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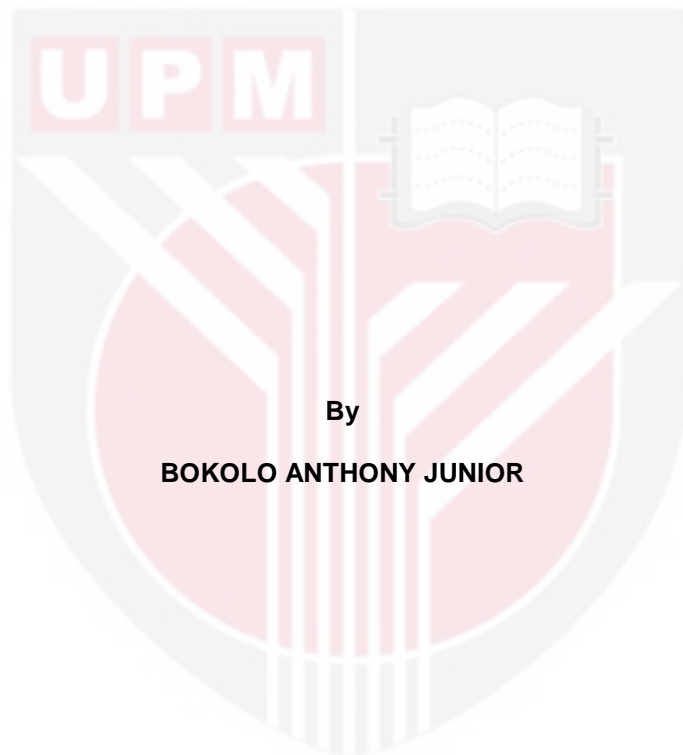
***A RISK MITIGATION MODEL OF INFORMATION TECHNOLOGY
GOVERNANCE IN SELECTED MALAYSIAN UNIVERSITIES***

BOKOLO ANTHONY JUNIOR

FSKTM 2015 2



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GOVERNANCE IN SELECTED MALAYSIAN UNIVERSITIES**



By

BOKOLO ANTHONY JUNIOR

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of Master of
Science**

November 2015

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

**A RISK MITIGATION MODEL OF INFORMATION TECHNOLOGY
GOVERNANCE IN SELECTED MALAYSIAN UNIVERSITIES**

By

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November 2015

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Information Technology (IT) Governance faces various risks such as strategic, operational and technical risks. These risks should be identified, measured and mitigated. After risks are identified, appropriate actions should be devoted to mitigate these risks. However, risk mitigation is a complicated process especially in IT Governance. It leads to difficulty in choosing and executing mitigation actions. The mitigation of risks aids practitioners to identify the cause and effect among the components of risks mitigation and it provides a suitable metric to measure these risks. In mitigating risk, accurate decision making is based on the identified and measured risks. Risk mitigation in IT Governance provides a multi-disciplinary environment for proactive decision making to measure and treat potential risk continuously. However, the existing standards for risk mitigation show limitations when mitigating operational and technical risks. Besides, the existing model provides inadequate support to practitioners in making risk decision pertaining to risk mitigation especially in IT governance. This is due to the fact that existing models lacks the capabilities to support practitioners in making decision relating to risk mitigation. The mitigation risks were identified by previous researchers, academicians and practitioners use various techniques such as prioritizing, evaluating and ranking the risks. This research develops a risk mitigation model for risk mitigation of IT Governance. In order to develop the model, this research identifies the processes and operational and technical risk components in mitigating risk of IT Governance. The risk mitigation system (RMS) is developed based on proposed model using software agents and knowledge mapping. The research scope is mainly on several Malaysian universities that specifically mainly decision in risk mitigation process. Qualitative research using Case study was adopted using only interview mainly in this research. Pilot study was carried out in 2 Malaysian universities with 5 expert informants to verify the instrument and the data of risk mitigation based on IT Governance. The case study was carried out in 2 Malaysian Universities which involved 7 expert informants to verify the risk mitigation process and components derived from the literature review. The risk decisions process was verified by adopting Iterative triangulation. The risk mitigation model can assists in measuring the probabilities and impact of risks, provides risk reduction advice using risk data, provide suggestions for monitoring activities, supporting

collaborative decision-making process among risk mitigation practitioners in their organisation.

