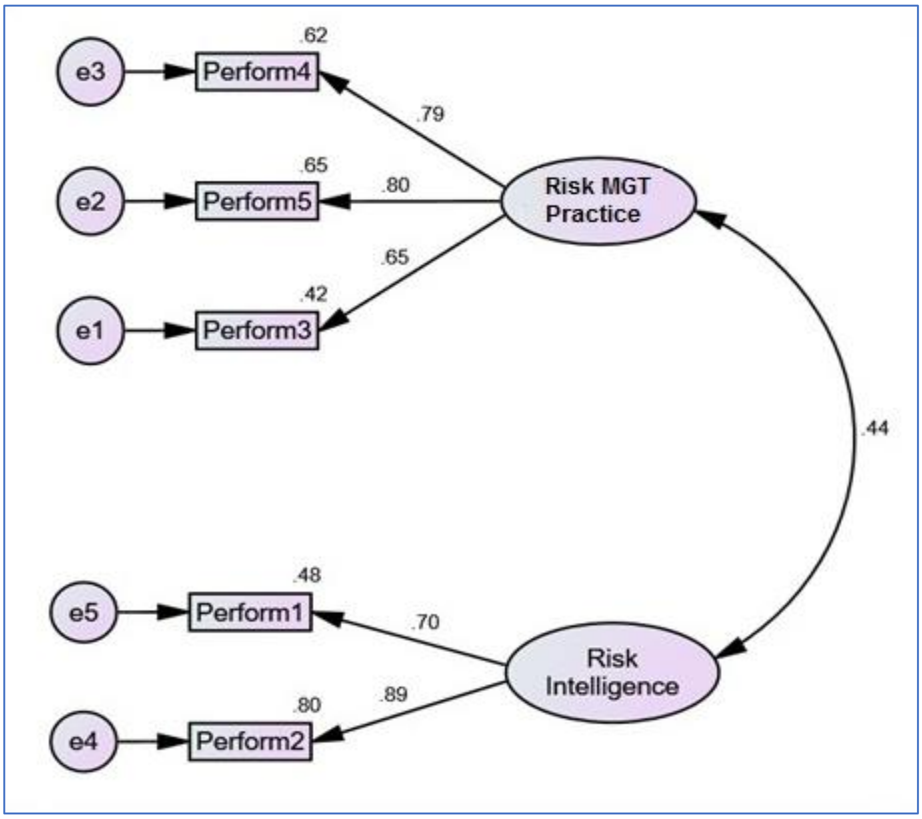


Figure 6.22: Confirmatory factor analysis of managerial performance factors

In regard to the overall model fit, the absolute fit indicator CMIN = 5.180, ($p > 0.05$) did not reach the 1% significant level, and the normal CMIN/DF = 1.295 is within the acceptable range. In addition, TLI = 0.985, CFI = 0.994, and RMSEA = 0.048 are acceptable standard values. Overall, the theoretical model is acceptable.

In conclusion, represent managerial performance factors can be divided into two variables: risk management practices and risk intelligence. These sub-variables are summarized in table 6.43.

Table 6.43: Latent variables of risk management performance factors

Variable	Factor Code	Factor Statement
Variable 1 Risk Management Practices	Perfor4	Risks are linked to performance
	Perfor5	Risk-informed metrics are used to track performance
	Perfor3	Data turned into actionable information
Variable 2 Risk Intelligence	Perfor1	Only what need to be known is identified
	Perfor2	Only measures that matter most are identified

6.6. Summary

This chapter presented the results of the factor analysis and data reduction processes. The first section described the processes used to generate the latent variables. The second section explained the results of confirmatory factor analysis. The most significant latent variables are extracted and treated as representative of the whole set of fragility indicators and resilience indicators. The chapter presented a manageable clusters of risk events inducing enterprise fragility and clusters of resilience attributes.

CHAPTER SEVEN

DETERMINING THE INFLUENCE OF ENTERPRISE FRAGILITY AND ENTEPRISE RESILIENCE ON RISK MANAGEMENT PERFORMANCE

7.1 Introduction

To test the proposed relationships among the fragility variables and performance and among the resilience variables and performance, SEM analysis was performed on data from 129 practitioners of ERM with the AMOS 23.0 statistical package software. The results of the CFA were presented in chapter six, while this chapter presents the results of SEM analyses. Circles represent latent variables and rectangles represent measure variables. There was no missing data. Maximum likelihood parameter estimation was chosen over other estimation methods because the data was normally distributed.

7.2. The influence of strategy fragility on the managerial performance

The hypothesized SEM is described graphically in Figure7.1. For the structural model, all four estimated paths coefficients are strongly statistically significant. For each coefficient, the null hypothesis that the true value of the coefficient is zero is rejected. Only one path (fragility of strategy → performance) the probability of a t value equal to or greater than the actual t value is rejected at the .005 level of significance; while in the other three paths the probability of a t value equal to or greater than the actual t value is rejected at the .001 level of significance. With respect to the SMCC, two measures (Business Models and Plans and Financial and Strategic Innovations) have an acceptable coefficient, being greater than 0.3, while the other two (Globalization and Politics and Performance) do not. All the measures exhibited CR above the acceptable 0.60 standard. See appendix 7.1.

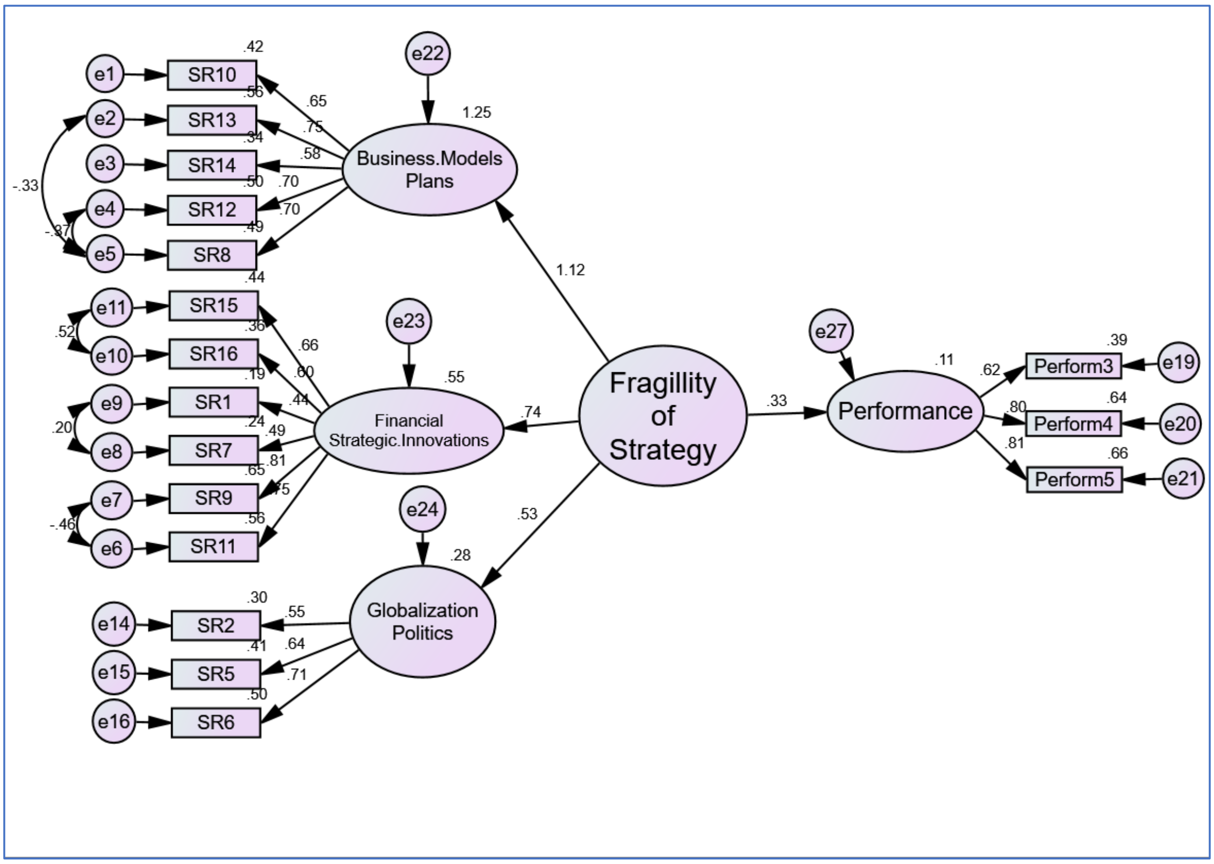


Figure 7.1: The dependence of risk management performance on the fragility of strategy

7.2.1 Analysis of the empirical results overall model fit

The absolute fit indicator CMIN = 194.969 ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.772 is within the acceptable range. In addition, TLI = 0.865, CFI = 0.891, and RMSEA = 0.078 are barely acceptable standard values. Overall, the theoretical model fit is acceptable.

7.2.2 Hypotheses testing results

A summary of the hypotheses is presented in table 7.1.

H01: The hypothesis is presented in the path (Fragility of Strategy → Financial and Strategic Innovations). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H02: The hypothesis is presented in the path (Fragility of Strategy → Risks of Globalization & Politics). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H03: The hypothesis is presented in the path (Fragility of Strategy → Business Models and Plans). It is supported as the path coefficient is statistically significant at 0.01 level and has the expected positive sign.

H04: The hypothesis is presented in the path (Fragility of Strategy → Risk management performance). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

Table 7.1: Hypotheses testing results - Fragility of Strategy → Risk management performance

Path	**Expected sign**	**P-value**	**t-value**	**Hypotheses**
Fragility of Strategy → Financial and Strategic Innovations	+	***	4.643	Supported
Fragility of Strategy → Globalization & Politics	+	***	3.802	Supported
Fragility of Strategy → Business Models and Plans	+	***	4.408	Supported
Fragility of Strategy → Performance	+	**	3.068	Supported

Note: Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.

7.3 The influence of governance fragility on the managerial performance

The hypothesized SEM is described graphically in Figure 7.2. For the structural model, all six estimated paths coefficients are strongly statistically significant. For each coefficient, the null hypothesis that the true value of the coefficient is zero is rejected. In all the four paths the probability of a t value equal to or greater than the actual t value is rejected at the .001 level of significance. With respect to the SMCC, all measures except performance have an acceptable coefficient, being greater than .3. All the measures exhibited CR above the acceptable 0.60 standard. See appendix 7.2.

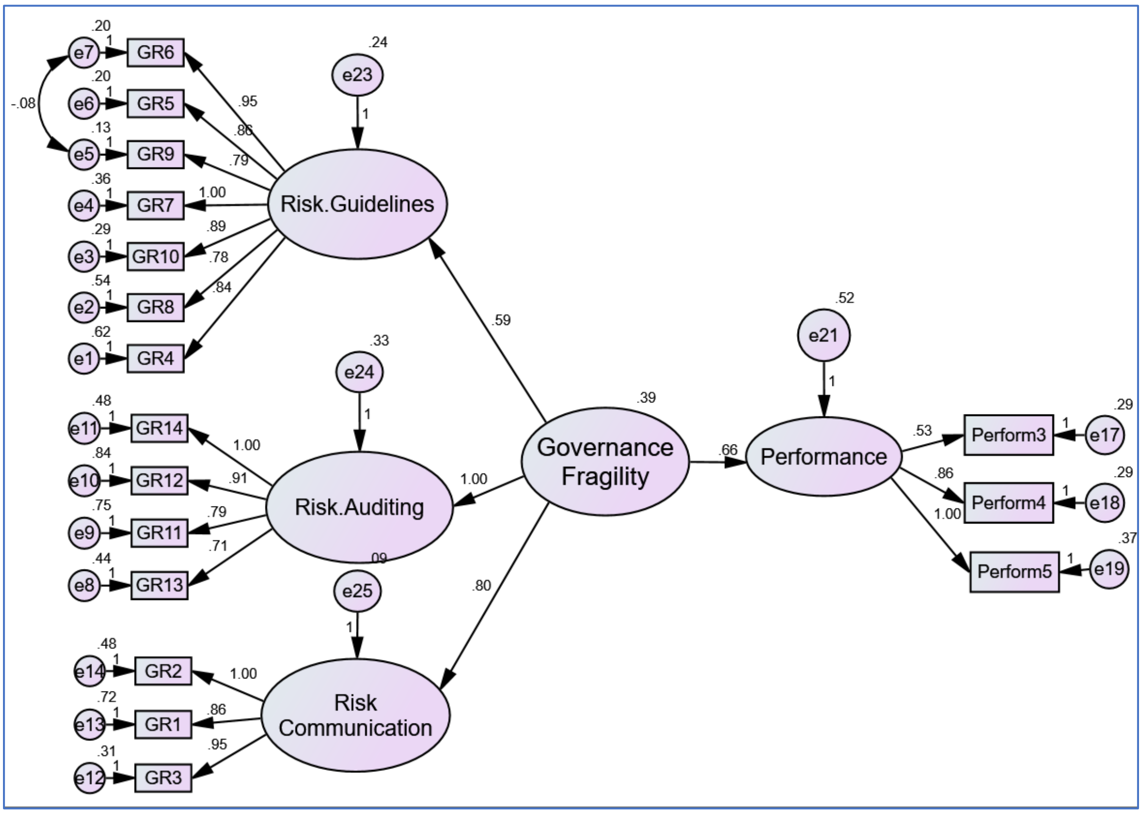


Figure 7.2: The dependence of risk management performance on the fragility of governance procedures

7.3.1 Analysis of the empirical results overall model fit

The absolute fit indicator CMIN = 158.067 ($p < 0.01$) reached the 1% significant level, and the normal CMIN/DF = 1.387 is within the acceptable range. In addition, TLI = 0.931, CFI = 0.942, and RMSEA = 0.055 are acceptable standard values. Overall, the theoretical model fit is acceptable.

7.3.2 Hypotheses testing results

A summary of the hypotheses is presented in table 7.2.

H05: The hypothesis is presented in the path (Governance Fragility → Risk Guidelines). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H06: The hypothesis is presented in the path (Governance Fragility → Risk Auditing). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H07: The hypothesis is presented in the path (Governance Fragility → Risk Communication). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H08: The hypothesis is presented in the path (Governance Fragility → Risk management performance). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

Table 7.2: Hypotheses testing results - Governance Fragility → Risk management performance

Path	Expected sign	P-value	t-value	Hypotheses
Governance Fragility → Risk Guidelines	+	***	4.091	Supported
Governance Fragility → Risk Auditing	+	***	3.863	Supported
Governance Fragility → Risk Communication	+	***	4.048	Supported
Governance Fragility → Performance	+	***	3.596	Supported

Note: Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.

7.4 The of the operations fragility on the managerial performance

The hypothesized SEM is described graphically in Figure 7.3. This model is a modified version of the confirmatory factor analysis in the sense that factors loading less than 0.40 have been deleted. All twelve estimated paths coefficients are strongly statistically significant. For each coefficient, the null hypothesis that the true value of the coefficient is zero is rejected. Only one path (fragility of operations → performance) the probability of a t value equal to or greater than the actual t value is rejected at the .01 level of significance; while in the other eleven paths the probability of a t value equal to or greater than the actual t value is rejected at the .001 level of significance. With respect to the SMCC, most measures have an acceptable coefficient, being greater than .3. All the measures exhibited CR above the acceptable 0.60 standard. See appendix 7.3.

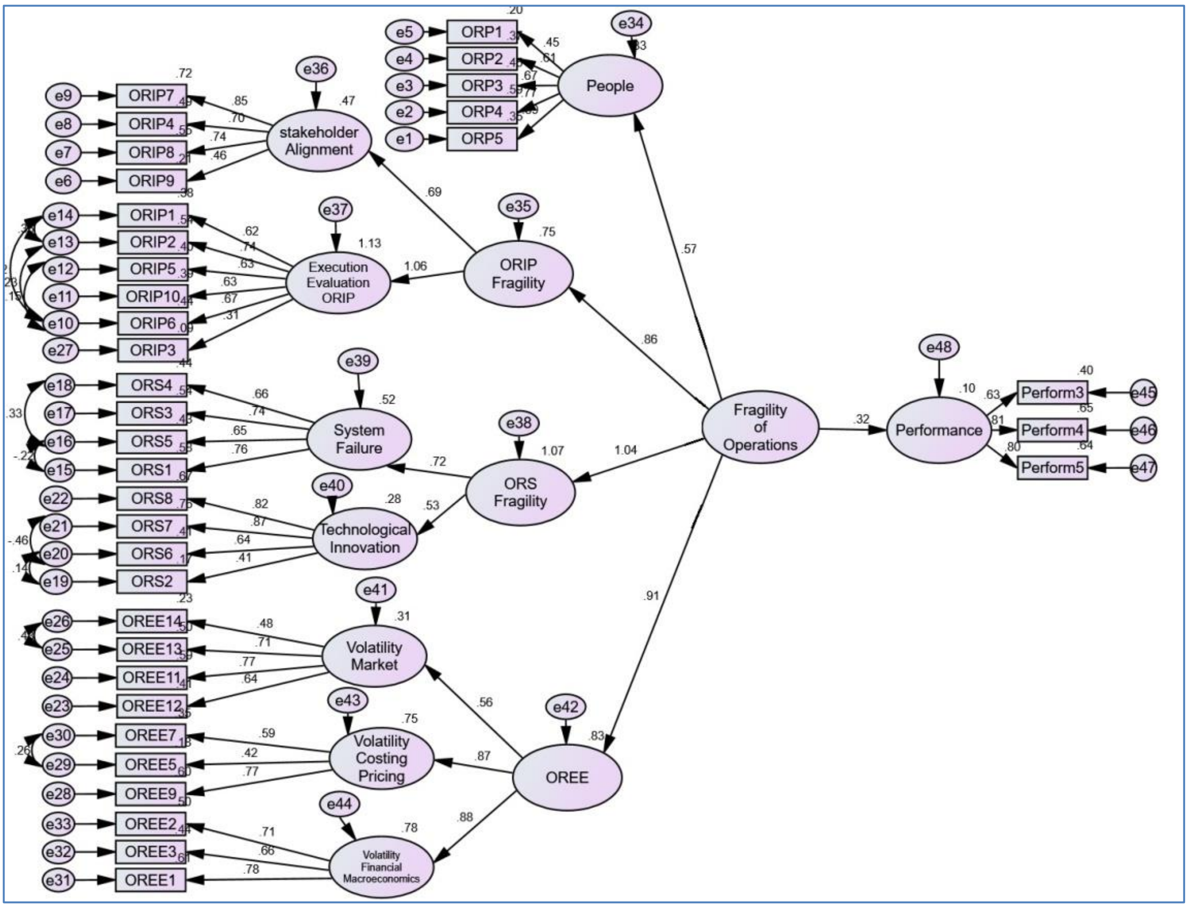


Figure 7.3: The dependence of performance on the fragility of operation processes

7.4.1 Analysis of the empirical results overall model fit

The absolute fit indicator CMIN = 1110.737 ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.942 is within the acceptable range. In addition, TLI = 0.711, CFI = 0.738, and RMSEA = 0.086 are below acceptable standard values. Overall, the theoretical model fit is not acceptable.

7.4.2 Hypotheses testing results

A summary of the hypotheses is presented in table 7.3.

H09: The hypothesis is presented in the path (Fragility of operations → fragility of human resources). It is supported as the path coefficient is statistically significant at 0.01 level and has the expected positive sign.

H10: The hypothesis is presented in the path (Fragility of operations → Fragility of operational Systems). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H11: The hypothesis is presented in the path (Fragility of operational Systems → system failure). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H12: The hypothesis is presented in the path (Fragility of operational Systems → technological innovative capabilities). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H13: The hypothesis is presented in the path (Fragility of operations → Fragility of internal operational processes). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H14: The hypothesis is presented in the path (Fragility of internal operational processes → Alignment with stakeholders). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H15: The hypothesis is presented in the path (Fragility of internal operational processes → Execution and evaluation of internal operational processes). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H16: The hypothesis is presented in the path (Fragility of operations → Fragility to external events. It is supported as the path coefficient is statistically significant at 0.01 level and has the expected positive sign.

H17: The hypothesis is presented in the path (Fragility to external events → Volatility of financial macroeconomic conditions). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H18: The hypothesis is presented in the path (Fragility to external events → Volatility of costing and pricing). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H19: The hypothesis is presented in the path (Fragility to external events → Volatility of market conditions). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H20: The hypothesis is presented in the path (Fragility of operations → Risk management performance). It is supported as the path coefficient is statistically significant at 0.01 level and has the expected positive sign.

Table 7.3: Hypotheses testing results - Fragility of operations → Risk management performance

Path	Expected sign	P-value	t-value	Hypotheses
Operational Fragility → Human Resources Fragility	+	**	2.711	Supported
Operational Fragility → OS Fragility	+	***	3.830	Supported
OS Fragility → Systems failure	+	***	4.125	Supported
OS Fragility → Technological innovative capabilities	+	***	3.240	Supported
Operational Fragility → OIP Fragility	+	***	4.069	Supported
OIP Fragility → Alignment with stakeholders	+	***	3.883	Supported
OIP Fragility → Execution and Evaluation OIP	+	***	5.137	Supported
Operational Fragility → Fragility to External Events	+	***	4.056	Supported
Fragility to External Events → Volatility of market conditions	+	***	4.139	Supported
Fragility to External Events → Volatility of financial macro-economic condition	+	***	6.334	Supported
Fragility to External Events → Volatility of costing and pricing	+	***	3.249	Supported
Operational Fragility → Performance	+	*	2.501	Supported

Note: Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.

7.5 The influence of business unit fragility on the managerial performance

The hypothesized SEM is described graphically in Figure 7.4. For the structural model, all three estimated paths coefficients are strongly statistically significant. For each coefficient, the null hypothesis that the true value of the coefficient is zero is rejected. Only one path (resilience → performance) the probability of a t value equal to or greater than the actual t value is rejected at the .005 level of significance; while in the other five paths the probability of a t value equal to or greater than the actual t value is rejected at the .001 level of significance. With respect to the SMCC, all measures except performance have an acceptable coefficient, being greater than 0.3. All the measures exhibited CR above the acceptable 0.60 standard. See appendix 7.4.

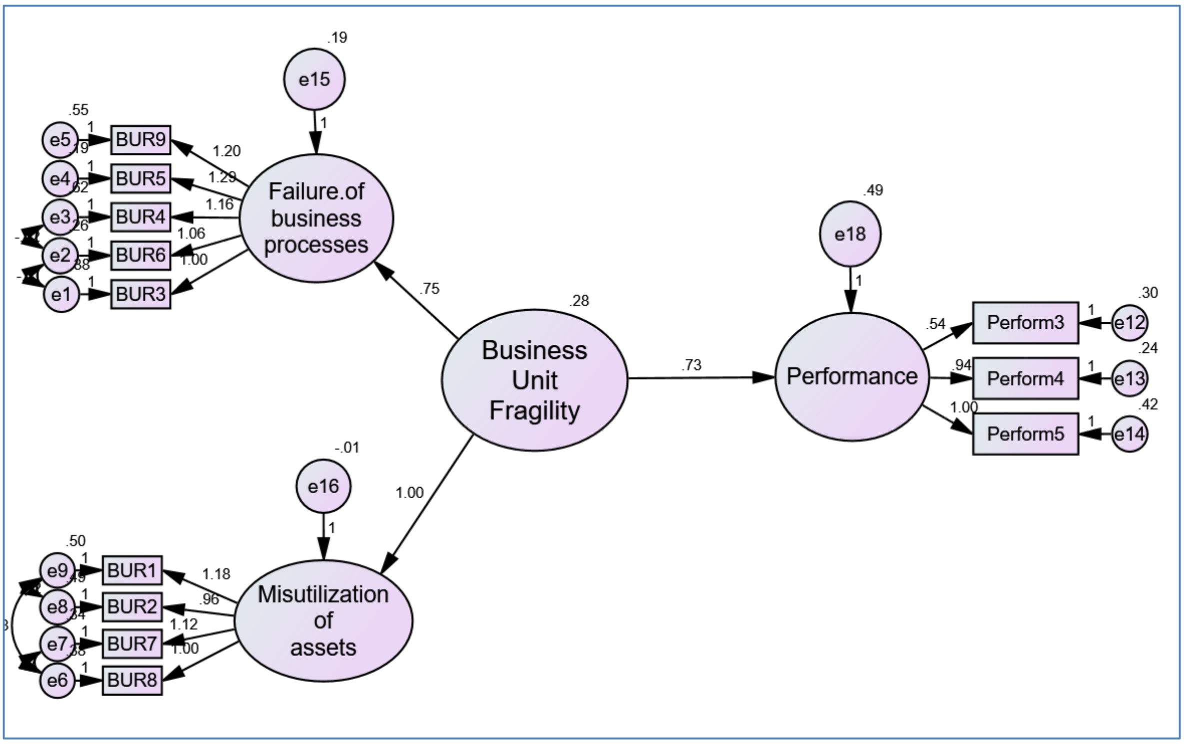


Figure 7.4: The dependence of performance on the fragility of business unit processes

7.5.1 Analysis of the empirical results overall model fit

The absolute fit indicator CMIN = 80.905 ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.759 is within the acceptable range. In addition, TLI = 0.914, CFI = 0.940, and RMSEA = 0.077 are acceptable standard values. Overall, the theoretical model fit is acceptable.

