IDENTIFICATION OF ROYAL MALAYSIAN AIR FORCE

TECHNOLOGY NEEDS AS A CREDIBLE AIR POWER

MD ZAKI BIN MD ZAIN

UNIVERSITI TEKNOLOGI MALAYSIA

IDENTIFICATION OF ROYAL MALAYSIAN AIR FORCE TECHNOLOGY NEEDS AS A CREDIBLE AIR POWER

MD ZAKI BIN MD ZAIN

A dissertation submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Engineering (Engineering Business Management)

UTM Razak School of Engineering and Advanced Technology
Universiti Teknologi Malaysia

JUNE 2011

To my beloved mother and father,

and Malaysia.

ACKNOLWEDGEMENTS

I would like to express my sincere appreciation to my Academic Supervisor, Associate Professor Dr. Ahmad Rahman Songip and Industrial Supervisor, Colonel Mohamad Sani Sumarnak RMAF for their guidance and continuous encouragement from the start of this dissertation to its successful implementation.

Many people helped make this study project possible. Most importantly, my thanks go to the Royal Malaysian Air Force leadership and senior executives at RMAF Headquarters for their blessing and formal support of the project. My special thanks and gratitude go to all workshops and seminars participants for their contributions in the scenario development and the subsequent activities. My appreciation also goes to all RMAF officers who have provided their insight and support for the study. They were all always willing to help.

I'm grateful to God for the good health and happiness of my parent and family. My special thanks to my wife Rozlina for her love and understanding. A dissertation for my father Hj Md Zain bin Hj Darus and mother Hajjah Zainab binti Hj Ibrahim, and my children; Atthashien, Atasha, Amirah and Athirah.

ABSTRACT

Changes in the global security environment after September 11, providing new challenges to the Royal Malaysian Air Force (RMAF), where the international system has moved from reasonably confident assumptions of the Cold War posture to turmoil with different forms of crisis and conflict. The challenges and future uncertainties where any vision will be limited, raised the need for RMAF to anticipate the future environment, roles and capabilities, and identify the technologies for future competitive edge. The aim of the study was to evaluate the environmental forces and examine the technologies associated with RMAF Air Power projection in 2020. RMAF future scenarios have been developed using scenario planning, that is, the foresight methodology to provide an understanding of future possibilities. Based on the scenarios, the Delphi Method was used to obtain the views and consensus for a shared and owned policy decisions on RMAF future roles, capabilities and technology needs. The survey respondents comprised of senior executives from RMAF, government officers, defense industry and academia. Four future scenarios were developed, called 'Blue Sky', 'Hazy', 'Hail Storm' and 'Thunderstorm'. The study found that the future ranges from a scenario of organised setting shaped by economic and political driving forces, to evolutionary setting driven by technology and chaotic social scenario. The range of technologies identified includes conventional and asymmetric warfare. This study has revealed the increasing significance of Military Operations Other Than War (MOOTW) that may have implications to, and even the very existence of an independent Air Force. This study also proposed an organization strategic planning framework, a contribution to the field of strategic and technology management on the understanding of important policy issues of an organization.