Keywords

Risk, Risk Mitigation, Knowledge Mapping, Software Agent, Risk Decision, IT Governance.



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

SUATU MODEL PENGURANGAN RISIKO DALAM TADBIR URUS TEKNOLOGI MAKLUMAT DI UNIVERSITIES MALAYSIA DIPILIH

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Tadbir Urus Teknologi Maklumat (IT) menghadapi pelbagai risiko seperti risiko strategik, operasi dan teknikal. Risiko ini perlu dikenal pasti, diukur dan dikurangkan. Selepas risiko dikenal pasti, tindakan yang bersesuaian perlu untuk mengurangkan risiko ini. Walau bagaimanapun, pengurangan risiko adalah satu proses yang rumit terutama dalam Tadbir Urus IT. Ia membawa kepada kesukaran dalam memilih dan melaksanakan tindakan pengurangan. Pengurangan risiko membantu pengamal untuk mengenalpasti kesan dan akibat antara komponen pengurangan risiko dan ia menyediakan metrik yang sesuai untuk mengukur risiko ini. Dalam mengurangkan risiko, membuat keputusan yang betul adalah berdasarkan risiko yang dikenalpasti dan diukur. Pengurangan risiko dalam Tadbir Urus IT menyediakan persekitaran yang multi disiplin untuk membuat keputusan proaktif bagi mengukur dan merawat potensi risiko secara berterusan. Walaubagaimanapun, piawai yang sedia ada menunjukkan kekangan apabila mengurangkan risiko teknikal dan operasi. Selain itu, model yang sedia ada memberikan sokongan yang tidak mencukupi kepada pengamal dalam membuat keputusan berkaitan dengan pengurangan risiko dalam Tadbir Urus IT. Ini adalah menunjukkan bahawa pendekatan yang sedia ada tidak mempunyai keupayaan untuk menyokong pengamal dalam membuat keputusan yang berkaitan dengan pengurangan risiko. Pengurangan risiko yang dikenal pasti oleh penyelidik, ahli akademik dan pengamal sebelum ini, menggunakan pelbagai teknik seperti membuat keutamaan, menilai dan menyusun risiko. Kajian ini membangunkan suatu model untuk pengurangan risiko bagi Tadbir Urus IT. Dalam usaha untuk membangunkan model, kajian ini mengenalpasti proses dan komponen teknikal dan operasi bagi pengurangan risiko dalam bidang Tadbir Urus IT. Sistem Pengurangan Risiko (RMS) telah dibangunkan berdasarkan model yang telah dikemukakan menggunakan agen perisian dan pemetaan pengetahuan. Secara umum skop penyelidikan ini melibatkan beberapa buah universiti di Malaysia dan secara khususnya membuat keputusan dalam mengurangkan risiko. Kajian kes kualitatif yang telah digunakan hanya melibatkan temubual sahaja. Kajian rintis telah dijalankan di dua buah universiti di Malaysia dengan melibatkan lima orang pakar untuk mengesahkan instrumen dan data pengurangan risiko berdasarkan Tadbir Urus IT. Kajian kes telah dijalankan di dua buah universiti

di Malaysia dengan melibatkan tujuh orang pakar untuk mengesahkan proses pengurangan risiko dan komponen yang diperolehi daripada kajian literatur. Proses keputusan risiko telah disahkan dengan berpandukan teknik Iterative Triangulation. Model pengurangan risiko ini adalah berupaya untuk membantu dalam mengukur kebarangkalian dan kesan risiko, menyediakan nasihat risiko pengurangan menggunakan data risiko, menyediakan cadangan untuk aktiviti pemantauan, menyokong proses membuat keputusan kerjasama di kalangan pengamal pengurangan risiko dalam organisasi mereka.

Kata kunci

Risiko, Pengurangan Risiko, Pemetaan Pengetahuan, Agen Perisian, Keputusan Risiko, Tadbir Urus IT.