7.5.2 Hypotheses testing results

A summary of the hypotheses is presented in table 7.4.

H21: The hypothesis is presented in the path (Fragility of business unit → Failure of business processes). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H22: The hypothesis is presented in the path (Fragility of business unit → Mis-utilization of assets). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H23: The hypothesis is presented in the path (Fragility of business unit → Risk management performance). It is supported as the path coefficient is statistically significant at 0.005 level and has the expected positive sign.

Table 7.4: Hypotheses testing results - Fragility of business unit → Risk management performance

Path	Expected sign	P-value	t-value	Hypotheses
Fragility of business unit → Failure of business processes	+	***	3.217	Supported
Fragility of business unit → Mis-utilization of assets	+	***	3.233	Supported
Fragility of business unit → Performance	+	**	3.037	Supported

Note: Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.

7.6 The influence of the projects fragility on the managerial performance

The hypothesized SEM is described graphically in Figure 7.5. For the structural model, all five estimated paths coefficients are strongly statistically significant. For each coefficient, the null hypothesis that the true value of the coefficient is zero is rejected. In all five paths, the probability of a t value equal to or greater than the actual t value is rejected at the .001 level of significance. With respect to the SMCC, almost all measures have an acceptable coefficient, being greater than .3. All the measures exhibited CR above the acceptable 0.60 standard. See appendix 7.5.

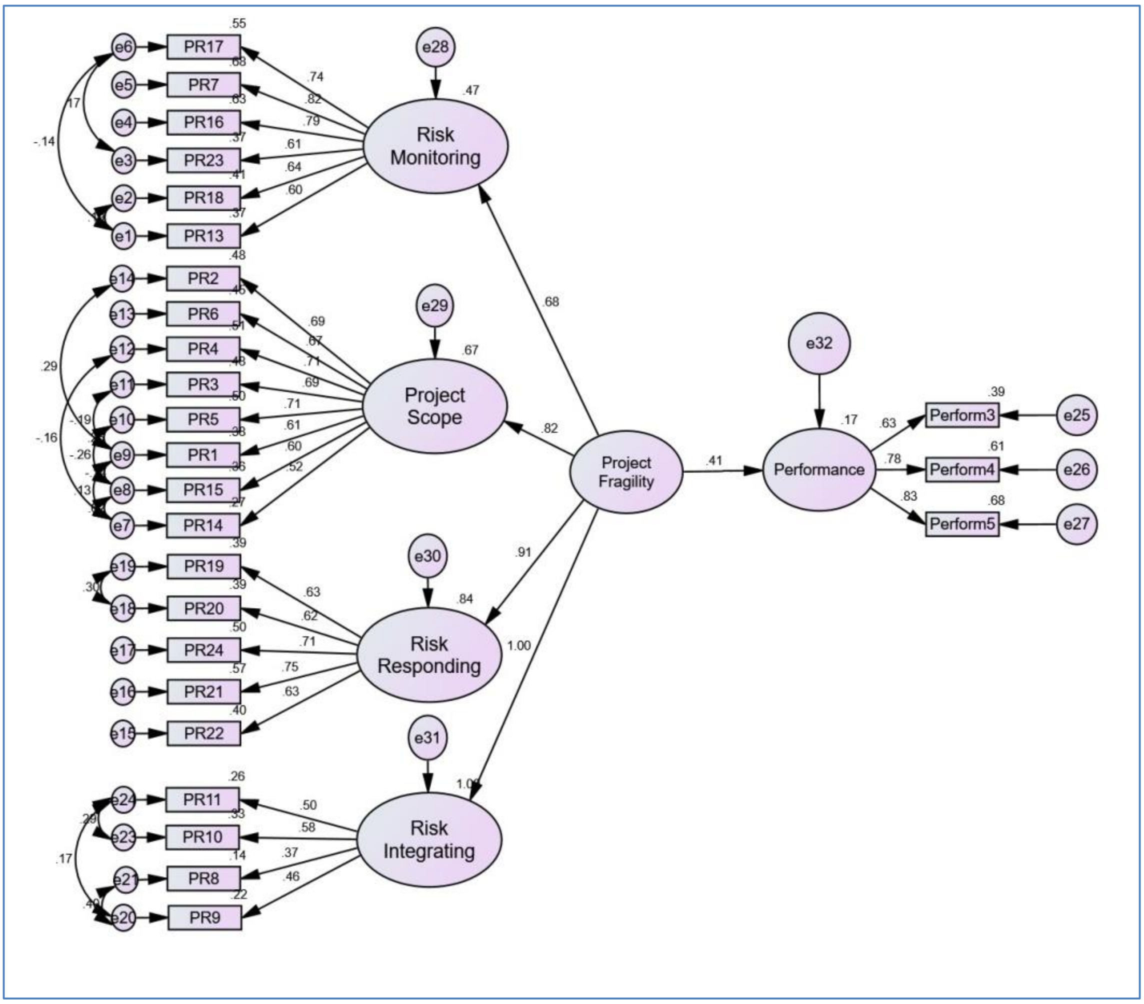


Figure 7.5: The dependence of performance on the fragility of project processes

7.6.1 Analysis of the empirical results overall model fit

The absolute fit indicator CMIN = 525.874 ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 2.070 is within the acceptable range. In addition, TLI = 0.782, CFI = 0.813, and RMSEA = 0.092 are below acceptable standard values. Overall, the theoretical model fit is not acceptable.

7.6.2 Hypotheses testing results

A summary of the hypotheses is presented in table 7.5.

H24: The hypothesis is presented in the path (Project fragility →Risk monitoring). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H25: The hypothesis is presented in the path (Project fragility → Project scope). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H26: The hypothesis is presented in the path (Project fragility →Risk responding). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H27: The hypothesis is presented in the path (Project fragility →Risk integrating). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H28: The hypothesis is presented in the path (Project fragility → Risk management performance). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

Table 7.5: Hypotheses testing results - Project fragility → Risk management performance

Path	Expected sign	P-value	t-value	Hypotheses
Project fragility →Risk monitoring	+	***	4.651	Supported
Project fragility → Project scope	+	***	4.738	Supported
Project fragility → Risk responding	+	***	4.997	Supported
Project fragility → Risk Integrating	+	***	4.480	Supported
Project fragility → Performance	+	***	3.248	Supported

Note: Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.

7.7 The influence of the enterprise resilience on managerial performance

The hypothesized SEM is described graphically in Figure7.6. For the structural model, all six estimated paths coefficients are strongly statistically significant. For each coefficient, the null hypothesis that the true value of the coefficient is zero is rejected. Only one path (resilience → performance) the probability of a t value equal to or greater than the actual t value is rejected at the .005 level of significance; while in the other five paths the probability of a t-value equal to or greater than the actual t value is rejected at the .001 level of significance. With respect to the SMCC, all measures have an acceptable coefficient, being greater than .3. All the measures exhibited CR above the acceptable 0.60 standard. See appendix 7.6.

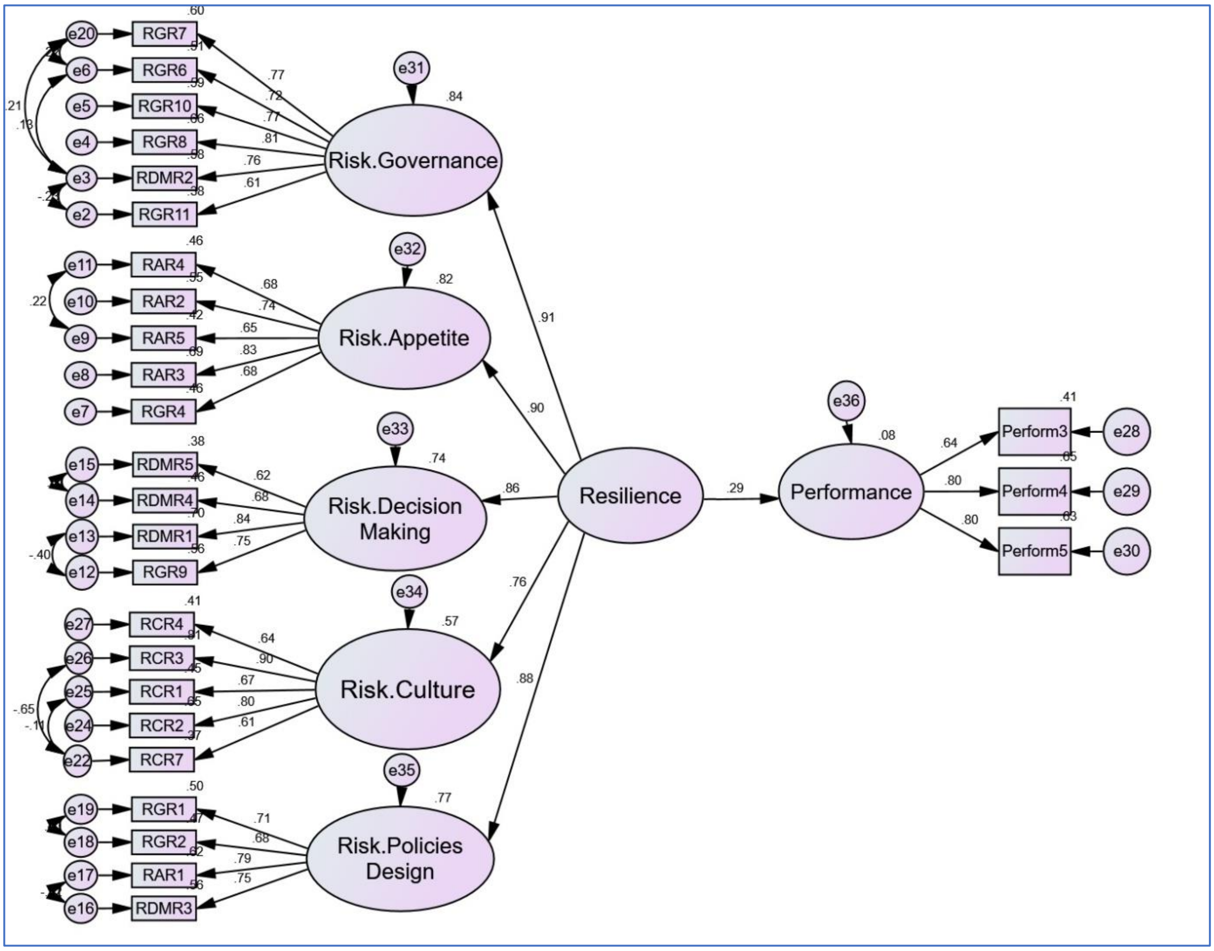


Figure 7.6: The dependence of managerial performance on enterprise resilience

7.7.1 Analysis of the empirical results overall model fit

The absolute fit indicator CMIN = 478.176 ($p < 0.001$) reached the 1% significant level, and the normal CMIN/DF = 1.558 is within the acceptable range. In addition, TLI = 0.896, CFI = 0.909, and RMSEA = 0.066 are acceptable standard values. Overall, the theoretical model fit is acceptable.

7.7.2 Hypotheses testing results

A summary of the hypotheses is presented in table 7.6.

H29: The hypothesis is presented in the path (Resilience → Risk Appetite). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H30: The hypothesis is presented in the path (Resilience → Risk Governance). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H31: The hypothesis is presented in the path (Resilience → Risk Appetite). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H32: The hypothesis is presented in the path (Resilience → Risk Decision Making). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H33: The hypothesis is presented in the path (Resilience → Risk Culture). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

H34: The hypothesis is presented in the path (Resilience → Risk Policies Design). It is supported as the path coefficient is statistically significant at 0.005 level and has the expected positive sign.

H35: The hypothesis is presented in the path (Resilience → Risk management performance). It is supported as the path coefficient is statistically significant at 0.001 level and has the expected positive sign.

Table 7.6: Hypotheses testing results - Resilience → Risk management performance

Path	Expected sign	P-value	t-value	Hypotheses
Resilience → Risk Governance	+	***	8.341	Supported
Resilience → Risk Appetite	+	***	6.716	Supported
Resilience → Risk Decision Making	+	***	6.908	Supported
Resilience → Risk Culture	+	***	7.621	Supported
Resilience → Risk Policies and Design	+	**	6.575	Supported
Resilience → Performance	+	***	2.739	Supported

Note: Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.

7.8. Summary

This chapter presented six structural equation models that can be summarizes as follows: the dependence of risk management performance on the fragility of the strategy, the dependence on the risk management performance on the fragility of the governance, the dependence of the risk management performance on the fragility of operations, the dependence of the risk management performance on the fragility of the business unit, the dependence of risk management performance on the fragility of the project, and the dependence of the risk management performance on the enterprise resilience. Four models were statistically acceptable. Overall, the risk management performance is influenced by the enterprise fragility and the enterprise resilience.

CHAPTER EIGHT

ENTERPRISE FRAGILITY ASSESSMENT TOOL

8.1. Introduction

This chapter is mainly aimed to develop an assessment tool that presents the most significant drivers that contribute to the enterprise fragility. The first section of this chapter reviews the existing assessment models. The second section provides an explanation of the techniques used to extract the fragility drivers at the strategy, governance, operations, business unit and project levels. The final section presents the results obtained from validating the tool in three different enterprises: a bank, an engineering enterprise, and a hotel.

8.2. Developing enterprise fragility assessment tool

The assessment tool of enterprise fragility has been developed and integrated based on critical literature review, extracting fragility drivers, refining them and comparing the methodology of the existing tools. The refinement and data reduction was shown in Chapter 6. The fragility indicators have been identified and highlighted in each component then grouped into clusters based on their relation to each other. This assessment tool is based on a scoring system for the indicators, weighting them based on the confirmatory factor analysis, computing the scoring, plotting the result, testing the tools, and finally implications and discussion.

8.2.1. Indicators selection

The reduction of data and the selection of the fragility indicators and the identified clusters in each organizational level have been described in details in chapter 6. First of all, lists of fragility drivers are extracted for each one of the following organizational levels: strategy, governance, operations, business unit and project. Then examine the most contributing fragility drivers by sending questionnaire to risk management practitioners to rate the level of contribution of each risk factor to the enterprise fragility. After that, data ranking factor analysis and data reduction technique were used to extract the fragility components then components are grouped into clusters based on their relation to each other. The most effective indicators for the fragility of strategy are 15 fragility indictors distributed into three clusters (business models and plans, financial and strategic innovations, globalization and politics); 14 indicators for the fragility of governance distributed into three clusters (risk guidelines, risk auditing and risk communication); 32 indicators for the fragility of operations distributed into eight clusters (alignment with stakeholders, execution and evaluation of internal operational processes, failure of IT systems, technological innovative capabilities, people related operational risks, volatility of financial macro-economic conditions, volatility of market conditions and volatility of costing and pricing); 9 indictors for the fragility of business units distributed into two clusters (failure of business units and mis-utilization of assets); and 23 indictors for the fragility of projects distributed into four clusters (risk monitoring, project scope, risk responding and risk integrating).

8.2.2. Weighting the fragility drivers

The weighting system used to estimate the contribution of each of the fragility indicator is based on its impact or importance within each group. In order to aggregate component scores into one composite index, the implicit weights introduced during scaling and multivariate techniques are employed. As a result of principal component analysis, components are weighted with the proportion of variance in the original set of variables explained by the first principal component of that particular component. After weights have been assigned to each component index and the component scores weighted accordingly, these scores are aggregated into a composite score, so that index scores are averages of the corresponding variable and component scores (Singh 2009).

The weight of each indicator is calculated based on the result of the questionnaire survey and a scientific approach of statistical confirmatory factor analysis. The following Table 8.1 shows the overall weight for each indicator.

Table 8.1: Weighting the fragility drivers

Value Drivers (criteria)	Cluster (sub-criteria)	Code	Indicator	Indicator Weight
Fragility of Strategy	Business Models and Plans	SR10	Lack of feasible strategic support and action plans	0.64
		SR13	Unawareness of legislation implications	0.75
		SR14	Misapplication of business models	0.57
		SR12	Unawareness of new technology	0.72
		SR8	Overoptimistic or vague projections	0.70
	Financial and Strategic innovations	SR15	Financial uncertainty	0.66
		SR16	Emerging aggregated risks	0.60
		SR1	Unable to catch up with new innovations	0.44

		SR7	Inaccurate strategic positioning	0.49
		SR9	Inefficient strategy execution	0.80
		SR11	Unawareness of market economic changes	0.75
	Globalization and Politics risks	SR3	Influence of Globalization	0.31
		SR2	Disruption in the political changes	0.55
		SR5	Inadequate assessment of organization capabilities	0.64
		SR6	Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies	0.70
Fragility of Governance	Risk Guidelines	GR4	Inadequate mechanism for internal control	0.54
		GR5	Unavailability of timely risk information	0.76
		GR6	Inadequate risk assessment methods	0.79
		GR7	Inadequate risk reporting systems	0.72
		GR8	Inadequate risk pricing policies	0.55
		GR9	Inadequate risk management reviewing processes	0.80
		GR10	Inadequate risk accountability system	0.71
	Risk Auditing	GR11	Inadequate external auditing processes	0.61
		GR12	Noncompliance with environmental guidelines	0.66
		GR13	Noncompliance with fiscal and monetary guidelines	0.66
		GR14	Noncompliance with mandatory reporting obligations	0.77
	Risk Communication	GR1	Fluctuation of policies and regulations	0.51
		GR2	Violation of policies and regulations	0.63
		GR3	Inadequate communication of objectives and targets	0.71
The fragility of operations	Alignment with stakeholders	ORIP4	Misalignment with stakeholders	0.76
		ORIP7	Noncompliance with client requirements	1.00
		ORIP8	Ineffective communication with clients	0.83
		ORIP9	Unexpected change of customer requirements	0.64
	Execution and evaluation of internal operational processes	ORIP1	Inadequate execution of operational plans	0.69
		ORIP2	Inadequate evaluation of operational plans	0.77
		ORIP5	Contractual risks	0.94
		ORIP6	Inaccurate pricing of services/products	1.00
		ORIP10	Unmaintained customer relationships	0.92
		ORIP3	Excessive implementation requirements	0.50
	People-related operational risks	ORP1	Fraud or corruption	0.39
		ORP2	Unhappy work environment	0.63
		ORP3	Turnover of key talents	0.70

		ORP4	Inadequate talent configuration and management	0.76
		ORP5	Inappropriate behaviour (discrimination/harassment)	0.85
	Failure of IT systems	ORS1	Hardware/software failure	0.51
		ORS3	Cyber-attack/ Malware or virus/ ISP disruption	0.68
		ORS4	Data Disclosure	078
		ORS5	Data integrity failure	0.51
	Technological innovative capabilities	ORS6	Data Reporting failure	0.54
		ORS7	Inadequate technological innovative ability	0.78
		ORS8	Inadequate technical transformation ability	0.94
	Volatility of non-financial market conditions	OREE11	Infrastructure uncertainty	0.79
		OREE13	Service/products obsolescence	0.72
		OREE14	The scarcity of complementary services/products	0.49
		OREE12	Misalignment of interests with suppliers	0.61
	Volatility of financial macroeconomic conditions	OREE1	Market volatility	0.66
		OREE2	Credit availability	0.38
		OREE3	Interest rate level	0.72
	Volatility of costing and pricing	OREE7	Inflation escalation	0.67
		OREE5	Equity price fluctuation	0.50
		OREE9	Cost volatility	0.72
Fragility of Business Units	Failure of business processes	BUR3	Inadequate business unit supervision ability	0.69
		BUR4	Red-tape risk	0.65
		BUR5	Failure to follow processes	0.86
		BUR6	Failure to integrate with business processes	0.77
		BUR9	Improper planning for daily operations	0.69
	Mis-utilization of assets	BUR1	Fixed assets mis-utilization	0.58
		BUR2	Inadequate fund management ability	0.56
		BUR7	Lack of cost control	0.77
		BUR8	Lack of resources	0.67
Fragility of Projects	Risk Monitoring	PR17	Lack of existing risk documentations on all processes and standards	0.75
		PR18	Lack of using performance indices to measure project risk	0.83
		PR7	Inadequate project monitoring	0.77
		PR16	Lack of risk quantification	0.61
		PR23	Lack of information on risk triggers	0.64
		PR13	Lack of integrating cost and time management	0.61
	Project Scope	PR1	Inadequate project requirements	0.61

		PR2	Inadequate scope of control	0.69
		PR3	Inadequate project management ability	0.70
		PR4	Inadequate project risk culture building	0.71
		PR5	Inadequate change management ability	0.71
		PR6	Inadequate procurement management ability	0.67
		PR14	Lack of project risk identification	0.51
		PR15	Lack of identifying risk triggers	0.60
	Risk Responding	PR19	Lack of immediate response to risks as they arise	0.64
		PR20	Lack of processes for tracking project risks	0.62
		PR21	Lack of contingency risk plans	0.77
		PR22	Lack of using risk assessment and project performance status in decision making	0.62
		PR24	Lack of risk information collection	0.69
	Risk Integrating	PR10	Disengagement of executives with the project	0.47
		PR11	Lack of re-alignment between strategic and project objectives	0.40
		PR8	User's rejection of the product/service	0.50
		PR9	Failure to record/archive lessons learned	0.53

8.2.3. Scales and scores

The enterprise fragility assessment tool will be tested by asking risk practitioners in enterprises to evaluate what extent the fragility indicators contribute to the enterprise fragility. The scales are form 0 (do not contribute) to 5 (highly contribute) and 3 (moderately contribute). The sub-criteria gained score is computed by the below equation:

$$criteria\ gained\ score = \ Average\ mean\ of\ (subcriteria1\ gained\ score, subcriteria2\ gained\ score, subcriteriaN\ gained\ score)$$

$$subcriteria\ gained\ score\ = \ \left(\frac{\sum(indicator\ weight\ X\ indicator\ score)}{(\sum indicator\ weight) X\ 5}\right) X\ 100\%$$

An example of calculating the score is presented in table 8.2.

The criteria gained score is the average of the sub-criteria gained scores.

Moreover, the participants were asked to rate how often managerial performance in each fragile area is linked to risk management on a scale of ten (0 = very rarely, 5 = occasionally, 10 = very frequently. Their response will be based on their observation regarding turning data into actionable information and performance is tracked by risk-informed metrics.

The scores will be visualized by the spider diagram in order to make the results easy to read and interpret. The results obtained from the participants will be graphically represented between 0 and 100. The higher the score, the farther the plot from the centre of the spider web.