ABSTRAK

Perubahan persekitaran keselamatan sejagat selepas September 11 telah memberikan cabaran baru kepada Tentera Udara DiRaja Malaysia (TUDM), yang mana sistem antarabangsa telah beralih daripada andaian keyakinan wajar postur Perang Dingin kepada kekacauan dengan pelbagai bentuk krisis dan konflik. Cabaran dan ketaktentuan masa depan dengan visi yang terhad telah menimbulkan keperluan kepada TUDM untuk menjangka persekitaran masa depan, peranan dan keupayaan, dan mengenalpasti teknologi untuk daya saing di masa depan. Matlamat kajian ini ialah untuk menilai pengaruh persekitaran dan mengkaji teknologi yang berkait dengan penunjulan Kuasa Udara TUDM pada tahun 2020. Senario masa depan TUDM telah dibangun menggunakan perancangan scenario, iaitu kaedah pandangan jauh yang memberi kefahaman mengenai kemungkinan masa depan. Berdasarkan senario tersebut, kaedah Delphi digunakan untuk mendapatkan pandangan dan konsensus berkenaan keputusan polisi yang dimilik dan dikongsi bersama tentang peranan masa depan TUDM, keupayaan dan keperluan teknologi. Responden kajian terdiri daripada eksekutif kanan TUDM, pegawai kerajaan, industri pertahanan dan ahli akademik. Empat scenario masa depan telah dibangunkan, yang dinamakan 'Blue Sky', 'Hazy', 'Hail Storm' dan 'Thunderstorm'. Kajian ini mendapati masa depan menjangkau daripada senario berkeadaan terancang yang dibentuk oleh kuasa ekonomi dan politik kepada keadaan evolusi yang dipacu oleh scenario kekacauan sosial dan teknologi. Julat teknologi yang dikenalpasti termasuk peperangan konvensional dan asimatrik. Kajian ini menunjukkan peningkatan kepentingan Operasi Ketenteraan Selain Peperangan (OKSP) yang boleh membawa implikasi kepada kewujudan suatu Tentera Udara mendiri. Kajian ini juga mencadangkan satu rangka kerja perancangan strategik organisasi, sumbangan kepada bidang pengurusan strategik dan teknologi bagi memahami isu polisi penting bagi sesebuah organisasi.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABL	-	Airborne Laser weapons
AI	-	Air Interdiction
ASEAN	-	Association of Southeast Asian Nation
AWACS	-	Airborne Warning and Control System
BATC	-	Business & Advance Technology Centre
BVR	-	Beyond visual range
BW	-	Biological weapon
CAS	-	Close Air Support
CBT	-	Computer base training
CGF	-	Computer generated forces
CNN	-	Cable News Network
COIL	-	Chemical oxygen iodine laser
CSAR	-	Combat Search and Rescue
C2W	-	Command and control warfare
C^2	-	Command and control
C^3	-	Command, control and communications
C^3I	-	Command, control, communications, and intelligence
C4I	-	Command, control, communications, computing and intelligence
DCA	-	Defensive Counter Air
ECCM	-	Electronic counter-counter measure
EEG	-	Electroencephalograph
EMP	-	Electromagnetic pulse
EO	-	Electro-optic
EU	-	European Union

EW	-	Electronic Warfare
FPA	-	Focal Plane Array
FLOT	-	Forward line of own troops
GNP	-	Gross national products
GPS	-	Global Positioning System
HIV/AIDS	-	Sexually transmitted disease
ICT	-	Information communication technology
IMT-GT	-	Indonesia, Malaysia, Thailand - Growth Triangle
INS	-	Initial Navigation System
IR	-	Infra Red
ISR	-	Intelligence, surveillance and reconnaissance
IA	-	Information attack
IW	-	Information Warfare
JDAM	-	Joint Direct Attack Munition
JSF	-	Joint Strike Fighter
LIDAR	-	Laser based light detection and ranging
MAF	-	Malaysian Armed Forces
MILO	-	Magnetically insulated line oscillator
MINDEF	-	Ministry of Defence
MEMS	-	Micro electromechanical system
mm	-	millimetre
MMIC	-	Monolythic Microwave Integrated Circuit
MNC	-	Multinational corporation
MOOTW	-	Military operation other than war
MTR	-	Military Technical Revolution
NAM	-	Non-Allied Movement
NATO	-	North Atlantic Treaty Organisation
NCW	-	Network Centric Warfare
NGO	-	Non-government organisation
OCA	-	Offensive Counter Air
OEM	-	Original Equipment Manufacturer
OODA	-	Observation, orientation, decision, action
OPEC	-	Organisation of the Petroleum Exporting Countries