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I certify that a Thesis Examination Committee has met on 25 November 2015 to conduct the final examination of Bokolo Anthony Junior on his thesis entitled "A Risk Mitigation Model of Information Technology Governance in Selected Malaysian Universities" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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LIST OF ABBREVIATIONS

BSC	Balance Score Card
CIO	Chief Information Officer
DA	Data Analysis
DSS	Decision Support System
FST	Faculty Science Technology
GB	Gigabyte
GSD	Global Software Development
HTML	Hypertext Markup Language
ICT	Information and Communications Technology
iDEC	InfoComm Development Centre
IDS	Intrusion Detection System
IS	Information Systems
IT	Information Technology
ITC	Information Technology Care
ITGI	Information Technology Governance Institute
ISMS	Information Security Management System
ISO/IEC	International Organization for Standardization/The International Electro Technical Commission
ISP	Internet Service Provider
KM	Knowledge Mapping
MUs	Malaysian Universities
MyRAM	Malaysian Public Sector Information Security Risk Assessment System
MYSQL	Microsoft Structured Query Language
PHP	Hypertext Preprocessor
PMO	Project Monitoring Officer
QDA	Qualitative Data Analysis
RAM	Random Access Memory
RMS	Risk Mitigation System
SDLC	System Development Life Cycle
SLR	Systematic Literature Review Systematic Literature Review
SMB	Small and Medium Business
SMEs	Small and Medium-Sized Enterprises
SPM	Student Information System
SWOT	Strength, Weakness, Opportunity and Threats
TCP/IP	Transmission Control Protocol/Internet Protocol
UML	Unified Modelling Language
UPM	Universiti Putra Malaysia
URL	Uniform Resource Locator
USIM	Universiti Sains Islam
VGA	Video Graphics Array
VPN	Virtual Private Network
WAF	Web Application Firewall

CHAPTER 1

INTRODUCTION

1.1 Overview

Information Technology (IT) governance aims to direct IT activities to guarantee that its performance meets the objectives set out in its strategy (Lin, et al., 2011). With effective governance, the return of IT project can be optimized to support IT practitioner in their organisational business strategies and goal. IT governance mainly focused on the area of IT strategic alignment, IT resource management, risk management, performance measurement and IT value delivery (ITGI, 2008). In IT Governance risk occurs, risk can be normally said as something that what might go wrong in any organisation. Risk is also a combination of the likelihood of an event and its effects (Saint, 2005), thus practitioners must learn to treat the possible negative effects of risk against the possible gains of its related opportunity (ITGI, 2005).

In IT Governance, risk management is a safety consideration that defines, measures, and controls uncertain events in an attempt to reduce as many losses as possible, and to optimize IT infrastructure. Therefore risk management in IT Governance involves methods to uncover potential risks, to predict losses, and to take proper action to prevent and control risk (Yu, 2009). Risk mitigation has been a prime area of research since last two decades, and this area of research has received a highly overwhelming response and contribution from the researcher both: in industry and academia. Risk mitigation is one of the main activities in IT governance. Risk mitigation is defined as the process of identifying risk and selects suitable solutions to reduce risk according to the objectives of the practitioners (experts, IT managers, staffs, decision makers). It includes monitoring, tracking and evaluating risk process effectiveness throughout the utilization of IT infrastructures. The mitigation of risk provides a mechanism for practitioners to handle risk effectively by providing the step wise execution of the risk method, thus presenting a medium to understand and express the each mitigation strategy against any risk factors in IT Governance (Basit et al., 2011).

Risk mitigation can be said to be an important process to assist practitioners achieving the new business changes, future investment in information technology and information system (Lainhart, 2010). Risk mitigation is sequence of phase's aims at identifying, addressing, and reducing risk before they turn out to be either threat to effective IT operation (Bodnar, 2008). Mohd et al. (2007) stated that the mitigation of risks aids managers to understand the mutual relationships among the enablers of risks mitigation and provides a suitable metric to quantify these risks. Thus practitioners are provided with an opportunity to understand the focal areas that needs attention to minimise the risks to the real time and sharing of risk information. Thus risk mitigation gives

opportunity to the management to quantify risks in IT environments and develop suitable strategies to treat the risk.

Poor decision making by practitioners in risk mitigation is due to unwillingness to rely on others for decisions, not taking ownership of decisions, conflicting priorities and unstable staff availability of decision. In risk mitigation, decision making means recognizing risks, generating alternative solutions to the risks, choosing among alternatives, and implementing the chosen alternative (Mihane and Albana, 2013). Nowadays IT Governance decision making is the key to the long term survival of IT organisations. Each organisation must be capable in making good decisions. Making good decisions often requires knowledge that can provide the decision maker with data, information and answer to questions, relating to risk mitigation, without such support decisions may be based intuitions or guesses (Mihane and Albana, 2013).