Table 8.2: example of calculating the score of the fragility drivers

Value Drivers (criteria)	Cluster (sub-criteria)	Indicator	Indicator Weight	Indicator rate	Indicator gained score	sub-criteria gained score %	criteria gained score %
Fragility of Strategy	Business Models and Plans	Lack of feasible strategic support and action plans	0.64	1	0.64	31	46.84
		Unawareness of legislation implications	0.75	0	0		
		Misapplication of business models	0.57	2	1.14		
		Unawareness of new technology	0.72	1	0.72		
		Overoptimistic or vague projections	0.7	4	2.8		
	Financial and Strategic innovations	Financial uncertainty	0.66	4	2.64	67	
		Emerging aggregated risks	0.6	5	3		
		Unable to catch up with new innovations	0.44	0	0		
		Inaccurate strategic positioning	0.49	3	1.47		
		Inefficient strategy execution	0.8	3	2.4		
		Unawareness of market economic changes	0.75	4	3		
	Globalization and Politics risks	Influence of Globalization	0.31	3	0.93	42.27	
		Disruption in the political changes	0.55	2	1.1		
		Inadequate assessment of organization capabilities	0.64	3	1.92		
		Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies	0.7	1	0.7		

$$subcriteria\ gained\ score \text{ of 'business models and plans'} = \left(\frac{(0.64*1)+(0.75*0)+(0.57*2)+(0.72*1)+(0.7*4)}{(0.64+0.75+0.57+0.72+0.7)*5}\right)X\ 100\% = 31\%$$

$$subcriteria\ gained\ score \text{ of 'financial and strategic innovations'} = \left(\frac{(0.66*4)+(0.6*5)+(0.44*0)+(0.49*3)+(0.8*3)+(0.75*4)}{(0.66+0.6+0.44+0.49+0.8+0.75)*5}\right)X\ 100\%$$

$$= 67\%$$

$$subcriteria\ gained\ score \text{ of 'globalization \& politics risks'} = \left(\frac{(0.31*3)+(0.55*2)+(0.64*3)+(0.7*1)}{(0.31+0.55+0.64+0.7)*5}\right)X\ 100\%$$

$$= 42.27\%$$

$$criteria\ gained\ score \text{ of 'fragility of strategy'} = \left(\frac{31+67+42.27}{3}\right)X\ 100\%$$

$$= 46.84\ \%$$

8.3. Enterprise Fragility Index

To assess the fragility of the different criteria in the enterprise, a five level index is developed based on IBM resilience maturity assessment framework (2009). The levels of resilience range from ‘Basic’, the lowest resilience level, to ‘Resilient’, the highest resilience level, and ‘Managed’, ‘Predictive’ and ‘Adaptive’ are in between. ‘Basic’ indicates that the criterion is distinguished with very high fragility and scarce linkage between risk and performance. ‘Managed’ indicates that the criterion is distinguished with high fragility and low linkage between risk and performance. ‘Predictive’ indicates that the criterion is distinguished with moderate fragility and moderate linkage between risk and performance. ‘Adaptive’ indicates that the criterion is distinguished with low fragility and high linkage between risk and performance. ‘Resilient’ indicates that the criterion is distinguished with scarce fragility and very high linkage between risk and performance. The resilience maturity levels are illustrated in table 8.3.

Table 8.3: Enterprise Fragility Index

Fragility Index	Description	
Resilient	*Anti-fragility*	*Very High risk/performance linkage*
Adaptive	*Low fragility*	*High risk/performance linkage*
Predictive	*Moderate fragility*	*Moderate risk/performance linkage*
Managed	*High fragility*	*Low risk/performance linkage*
Basic	*Very High fragility*	*scarce risk/performance linkage*

8.4. Testing the assessment tool

On purpose of validating the tool by pilot studies, the tool was tested on three enterprises from Dubai financial market. The enterprises were asked to rate the contribution of fragility indicators to the fragility of their organisation along the five areas: strategy, governance, operations, business units and projects. Moreover, the participants were asked to rate how often managerial performance in each fragile area is linked to risk management on a scale of ten (0 = very rarely, 5 = occasionally, 10 = very frequently).

8.4.1. Enterprise One: ABC Bank

ABC is one of the largest banks in the UAE. It was established more than four decades ago. It offers merchant banking, corporate banking and treasury products to the corporate market. Compared to the other banks in the region, ABC has extensive financial and physical infrastructure. As can be seen in Figure 8.4, the results of the assessment show that ABC Bank has robust operations and robust projects, while the strategy, governance and business units are slightly fragile. See appendix 8.1. Except operations, managerial performance is frequently linked to risk management in all other enterprise levels: strategy, governance, business units, and projects.

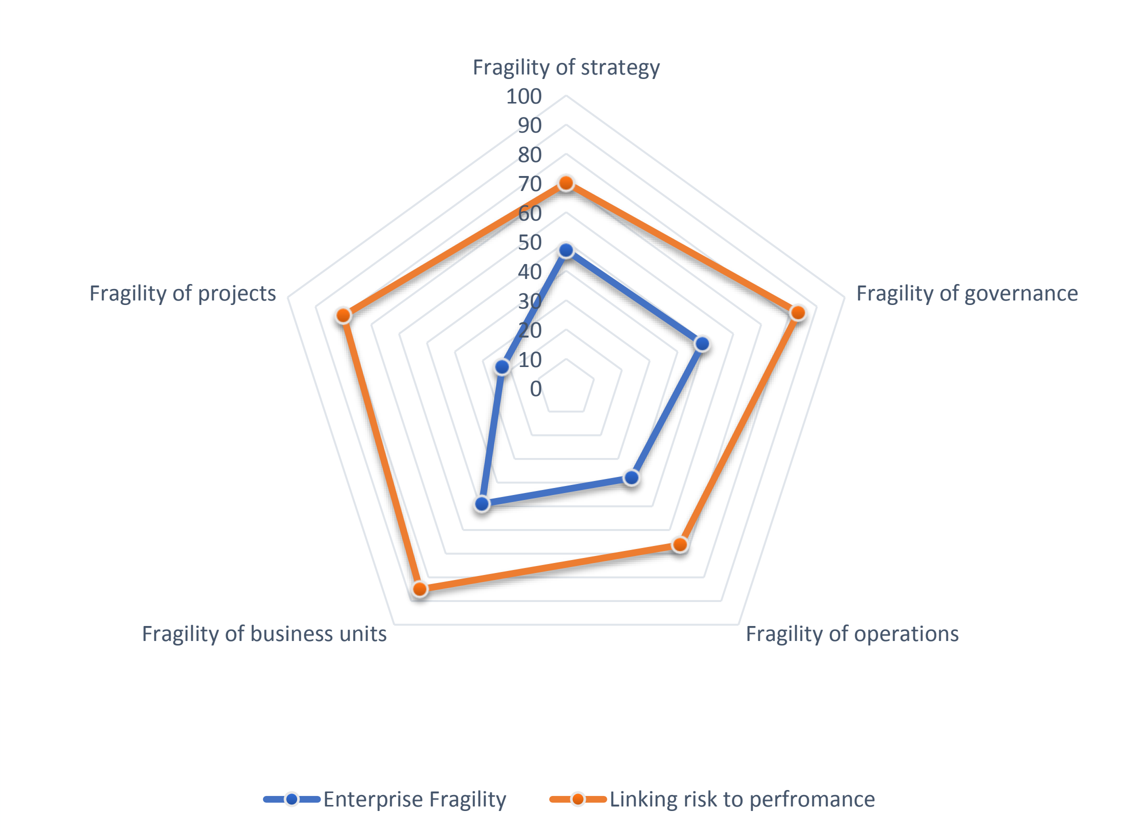


Figure 8.4: The Fragility of ABC's Enterprise

In regards of the strategy criteria in ABC Bank, although the risks of globalization of politics and other risks coming from business models and plans do not highly contribute to the fragility of ABC's strategy, yet the criterion financial and strategic innovations is a source of fragility. Managerial performance is highly linked to risk management in two criteria: business models and plans, and financial and strategic innovations. In regards of the governance criteria in ABC Bank, the three criteria relatively show the fragility of ABC's governance. Managerial performance is ultimately linked to risk management in two criteria: risk guidelines and risk auditing, unlike the case of risk communication. In regards of the operations criteria in ABC Bank, fragility is prominent in three criteria: volatility of financial macroeconomic conditions, failure of IT systems and volatility of costing and pricing, while the other criteria show relatively low fragility. Managerial performance is highly linked to risk management in all criteria except for two: alignment with stakeholders and technological innovative capabilities. In regards of the business unit criteria in ABC Bank, the business unit processes are likely a source of fragility unlike mis-utilization of assets. Managerial performance is very frequently linked to risk management in both criteria. In regards of the project criteria in ABC Bank, the four criteria are unlikely a source of fragility. Managerial performance is very frequently linked to risk management in almost all criteria. See figure 8.5.

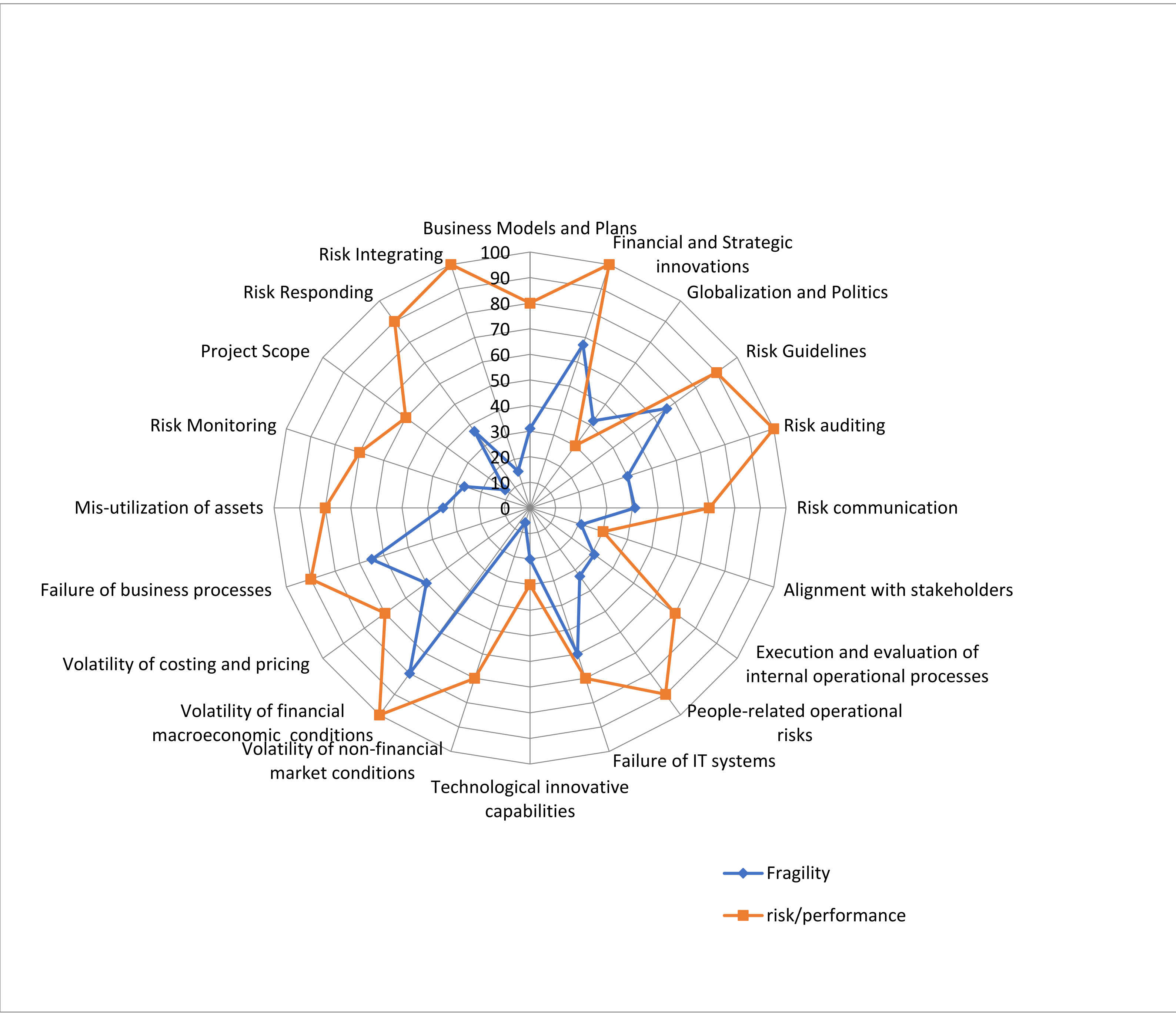


Figure 8.5: The Fragility of ABC's Enterprise - detailed

8.4.2. Enterprise Two: DEF Engineering

DEF is one of the largest engineering enterprises in Dubai. It was established more than twenty years ago. DEF is involved in mega infrastructure projects in Dubai. As can be seen in Figure 8.6, the results of the assessment show that DEF Engineering has robust governance and robust projects, while the strategy, governance and business units are slightly fragile. See appendix 8.2. Managerial performance is very frequently linked to risk management in all enterprise levels: strategy, governance, operations, business units and projects.

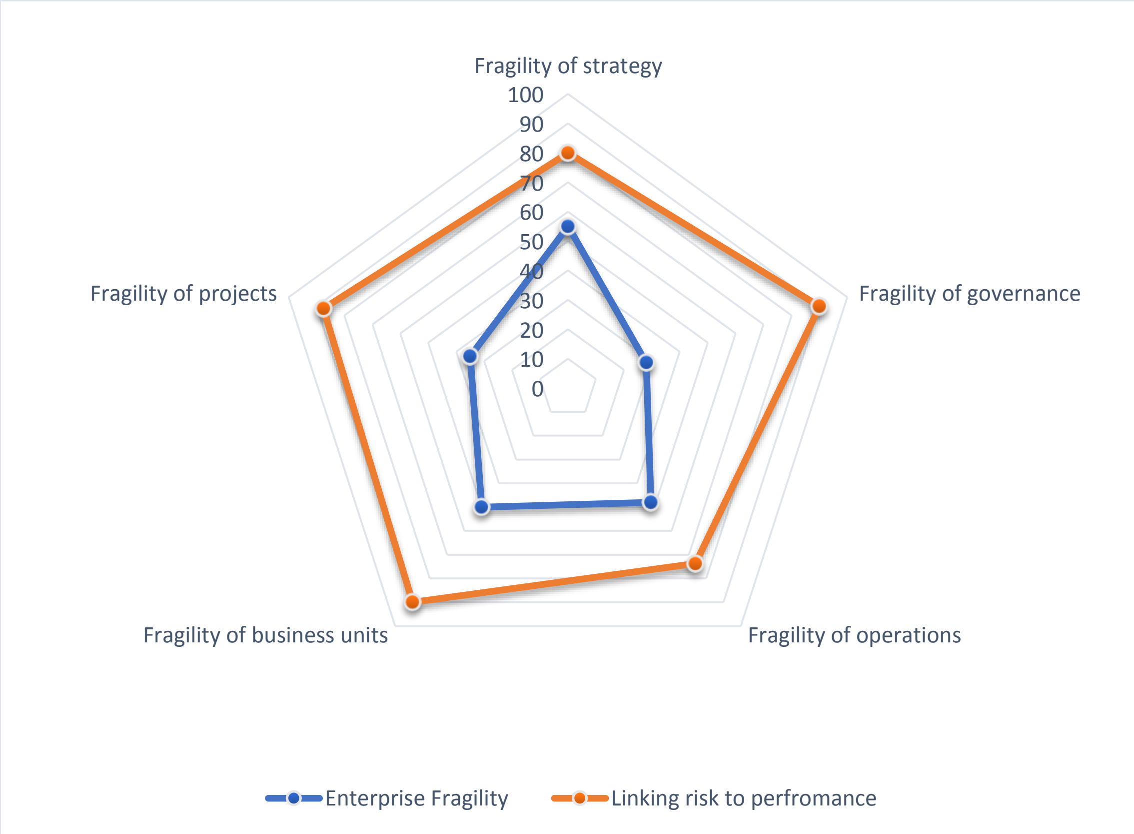


Figure 8.6: The Fragility of the DEF's Enterprise

In regards of the strategy criteria in DEF Engineering, although the risks of globalization and politics do not highly contribute to the fragility of DEF's strategy, yet risks coming from the criterion financial and strategic innovations and the criterion business models and plans are a source of fragility. Managerial performance is very frequently linked to risk management in two criteria: business models and plans, and financial and strategic innovations. In regards of the governance criteria in ABC Bank, risk communication criterion highly contributes to the fragility of DEF's unlike the other two criteria. Managerial performance is very frequently linked to risk management in all three criteria. In regards of the operations criteria in DEC Engineering, the fragility is prominent in three criteria: technological innovative capabilities, alignment with stakeholders and volatility of costing and pricing, while the other criteria show relatively low fragility. Managerial performance is very frequently linked to risk management in all criteria except for two: failure of IT systems, execution and evaluation of internal operational processes and volatility of non-financial macroeconomic conditions. In regards of the business unit criteria in DEF Engineering, mis-utilization of assets is very likely a source of fragility to the business unit while the business unit processes are less fragile. Managerial performance is very frequently linked to risk management in both criteria. In regards of the project criteria in DEF Engineering, other than risk integrating criterion, the other three criteria are unlikely a source of fragility. Managerial performance is very frequently linked to risk management in almost all criteria. See figure 8.7.

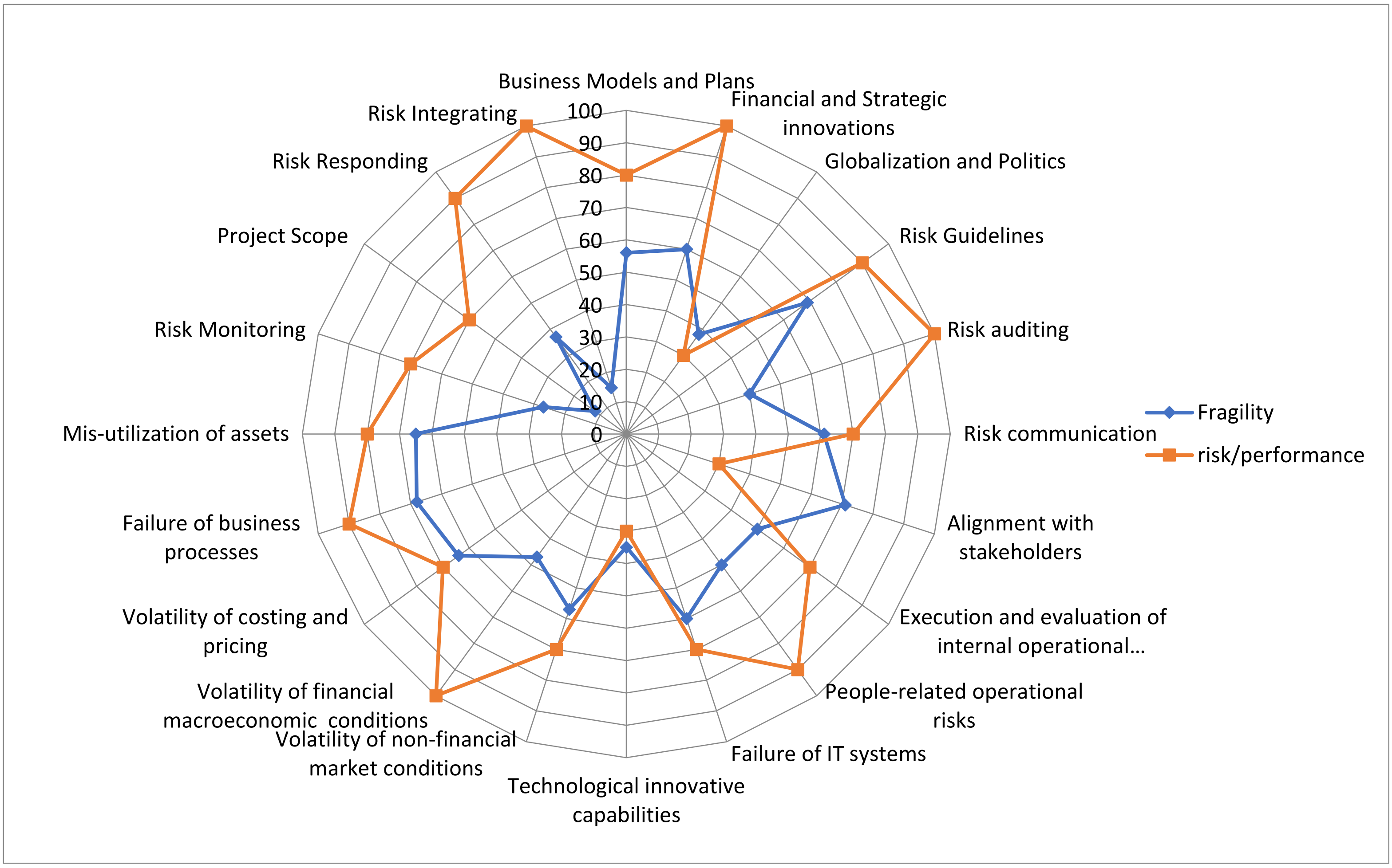


Figure 8.7: The Fragility of the DEF's Enterprise - detailed

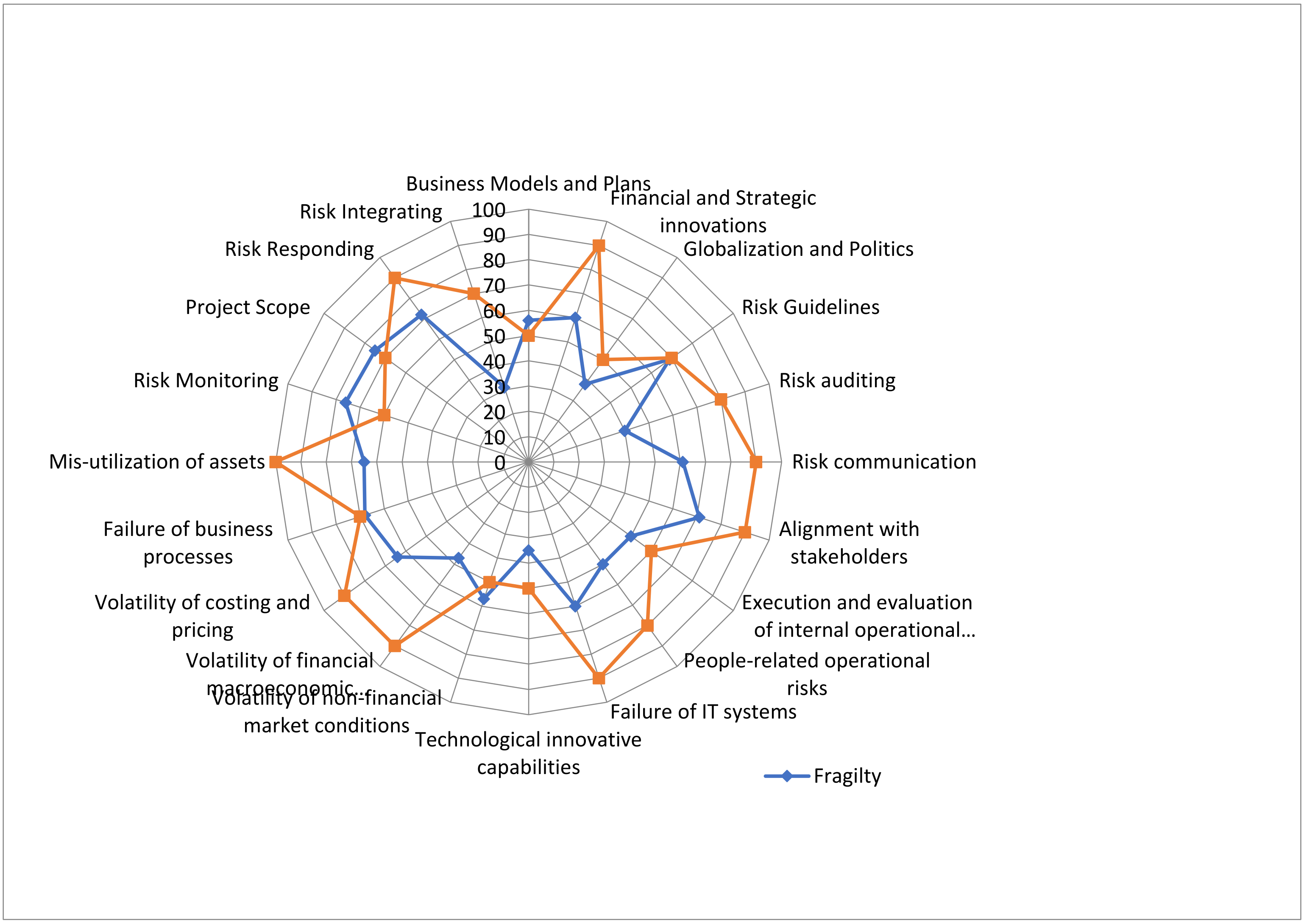
8.4.3. 8.4.3 Enterprise Three: XYZ Hotel

XYZ Hotel was built in the 1970s with a capacity of around 300 rooms and suits. It is one of the market leading five star hotels in Dubai and it is managed by a globally well-known brand name. As can be seen in Figure 8.8, the results of the assessment show that XYZ Hotel has fragile strategy, governance, operations, projects and business units. See appendix 8.3. Managerial performance is very frequently linked to risk management in all enterprise levels: strategy, governance, operations, business units and projects.