PESTELS	-	Political, economic, social and culture, technology, ecology, legal and system
PGM	-	Precision guided munitions
RMA	-	Revolution in military affair
RMAF	-	Royal Malaysian Air Force
R&D	-	Research and Development
SLOC	-	Sea lane of communication
SAR	-	Synthetic Aperture Radar
September 11	-	11 September 2001
SWOT	-	Strengths, weaknesses, opportunities, and threats
UAV	-	Uninhabited Aerial Vehicle
UCAV	-	Uninhabited Combat Air Vehicles
US	-	United States
USAF	-	United States Air Force
UN	-	United Nations
UWB	-	Ultra wideband
WVR	-	Within visual range
WMD	-	Weapons of mass destruction
4D MAF	-	4th Dimension Malaysian Armed Forces

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

The global security landscape has remains unsettled since the 11 September 2001 attack on the United States of America. Since then, the incident commonly known as September 11 has been regarded as the beginning of the new shape of global security environment in the post Cold War era (Baylis *et al.*, 2007; Collins, 2007; Nye, 2009). The emergence and rise of the more unfamiliar nature of security issues and threats has prompted national security and defence concern to reflect on new form of challenges and uncertainties that the future might hold (Baylis *et al.*, 2007; Collins, 2007; Evans, 2008; Nye, 2009). Under such circumstances, national interest and defence policy are no longer confined to state security concern and conventional military dimension (Baylis *et al.*, 2007; Collins, 2007). In view of such development, the future looks uncertain, imprecise, complex and challenging (York, 2003; Krepinevich, 2009).

In light of these challenges, the Royal Malaysian Air Force (RMAF) as the national Air Power has to constantly ensure its concepts of operation are attuned to the emerging shape of new security environment, characteristics of the 21st Century. RMAF current posture and force structure should not be set firm, where the concept of operation must have a degree of relevancy to the contours of the current global security environment dynamic and flexibility for future contingencies. Such considerations require analysis of the evolving security environment and Air Power capability enablers for future development of RMAF force structure.

This study concerns the technology needs of RMAF as an Air Power. The purpose is to identify emerging technologies for RMAF competitiveness and capabilities effectiveness in future security environment. Using technology foresight tools; scenario planning and Delphi method, this study approach is to increase understanding of ongoing developments in the global security environment, to envision the future and account for future challenges to national security. That is to better define the roles of RMAF as an Air Power in national defence, as well as to present a strategic planning framework for policy formulation that addresses future challenges.

From this study, plausible future scenarios will be developed using scenario planning and named against familiar themes to RMAF. The future world could range from a scenario shaped by environmental forces that range from economic, political, technology to social. These variations thus highlights that RMAF future posture could be much different than that today. Based on Air Power generic capabilities of awareness, reach, power and support, Delphi method process consolidates consensus among RMAF executives with input from experts towards a sound and owned policy decision in addressing RMAF future challenges. This study will then identify the technology needs required by RMAF as an Air Power that encompasses the whole spectrum of RMAF projected roles and capabilities in the future.

This study has contributed to the development of 'RMAF Strategic Readiness System' officialised in 2007, as well as the development and review of RMAF Engineering business plan namely 'Engineering 2005' and 'Engineering 2010' (RMAF, 2000; RMAF, 2005; RMAF 2007). Involvement of RMAF managers and executives in the study and researcher subsequent participation in RMAF strategic planning initiatives based on the study has given the study its own unique authority, legitimacy and credibility.

1.1   Global Security Environment

The following sections of this introduction chapter are to provide an overview and background of the study leading to the Problem Statement in Section 1.5. This Section 1.1 begins with the nature of the contemporary global security environment, followed by Section 1.2 on the Malaysian Armed Forces, while Section 1.3 provides an overview of the RMAF and Section 1.4 describes RMAF future challenges.

The first decade of the 21st Century has been characterised by the widespread impact of technology in many fields (Baylis et al., 2007; Nye, 2009). Mechanisation, communications, and data processing have profoundly influenced every significant aspect of human activity (Sloan, 2008). A global condition where the process of globalisation has led and facilitate for internal issues becoming externalised and external issues internalised (Collins, 2007). Coupled with the globalisation phenomena, the information technology revolution that swept the world is also accompanied by potential new vulnerabilities that scholars and strategist are still debating on how to address them (Gray, 2006). Out of necessity the nature of warfare also has changed (Baylis et al., 2007). As such contemporary security environment has been potentially both much intense and complex than that of the past (Baylis et al., 2007; Collins, 2007; Krepinevich, 2009).