Decision making is important in risk mitigation to align the organisation policy and procedure structure for effective decision making in IT governance, build varied and continuous feedback to be applied into IT governance, decision making and planning processes (James, 2005). According to Gabriel and Obara (2013) decision making is important in risk mitigation and it dependent on the quality of decisions that informs its operation. If decisions are right, it translates in positive organizational outcomes, but where organizational activities are executed in conditions of poor decisions resulting from insufficient or inaccurate information, such organization could be ruined. A suitable decision making process can assist organisations to increase the effectiveness and incorporating improvements aimed at better understanding, improved communication and more effective management (Ddembe and Michael, 2005).

1.2 Problem Statement

The main problem emerging in the field of IT risk mitigation is mainly due to existing approaches not being able to provide adequate support to practitioners in mitigating risk in IT Governance. Literature revealed that increasing complexity of IT processes and the continuously growth of risk in IT governance shows that critical decisions on mitigating operational and technical risk in IT infrastructures must be made as early as possible, once the risk is identified (Khoo, et al., 2009 and Kayis, et al., 2007). Mitigating technical and operational risks under limited knowledge is also a limitation and major setback to secure a successful IT governance implementation. Thus the lack of risk decision in risk mitigation and the inadequate support and lack of capabilities to support practitioners in mitigating risk are the identified problems that will be addressed in this research.

1.2.1 Lack of Risk Decision in Risk Mitigation

Decisions are performed to mitigating risk in IT Governance. Practitioners make decisions to solve operational and technical risk. However, existing approaches provide inadequately assistance for practitioners to make risk decision on mitigating identified risk in IT governance (Ahdieh et al., 2012). Therefore mitigation of risk in IT Governance is not properly carried out, since the risk decisions are basically ignored by practitioners. The risk decisions needs to be performed in order to have a proficient risk mitigation process in the mitigation of identified risks in IT Governance (Ahdieh et al., 2012).

1.2.2 Inadequate Support and Lack of Capabilities to Support Practitioners

Mitigating risk in IT Governance is unsuccessful due to inadequate support in the reuse of lessons learnt; best practices and expertise to mitigate risk (Khoo, et al., 2009). These supports can be useful to practitioners who are less experienced with the current risks (John, et al., 2009; Kayis, et al., 2007). Risk mitigation practitioners can derive huge benefits from the sharing and reuse of historical data extracted from past projects which is lacking in existing risk mitigation approaches (Thamer, et al., 2009; Gregory, 1994). Furthermore, existing techniques lacks capabilities to support practitioners in IT Governance in mitigating the risk and reuse the knowledge to identify undiscovered risks (Rajesh and Suraj, 2009).

1.3 Research Questions

1. What are the components for risk decisions in mitigating risk of IT Governance?
2. What are the processes for risk decisions in mitigating risk of IT Governance?
3. How to make risk decisions for mitigating risk in IT Governance?

1.4 Research Objectives

The objectives of this study are:

1. To identify the processes and components of risk decisions in mitigating risk of IT Governance.
2. To propose a model of risk mitigation to assist practitioners in risk decisions and provides support in mitigating risk in IT Governance.
3. To develop a risk mitigation system based on the proposed model to provide support to practitioners in making decisions based on a risk knowledge base.

1.5 Research Scope

This research covers risk mitigation in IT Governance for risk decision in mitigating risk. The scope of this research is encompassed as below:

The research on risk mitigation will only focus on technical and operational risk. Operational, technical and strategic risks are the main types of risk that occurs in IT Governance. The research is based mainly on risk decision on how to mitigate the operational and technical risk that occurs in the utilization of IT infrastructures in IT Governance. Operational and technical risks are considered in this research because; operational risk involves people (practitioners), external factors, processes and systems (technology) used by the organisation (Frits and Chris, 2013). According to Chittister and Haimes (1994) technical risk is perhaps the most important risk to be considered in risk management, because technical risk is a significant driver of all other risks. Therefore it's important to mitigate both technical and operational risk.