Figure 8.8: The Fragility of the XYZ's enterprise

In regards of the strategy fragility in XYZ Hotel, risks which reside in business models and plans financial, and strategic innovations have higher contribution to fragility if compared with the risks coming from globalization and politics. Managerial performance is very frequently linked to risk management in two criteria: globalization and politics, and financial and strategic innovations; while the third criterion shows less frequent link between risk management and managerial performance. In regards of the governance fragility in XYZ Hotel, all three criteria highly contribute to the fragility of XYZ's governance. Managerial performance is very frequently linked to risk management in all three criteria. In regards of the operations fragility in XYZ Hotel, the fragility is prominent in four criteria: failure of IT systems, alignment with stakeholders, people related operational risks and volatility of costing and pricing, while the other criteria show relatively lower fragility. Managerial performance is very frequently linked to risk management in all criteria except for two: volatility of non-financial macroeconomic conditions and execution and evaluation of internal operational processes. In regards of the business unit fragility in XYZ Hotel, both criteria – mis-utilization of assets and business unit processes – are very likely a source of fragility to the business unit. Mangerial performance is very frequently linked to risk management in both criteria. In regards of the project fragility in XYZ Hotel, other than risk integrating criterion, the other three criteria are likely a source of fragility. Managerial performance is very frequently linked to risk management in almost all criteria but less frequently linked risk monitoring. See figure 8.9.

Figure 8.9: The Fragility of the XYZ's enterprise –detailed



8.5. Summary

In this chapter, a description was provided to the development of an assessment tool that helps enterprise to assess areas of fragility. The techniques applied to extract the fragility indicators were explained and justified. Three existing assessment models were briefly reviewed. The chapter was concluded by the results of validating the tools in three different enterprises: a bank, an engineering enterprise, and a hotel.

CHAPTER NINE

DISCUSSIONS

9.1. Introduction

This research has aimed to achieve different objectives, mainly identifying the risk events that induce enterprise fragility and the strategies/tactics that enhance enterprise resilience. This chapter brings together the results from this research by discussing the outcome and results from this research to extract the latent constructs that induce fragility into the operation of the enterprise. The chapter also aims to discuss the development of a framework to enable enterprises to measure their fragility to risk events. The first section of chapter addresses the ranking of risk-events inducing fragility and the ranking of resilience attributes. The second section discusses the extraction of the latent fragility inducing events and latent resilience attributes. The third section discusses structural equation modelling of risk management performance with enterprise fragility on the first hand and with enterprise resilience on the other. The final section of this chapter addresses the development of an enterprise fragility tool and the rationale behind it in addition to the validation of the tool.

9.2. The concept of fragility to risk events

This section discusses the concepts of fragility to risk events with the findings from literature and the analysis of primary data. In chapters 2 and 3, the researcher demonstrated the importance of identifying those events that lead to enterprise fragility. The research found that these events were classified either on theme/source of risk or the processes on which the risks will have an influence on. Thus, the researcher recognized the importance of systematically extracting and clustering those fragility-inducing events. Along these lines, the researcher identified the following research gaps:

1. Lack of link between risk events and enterprise fragility
2. Systematic extraction and classification of fragility inducing events
3. The modelling and explanation of the influence of the fragility events on enterprise performance
4. The selection of a suitable medium for assessing the fragility of enterprises to risk events

The findings from the theoretical background studies allowed the derivation of the following fragility inducing risk events. Risk management practitioners were surveyed and the results were analyzed with the objective of ascertaining their views concerning the significance of fragility inducing risk events.

9.2.1. The fragility of strategy

This research found that 9 risk events have high influence on strategy fragility. The research found that negative media and news affecting the reputation induce strategy fragility and this is supported by the findings of Nicolo (2015), Bhat & Agrawal (2015) and Stepashkin & Khusnoiarov (2015). Another finding of the research is that overoptimistic or vague projections induce strategy fragility and this finding is similar to the findings of Patil, Grantham, and Steele (2012). The research also found that the inefficient strategy execution induces the strategy fragility and this echoes the findings of Heesen (2012), Malik & Holt (2013) and Sabourin (2015). Moreover the findings of the research show that lack of feasible strategic support and action plans, inaccurate strategic positioning, unawareness of market economic changes and inability to catch up with new innovations are risk events inducing the strategy fragility. These findings are similar to the findings of Smyth (2016), Theriou and Aggelidis (2014), Zhang et al. (2013), and Castellacci (2015) and Lochhead (2017), respectively. It is agreed that financial uncertainty induce the strategy fragility (Nishimura 2015; Stockhammer & Grafl 2010; Asongu, Koomson & Tchamyou 2017), and this research supported this finding. Furthermore, the research found that emerging aggregated risks is a significant event that induces the fragility of enterprise strategies and this is supported by the findings of Linkov et al. (2014) and Embrechts, Wang and Wang (2015).

9.2.2. The fragility of enterprise governance

This research found that 6 risk events have high influence on governance fragility. Governance fragility is induced by inadequate risk pricing policies and this finding is supported by Xiang et al. (2012), Boussabaine (2013), Hussein (2014) and Gatzert & Kolb (2014), who indicated such events will induce fragility. There is an agreement that inadequate mechanism for internal control induces the fragility of governance (Kanellou and Spathis 2011; Eulerich, Velte and Theis 2015; Hrbackova 2016) and this research reached the same finding. The research also found that noncompliance with mandatory reporting obligations induces governance fragility and this finding is like the findings of Jeffrey and Perkins (2014), Ong (2015) and Rosman & Abdul Rahman (2015). Moreover, this research found that the unavailability of timely risk information induce the fragility of governance and this is in agreement with Mark & Krishna (2008) and Ballou, Heitger & Stoel (2011), who found that such a risk event highly contributes to governance fragility. In relation to inadequate communication of objectives and targets, the findings of this research are similar to Crowe & Meade (2007) and Wilkes, Yip & Simmons (2011), who indicated that this event induces fragility of governance. Furthermore, the research found that inadequate risk management reviewing processes are events that induce the fragility of governance and this finding is supported by Hrbackova (2016).

9.2.3. The fragility of enterprise operations

This research found that 4 risk events have high influence on operations fragility. There is an agreement that fraud and corruption induce the fragility of governance (Le et al. 2014; McNeil, Frey & Embrechts 2015.) and this research reached the same finding. The research also found that inadequate execution of operational plans induces operations fragility and this finding is similar to the findings of Havlícek & Schlossberger (2013), Dulisse (2015) and Schubert et al. (2015). Moreover, literature shows agreement that market volatility is a significant factor that induces operations fragility (Claessens et al. 2010; Chabi-Yo 2012; McNeil, Frey & Embrechts 2015), and this research reached the same finding. In relation to data disclosure, the finding of this research is similar to Oktay et al (2014) and Sen & Borle (2015) who supported the view that this event induces operations fragility.

9.2.4. The fragility of enterprise business units

This research found that 3 risk events have high influence on the fragility of enterprise business unit. The research found that lack of cost control induces business unit fragility and this finding is similar to the findings of Pajares and Lopez-Paredes (2011) and Caniëls, Gelderman and Vermeulen (2015). There is an agreement that lack of resources induces the fragility of business units (Christopher & Peck 2004; Manuj & Mentzer 2008; Aureli & Salvatori 2013) and this research reached the same finding. Moreover, this research found that the failure of business units to integrate with other business processes induces their fragility and this is supported by the findings of Ferri-Reed (2014) and Khosravi (2016).

9.2.5. The fragility of enterprise projects

This research found that 8 risk events have high influence on the fragility of enterprise projects. The research found that inadequate change management ability induces the fragility of projects and this finding is similar to the findings of Crawford & Nahmias (2010) and Ahmad & Shamsudin (2013). The research also found that when project managers lack immediate response to risks as they arise, the fragility of projects is induced. This finding is supported by Moeller (2007) and Lloyd-walker, Mills & Walker (2014). There is an agreement that lack of using risk assessment and project performance status in decision making induce the fragility of projects (Pillai, Joshi & Rao 2002; Hartono et al. 2014; Sundararajan & Tseng 2017) and this research reached the same finding. Moreover, this research found that inadequate project management ability induces the fragility of projects and this is supported by the findings of Fan and Yuan (2016) who indicated the same. Furthermore, the research found that lack of project risk identification induces the fragility of projects and this is similar to the findings of Moeller (2007) and Thamhain (2013). In addition, the research found that if risk triggers are not well identified in projects, these projects are more fragile. This finding agrees with Boussabaine (2013) and Cozmei & Şerban (2014), who indicated the same. The research also found that the lack of contingency risk plans is a significant event that induces the fragility of projects and this finding echoes the finding of Kerzner (2017) who indicated the same.

9.3. The concepts of resilience to risk events

This section discusses the concepts of resilience to risk events (or fragility identified in the previous section) with the findings from literature and the analysis of primary data. The findings from the theoretical background studies allowed the derivation of the following anti-fragility attributes: risk culture, risk governance, risk appetite and risk-informed decision making. Risk management practitioners were surveyed and the results were analyzed with the objective of ascertaining their views concerning the significance of anti-fragility attributes and their impact on the enterprise resilience.

9.3.1. Resilience attributes to risk culture

The systematic literature review facilitated the extraction of 7 risk culture attributes that induce the resilience of enterprise. These attributes were mainly related to embedding risk norms in different business processes and using business-specific scenarios to understand risks and opportunities. There was agreement in literature on the potential influence of the extracted events on the fragility of projects. See table 3.9. This research found that 2 risk culture attributes have high influence on enterprise resilience: existence of thorough risk culture across entire organization and using business-specific scenarios and early indicators to understand risks and opportunities. These findings were supported by the findings of Atkinson (2013), Bezzina et al. (2014), and Fritz-Morgenthal, Hellmuth and Packham (2016).

9.3.2. Resilience attributes to risk governance

This research found that 6 risk governance attributes have high influence on enterprise resilience, namely: existence of key intelligence risks indicators, existence of a risk management organizational structure with clear reporting lines, existence of regular review of formal organizational risk report, existence of well-defined risk ownership and accountability, provision of clarity and responsibility on taking actionable measures, and existence of risk models as support tool for business decisions. These findings were supported by the findings of van Asselt & Renn (2011), Klinke & Renn (2012), and Welsh (2014).

9.3.3. Resilience attributes to risk appetite

This research found that 3 risk appetite attributes have high influence on enterprise resilience, namely: existence of policies on risk ownership, existence of policies on risk appetite (how much risk can be taken), and existence of guidelines on risk taking capacity (how much risk can be comfortably taken). These findings were supported by the findings of Polasky et al (2011), Evans (2012), Kinman (2012), Boussabaine (2013), Lundqvist (2014), and Farrell and Gallagher (2015), who agreed that risk appetite is an essential factor that induces enterprise antifragility and resilience.

9.3.4. Resilience attributes to risk-informed decision making

This research found that 3 risk-informed decision making attributes have high influence on enterprise resilience, namely: embedding business decisions, especially major strategic ones, on risk before deployment and designing and executing core business processes on a risk-informed basis. These findings were supported by the findings of van Asselt & Renn (2011), Klinke & Renn (2012), and Welsh (2014).

9.3.5. Correlation Findings

The findings from the correlation analysis are demonstrated in table 9.1.

Table 9.1: Correlation findings

Path	Correlation	Hypothesis
The fragility of strategy → risk management performance	(0.288, $p<0.01$)	H1 confirmed
The fragility of governance → risk management performance	(0.371, $p<0.001$)	H2 confirmed
The fragility of operations → risk management performance	(0.263, $p<0.01$)	H3 confirmed
The fragility of business units → risk management performance	(0.314, $p<0.001$)	H4 confirmed
The fragility of projects → risk management performance.	(0.301, $p<0.01$)	H5 confirmed
Resilience attributes to risk culture → risk management performance.	(0.310, $p<0.001$)	H6 confirmed
Resilience attributes to risk governance → risk management performance.	(0.329, $p<0.001$)	H7 confirmed
Resilience attributes to risk appetite → risk management performance.	(0.223, $p<0.01$)	H8 confirmed
Resilience attributes to risk-informed decision making→ risk management performance.	(0.349, $p<0.001$)	H9 confirmed

9.4. Extraction of the latent fragility inducing events and latent resilience attributes

This study used both factor analysis and confirmatory analysis to extract the most critical events that induce fragility and the most significant attributes of resilience. Several indices were used to measure the fitness of the models created by CFA. This research used the chi-square statistic, TLI, CFI, and RMSEA. Overall, the models are acceptable except for the operation system fragility model. A summary of the model fitness results is presented in table 9.2. The results of the model fitness tests are close to the results in other studies that followed the same methodology. For example, the results of confirmatory factor analysis conducted by Naidoo (2010) revealed the following fit indices: $\chi2=127.23$ ($p<0.05$), $\chi2/df=1.542$, GFI=0.86, AGFI =0.82, and RMSR= 0.073; in addition to, $\chi2=92.09$, ($p<0.05$), $\chi2/df=1.193$, GFI=0.92, AGFI=0.86, and RMSR=0.067, when he attempted to structure constructs of marketing orientation and firm performance to test the association between competitive advantage and firm's survival.

Table 9.2: The fitness indices of the models created by CFA

Model	CMIN	CMIN/DF	TLI	CFI	RMSEA
Cutoff point	p < 0.01	< 3	>0.9	>0.9	< 0.8
Strategy fragility	145.028 (p < 0.001)	1.790	0.875	0.903	0.079
Governance fragility	131.361 (p < 0.001)	1.799	0. 886	0.909	0.079
Internal operational processes fragility	52.736 (p < 0.01)	1.7	0.929	0.951	0.074
People-related operations fragility	1.069 (p > 0.05)	0.21	1.061	1.000	0.000
Operation systems fragility	86.247 (p < 0.001)	5.073	0.722	0.831	0.178
Operation fragility related to external events	42.007 (p < 0.001)	1.449	0.951	0.968	0.059
Business unit fragility	61.021 (p <0.001)	2.653	0.869	0.916	0. 114
Project fragility	461.185 (p < 0.001)	2.207	0.789	0.826	0.097
Enterprise resilience	377.221 (p < 0.001)	1.633	0.899	0.916	0.070
Risk management performance	5.180 (p > 0.05)	1.295	0.985	0.994	0.048

9.4.1. Extraction of the latent risk management performance

The results from the modelling showed that risk management practices and risk intelligence are indicators of risk management performance. The research excluded the factors related to risk intelligence as this indicator is not consistent among enterprises and it does not directly reflect the performance of the manger.

9.4.2. Extraction of the latent strategy fragility inducing events

The results from the modelling showed that business models and plans, financial and strategic innovations, and globalization and politics are strategy fragility indicators. The results of the research confirm earlier findings that emphasized inadequate business models and plans (Altunbas, Manganelli, & Marques-Ibanez 2011, Zott, Amit & Massa 2011), inefficient financial and strategic innovations (Koen et al. 2010; Naidoo 2010; Laperche, Lefebvre & Langlet 2011; Mosley, Maronick & Katz 2012; Ezzi & Jarboui 2016) and risks of political disruptions and globalization (Kleindorfer & Saad 2005; Pierson & Tormey 1999; Roe & Siegel 2011, Tang & Musa 2011; Akopova & Akopov 2012; Lopatina 2012; Campbell 2015) as events that induce the fragility of the enterprise strategy.

9.4.3. Extraction of the latent governance fragility inducing events

The results from the modelling also showed that risk guidelines, risk auditing and risk communication are governance fragility indicators. The results of the research confirm earlier findings that suggest that inadequate risk guidelines (Dequae 2009), inadequate risk auditing (Curtis & Turley 2007; Messier 2010) and inadequate risk communication (Beretta & Bozzolan 2004; Hopkin 2017; Radovic & Mercantini 2015) are events that induce the fragility of the enterprise governance.

9.4.4. Extraction of the latent operations fragility inducing events

The results from the modelling also showed that alignment with stakeholders and execution and evaluation of internal operational processes are indicators of the internal operational processes fragility. The results of the research confirm earlier findings suggesting that alignment with stakeholders (Garengo, Biazzo & Bititci 2005; Jahansoozi 2006; Asif et al. 2010) and inadequate execution and evaluation of internal operational processes (Havlícek & Schlossberger 2013; Dulisse 2015; Schubert et al. 2015) are events that induce the fragility of the enterprise internal operational processes.

The results from the modelling also showed that people-related risks are an indicator of the operations fragility. The results of the research confirm earlier findings that suggest that risk events caused by people are events that induce the fragility of the enterprise operations (Sewell & Gilbert 2015; Gatzert, Schmit & Kolb 2015; Amin 2016).

Moreover, the results from the modelling showed that failure of systems and technological innovative capabilities are indicators of the operation systems fragility. The results of the research confirm earlier findings which suggest that risk events caused the failure of systems (Spekman & Davis 2004; Zhu & Basar 2011; Linkov et al. 2013) and risk events caused by inadequate technological innovative capabilities (Hill & Rothaermel 2003; Sher & Yang 2005; Fan & Yuan 2016) are events that induce the fragility of the enterprise operation systems.

Furthermore, the results from the modelling showed that volatility of market conditions, volatility of costing and pricing, and volatility of financial macro-economic conditions are indicators of the fragility of operations. The results of the research confirm earlier findings that suggest that volatility of market conditions (Ingenbleek, Frambach & Verhallen 2013; Chari et al 2014; Ahmadi, Iravani & Mamani 2015) volatility of costing and pricing (Shukla, Naim, & Yaseen, 2009; Stonebraker, Goldhar & Nassos 2009; Zhang & Burke 2011; Bloch & Metcalfe 2017), and volatility of financial macro-economic conditions (Ben Omrane & Savaşer 2017; Kurov & Stan 2017) induce the fragility of the enterprise operations.

9.4.5. Extraction of the latent business unit fragility inducing events

The results from the modelling showed that failure of business processes and mis-utilization of assets are indicators of the business unit fragility. The results of the research confirm earlier findings suggesting that failure of business processes (Schultz, Bierstaker & O'Donnell 2010; Asfe et al. 2014; Hsu & Chen 2014; Cui et al. 2016; Khosravi 2016; Hrbackova 2016) and mis-utilization of assets (Hastings 2009; Laue et al 2014) are events that induce the fragility of business units.

9.4.6. Extraction of the latent project fragility inducing events

The results from the modeling showed that risk monitoring, project scope, risk responding and risk integrating are indicators of the project fragility. The results of the research confirm earlier findings suggesting that risk monitoring (Hillson 2002; Sanchez et al. 2009; Marcelino-Sádaba et al. 2014), project scope (Chen, Law & Yang 2009; Irimia-

Diéguez, Sanchez-Cazorla & Alfalla-Luque 2014; Shrivastava & Rathod 2017), risk responding (Zhang & Fan 2014; Lloyd-walker, Mills & Walker 2014) and risk integrating (Hoyt & Liebenberg 2011; Farrell & Gallagher 2015; Zhang 2016) are events that induce the fragility of projects.

9.4.7. Extraction of the latent resilience attributes

The results from the modeling showed that risk governance, risk appetite, risk culture, risk-informed decision making and risk policies design are indicators of the enterprise resilience. Risk policies design is an indicator that has been explored after data analysis. The results of the research confirm earlier findings suggesting that adequate risk governance (Klinke & Renn 2012; Welsh 2014), well-defined risk appetite (Evans 2012 Boussabaine 2013; Lundqvist 2014; Farrell & Gallagher2015), strong risk culture (Sheffi 2005; Levy, Lamarre & Twining 2010; Fritz-Morgenthal, Hellmuth & Packham 2016), risk-informed decision making (Sheffi & Rice 2005; Sheffi 2005; Theriou & Aggelidis 2014; Moran 2014), and adequate risk policies design (Folke 2006; Berkes & Ross 2013; Bristow & Healy 2014) are attributes of a resilient enterprise.

9.5. Modelling the association between fragility and risk management performance

To confirm the association between fragility constructs and risk management performance, this research used structural equations. The results of the standardized regression weights in the structural equations that this research modelled are close to the results in other studies that followed the same methodology. For example, the results of regression analysis conducted by Ezzi and Jabouri (2016) to analyse the impact of innovation strategy on the performance of the firm revealed the following regression weights of the independent variables: 0,286119; 0,17634; and 0,165134.

9.5.1. Modelling the association between the fragility of strategy and risk management performance

The association between the latent variables of the fragility of strategy and risk management performance shows that risk management performance is dependent on the fragility of the strategy. The standardized regression weights of each coefficient are shown in figure 9.7.

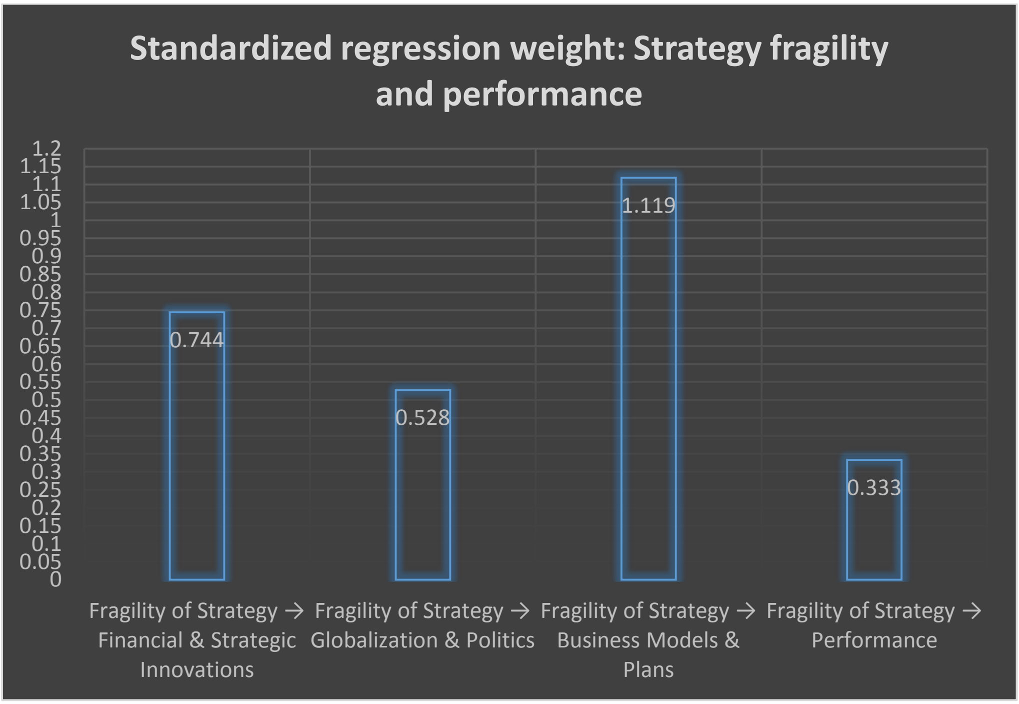


Figure 9.1: Standardized regression weights: fragility of strategy and risk management performance

9.5.2. Modelling the association between the fragility of governance and risk management performance

The association between the latent variables of the fragility of governance and risk management performance shows that risk management performance is dependent on the fragility of the governance. The standardized regression weights of each coefficient are shown in figure 9.8.

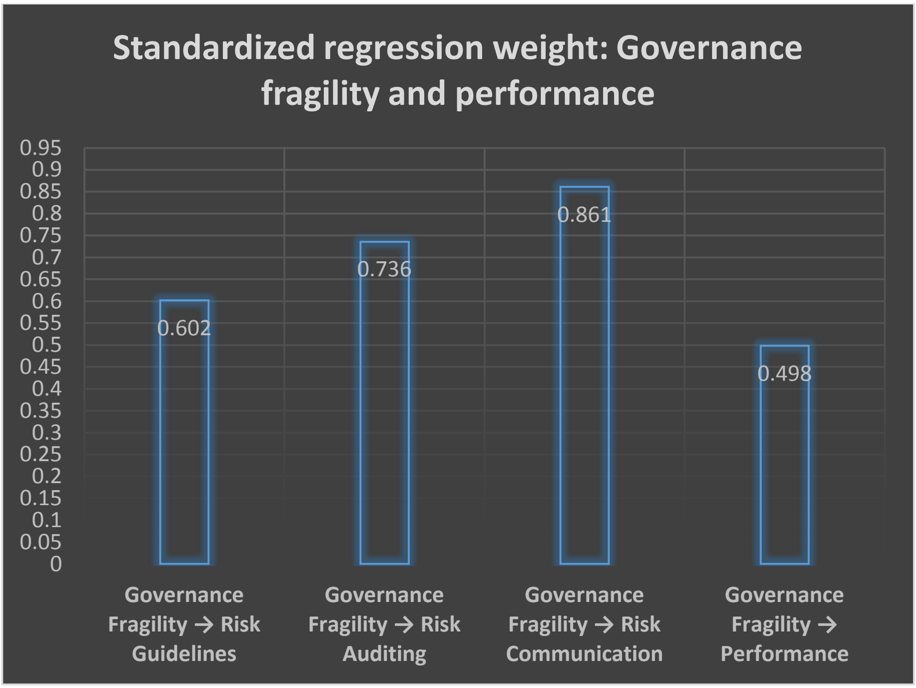


Figure 9.2: Standardized regression weights: fragility of governance and risk management performance

9.5.3. Modelling the association between the fragility of operations and risk management performance

The association between the latent variables of the fragility of operations and risk management performance shows that risk management performance is dependent on the fragility of the operations. The standardized regression weights of each coefficient are shown in figure 9.9.

Figure 9.3: Standardized regression weights: fragility of operations and risk management performance

9.5.4. Modelling the association between the fragility of business unit and risk management performance

The association between the latent variables of the fragility of business unit and risk management performance shows that risk management performance is dependent on the fragility of the business unit. The standardized regression weights of each coefficient are shown in figure 9.10.

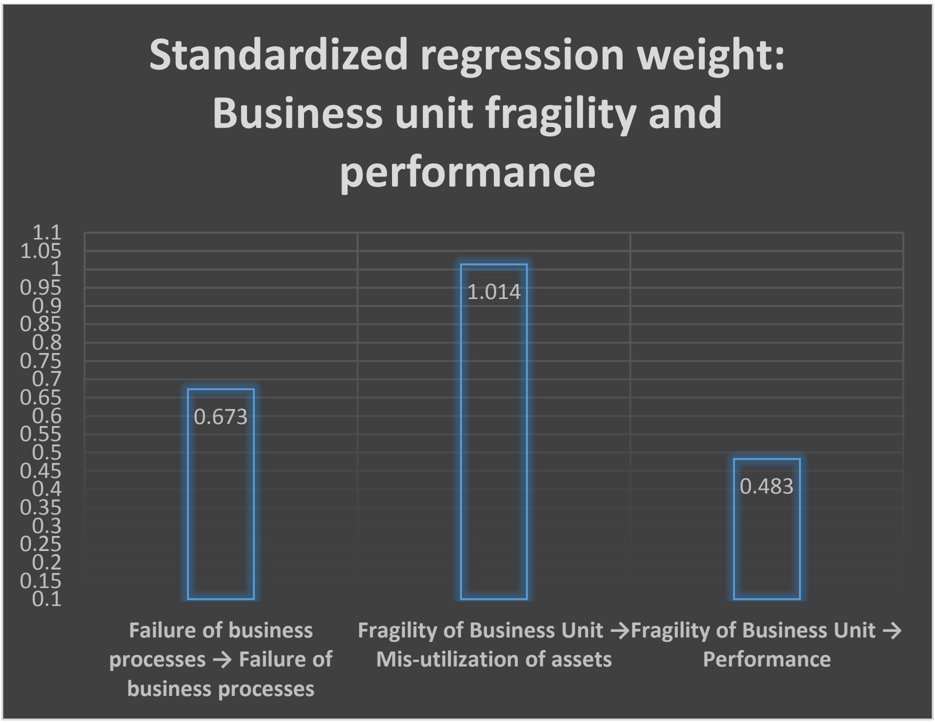


Figure 9.4: Standardized regression weights: fragility of business unit and risk management performance

9.5.5. Modelling the association between the fragility of project and risk management performance

The association between the latent variables of the fragility of project and risk management performance shows that risk management performance is dependent on the fragility of the project. The standardized regression weights of each coefficient are shown in figure 9.11.

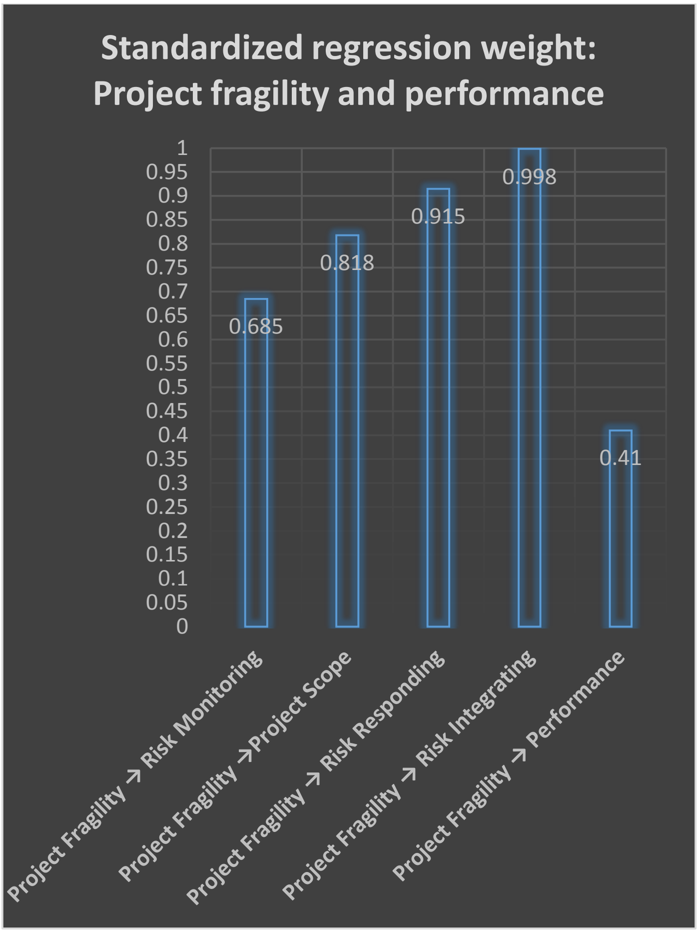


Figure 9.5: Standardized regression weights: fragility of project and risk management performance

9.5.6. Modelling the association between the enterprise resilience to risk-inducing events and risk management performance

The association between the latent variables of the enterprise resilience to fragility risk-inducing events and risk management performance shows that risk management performance is dependent on the enterprise resilience to fragility risk-inducing events. The standardized regression weights of each coefficient are shown in figure 9.12.

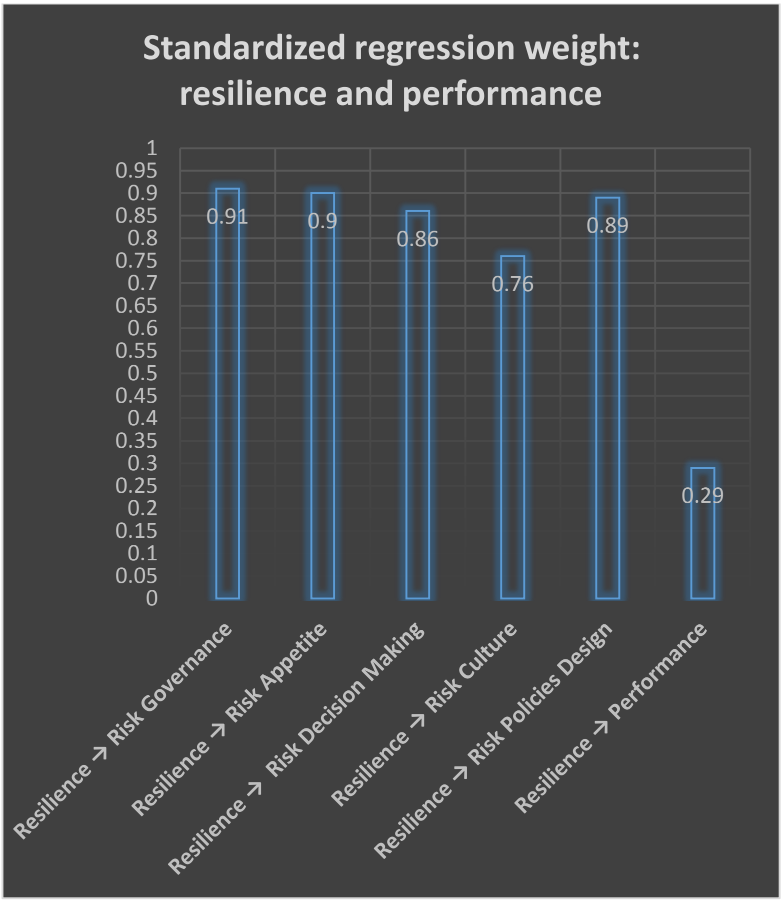


Figure 9.6: Standardized regression weights: resilience and risk management performance

9.5.7. The fitness of structural equation models

This section contains the construction of the model and its parameter estimation. Several indices were used to measure the fitness of the model. This research used the chi-square statistic, TLI, CFI, and RMSEA. Overall, the models are acceptable except for the operation system fragility model. A summary of the results is presented in table 9.3. The results of the model fitness tests are close to the results in other studies that followed the same methodology. For example, the results of structural equation modelling conducted by Naidoo (2010) revealed the following fit indices $\chi 2=18.06$ ($p<0.05$), and RMSEA= 0.06, NFI=0.93, CFI=0.92, when he attempted model the causal relationship between marketing orientation and firm's survival.

Table 9.3: The fitness indices of the models created by SEM

Model	CMIN	CMIN/DF	TLI	CFI	RMSEA
Cutoff point	**p < 0.01**	**< 3**	**>0.9**	**>0.9**	**< 0.8**
Strategy fragility and risk management performance	**194.969 (p < 0.001)**	**1.772**	**0.865**	**0.891**	**0.078**
Governance fragility and risk management performance	**158.067 (p < 0.01)**	**1.387**	**0.931**	**0.942**	**0.055**
Operations fragility and risk management performance	**1110.737 (p <0.001)**	**1.942**	**0.711**	**0.738**	**0.086**
Business unit fragility and risk management performance	**80.905 (p < 0.001)**	**1.759**	**0.914**	**0.940**	**0.077**
Project fragility and risk management performance	**525.874 (p < 0.001)**	**2.070**	**0.782**	**0.813**	**0.092**
Enterprise resilience and risk management performance	**478.176 (p < 0.001)**	**1.558**	**0.896**	**0.909**	**0.066**

9.6. The rational for developing the fragility assessment framework

The overlapping and aggregating impact of enterprise fragility factors puts the whole enterprise at the stake and makes it difficult for managers to implement and monitor the enterprise strategies and prepare on time responses and thus their task to enhance the business continuity and robust its resilience will be a daunting and complex task. In order to organize the fragility factors in a structured framework, the research structured the fragility factors based on the enterprise architecture: strategy, governance, operations, business unit, and project (Morris & Jamieson 2005; Ross, Weil & Robertson 2006; Gregor, Hart & Martin 2007). The basis of using risk factors as dimensions for fragility factors is based on risk management being the foundation of resilience or anti-fragility and thus the risks that enterprises face set the basis for its fragility. That is, if these risks are mitigated properly, the enterprise will reduce fragility and if resilience factors were deployed the enterprise will robust resilience.

Using risk management as basis for managing fragility gives a widely applicable thinking about how the inherent similarities of risk and fragility can be reframed on the purpose of analysing and mitigating threats or hazards and utilize opportunities. Another reason for employing a risk management perspective is that placing risks in context of all enterprise levels enhances robust resilience as an added value to the enterprise. As such, since ERM can be easily understood by practitioners and business managers, it can become the backbone of the enterprise aiming to reduce fragility and enhance resilience. Consequently, the enterprise will have clearly stated fragility framework within the context of their scope of work, and will be more responsible and accountable for the consequences of their actions. Furthermore, all risk management processes will be aligned to create the value or resilience, and fragility triggers will be effectively communicated among all the enterprise levels, both bottom-up or top-down.

9.6.1. Key fragility attributes

The framework of the fragility assessment tool consists of five attributes: fragility of strategy, fragility of governance, fragility of operations, fragility of business unit and fragility of project. See figure 9.13. Each attribute consists of a group of sub-attributes, and each sub-attribute consists of a group of indicators. The predictive power of each indicator varies as per the weight analysed through structured equations.

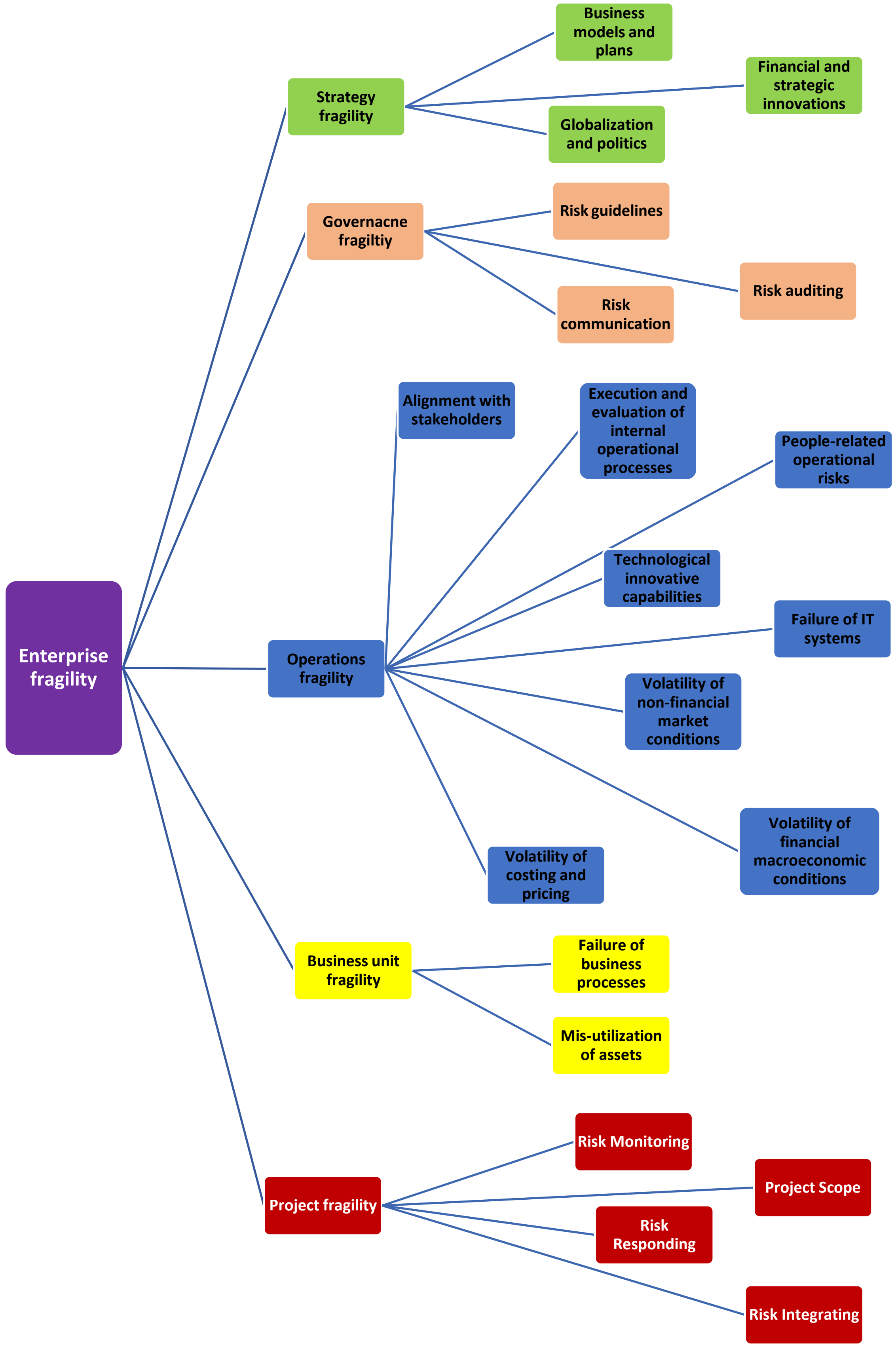


Figure 9.7: Key fragility attributes

9.6.1.1.The fragility of strategy

This attribute consists of three sub-attributes: business models and plans; financial and strategic innovations; and globalization and politics. The sub-attributes consists of 15 indicators: inefficient strategy execution; unawareness of legislation implications; unawareness of market economic changes; unawareness of new technology; overoptimistic or vague projections; inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies; financial uncertainty; lack of feasible strategic support and action plans; inadequate assessment of organization capabilities; emerging aggregated risks; misapplication of business models; disruption in the political changes; inaccurate strategic positioning; and inability to catch up with new innovations. The indicator with the highest weight is ‘inefficient strategy execution’ (0.8); while the indicator with the lowest weight is ‘influence of globalization’ (0.31). In general, it is agreed that inefficient strategy execution is more significant fragility-inducing risk event than the influence of globalization as the adverse effect of inefficient strategy execution significantly influence all industries, while the influence of globalization varies from one industry to another. The failure of strategy execution has massive adverse impact on the whole enterprise.

9.6.1.2.The fragility of governance

This attribute consists of three sub-attributes: risk guidelines, risk auditing and risk communication. The sub-attributes consist of 14 indicators: inadequate mechanism for internal control; Unavailability of timely risk information; inadequate risk assessment methods; inadequate risk reporting systems; inadequate risk pricing policies; inadequate risk management reviewing processes; inadequate risk accountability system; inadequate external auditing processes; noncompliance with environmental guidelines; noncompliance with fiscal and monetary guidelines; noncompliance with mandatory reporting obligations; fluctuation of policies and regulations; violation of policies and regulations; and inadequate communication of objectives and targets. The indicator with the highest weight is ‘inadequate risk management reviewing processes’ (0.8); while the indicator with the lowest weight is ‘fluctuation of policies and regulations (0.51). Inadequate risk management reviewing process is risk event that induces fragility not only in enterprises’ governance but also in all other enterprise management processes.

9.6.1.3.The fragility of operations

This attribute consists of eight sub-attributes: alignment with stakeholders; execution and evaluation of internal operational processes; people-related operational risks; failure of IT systems; technological innovative capabilities; volatility of non-financial market conditions;

volatility of financial macroeconomic conditions; and volatility of costing and pricing. The sub-attributes consists of 32 indicators: misalignment with stakeholders; noncompliance with client requirements; Ineffective communication with clients; unexpected change of customer requirements; inadequate execution of operational plans; inadequate evaluation of operational plans; contractual risks; inaccurate pricing of services/products; unmaintained customer relationships; excessive implementation requirements; fraud or corruption; unhappy work environment; turnover of key talents; inadequate talent configuration and management; inappropriate behaviour (discrimination/harassment); hardware or software failure; cyber-attack/ malware or virus/ ISP disruption; data disclosure; data integrity failure; data reporting failure; inadequate technological innovative ability; inadequate technical transformation ability; infrastructure uncertainty; service/products obsolescence; the scarcity of complementary services/products; misalignment of interests with suppliers; market volatility; credit availability; interest rate level; inflation escalation; equity price fluctuation; and cost volatility. The two indictors with the highest weight are 'noncompliance with client requirements' and 'inaccurate pricing of services/products' (1.0), while the indicator with the lowest weight is 'credit availability'. The operations of the enterprise are highly-adversely affected if the client requirements are not fulfilled or if the product/service is incorrectly priced.

9.6.1.4.The fragility of business units

This attribute consists of two sub-attributes: failure of business processes and mis-utilization of assets. The sub-attributes consist of 9 indicators: inadequate business unit supervision ability; red-tape risk; failure to follow processes; failure to integrate with business processes; improper planning for daily operations; fixed assets mis-utilization; inadequate fund management ability; lack of cost control; and lack of resources. The indicator with the highest weight is 'failure to follow processes' (0.86); while the indicator with the lowest weight is 'inadequate fund management ability' (0.56). Unlike fund management ability, failing to follow process is a risk that impacts all aspects of functions in the business unit.

9.6.1.5.The fragility of projects

This attribute consists of four sub-attributes: risk monitoring; project scope; risk responding; and risk integrating. The sub-attribute consists of 23 indicators: lack of existing risk documentations on all processes and standards; lack of using performance indices to measure project risk; inadequate project monitoring; lack of risk quantification; lack of information on risk triggers; lack of integrating cost and time management; inadequate project requirements; inadequate scope of control; inadequate project management ability; inadequate project risk culture building; inadequate change management ability; inadequate procurement management ability; lack of project risk identification; lack of identifying risk triggers; lack of immediate response to risks as they arise; lack of processes for tracking project risks; lack of contingency risk plans; lack of using risk assessment and project performance status in decision making; lack of risk information collection; disengagement of executives with the project; lack of re-alignment between strategic and project objectives; user's rejection of the product/service; and failure to record/archive lessons learned. The indicator with the highest weight is ‘lack of using performance indices to measure project risk’ (0.83); while the indicator with the lowest weight is ‘lack of re-alignment between strategic and project objectives’ (0.4). Failing to measure the project risk is a significant event that has substantially adverse impact on the success of the project.

9.6.2. Fragility Scale

Following the development of the fragility framework and testing its predicative power by using structured equations, a simpler method but all-inclusive was developed for assessing the fragility of businesses to risk events. The fragility tool assesses the enterprise fragility to risk events in five levels: resilient, adaptive, predictive, managed and basic. See figure 9.14. The tool comes from the point that when fragility goes down and linking risk to performance goes up, resilience goes up.

Figure 9.8: Fragility scale

9.6.3. Validation of the assessment tool and its practical implications

For validation purpose, the tool was tested in three enterprises from three different sectors. The aim was to identify the areas of fragility in these enterprises and identify how far risk is linked to performance in these same areas.

The results showed that the fragility areas in ABC Bank are: volatility of financial macroeconomic conditions, failure of IT systems, risk guidelines, business models and plans, failure of business processes. Overall, ABC's strategy as well as business units are more fragile if compared with its governance, operations or projects. While in relations to linking risk to managerial performance, besides the above-mentioned fragility areas, risk is highly linked to performance in areas such as risk integrating, risk responding, risk guidelines, financial and strategic innovations, risk auditing and people-related operational risks.

The results showed that the fragility areas in DEF Engineering are: failure of business processes, volatility of costing and pricing, mis-utilization of assets, failure of IT systems, risk guidelines, and alignment with stakeholders. Overall, DEF's strategy, operations and business units are more fragile if compared with its governance and projects. While in relations to linking risk to managerial performance, besides the above-mentioned fragility areas, risk is highly linked to performance to areas such as risk integrating, risk responding, volatility of financial macro-economic conditions and people-related operational risks.

The results showed that the fragility areas in XYZ Hotel are: failure of business processes, volatility of costing and pricing, alignment with stakeholders, project risk monitoring, project risk scope, project risk responding, and risk guidelines. . Overall, XYZ's operations, business units and projects are more fragile if compared with its strategy and governance. While in relations to linking risk to managerial performance, besides the above-mentioned fragility areas, risk is highly linked to performance in areas such as misutilization of assets, volatility of costing and pricing, volatility of financial macro-economic conditions, volatility of non-financial market conditions, failure of IT systems, alignment with stakeholders and financial and strategic innovations.

It can be found from the results that the tools managed to capture the differences among the three enterprises and their industries. For example, the results of the bank did not show fragility in the projects area unlike the engineering enterprise. This is justified due to the scarcity of projects in the core business of banks while projects are actually the core business of engineering enterprises. Another finding can be drawn is that the fragility of that area relatively goes down when risk is highly linked to performance in a certain.

This tool can be used by top managers to highlight the fragility areas in the enterprise. It can be also used by financing institutions, insurance companies or some government authorities to assess the fragility of enterprises. A financing institution needs to have an assessment of an enterprise's fragility before giving a loan and so does an insurance company before making a big insurance deal.

The tool is limited in the sense that the score relies on the top manager's mentality of risk management. Risk taking managers might have a relatively different evaluation of the fragility areas from those who are risk averter. This limitation can be sorted out in the sense that instead of one top manager to assess the enterprise as a whole, it can be filled by different heads to reflect upon the fragility of each department and the collective results can give a better indicator of the enterprise fragility. Moreover, the tool can be further developed to give a qualitative input on the score filled. This can help generate the risk intelligence needed to deal with the fragility areas.

9.6.4. Relationship between the fragility assessment tool and risk resilience

The tool not only assesses the fragility of the enterprise but also it does directly relate to the resilience attributes. The tool identifies which areas are fragile and which areas are anti-fragile, and thus the top management knows which areas to enhance and which areas need to be robust. The actions that should be taken after the assessment relate to the resilience attributes to risk culture, risk governance, risk appetite, risk-informed decision making and risk policies design. For example, if DEF Engineering enterprises is assessed with fragility of failure of business processes, volatility of costing and pricing, mis-utilization of assets. Actions can be taken through embedding risk norms in various corporate and governance processes as well as using business-specific scenarios and early indicators to understand risks and opportunities. Moreover, risk responsibilities should be incorporated into individual activities

9.7. Summary

This chapter brought together the results from this research and discussed their outcome. The first section of chapter addressed the ranking of risk-events inducing fragility and the ranking of resilience attributes. The second section discussed the extraction of the latent fragility inducing events and latent resilience attributes. The third section discussed structural equation modelling of risk management performance with both enterprise fragility and with enterprise resilience. The final section of this chapter addressed the development of an enterprise fragility tool and the rationale behind it in addition to the validation of the tool. Moreover, it discussed the findings drawn from the validation of the assessment tool as well as its limitation and practical implications.