IT Governance is practices by organisations, institutions, companies and universities to ensure that the IT infrastructures (hardware, software and network communications) are functioning properly. The research concern IT Governance practitioners among Malaysian universities only. Since IT Governance is also practices in the ICT department in the university and according to Anass and Xoliswa (2010); Janusz and Jakub (2001); Janusz and Jakub (2002) whose research on risk mitigation was on ICT practitioners in the university domain. Thus practitioners of IT Governance in organisation, companies or industries will not be considered in this research. The research will be based on risk mitigation practices in Malaysian universities.

Qualitative research was adopted in this research using case study to find out the risk decisions process and components involved in mitigating risk in the 2 Malaysian Universities. In the case study, data is collected using interview from 7 informants. Based on the case study technique stated by Yin (2004); Hallie and Darlene (2005) the minimum number of informants in a case study is 3 and the maximum number of informants is unlimited.

1.6 Research Contribution

The contribution of this research is to propose a risk mitigation model in IT Governance. In this way, the research contribution of this thesis is explained as follows:

1) Theoretical/Methodological

This research identifies the process and components involved for risk decisions in mitigating risk of IT governance. Practitioners use the identified process and components as a guideline in making decision in risk mitigation.

2) Practical

This research developed a risk mitigation model comprising of risk mitigation process, components and techniques which are software agents and knowledge mapping. The model shows how risk is being mitigated in IT Governance. Additionally risk mitigation system architecture is developed to implement the risk mitigation system (RMS), which supports practitioners pertaining to risk decisions in mitigating risk using knowledge base.

1.7 Structure of Thesis

The thesis is organized into eight chapters.

Chapter 1 introduces the research area of concern. The chapter begins with a description of the research background, encompassing the focus of previous research relating risk mitigation, problems arising based on previous studies. The chapter proceeds with a problem statement, containing the identified problems from previous studies. The chapter then clearly describes the research objectives, research questions and the scope of the research.

Chapter 2 reviews the literature related to the risk mitigation process and components for risk mitigation in IT governance. The chapter discussed risks and types of risk that occur in IT Governance. The chapter then discussed risk mitigation in IT Governance, risk mitigation process and risk decision components. The chapter reviewed related works and compares risk mitigation models. The chapter continues with risk mitigation technique. The chapter proceed to elaborate on risk decisions in mitigating risk, knowledge mapping and software agents.

Chapter 3 describes the methodology used in the research. The chapter begins by introducing the research methodology. The chapter explains the research phases and activities of the research in detail. Chapter 4 describes the preliminary study involving the pilot study and main interview using case study. The pilot study was carried out in 2 Malaysian Universities with a total of 5 informants. The pilot study aims to verify the instrument to ensure that the informants understand the interview questions. The chapter proceeds by describing the case study, which was conducted in 2 Malaysian Universities with a total of 7 informants.

The case study aims to confirm the risk mitigation process and risk decision components derived from the literature and to gain insight on how to mitigate operational and technical risk. Chapter 5 describes the proposed model by discussing the risk decisions in mitigating risk. This chapter also shows the final risk decision components and metrics for mitigating risk. Chapter 5 proceeds to explained on the risk mitigation system architecture showing how software agents and knowledge mapping assist to mitigate risk. Chapter 6 describes

prototype development by developing a risk mitigation system (RMS) using software agents and knowledge mapping, which assist in risk decisions in mitigating risk of IT Governance. The chapter discuss on how the SDLC methodology is used. The chapter shows the agent pseudocode, agent algorithms and RMS interface.

Chapter 7 describes the result and discussion based on verification of the risk decision process. This chapter proceeded by presenting the verification of the risk decision process based on the adoption of iterative triangulation of findings from the informants, organisation documents used for risk mitigation in 1 of the Malaysian University and the 7 informants comments from the implemented RMS. The chapter lastly explained on the discussion section based on the risk decision process involved in mitigating risk in IT Governance, Risk Mitigation System demo and risk document analyses.

Chapter 8 concludes the thesis by describing the research outcomes in relation to the achievement of the research question, research problem and research objectives. This chapter then summarizes the research and provides the research contributions. In conclusion, the chapter provides recommendations for future research.

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