CHAPTER TEN

CONCLUSTIONS AND FURTHER RESEARCH RECOMMENDATION

10.1. Introduction

This chapter presents the conclusions drawn out from the research analyses and the discussion of the findings. The first section projects the robustness of the adopted research methodology. The second section reviews the accomplishment of the research aim and objectives. The third section presents the key research contributions and highlights the generalizability, applicability and implications of the research findings. The fourth section lists the limitations of this research. The final section suggests recommendations for areas of further research.

10.2. Robustness of the Research Methodology

The detailed description of the research methodology adopted to achieve the research aims and objectives was presented in chapter four. The research relied on a comprehensive and in-depth qualitative review of the literature about risk, fragility and resilience in order to identify the gaps of knowledge in these areas and develop the research questions. Based on literature review, a questionnaire was developed and validated by two practitioners and two academics make sure the questions were understood as meant to be and to solicit their professional feedback. Later it was electronically distributed to collect data from risk management practitioners working for the enterprises enlisted in Dubai and Abu Dhabi financial markets. Questionnaires were completed anonymously without due influence from the researcher. A statistically significant number of responses were received. Data were checked for errors, completeness and consistency. Questionnaires that were incomplete were not used in the analysis. Furthermore, the responses were checked to see whether the respondents had completed the questions properly and not just ticked answers randomly. For example, answers from respondents who used the same score for each variable were not included in the analysis. Data were coded according to SPSS standards. Several statistical tools were deployed to analyse the survey results. Descriptive statistics were used to study the variation in the respondents' answers whilst severity index was used to rank the data.

Correlation analysis was used to investigate the relationship direction and strength between risk-events, resilience attributes and risk management performance. Factor analysis was used to reduce the number of risk events to facilitate the development of the assessment tool. Structural equation modelling was used to analyse and test the research hypotheses.

10.3. Accomplishing the Research Objectives

10.3.1. To review literature on risk, fragility and resilience

A plethora of scholars have argued about the concept of risk and uncertainty and their argument can be traced back to the beginning of twentieth century. Thus, this created a room of different interpretations and resulted in imprecise meaning of the terminology. This research reviewed the different viewpoints and reached the conclusion that risks are dynamic in nature and their outcomes change due to changes of uncertainties. The research also deconstructed the concept of fragility as the suffering of the system from the variability of its environment and explained that fragility is a cause of vulnerability. The research also deconstructed the concept of resilience and reached the conclusion that enterprise resilience means sustaining the dynamism and functionality of all enterprise systems by managing risk, uncertainty and fragility. The research also distinguished resilience from adaptability, transformability, robustness or redundancy. The three concepts – risk, fragility and resilience – were mapped with uncertainty, which is the common aspect among them. Chapter two presents all the details about the achievement of this objective

10.3.2. To classify and extract latent variables that represent fragility inducing risk events and resilience procedures and practices

This objective is concerned with synthesising existing literature with a view to compile a list of risk events that induce the fragility of enterprises and a list of attributes that induce the resilience of enterprises. A systematic literature review was used to extract those two lists. Chapter three lists 100 risk events and 28 resilience attributes. The lists were then used in the development of the questionnaire with a view to assess how far each risk events contribute to the fragility of enterprises and how significant each attributes in enhancing the resilience of enterprises. The collected data was analysed and ranked. The latent variables that represent fragility inducing risk events and the latent variables that represent the resilience enhancing attributes were extracted. This objective has been achieved through exploratory and confirmatory factor analyses. Chapter four presents the methodology used to collect and analyse the data. The results of the factor analyses are presented in chapter six.

10.3.3. To investigate the influence of fragility inducing risk events and resilience inducing attributes on risk management performance of enterprises

This objective has been achieved through the analysis of the collected data. To investigate the influence of the fragility inducing risk events and resilience inducing attributes on risk management performance of enterprises, structural equations were modelled. The results are described in various forms in chapter seven. What is observable from the results is that the null hypotheses were rejected for all equations and a statistically significant association was established between enterprise fragility and risk management performance as well as a statistically significant association between enterprise resilience and risk management performance.

10.3.4. To develop and test a framework/tool for assessing the fragility of enterprises to risk events

One of the main accomplishments of this research has been the development of an assessment tools for the fragility of enterprises. The proposed assessment tool emerged from a confirmatory factor analysis of one hundred fragility inducing risk events. The tool serves as a vehicle for identifying the fragile areas in the enterprise and can be integrated with resilience attributes framework. The tool will also encourage the early detections of risks that threaten the fragility of enterprises. This should assist risk practitioners to focus on the overall enterprise fragility and the long-term outcomes on the enterprise resilience. The proposed tool and the results of the validation process are fully explained in chapter eight.

10.4. Key research contributions

This research has contributed to the existing body of knowledge in the following areas:

- A comprehensive literature review to identify risk events that induce the fragility of enterprise and identify the enterprise resilience attributes. Although plenty of studies explored organizational resilience, engineering resilience, socio-ecological resilience, financial fragility, and socio-ecological fragility; yet there was no research that was conducted specifically on enterprise resilience and enterprise fragility from the perspective of enterprise risk management.

- New deconstruction and clustering of the risk events that induce the fragility of the enterprise and the attributes that induce the enterprise resilience.
- Development of an enterprise fragility framework and an enterprise resilience framework.
- Development of an assessment tool that can assess the enterprise fragility.
- Suggested development of an assessment tool that can assess the enterprise resilience.
- The research investigated the association between enterprise fragility and risk management performance and the association between enterprise resilience and risk management performance.

10.5. Generalisability, Applicability and Implications of the Findings

The developed fragility and resilience frameworks and associated fragility tools are usable by all enterprises in order to have a better understanding of the enterprise's overall capacity of not only withstand disruptions but also to create values out of them. These frameworks can be also used by banks, financing institutions, insurance companies or some government authorities to assess the fragility of other enterprises. The results from the assessment tool will give these institutions the intelligence to judge if a certain enterprise is a risky client for financing or insuring. This will provide opportunities for the above-mentioned institutions to develop their customized tools to assess certain capabilities in the enterprise.

10.6. Research Limitations

As like as the majority of research studies, this research is based on assumptions that suit the context of in which it was conducted. It is conducted within a specific time period and within resource constraints. Thus, a number of limitations are identified, as follows:

- One of the major limitations in this research is the number of questionnaire respondents for assuming generalizability of the results. Although the number of respondents is comparable to other studies in the UAE, yet it is not possible to claim that their views represent the views of the majority of risk management practitioners in UAE and consequently worldwide.

- The extraction of risk events was not from one specific industry and so were the responses of the survey practitioners. Risk events significance varies from one industry to another and the data collected.
- The proposed fragility tool has been tested and presented to risk managers in three different enterprises. The robustness of the proposed tool can be better demonstrated through prolonged observation and case studies.

10.7. Recommendations for Areas of Further Research

Based on the solid foundation that was served by the original contribution of this research, further research can be built in a number of areas as follows:

- There is an increasing endeavour in the industry to maximise the enterprise capabilities to survive disturbances and disruptions. Hence, further knowledge about enterprise fragility and enterprise resilience will consolidate the theoretical basis in these areas.
- Further research needs to be done to refine the extracted risk events that induce the enterprise fragility. New identified risk events can be added and analyzed. This refinement is recommended to be on enterprises that operate in the same industry, so that industry-specialized frameworks can be developed and this will increase the accuracy of the tool.
- Further research needs to be done to test the proposed enterprise fragility framework and enterprise resilience framework on cases studies. Consequently, further investigation is required to demonstrate the implementation and use of the proposed fragility tool and develop a similar resilience tool. The feedback of practitioners will help crystalize the tools.
- Further work is required to verify the correlation between risk management and enterprise resilience.

10.8. Summary

This chapter presented the conclusions based on the research analyses and the discussion of the findings. The first section projected the robustness of the adopted research methodology. The second section reviewed the accomplishment of the research aim and objectives. The third section presented the key research contributions and highlighted the generalizability, applicability and implications of the research findings. The fourth section listed the limitations of this research. While, the final section suggested future further research.

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APPENDICES

Appendix 4.1

Introduction

You are kindly being invited to participate in an online survey to investigate the influence of risk events on enterprise fragility and resilience. There are no foreseeable risks or adverse events to you for taking part in this study. It should only take 15-20 minutes of your time.

The 2008-2009 financial crisis led plenty of enterprises to default and Enterprise Risk Management practices failed to assess the resilience capacity of these enterprises. Therefore, there is a need to assess enterprise resilience and fragility from a risk management perspective. Hence, the purpose of this survey is to understand how risk management may or may not contribute to the enterprise resilience.

All individual responses will remain confidential and study data will be amalgamated and analysed as a whole. Results will be reported in summary form to protect confidentiality. However, if you have any questions or concerns about the questionnaire or about participating in this research, you may contact me on 00971 50 4490 591 or at amer.alaya@buid.ac.ae. Alternatively, you may communicate concerns to my Director of Studies, Professor Halim Boussabaine, on +971 4 279 1400 Ext: 437 (halim@buid.ac.ae).

Thank you for your time and support. Please also feel free to forward URL of the web survey to relevant risk intelligence/enterprise resilience stakeholders.

Kind regards and many thanks in advance
Amer Alaya

Section One

Risk events contributing to the fragility of the enterprise

The fragility of strategy					
Please rate how likely the risk events stated below contribute to the fragility of the enterprise strategies	Very likely	Likely	Neutral	Unlikely	Very unlikely
Unable to catch up with new innovations					
Disruption in the political changes					
Influence of Globalization					
Negative media and news affecting the reputation					
Inadequate assessment of organization capabilities					
Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies					
Inaccurate strategic positioning					
Overoptimistic or vague projections					
Inefficient strategy execution					
Lack of feasible strategic support and action plans					
Unawareness of market economic changes					
Unawareness of new technology					
Unawareness of legislation implications					
Misapplication of business models					
Financial uncertainty					
Emerging aggregated risks					
The fragility of governance					
Please rate how likely the risk events stated below contribute to the fragility of the enterprise governance	Very likely	Likely	Neutral	Unlikely	Very unlikely
Fluctuation of policies and regulations					
Violation of policies and regulations					
Inadequate communication of objectives and targets					

Inadequate mechanism for internal control					
Unavailability of timely risk information					
Inadequate risk assessment methods					
Inadequate risk reporting systems					
Inadequate risk pricing policies					
Inadequate risk management reviewing processes					
Inadequate risk accountability system					
Inadequate external auditing processes					
Noncompliance with environmental guidelines					
Noncompliance with fiscal and monetary guidelines					
Noncompliance with mandatory reporting obligations					
The fragility of operations					
Please rate how likely the risk events stated below contribute to the fragility of the enterprise internal operational processes	**Very likely**	**Likel y**	**Neutral**	**Unlikel y**	**Very unlikely**
Inadequate execution of operational plans					
Inadequate evaluation of operational plans					
Excessive implementation requirements					
Misalignment with stakeholders					
Contractual risks					
Inaccurate pricing of services/products					
Non-compliance with client requirements					
Ineffective communication with clients					
Unexpected change of customer requirements					
Unmaintained customer relationships					
Please rate how likely do the people-related risk events stated below will contribute the fragility of the enterprise operations	**Very likely**	**Likel y**	**Neutral**	**Unlikel y**	**Very unlikely**
Fraud or corruption					
Unhappy work environment					

Turnover of key talents					
Inadequate talent configuration and management					
Inappropriate behaviour (discrimination/harassment)					
Please rate how likely the risk events stated below contribute to the fragility of the enterprise operational systems	**Very likely**	**Likel y**	**Neutral**	**Unlikel y**	**Very unlikely**
Hardware/software failure					
Disruption in communication channels					
Cyber-attack/ Malware or virus/ ISP disruption					
Data Disclosure					
Data integrity failure					
Data Reporting failure					
Inadequate technological innovative ability					
Inadequate technical transformation ability					
Please rate how likely the external risk events stated below contribute to the fragility of the enterprise operations	**Very likely**	**Likel y**	**Neutral**	**Unlikel y**	**Very unlikely**
Market volatility					
Credit availability					
Interest rate level					
Prepayment/extension availability					
Equity price fluctuation					
Foreign exchange rate fluctuation					
Inflation escalation					
Tax rate uncertainty					
Cost volatility					
Outsourcing failure					
Infrastructure uncertainty					
Misalignment of interests with suppliers					
Service/products obsolescence					

The scarcity of complementary services/products					
The fragility of business unit					
Please rate how likely the risk events stated below contribute to the fragility of the business unit functions	**Very likely**	**Likel y**	**Neutral**	**Unlikel y**	**Very Unlikely**
Fixed assets mis-utilization					
Inadequate fund management ability					
Inadequate business unit supervision ability					
Red-tape risk					
Failure to follow processes					
Failure to integrate with business processes					
Lack of cost control					
Lack of resources					
Improper planning for daily operations					
The fragility of project					
Please rate how likely the risk events stated below contribute to the fragility of the project activities	**Very likely**	**Likel y**	**Neutral**	**Unlikel y**	**Very Unlikely**
Inadequate project requirements					
Inadequate scope of control					
Inadequate project management ability					
Inadequate project risk culture building					
Inadequate change management ability					
Inadequate procurement management ability					
Inadequate project monitoring					
User's rejection of the product/service					
Failure to record/archive lessons learned					
Disengagement of executives with the project					
Lack of re-alignment between strategic and project objectives					
Conflict between key stakeholders					

Lack of integrating cost and time management					
Lack of project risk identification					
Lack of identifying risk triggers					
lack of risk quantification					
Lack of existing risk documentations on all processes and standards					
Lack of using performance indices to measure project risk					
Lack of immediate response to risks as they arise					
Lack of processes for tracking project risks					
Lack of contingency risk plans					
Lack of using risk assessment and project performance status in decision making					
Lack of information on risk triggers					
Lack of risk information collection					

Section Two:

<u>Drivers that contribute to the resilience of the enterprise</u>

Risk Culture and Resilience					
Please rate how likely the below risk culture statements contribute to the resilience of the enterprise	**Very likely**	**Likely**	**Neutral**	**Unlikely**	**Very Unlikely**
Existence of thorough risk culture across entire organization					
Risk norms are embedded through various corporate processes					
Risk norms are embedded through various governance processes					
Existence of risk skill-enhancement program for key roles					
Existence of common vocabulary for different risks					
Using business-specific scenarios and stress tests, to understand risks and opportunities					
Using business-specific scenarios and early indicators to understand risks and opportunities					

Risk Governance and Resilience					
Please rate how likely the below risk governance statements contribute to the resilience of the enterprise	**Very likely**	**Likely**	**Neutral**	**Unlikely**	**Very Unlikely**
Enterprise Risk Management mandate of the risk function is clearly defined					
Robust design risk organization across entire organization					
Ensure appropriation of top management					
Existence of clear allocation of responsibilities between risk taking and controlling units					
Risks are communicated via appropriate channels and technology					
Risk ownership and accountability is well defined					
The organization has a risk management organizational structure with clear reporting lines					
Formal organizational risk reports are regularly reviewed					
Existence of risk models as support tool for business decisions					
Existence of key intelligence risks indicators					
Provision of clarity and responsibility on taking actionable measures					
Risk Appetite and Resilience					
Please rate how likely the below risk appetite statements contribute to the resilience of the enterprise	**Very likely**	**Likely**	**Neutral**	**Unlikely**	**Very Unlikely**
Existence of policies on risk ownership					
Policies on risk appetite (how much risk can be taken)					
Existence of guidelines on risk taking capacity (how much risk can be comfortably taken)					
Existence of guidelines on trade-offs between risk taking and the corresponding cost					
Existence of guidelines on actions to transform company risk profile					

Risk-informed Decision Making and Resilience					
Please rate how likely the below statements about risk-related decision contribute to the resilience of the enterprise	**Very likely**	**Likely**	**Neutral**	**Unlikely**	**Very Unlikely**
Business decision making is embedded on risk					
Major strategic decisions are embedded on risk before deployment					
Core business processes are designed and executed on a risk-informed basis					
core business operations are designed and executed on a risk-informed basis					
Risk responsibilities are incorporated into individual activities					
The minimum process functionality requirements are well identified					

Section Three:

Demographics

1. **Please indicate how long have you been working for your current enterprise.**
   - o Less three years
   - o 3-5 years
   - o 6-10 years
   - o More than 10 years

2. **Please indicate your position in your enterprise.**
   - o Entry Level
   - o Middle Level
   - o Senior Level
   - o Top Management

3. **How many employees does your enterprise currently have?**
   - o 100 employees or less
   - o 101-300 employees
   - o More than 300 employees

4. **Which industry does your enterprise operate in?**
   - o Engineering & Consultancy   o Construction & real estate   o Energy

- o Insurance o Banking o Hospitality
- o Public services o Telecommunication o Manufacturing
- o Other (please specify) ……………………

5. **How do you currently measure the potential effects of risk?**
   - o Using risk matrix
   - o Using check list
   - o Using scoring systems
   - o Using Monte Carlo simulation
   - o Not using a systematic method
   - o Other (please specify) ……………………

6. **Please rate how often you use the following to manage your risks and performance.**

	Very Frequently	Frequently	Occasionally	Rarely	Very Rarely
1. Only what need to be known is identified					
2. Only measures that matter most are identified					
3. Data turned into actionable information					
4. Risks are linked to performance					
5. Risk-informed metrics are used to track performance					

Do you agree with the below statements?

7. **Monitoring the effectiveness of risk management in your enterprise is an integral part of routine management reporting**
   - o Strongly disagree
   - o Disagree
   - o Neutral
   - o Agree
   - o Strongly Agree
8. **Your enterprise's senior management is receptive to all communications about risks, including bad news.**
   - o Strongly disagree
   - o Disagree
   - o Neutral
   - o Agree

- Strongly Agree

9. **Overall, at what stage of risk management practice development does your enterprise consider itself to be?**
    - Best Practice
    - Well developed
    - Reasonably well developed
    - Basic
    - Non- Existent

End of Questionnaire

Thank You

Appendix 5.1

Industry * risk monitor routine Crosstabulation							
Count							
		Monitoring the effectiveness of risk management in your enterprise is an integral part of routine management reporting					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Industry	Engineering	0	1	3	6	7	17
	Construction & Real Estate	0	0	1	3	5	9
	Energy	1	0	1	4	3	9
	Insurance	1	0	1	10	6	18
	Banking	1	0	4	5	6	16
	Hospitality	0	0	1	6	0	7
	Public Services	1	0	1	9	3	14
	Telecommunication	1	1	0	10	3	15
	Manufacturing	0	2	5	2	4	13
	Others	0	0	4	6	1	11
Total		5	4	21	61	38	129

Appendix 5.2

Industry * management reception to risk news Crosstabulation							
Count							
		Your enterprise's senior management is receptive to all communications about risks, including bad news.					Total
		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
Industry	Engineering	0	4	4	3	6	17
	Construction & Real Estate	0	0	2	3	4	9
	Energy	0	1	2	4	2	9
	Insurance	0	0	4	8	6	18
	Banking	1	0	3	4	8	16
	Hospitality	0	2	0	4	1	7
	Public Services	1	2	0	8	3	14
	Telecommunication	1	1	2	8	3	15
	Manufacturing	0	5	2	2	4	13
	Others	0	1	4	5	1	11
Total		3	16	23	49	38	129

Appendix 5.3

Industry * Development of risk management Crosstabulation							
Count							
		Overall, at what stage of risk management practice development does your enterprise consider itself to be?					Total
		Non-Existent	Basic	Reasonably Well Developed	Well Developed	Best Practice	
Industry	Engineering	1	4	3	7	2	17
	Construction & Real Estate	0	2	3	3	1	9
	Energy	0	3	5	1	0	9
	Insurance	0	1	7	8	2	18
	Banking	0	0	6	6	4	16
	Hospitality	0	2	5	0	0	7
	Public Services	0	4	5	4	1	14
	Telecommunication	0	3	4	6	2	15
	Manufacturing	0	8	0	5	0	13
	Others	2	5	1	2	1	11
Total		3	32	39	42	13	129

Appendix 5.4

Ranking of risk events inducing the fragility of strategy

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	Ranking within level	Overall ranking
SR1	4.093	0.795	19.421	46.115	10	21
SR2	3.915	0.992	25.350	31.012	16	80
SR3	3.884	0.816	21.014	36.544	3	69
SR4	4.512	0.651	14.428	54.346	1	3
SR5	4.101	0.769	18.752	43.202	6	46
SR6	4.016	0.952	23.704	36.220	2	70
SR7	4.124	0.750	18.188	46.691	12	17
SR8	3.930	0.762	19.395	53.171	15	4
SR9	4.248	0.674	15.854	50.747	13	7
SR10	4.093	0.775	18.935	50.912	14	6
SR11	4.217	0.819	19.428	46.664	11	18
SR12	3.992	0.870	21.804	44.048	7	36
SR13	3.984	0.884	22.180	40.273	4	58
SR14	4.016	0.875	21.787	41.119	5	57
SR15	4.271	0.899	21.053	46.054	9	22
SR16	4.287	0.773	18.021	44.997	8	27

Appendix 5.5

Ranking of risk events inducing the fragility of governance

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	Ranking within level	Overall ranking
GR1	3.791	0.990	26.106	29.493	11	84
GR2	4.016	0.910	22.659	41.501	7	53
GR3	4.039	0.785	19.428	45.927	5	24
GR4	4.178	0.947	22.675	49.823	2	8
GR5	4.000	0.696	17.399	47.546	4	15
GR6	4.256	0.742	17.446	41.417	8	54
GR7	4.140	0.864	20.865	38.800	9	65
GR8	4.062	0.882	21.706	58.008	1	1
GR9	4.085	0.613	14.999	44.726	6	29
GR10	4.093	0.775	18.935	25.735	12	91
GR11	3.605	1.100	30.512	15.887	14	100
GR12	2.736	1.202	43.938	36.651	10	68
GR13	3.783	0.901	23.819	23.819	13	97
GR14	3.558	1.103	31.008	49.321	3	9

Appendix 5.6

Ranking of risk events inducing the fragility of operations

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	Ranking within level	Overall ranking
ORIP1	4.326	0.762	17.617	52.642	2	5
ORIP2	3.969	0.706	17.799	26.874	31	89
ORIP3	3.581	0.982	27.415	40.147	19	60
ORIP4	3.992	0.834	20.886	40.147	20	61
ORIP5	4.209	0.854	20.288	43.893	10	38
ORIP6	4.023	0.905	22.504	44.209	8	35
ORIP7	4.147	0.911	21.963	41.713	17	52
ORIP8	4.109	0.868	21.131	41.181	18	55
ORIP9	3.597	1.093	30.400	25.569	33	92
ORIP10	4.271	0.846	19.795	44.557	6	31
ORP1	4.426	0.818	18.470	54.349	1	2
ORP2	3.868	0.939	24.264	33.763	25	76
ORP3	4.194	0.830	19.788	42.616	15	49
ORP4	4.016	0.829	20.645	39.678	21	62
ORP5	3.783	0.960	25.372	28.645	30	87
ORS1	4.240	0.917	21.617	44.572	5	30
ORS2	3.543	1.008	28.449	25.000	36	95
ORS3	4.248	0.866	20.393	43.665	13	41
ORS4	4.163	0.758	18.214	45.298	4	25
ORS5	4.147	0.719	17.341	43.775	12	40
ORS6	4.031	0.847	21.018	37.538	23	67
ORS7	3.682	0.952	25.850	29.760	28	83
ORS8	3.535	1.097	31.039	24.840	37	96

OREE1	4.287	0.802	18.715	46.042	3	23
OREE2	4.132	0.794	19.224	43.949	9	37
OREE3	3.961	0.842	21.263	43.778	11	39
OREE4	3.496	0.985	28.181	26.589	32	90
OREE5	3.922	0.941	23.978	33.974	24	75
OREE6	3.535	1.000	28.300	25.429	34	93
OREE7	4.101	0.799	19.481	39.347	22	63
OREE8	3.512	1.001	28.503	25.051	35	94
OREE9	4.248	0.771	18.146	44.288	7	34
OREE10	4.109	0.841	20.464	42.420	16	50
OREE11	3.822	0.964	25.219	32.247	26	78
OREE12	3.992	0.861	21.579	43.276	14	45
OREE13	3.760	1.021	27.168	30.513	27	81
OREE14	3.597	1.050	29.183	28.825	29	86

Appendix 5.7

Ranking of risk events inducing the fragility of business units

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	Ranking within level	Overall ranking
BUR1	4.008	0.940	23.443	36.203	5	71
BUR2	3.953	0.865	21.873	38.878	4	64
BUR3	3.891	0.850	21.843	34.825	6	73
BUR4	3.372	1.039	30.807	23.403	9	98
BUR5	3.775	0.868	22.997	34.364	7	74
BUR6	3.977	0.805	20.241	45.236	3	26
BUR7	4.333	0.823	18.989	48.836	1	11
BUR8	4.279	0.810	18.926	47.616	2	13
BUR9	3.806	1.024	26.897	29.171	8	85

Appendix 5.8

Ranking of risk events inducing the fragility of projects

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	Ranking within level	Overall ranking
PR1	4.178	0.897	21.459	43.084	13	47
PR2	4.171	0.849	20.355	44.490	8	32
PR3	4.240	0.808	19.053	47.456	4	16
PR4	4.140	0.808	19.510	42.887	14	48
PR5	4.225	0.687	16.270	49.245	1	10
PR6	4.155	0.785	18.895	44.301	9	33
PR7	4.016	0.927	23.083	35.721	19	72
PR8	3.760	1.052	27.970	27.326	23	88
PR9	3.442	1.110	32.261	23.219	24	99
PR10	4.023	0.815	20.246	41.921	15	51
PR11	4.132	0.851	20.603	43.288	12	44
PR12	4.209	0.872	20.718	43.400	11	43
PR13	4.085	0.902	22.071	41.177	16	56
PR14	4.093	0.755	18.436	46.484	5	19
PR15	4.078	0.777	19.049	46.136	6	20
PR16	3.845	1.004	26.099	30.304	22	82
PR17	3.682	1.031	27.991	31.930	21	79
PR18	3.891	0.994	25.544	33.724	20	77
PR19	4.318	0.790	18.306	47.704	2	12
PR20	4.147	0.741	17.857	43.447	10	42
PR21	4.248	0.729	17.166	44.816	7	28
PR22	4.202	0.733	17.444	47.563	3	14
PR23	3.899	0.759	19.459	40.250	17	59
PR24	3.969	0.819	20.637	38.530	18	66

Appendix 5.9

Ranking of resilience attributes to risk culture

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	ranking within the category	overall ranking
RCR1	4.279	0.770	18.002	46.270	1	10
RCR2	4.163	0.873	20.975	41.837	4	17
RCR3	4.240	0.798	18.824	43.695	3	15
RCR4	4.016	0.866	21.564	38.540	5	25
RCR5	3.659	0.906	24.753	30.093	7	27
RCR6	3.930	0.831	21.141	37.484	6	26
RCR7	4.023	0.795	19.764	44.860	2	12

Appendix 5.10

Ranking of resilience attributes to risk governance

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	ranking within the category	overall ranking
RGR1	4.155	0.795	19.133	40.871	9	23
RGR2	4.140	0.899	21.721	40.034	10	24
RGR3	4.047	0.818	20.224	41.581	7	18
RGR4	4.147	0.911	21.963	41.140	8	21
RGR5	3.736	1.064	28.489	27.262	11	28
RGR6	4.333	0.851	19.635	48.467	4	8
RGR7	4.349	0.787	18.099	51.288	2	3
RGR8	4.264	0.755	17.717	49.091	3	5
RGR9	4.147	0.782	18.847	43.847	6	14
RGR10	4.395	0.723	16.440	51.381	1	2
RGR11	4.147	0.761	18.359	44.736	5	13

Appendix 5.11

Ranking of resilience attributes to risk appetite

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	ranking within the category	overall ranking
RAR1	4.372	0.740	16.931	49.088	2	6
RAR2	4.364	0.706	16.186	49.797	1	4
RAR3	4.248	0.718	16.911	45.042	3	11
RAR4	4.124	0.839	20.334	42.738	4	16
RAR5	4.178	0.795	19.027	41.468	5	20

Appendix 5.12

Ranking of resilience attributes to risk-informed decisions-making

Code	Mean	Std. Deviation	Coefficient of variation	Severity Index	ranking within the category	overall ranking
RDMR1	4.349	0.816	18.772	48.572	2	7
RDMR2	4.465	0.708	15.848	54.394	1	1
RDMR3	4.302	0.767	17.817	46.681	3	9
RDMR4	4.124	0.875	21.219	41.070	5	22
RDMR5	4.101	0.846	20.639	41.474	4	19

Appendix 6.1

Results of CFA: Fragility of Strategy

Path			Standardized regression weight	S.E.	C.R.	P	SMMC
SR10	<---	Business Models Plans	.640	.110	6.863	***	.409
SR13	<---	Business Models Plans	.746	194	6.863	***	.557
SR14	<---	Business Models Plans	.574	.123	6.171	***	.330
SR12	<---	Business Models Plans	.717	.126	7.505	***	.514
SR8	<---	Business Models Plans	.705	.125	6.499	***	.496
SR11	<---	Financial & Strategic Innovations	.752	.153	6.764	***	.565
SR9	<---	Financial & Strategic Innovations	.804	.127	7.156	***	.647
SR7	<---	Financial & Strategic Innovations	.487	.122	5.018	***	.237
SR1	<---	Financial & Strategic Innovations	.443	.129	4.596	***	.196
SR16	<---	Financial & Strategic Innovations	.601	.089	8.725	***	.361
SR15	<---	Financial & Strategic Innovations	.663	143	6.764	***	.439
SR3	<---	Globalization & Politics	.308	.136	2.768	.006	.095
SR2	<---	Globalization & Politics	.546	.178	4.569	***	.298
SR5	<---	Globalization & Politics	.642	.149	4.969	***	.413
SR6	<---	Globalization & Politics	.702	961	2.768	.006	.493

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.2

Results of CFA: Fragility of Governance

Path			**Standardized regression weight**	**S.E.**	**C.R.**	**P**	**SMMC**
GR4	<---	Risk Guidelines	.545	.140	5.942	***	.297
GR8	<---	Risk Guidelines	.548	.130	5.984	***	.301
GR10	<---	Risk Guidelines	.714	.114	7.806	***	.509
GR7	<---	Risk Guidelines	.717	127	8.308	***	.514
GR9	<---	Risk Guidelines	.804	.094	8.424	***	.646
GR5	<---	Risk Guidelines	.764	.103	8.355	***	.583
GR6	<---	Risk Guidelines	.793	.114	8.308	***	.629
GR13	<---	Risk Auditing	.663	.107	6.559	***	.440
GR11	<---	Risk Auditing	.612	.129	6.109	***	.374
GR12	<---	Risk Auditing	.657	.143	6.507	***	.432
GR14	<---	Risk Auditing	.772	217	6.559	***	.595
GR3	<---	Risk Communication	.712	.191	5.108	***	.507
GR1	<---	Risk Communication	.514	.205	4.337	***	.264
GR2	<---	Risk Communication	.628	200	5.108	***	.395

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.3

Results of CFA: Fragility of operations (internal processes)

Path			**Standardized regression weight**	**S.E.**	**C.R.**	**P**	**SMMC**
ORIP9	<---	Alignment with stakeholders	.454	.129	4.948	***	.206
ORIP8	<---	Alignment with stakeholders	.738	.097	8.498	***	.545
ORIP4	<---	Alignment with stakeholders	.707	.094	8.119	***	.500
ORIP7	<---	Alignment with stakeholders	.852	142	8.498	***	.725
ORIP6	<---	Execution and evaluation of internal operational processes	.661	281	5.125	***	.437
ORIP10	<---	Execution and evaluation of internal operational processes	.648	.156	5.886	***	.421
ORIP5	<---	Execution and evaluation of internal operational processes	.661	.157	6.010	***	.437
ORIP2	<---	Execution and evaluation of internal operational processes	.646	.130	5.908	***	.417
ORIP1	<---	Execution and evaluation of internal operational processes	.545	.135	5.125	***	.297
ORIP3	<---	Execution and evaluation of internal operational processes	.305	.170	2.921	.003	.093

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.4

Results of CFA: Fragility of operations (people-related risk events)

Path			**Standardized regression weight**	**S.E.**	**C.R.**	**P**	**SMMC**
ORP5	<---	Human Resources	.579	.158	5.593	***	.336
ORP4	<---	Human Resources	.760	.517	3.841	***	.578
ORP3	<---	Human Resources	.704	.143	6.474	***	.495
ORP2	<---	Human Resources	.627	.156	5.981	***	.393
ORP1	<---	Human Resources	.388	.131	3.841	***	.151

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.5

Results of CFA: Fragility of operations (operation systems)

Path			Standardized regression weight	S.E.	C.R.	P	SMMC
ORS1	<---	Failure of System	.510	.147	5.190	***	.260
ORS5	<---	Failure of System	.781	.232	5.176	***	.610
ORS3	<---	Failure of System	.681	.213	5.919	***	.463
ORS4	<---	Failure of System	.811	.253	5.190	***	.657
ORS2	<---	Technological Innovative Capabilities	.436	.092	4.701	***	.190
ORS6	<---	Technological Innovative Capabilities	.550	.228	4.654	***	.303
ORS7	<---	Technological Innovative Capabilities	.779	.355	4.766	***	.607
ORS8	<---	Technological Innovative Capabilities	.925	.492	4.701	***	.856

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * p < 0.05, ** p < 0.01, *** p < 0.001.
e. SMCC = squared multiple correlation coefficient

Appendix 6.6

Results of CFA: Fragility of operations (external events)

Path			Standardized regression weight	S.E.	C.R.	P	SMMC
OREE12	<---	Volatility of market conditions	.607	.128	5.559	***	.368
OREE11	<---	Volatility of market conditions	.788	.177	5.844	***	.621
OREE13	<---	Volatility of market conditions	.720	.253	5.559	***	.518
OREE14	<---	Volatility of market conditions	.495	.116	6.064	***	.245
OREE9	<---	Volatility of costing and pricing	.717	.226	5.171	***	.513
OREE5	<---	Volatility of costing and pricing	.502	.165	5.171	***	.252
OREE7	<---	Volatility of costing and pricing	.673	.142	6.844	***	.452
OREE1	<---	Volatility of financial macroeconomic conditions	.665	.131	6.722	***	.442
OREE3	<---	Volatility of financial macroeconomic conditions	.721	.467	4.295	***	.519
OREE2	<---	Volatility of financial macroeconomic conditions	.381	.116	4.295	***	.145

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.7

Results of CFA: Fragility of business units

Path			**Standardized regression weight**	**S.E.**	**C.R.**	**P**	**SMMC**
BUR3	<---	Failure of business processes	.687	.121	6.888	***	.472
BUR6	<---	Failure of business processes	.774	.159	6.677	***	.599
BUR4	<---	Failure of business processes	.653	.179	6.490	***	.426
BUR5	<---	Failure of business processes	.863	.157	8.158	***	.745
BUR9	<---	Failure of business processes	.686	.175	6.888	***	.471
BUR8	<---	Mis-utilization of assets	.670	.192	5.233	***	.449
BUR7	<---	Mis-utilization of assets	.774	.187	6.285	***	.600
BUR2	<---	Mis-utilization of assets	.560	.175	5.111	***	.314
BUR1	<---	Mis-utilization of assets	.576	.190	5.233	***	.332

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.8

Appendix 6.8: Results of CFA: Fragility of projects

Path			Standardized regression weight	S.E.	C.R.	P	SMMC
PR13	<---	Risk Monitoring	.607	.106	6.665	***	.368
PR18	<---	Risk Monitoring	.637	.114	7.119	***	.405
PR23	<---	Risk Monitoring	.608	.088	6.721	***	.370
PR16	<---	Risk Monitoring	.774	.119	8.495	***	.599
PR7	<---	Risk Monitoring	.832	.103	9.630	***	.692
PR17	<---	Risk Monitoring	.750	.117	8.495	***	.562
PR14	<---	Project Scope	.509	.126	5.189	***	.259
PR15	<---	Project Scope	.598	.131	6.048	***	.357
PR1	<---	Project Scope	.611	.132	7.090	***	.373
PR5	<---	Project Scope	.710	.116	7.143	***	.504
PR3	<---	Project Scope	.696	.135	7.057	***	.484
PR4	<---	Project Scope	.712	.135	7.221	***	.508
PR6	<---	Project Scope	.668	.131	6.816	***	.447
PR2	<---	Project Scope	.693	.209	6.048	***	.480
PR22	<---	Risk Responding	.622	.129	6.212	***	.387
PR21	<---	Risk Responding	.772	.133	7.465	***	.597
PR24	<---	Risk Responding	.695	.177	6.351	***	.483
PR20	<---	Risk Responding	.616	.131	6.117	***	.380
PR19	<---	Risk Responding	.641	.140	6.351	***	.411

PR9	<---	Risk Integrating	.533	.379	4.563	***	.284
PR8	<---	Risk Integrating	.501	.150	5.939	***	.251
PR10	<---	Risk Integrating	.472	.139	4.688	***	.223
PR11	<---	Risk Integrating	.401	.127	4.563	***	.161

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.9

Results of CFA: Resilience attributes

Path			Standardized regression weight	S.E.	C.R.	P	SMMC
RGR11	<---	Risk Governance	.613	.104	7.256	***	.376
RDMR2	<---	Risk Governance	.755	.093	9.327	***	.570
RGR8	<---	Risk Governance	.818	.107	9.565	***	.670
RGR10	<---	Risk Governance	.777	.091	9.945	***	.604
RGR6	<---	Risk Governance	.706	.113	8.574	***	.498
RGR4	<---	Risk Appetite	.677	.158	6.860	***	.458
RAR3	<---	Risk Appetite	.837	.119	8.231	***	.701
RAR5	<---	Risk Appetite	.643	.127	6.542	***	.414
RAR2	<---	Risk Appetite	.740	.114	7.432	***	.548
RAR4	<---	Risk Appetite	.678	.134	6.860	***	.459
RGR9	<---	Risk Decision Making	.767	.113	7.729	***	.588
RDMR1	<---	Risk Decision Making	.837	.196	6.756	***	.701
RDMR4	<---	Risk Decision Making	.667	.115	7.419	***	.444
RDMR5	<---	Risk Decision Making	.611	.112	6.756	***	.373
RDMR3	<---	Risk Policies Design	.769	.140	7.003	***	.591
RAR1	<---	Risk Policies Design	.802	.136	7.254	***	.643
RGR2	<---	Risk Policies Design	.668	.118	9.214	***	.446
RGR1	<---	Risk Policies Design	.697	.100	9.214	***	.485
RGR7	<---	Risk Governance	.765	.102	9.565	***	.586
RCR7	<---	Risk Culture	.614	.111	6.118	***	.377
RCR2	<---	Risk Culture	.802	.087	11.175	***	.643
RCR1	<---	Risk Culture	.672	.085	8.504	***	.451
RCR3	<---	Risk Culture	.902	.159	8.150	***	.813
RCR4	<---	Risk Culture	.641	.095	8.150	***	.411

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 6.10

Results of CFA: Risk management performance

Path			**Standardized regression weight**	**S.E.**	**C.R.**	**P**	**SMMC**
Perform3	<---	Risk Management Practice	.650	.083	6.616	***	.423
Perform5	<---	Risk Management Practice	.804	.276	6.616	***	.646
Perform4	<---	Risk Management Practice	.789	.236	6.610	***	.622
Perform2	<---	Risk Intelligence	.892	.324	3.922	***	.796
Perform1	<---	Risk Intelligence	.695	.201	3.922	***	.483

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 7.1

SEM Results: The fragility of strategy and risk management performance

			ERC (Stand)	S.E.	C.R.	P	SMCC
Financial & Strategic Innovations	<---	Fragility of Strategy	.744	.129	4.643	***	.553
Globalization Politics	<---	Fragility of Strategy	.528	.126	3.802	***	.279
Business Models & Plans	<---	Fragility of Strategy	1.119	.282	4.408	***	1.252
Performance	<---	Fragility of Strategy	.333	.123	3.068	**	.111
SR10	<---	Business Models & Plans	.646	.109	6.974	***	.418
SR13	<---	Business Models & Plans	.748	.207	6.278	***	.560
SR14	<---	Business Models & Plans	.581	.123	6.278	***	.338
SR12	<---	Business Models & Plans	.704	.124	7.458	***	.496
SR8	<---	Business Models & Plans	.702	.123	6.559	***	.493
SR11	<---	Financial & Strategic Innovations	.751	.153	6.751	***	.565
SR9	<---	Financial & Strategic Innovations	.807	.127	7.166	***	.651
SR7	<---	Financial & Strategic Innovations	.485	.122	5.005	***	.235
SR1	<---	Financial & Strategic Innovations	.441	.128	4.578	***	.194
SR16	<---	Financial & Strategic Innovations	.601	.089	8.734	***	.361

SR15	<---	Financial & Strategic Innovations	.663	.143	6.751	***	.439
SR2	<---	Globalization & Politics	.548	.177	4.573	***	.300
SR5	<---	Globalization & Politics	.637	.148	4.938	***	.406
SR6	<---	Globalization &Politics	.706	.278	4.938	***	.498
Perform5	<---	Performance	.813	.304	6.361	***	.661
Perform4	<---	Performance	.800	.119	7.196	***	.641
Perform3	<---	Performance	.621	.081	6.361	***	.386

Notes

f. Estimated regression coefficients: Standardised
g. Standard error of estimated coefficient
h. composite reliability
i. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.
j. SMCC = squared multiple correlation coefficient

Appendix 7.2

SEM Results: The fragility of governance and risk management performance

			ERC	S.E.	C.R.	P	SMCC
Risk Guidelines	<---	Governance Fragility	.602	.145	4.091	***	.362
Risk Auditing	<---	Governance Fragility	.736	.360	3.863	***	.541
Risk Communication	<---	Governance Fragility	.861	.198	4.048	***	.742
Performance	<---	Governance Fragility	.498	.183	3.596	***	.248
GR4	<---	Risk Guidelines	.547	.140	5.978	***	.300
GR8	<---	Risk Guidelines	.548	.130	5.988	***	.301
GR10	<---	Risk Guidelines	.713	.114	7.810	***	.508
GR7	<---	Risk Guidelines	.719	.126	8.350	***	.516
GR9	<---	Risk Guidelines	.801	.094	8.417	***	.642
GR5	<---	Risk Guidelines	.763	.102	8.362	***	.582
GR6	<---	Risk Guidelines	.795	.114	8.350	***	.632
GR13	<---	Risk Auditing	.673	.106	6.681	***	.454
GR11	<---	Risk Auditing	.611	.128	6.130	***	.373
GR12	<---	Risk Auditing	.644	.141	6.432	***	.415
GR14	<---	Risk Auditing	.774	.207	6.130	***	.599
GR3	<---	Risk Communication	.704	.179	5.293	***	.496
GR1	<---	Risk Communication	.508	.196	4.389	***	.258
GR2	<---	Risk Communication	.641	.264	4.389	***	.411
Perform3	<---	Performance	.635	.082	6.519	***	.403
Perform4	<---	Performance	.796	.117	7.346	***	.634
Perform5	<---	Performance	.807	.158	7.346	***	.651

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 7.3

SEM Results: The fragility of operations and risk management performance

Path			**ERC (Stand)**	**S.E.**	**C.R.**	**P**	**SMCC**
ORIP Fragility	<---	Fragility of Operations	.865	.418	4.069	***	.748
ORS Fragility	<---	Fragility of Operations	1.037	.300	3.830	***	1.075
OR External Events	<---	Fragility of Operations	.909	.355	4.056	***	.825
Stakeholder Alignment	<---	ORIP Fragility	.689	.138	3.883	***	.474
Execution Evaluation ORIP	<---	ORIP Fragility	1.061	.182	5.137	***	1.126
System Failure	<---	ORS Fragility	.719	.182	4.125	***	.517
Technological Innovation	<---	ORS Fragility	.534	.190	3.240	.001	.285
Volatility Market	<---	OR External Events	.557	.143	4.139	***	.311
Volatility Costing Pricing	<---	OR External Events	.867	.445	3.249	.001	.751
Volatility Financial Macroeconomics	<---	OR External Events	.881	.169	6.334	***	.776
People	<---	Fragility of Operations	.575	.301	2.711	.007	.330
Performance	<---	Fragility of Operations	.322	.174	2.501	.012	.103
ORP5	<---	People	.590	.382	4.074	***	.348
ORP4	<---	People	.765	.191	5.849	***	.585
ORP3	<---	People	.671	.179	5.489	***	.450
ORP2	<---	People	.611	.196	5.170	***	.373
ORP1	<---	People	.445	.158	4.074	***	.198
ORIP9	<---	Stakeholder Alignment	.455	.129	4.962	***	.207
ORIP8	<---	Stakeholder Alignment	.741	.270	4.783	***	.549
ORIP4	<---	Stakeholder Alignment	.703	.251	4.690	***	.495
ORIP7	<---	Stakeholder Alignment	.851	.314	4.962	***	.725
ORIP6	<---	Execution Evaluation ORIP	.666	.238	5.399	***	.443
ORIP10	<---	Execution Evaluation ORIP	.628	.146	5.997	***	.394

ORIP5	<---	Execution Evaluation ORIP	.634	.134	6.683	***	.402
ORIP2	<---	Execution Evaluation ORIP	.738	.137	6.307	***	.544
ORIP1	<---	Execution Evaluation ORIP	.616	.144	5.399	***	.380
ORS1	<---	System Failure	.764	.212	6.578	***	.584
ORS5	<---	System Failure	.653	.132	7.076	***	.426
ORS3	<---	System Failure	.737	.195	6.529	***	.544
ORS4	<---	System Failure	.662	.109	6.578	***	.438
ORS2	<---	Technological Innovation	.414	.104	4.439	***	.171
ORS6	<---	Technological Innovation	.641	.305	4.254	***	.411
ORS7	<---	Technological Innovation	.874	.454	4.394	***	.764
ORS8	<---	Technological Innovation	.821	.486	4.439	***	.674
OREE12	<---	Volatility Market	.638	.255	4.264	***	.407
OREE11	<---	Volatility Market	.771	.229	5.908	***	.594
OREE13	<---	Volatility Market	.708	.226	5.805	***	.501
OREE14	<---	Volatility Market	.482	.216	4.264	***	.232
ORIP3	<---	Execution Evaluation ORIP	.305	.157	3.152	.002	.093
OREE9	<---	Volatility Costing Pricing	.773	.231	5.489	***	.597
OREE5	<---	Volatility Costing Pricing	.423	.166	4.034	***	.179
OREE7	<---	Volatility Costing Pricing	.588	.144	5.489	***	.346
OREE1	<---	Volatility Financial Macroeconomics	.784	.150	7.438	***	.615
OREE3	<---	Volatility Financial Macroeconomics	.664	.127	6.978	***	.441
OREE2	<---	Volatility Financial Macroeconomics	.710	.121	7.438	***	.505
Perform3	<---	Performance	.630	.083	6.407	***	.397
Perform4	<---	Performance	.808	.258	6.398	***	.653
Perform5	<---	Performance	.798	.292	6.407	***	.637

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appedix 7.4

SEM Results: The fragility of business units and risk management performance

Path			**ERC (Stand)**	**S.E.**	**C.R.**	**P**	**SMCC**
Failure of business processes	<---	Fragility of Business Unit	.673	.232	3.217	***	.453
Mis-utilization of assets	<---	Fragility of Business Unit	1.014	.406	3.233	***	1.029
Performance	<---	Fragility of Business Unit	.483	.241	3.037	.002	.233
BUR3	<---	Failure of business processes	.687	.121	6.895	***	.472
BUR6	<---	Failure of business processes	.770	.158	6.683	***	.593
BUR4	<---	Failure of business processes	.650	.178	6.488	***	.423
BUR5	<---	Failure of business processes	.867	.157	8.216	***	.752
BUR9	<---	Failure of business processes	.685	.174	6.895	***	.469
BUR8	<---	Mis-utilization of assets	.641	.181	4.697	***	.411
BUR7	<---	Mis-utilization of assets	.705	.178	6.263	***	.496
BUR2	<---	Mis-utilization of assets	.578	.215	4.480	***	.334
BUR1	<---	Mis-utilization of assets	.652	.250	4.697	***	.425
Perform3	<---	Performance	.615	.085	6.359	***	.379
Perform4	<---	Performance	.839	.129	7.339	***	.704
Perform5	<---	Performance	.776	.144	7.339	***	.601

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 7.5

SEM Results: The fragility of projects and risk management performance

Path			**ERC (Stand)**	**S.E.**	**C.R.**	**P**	**SMCC**
Risk Monitoring	<---	Project Fragility	.685	.167	4.651	***	.469
Project Scope	<---	Project Fragility	.818	.154	4.738	***	.669
Risk Responding	<---	Project Fragility	.915	.174	4.997	***	.837
Risk Integrating	<---	Project Fragility	.998	.184	4.480	***	.996
Performance	<---	Project Fragility	.410	.106	3.248	.001	.168
PR13	<---	Risk Monitoring	.605	.118	6.050	***	.366
PR18	<---	Risk Monitoring	.639	.122	6.806	***	.408
PR23	<---	Risk Monitoring	.609	.085	7.115	***	.370
PR16	<---	Risk Monitoring	.791	.123	8.433	***	.626
PR7	<---	Risk Monitoring	.822	.115	8.710	***	.676
PR17	<---	Risk Monitoring	.741	.231	6.050	***	.549
PR14	<---	Project Scope	.517	.109	7.648	***	.267
PR15	<---	Project Scope	.599	.130	6.061	***	.359
PR1	<---	Project Scope	.614	.233	5.100	***	.377
PR5	<---	Project Scope	.710	.189	5.540	***	.503
PR3	<---	Project Scope	.692	.198	6.048	***	.479
PR4	<---	Project Scope	.711	.200	6.163	***	.506
PR6	<---	Project Scope	.670	.191	5.922	***	.449
PR2	<---	Project Scope	.694	.209	6.061	***	.482
PR22	<---	Risk Responding	.633	.160	5.839	***	.401
PR21	<---	Risk Responding	.752	.167	6.606	***	.565
PR24	<---	Risk Responding	.710	.184	6.356	***	.504
PR20	<---	Risk Responding	.621	.133	6.950	***	.386

PR19	<---	Risk Responding	.628	.137	6.606	***	.395
PR9	<---	Risk Integrating	.465	.275	4.351	***	.216
PR8	<---	Risk Integrating	.371	.269	3.363	***	.137
PR10	<---	Risk Integrating	.576	.201	5.422	***	.332
PR11	<---	Risk Integrating	.505	.169	5.422	***	.255
Perform3	<---	Performance	.626	.097	6.424	***	.392
Perform4	<---	Performance	.782	.250	6.424	***	.612
Perform5	<---	Performance	.827	.304	6.409	***	.683

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 7.6

SEM Results: Resilience attributes and risk management performance

			ERC (Stand)	S.E.	C.R.	P	SMCC
Risk Governance	<---	Resilience	.91	.115	8.341	***	.837
Risk Appetite	<---	Resilience	.90	.141	6.716	***	.819
Risk Decision Making	<---	Resilience	.86	.152	6.908	***	.744
Risk Culture	<---	Resilience	.76	.121	7.621	***	.571
Risk Policies Design	<---	Resilience	.89	.139	6.575	***	.766
Performance	<---	Resilience	.29	.145	2.739	**	.081
RGR11	<---	Risk Governance	.61	.105	7.225	***	.376
RDMR2	<---	Risk Governance	.76	.097	9.049	***	.577
RGR8	<---	Risk Governance	.81	.113	9.789	***	.663
RGR10	<---	Risk Governance	.77	.093	9.789	***	.595
RGR6	<---	Risk Governance	.72	.115	8.655	***	.514
RGR7	<---	Risk Governance	.77	.102	9.701	***	.598
RGR4	<---	Risk Appetite	.68	.184	6.504	***	.459
RAR3	<---	Risk Appetite	.83	.121	7.953	***	.689
RAR5	<---	Risk Appetite	.65	.128	6.504	***	.421
RAR2	<---	Risk Appetite	.74	.116	7.310	***	.553
RAR4	<---	Risk Appetite	.68	.134	6.896	***	.463
RGR9	<---	Risk Decision Making	.75	.114	7.555	***	.563
RDMR1	<---	Risk Decision Making	.83	.193	6.794	***	.698
RDMR4	<---	Risk Decision Making	.68	.115	7.519	***	.457
RDMR5	<---	Risk Decision Making	.62	.113	6.794	***	.379
RDMR3	<---	Risk Policies Design	.75	.135	6.917	***	.564
RAR1	<---	Risk Policies Design	.79	.131	7.256	***	.621

RGR2	<---	Risk Policies Design	.68	.155	6.917	***	.469
RGR1	<---	Risk Policies Design	.71	.099	9.279	***	.502
RCR7	<---	Risk Culture	.61	.111	6.076	***	.372
RCR2	<---	Risk Culture	.80	.089	10.969	***	.646
RCR1	<---	Risk Culture	.67	.085	8.437	***	.449
RCR3	<---	Risk Culture	.90	244	6.076	***	.811
RCR4	<---	Risk Culture	.64	.094	8.281	***	.414
Perform3	<---	Performance	.64	.084	6.474	***	.410
Perform4	<---	Performance	.80	.120	7.311	***	.645
Perform5	<---	Performance	.80	.283	6.474	***	.634

Notes

a. Estimated regression coefficients: Standardised
b. Standard error of estimated coefficient
c. composite reliability
d. Probability of a t value equal to or greater than actual t value in a two-tailed test for significance of coefficient under the null hypothesis that the true value is zero. * $p < 0.01$, ** $p < 0.005$, *** $p < 0.001$.
e. SMCC = squared multiple correlation coefficient

Appendix 8.1

Score of fragility assessment tool: ABC Bank

Value Drivers (criteria)	Cluster (sub-criteria)	Indicator	Indicator Weight	Indicator rate	Indicator gained score	sub-criteria gained score	criteria gained score
Fragility of Strategy	Business Models and Plans	Lack of feasible strategic support and action plans	0.64	1	0.64		
		Unawareness of legislation implications	0.75	0	0		
		Misapplication of business models	0.57	2	1.14		
		Unawareness of new technology	0.72	1	0.72		
		Overoptimistic or vague projections	0.7	4	2.8	31	
	Financial and Strategic innovations	Financial uncertainty	0.66	4	2.64		
		Emerging aggregated risks	0.6	5	3		
		Unable to catch up with new innovations	0.44	0	0		
		Inaccurate strategic positioning	0.49	3	1.47		
		Inefficient strategy execution	0.8	3	2.4		
		Unawareness of market economic changes	0.75	4	3	67	
	Globalization and Politics	Influence of Globalization	0.31	3	0.93		
		Disruption in the political changes	0.55	2	1.1		
		Inadequate assessment of organization capabilities	0.64	3	1.92		
		Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies	0.7	1	0.7	42.27273	46.84402
Fragility of Governance	Risk Guidelines	Inadequate mechanism for internal control	0.54	3	1.62		
		Unavailability of timely risk information	0.76	3	2.28		
		Inadequate risk assessment methods	0.79	4	3.16		
		Inadequate risk reporting systems	0.72	5	3.6		
		Inadequate risk pricing policies	0.55	3	1.65		
		Inadequate risk management reviewing processes	0.8	3	2.4		
		Inadequate risk accountability system	0.71	2	1.42	66.2423	
	Risk Auditing	Inadequate external auditing processes	0.61	2	1.22		
		Noncompliance with environmental guidelines	0.66	0	0		
		Noncompliance with fiscal and monetary guidelines	0.66	3	1.98		
		Noncompliance with mandatory reporting obligations	0.77	3	2.31	40.81481	
	Risk Communication	Fluctuation of policies and regulations	0.51	1	0.51		
		Violation of policies and regulations	0.63	3	1.89		
		Inadequate communication of objectives and targets	0.71	2	1.42	41.2973	49.45147
The fragility of operations	Alignment with stakeholders	Misalignment with stakeholders	0.76	2	1.52		
		Noncompliance with client requirements	1	1	1		
		Ineffective communication with clients	0.83	1	0.83		
		Unexpected change of customer requirements	0.64	0	0	20.74303	
	Execution and evaluation of internal operational processes	Inadequate execution of operational plans	0.69	2	1.38		
		Inadequate evaluation of operational plans	0.77	3	2.31		
		Contractual risks	0.94	3	2.82		
		Inaccurate pricing of services/products	1	0	0	30.82988	37.64695

		Unmaintained customer relationships	0.92	1	0.92		
		Excessive implementation requirements	0.5	0	0		
	People-related operational risks	Fraud or corruption	0.39	3	1.17		
		Unhappy work environment	0.63	1	0.63		
		Turnover of key talents	0.7	2	1.4		
		Inadequate talent configuration and management	0.76	2	1.52		
		Inappropriate behaviour (discrimination/harassment)	0.85	1	0.85	33.45345	
	Failure of IT systems	Hardware/software failure	0.51	3	1.53		
		Cyber-attack/ Malware or virus/ ISP disruption	0.68	4	2.72		
		Data Disclosure	78	3	234		
		Data integrity failure	0.51	2	1.02	60.04266	
	Technological innovative capabilities	Data Reporting failure	0.54	1	0.54		
		Inadequate technological innovative ability	0.78	1	0.78		
		Inadequate technical transformation ability	0.94	1	0.94	20	
	Volatility of non-financial market conditions	Infrastructure uncertainty	0.79	1	0.79		
		Service/products obsolescence	0.72	0	0		
		The scarcity of complementary services/products	0.49	0	0		
		Misalignment of interests with suppliers	0.61	0	0	6.05364	
	Volatility of financial macroeconomic conditions	Market volatility	0.66	4	2.64		
		Credit availability	0.38	4	1.52		
		Interest rate level	0.72	4	2.88	80	
	Volatility of costing and pricing	Inflation escalation	0.67	3	2.01		
		Equity price fluctuation	0.5	4	2		
		Cost volatility	0.72	1	0.72	50.05291	
Fragility of Business Units	Failure of business processes	Inadequate business unit supervision ability	0.69	4	2.76		
		Red-tape risk	0.65	3	1.95		
		Failure to follow processes	0.86	4	3.44		
		Failure to integrate with business processes	0.77	3	2.31		
		Improper planning for daily operations	0.69	2	1.38	64.69945	
	Mis-utilization of assets	Fixed assets mis-utilization	0.58	3	1.74		
		Inadequate fund management ability	0.56	1	0.56		
		Lack of cost control	0.77	1	0.77		
		Lack of resources	0.67	2	1.34	34.18605	49.44275
Fragility of Projects	Risk Monitoring	Lack of existing risk documentations on all processes and standards	0.75	3	2.25		
		Lack of using performance indices to measure project risk	0.83	2	1.66		
		Inadequate project monitoring	0.77	0	0		
		Lack of risk quantification	0.61	0	0		
		Lack of information on risk triggers	0.64	1	0.64		
		Lack of integrating cost and time management	0.61	2	1.22	27.41093	
	Project Scope	Inadequate project requirements	0.61	1	0.61		
		Inadequate scope of control	0.69	1	0.69		
		Inadequate project management ability	0.7	0	0		
		Inadequate project risk culture building	0.71	0	0	11.57692	22.81062

		Inadequate change management ability	0.71	0	0		
		Inadequate procurement management ability	0.67	0	0		
		Lack of project risk identification	0.51	1	0.51		
		Lack of identifying risk triggers	0.6	2	1.2		
	Risk Responding	Lack of immediate response to risks as they arise	0.64	3	1.92	36.88623	
		Lack of processes for tracking project risks	0.62	1	0.62		
		Lack of contingency risk plans	0.77	3	2.31		
		Lack of using risk assessment and project performance status in decision making	0.62	1	0.62		
		Lack of risk information collection	0.69	1	0.69		
	Risk Integrating	Disengagement of executives with the project	0.47	0	0	15.36842	
		Lack of re-alignment between strategic and project objectives	0.4	1	0.4		
		User's rejection of the product/service	0.5	0	0		
		Failure to record/archive lessons learned	0.53	2	1.06		

Appendix 8.2

Score of fragility assessment tool: DEF Engineering

Value Drivers (criteria)	Cluster (sub-criteria)	Indicator	Indicator Weight	Indicator rate	Indicator gained score	sub-criteria gained score	criteria gained score
Fragility of Strategy	Business Models and Plans	Lack of feasible strategic support and action plans	0.64	4	2.56	56	51.04334
		Unawareness of legislation implications	0.75	2	1.5		
		Misapplication of business models	0.57	2	1.14		
		Unawareness of new technology	0.72	1	0.72		
		Overoptimistic or vague projections	0.7	5	3.5		
	Financial and Strategic innovations	Financial uncertainty	0.66	4	2.64	60	
		Emerging aggregated risks	0.6	5	3		
		Unable to catch up with new innovations	0.44	1	0.44		
		Inaccurate strategic positioning	0.49	4	1.96		
		Inefficient strategy execution	0.8	2	1.6		
		Unawareness of market economic changes	0.75	2	1.5		
	Globalization and Politics	Influence of Globalization	0.31	2	0.62	37.81818	
		Disruption in the political changes	0.55	4	2.2		
		Inadequate assessment of organization capabilities	0.64	1	0.64		
		Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies	0.7	1	0.7		
Fragility of Governance	Risk Guidelines	Inadequate mechanism for internal control	0.54	2	1.08	68.95277	56.87348
		Unavailability of timely risk information	0.76	2	1.52		
		Inadequate risk assessment methods	0.79	4	3.16		
		Inadequate risk reporting systems	0.72	4	2.88		
		Inadequate risk pricing policies	0.55	4	2.2		
		Inadequate risk management reviewing processes	0.8	3	2.4		
		Inadequate risk accountability system	0.71	5	3.55		
	Risk Auditing	Inadequate external auditing processes	0.61	1	0.61	40.37037	
		Noncompliance with environmental guidelines	0.66	3	1.98		
		Noncompliance with fiscal and monetary guidelines	0.66	2	1.32		
		Noncompliance with mandatory reporting obligations	0.77	2	1.54		
	Risk Communication	Fluctuation of policies and regulations	0.51	2	1.02	61.2973	
		Violation of policies and regulations	0.63	4	2.52		
		Inadequate communication of objectives and targets	0.71	3	2.13		
The fragility of operations	Alignment with stakeholders	Misalignment with stakeholders	0.76	4	3.04	70.77399	54.24848
		Noncompliance with client requirements	1	5	5		
		Ineffective communication with clients	0.83	1	0.83		
		Unexpected change of customer requirements	0.64	4	2.56		
	Execution and evaluation of internal operational processes	Inadequate execution of operational plans	0.69	1	0.69	50.04149	
		Inadequate evaluation of operational plans	0.77	3	2.31		
		Contractual risks	0.94	2	1.88		
		Inaccurate pricing of services/products	1	3	3		

		Unmaintained customer relationships	0.92	4	3.68		
		Excessive implementation requirements	0.5	1	0.5		
	People-related operational risks	Fraud or corruption	0.39	4	1.56		
		Unhappy work environment	0.63	3	1.89		
		Turnover of key talents	0.7	1	0.7		
		Inadequate talent configuration and management	0.76	1	0.76		
		Inappropriate behaviour (discrimination/harassment)	0.85	4	3.4	49.90991	
	Failure of IT systems	Hardware/software failure	0.51	2	1.02		
		Cyber-attack/ Malware or virus/ ISP disruption	0.68	2	1.36		
		Data Disclosure	78	3	234		
		Data integrity failure	0.51	3	1.53	59.70138	
	Technological innovative capabilities	Data Reporting failure	0.54	1	0.54		
		Inadequate technological innovative ability	0.78	2	1.56		
		Inadequate technical transformation ability	0.94	2	1.88	35.22124	
	Volatility of non-financial market conditions	Infrastructure uncertainty	0.79	3	2.37		
		Service/products obsolescence	0.72	1	0.72		
		The scarcity of complementary services/products	0.49	4	1.96		
		Misalignment of interests with suppliers	0.61	4	2.44	57.39464	
	Volatility of financial macroeconomic conditions	Market volatility	0.66	4	2.64		
		Credit availability	0.38	2	0.76		
		Interest rate level	0.72	1	0.72	46.81818	
	Volatility of costing and pricing	Inflation escalation	0.67	4	2.68		
		Equity price fluctuation	0.5	1	0.5		
		Cost volatility	0.72	4	2.88	64.12698	
Fragility of Business Units	Failure of business processes	Inadequate business unit supervision ability	0.69	5	3.45		
		Red-tape risk	0.65	1	0.65		
		Failure to follow processes	0.86	3	2.58		
		Failure to integrate with business processes	0.77	4	3.08		
		Improper planning for daily operations	0.69	4	2.76	68.4153	
	Mis-utilization of assets	Fixed assets mis-utilization	0.58	4	2.32		
		Inadequate fund management ability	0.56	3	1.68		
		Lack of cost control	0.77	4	3.08		
		Lack of resources	0.67	2	1.34	65.27132	66.84331
Fragility of Projects	Risk Monitoring	Lack of existing risk documentations on all processes and standards	0.75	4	3		
		Lack of using performance indices to measure project risk	0.83	4	3.32		
		Inadequate project monitoring	0.77	3	2.31		
		Lack of risk quantification	0.61	4	2.44		
		Lack of information on risk triggers	0.64	5	3.2		
		Lack of integrating cost and time management	0.61	3	1.83	76.48456	
	Project Scope	Inadequate project requirements	0.61	4	2.44		
		Inadequate scope of control	0.69	3	2.07		
		Inadequate project management ability	0.7	3	2.1		
		Inadequate project risk culture building	0.71	2	1.42	64.5	60.82682

		Inadequate change management ability	0.71	3	2.13		
		Inadequate procurement management ability	0.67	4	2.68		
		Lack of project risk identification	0.51	3	1.53		
		Lack of identifying risk triggers	0.6	4	2.4		
	Risk Responding	Lack of immediate response to risks as they arise	0.64	5	3.2		
		Lack of processes for tracking project risks	0.62	3	1.86		
		Lack of contingency risk plans	0.77	3	2.31		
		Lack of using risk assessment and project performance status in decision making	0.62	3	1.86		
		Lack of risk information collection	0.69	4	2.76	71.79641	
	Risk Integrating	Disengagement of executives with the project	0.47	1	0.47		
		Lack of re-alignment between strategic and project objectives	0.4	1	0.4		
		User's rejection of the product/service	0.5	3	1.5		
		Failure to record/archive lessons learned	0.53	1	0.53	30.52632	

Appendix 8.3

Score of fragility assessment tool: XYZ Hotel

Value Drivers (criteria)	Cluster (sub-criteria)	Indicator	Indicator Weight	Indicator rate	Indicator gained score	sub-criteria gained score	criteria gained score
Fragility of Strategy	Business Models and Plans	Lack of feasible strategic support and action plans	0.64	4	2.56	56	51.04334
		Unawareness of legislation implications	0.75	2	1.5		
		Misapplication of business models	0.57	2	1.14		
		Unawareness of new technology	0.72	1	0.72		
		Overoptimistic or vague projections	0.7	5	3.5		
	Financial and Strategic innovations	Financial uncertainty	0.66	4	2.64	60	
		Emerging aggregated risks	0.6	5	3		
		Unable to catch up with new innovations	0.44	1	0.44		
		Inaccurate strategic positioning	0.49	4	1.96		
		Inefficient strategy execution	0.8	2	1.6		
		Unawareness of market economic changes	0.75	2	1.5		
	Globalization and Politics	Influence of Globalization	0.31	2	0.62	37.81818	
		Disruption in the political changes	0.55	4	2.2		
		Inadequate assessment of organization capabilities	0.64	1	0.64		
		Inadequate, uncertain or inconsistent definitions of business objectives, goals and strategies	0.7	1	0.7		
Fragility of Governance	Risk Guidelines	Inadequate mechanism for internal control	0.54	2	1.08	68.95277	56.87348
		Unavailability of timely risk information	0.76	2	1.52		
		Inadequate risk assessment methods	0.79	4	3.16		
		Inadequate risk reporting systems	0.72	4	2.88		
		Inadequate risk pricing policies	0.55	4	2.2		
		Inadequate risk management reviewing processes	0.8	3	2.4		
		Inadequate risk accountability system	0.71	5	3.55		
	Risk Auditing	Inadequate external auditing processes	0.61	1	0.61	40.37037	
		Noncompliance with environmental guidelines	0.66	3	1.98		
		Noncompliance with fiscal and monetary guidelines	0.66	2	1.32		
		Noncompliance with mandatory reporting obligations	0.77	2	1.54		
	Risk Communication	Fluctuation of policies and regulations	0.51	2	1.02	61.2973	
		Violation of policies and regulations	0.63	4	2.52		
		Inadequate communication of objectives and targets	0.71	3	2.13		
The fragility of operations	Alignment with stakeholders	Misalignment with stakeholders	0.76	4	3.04	70.77399	54.24848
		Noncompliance with client requirements	1	5	5		
		Ineffective communication with clients	0.83	1	0.83		
		Unexpected change of customer requirements	0.64	4	2.56		
	Execution and evaluation of internal operational processes	Inadequate execution of operational plans	0.69	1	0.69	50.04149	
		Inadequate evaluation of operational plans	0.77	3	2.31		
		Contractual risks	0.94	2	1.88		
		Inaccurate pricing of services/products	1	3	3		

		Unmaintained customer relationships	0.92	4	3.68		
		Excessive implementation requirements	0.5	1	0.5		
	People-related operational risks	Fraud or corruption	0.39	4	1.56		
		Unhappy work environment	0.63	3	1.89		
		Turnover of key talents	0.7	1	0.7		
		Inadequate talent configuration and management	0.76	1	0.76		
		Inappropriate behaviour (discrimination/harassment)	0.85	4	3.4	49.90991	
	Failure of IT systems	Hardware/software failure	0.51	2	1.02		
		Cyber-attack/ Malware or virus/ ISP disruption	0.68	2	1.36		
		Data Disclosure	78	3	234		
		Data integrity failure	0.51	3	1.53	59.70138	
	Technological innovative capabilities	Data Reporting failure	0.54	1	0.54		
		Inadequate technological innovative ability	0.78	2	1.56		
		Inadequate technical transformation ability	0.94	2	1.88	35.22124	
	Volatility of non-financial market conditions	Infrastructure uncertainty	0.79	3	2.37		
		Service/products obsolescence	0.72	1	0.72		
		The scarcity of complementary services/products	0.49	4	1.96		
		Misalignment of interests with suppliers	0.61	4	2.44	57.39464	
	Volatility of financial macroeconomic conditions	Market volatility	0.66	4	2.64		
		Credit availability	0.38	2	0.76		
		Interest rate level	0.72	1	0.72	46.81818	
	Volatility of costing and pricing	Inflation escalation	0.67	4	2.68		
		Equity price fluctuation	0.5	1	0.5		
		Cost volatility	0.72	4	2.88	64.12698	
Fragility of Business Units	Failure of business processes	Inadequate business unit supervision ability	0.69	5	3.45		
		Red-tape risk	0.65	1	0.65		
		Failure to follow processes	0.86	3	2.58		
		Failure to integrate with business processes	0.77	4	3.08		
		Improper planning for daily operations	0.69	4	2.76	68.4153	
	Mis-utilization of assets	Fixed assets mis-utilization	0.58	4	2.32		
		Inadequate fund management ability	0.56	3	1.68		
		Lack of cost control	0.77	4	3.08		
		Lack of resources	0.67	2	1.34	65.27132	66.84331
Fragility of Projects	Risk Monitoring	Lack of existing risk documentations on all processes and standards	0.75	4	3		
		Lack of using performance indices to measure project risk	0.83	4	3.32		
		Inadequate project monitoring	0.77	3	2.31		
		Lack of risk quantification	0.61	4	2.44		
		Lack of information on risk triggers	0.64	5	3.2		
		Lack of integrating cost and time management	0.61	3	1.83	76.48456	
	Project Scope	Inadequate project requirements	0.61	4	2.44		
		Inadequate scope of control	0.69	3	2.07		
		Inadequate project management ability	0.7	3	2.1		
		Inadequate project risk culture building	0.71	4	2.84	75.42308	63.55759

		Inadequate change management ability	0.71	5	3.55		
		Inadequate procurement management ability	0.67	4	2.68		
		Lack of project risk identification	0.51	3	1.53		
		Lack of identifying risk triggers	0.6	4	2.4		
	Risk Responding	Lack of immediate response to risks as they arise	0.64	5	3.2		
		Lack of processes for tracking project risks	0.62	3	1.86		
		Lack of contingency risk plans	0.77	3	2.31		
		Lack of using risk assessment and project performance status in decision making	0.62	3	1.86		
		Lack of risk information collection	0.69	4	2.76	71.79641	
	Risk Integrating	Disengagement of executives with the project	0.47	1	0.47		
		Lack of re-alignment between strategic and project objectives	0.4	1	0.4		
		User's rejection of the product/service	0.5	3	1.5		
		Failure to record/archive lessons learned	0.53	1	0.53	30.52632	