The new and complex global security environment is continuously shaping Malaysia international relations and defence posture (Balakrishnan, 2009). As such, Malaysia continues and has been significant in international affairs while the society becoming more affluent and promotes civil-society values and ideals. Consequently, Malaysian public and national priorities are also changing (Navaratnam, 2003). Increasing Malaysia international engagement and commitment in effect causes the armed services and its military contingencies become embroiled in what known as 'military operation other than war' (MOOTW) (Olsen, 2002; Hj Sutarji bin Hj Kasmin, 2009).

The evolving global security environment and changing nature of threats to national interest requires analysis of the global environment forces and actors that are linked to the current realities as well as future uncertainties, national security and the dynamic of the international system (Baylis *et al.*, 2007; Evans, 2008). Arguably, what states need most in order to face future challenges and gain the benefits of the globalised world is to focus on strengthening their institutions, among which is the Armed Forces (Pallin, 2009). In turn, to achieve technological adequacy and capture the economic gains which globalisation may bring, that includes mitigating the social costs which in part is the emergent and explosion of non-traditional security threats (Baylis *et al.*, 2007; Collins, 2007; Nye, 2009).

1.2   Malaysian Armed Forces

At the early transition into the 21st Century, the RMAF and Malaysian Armed Forces (MAF) in general, have already been facing challenging and troubling issues following the widening roles of the Armed Forces (Olsen, 2002; Krepinevich, 2009). Adding to the difficulty, is the fact that the concept of national security and defence has broadened beyond national boundary and the Armed Forces has been drawn into a variety of contingencies that may have little to do with its traditional roles and functions (Olsen, 2002). As such the Armed Forces now faces a dilemma as to how to respond to the characteristics of the new security environment, safeguard national sovereignty and interest, prepare for the future and yet retain its primary purpose in national defence.

Malaysia has been committed towards developing a well balanced and credible Armed Forces and has continue with 'defensive' defence posture with emphasis on air and sea power; while realises that Air Power is an important capability for national defence (Haji Sutarji bin Haji Kasmin, 2009). The challenges of the 21st Century global security environment are formidable to the armed services

not only in terms of the revolution in military affairs (RMA), but also the changing national priorities with the dynamic nature of the post Cold War global security environments particularly since the September 11 (Collins, 2007; Sloan, 2008). Taking that as a juncture, no one can set the specific direction with any sense of accuracy on the future roles and capabilities required of the Armed Forces. (Sarkesian and Connor, 1999).

Conventional Armed Forces services have three components, Navy, Army and Air Force, which are based on the physical dimensions of sea, land and air in which force can be threatened or applied conventionally. Military capabilities can be applied by the three armed services either independently or jointly (Taylor, 2003). Today, 'joint warfare' is the more usual means of employing modern military power (McConville and Holmes, 2003). At the same time, other government agencies have also shown interest in maintaining or where possible expand the roles or activities of their particular favourites, thus the current trends reflect that some armed services support roles have been assigned to other government security services and agencies (Sloan, 2008). This is the reality where defence capability development is dependent on budget allocations, the outcome has been the product of conflict, bargaining and compromise among the interest groups in the Ministry of Defence (MINDEF) and government agencies (Sarkesian and Connor, 1999). In practice, defence budget allocation and ceilings tended to become arbitrary because regardless of changing needs, each service usually got its regular cut due to other national priorities (Cochran, 1974).

1.3 Royal Malaysian Air Force

The single service function for the RMAF is to conduct air campaigns for the most effective defence of Malaysia and its interest through the prosecution of air roles and provision of air support functions (RMAF, 2002). The success of RMAF

thus far has been with the capability to provide national air defence service required of it. That is through effective application of Air Power; effective integration and mix of weapon systems, logistics, support infrastructure and people (Lambert and Williamson, 1996; RMAF, 2002). In context of this study, Air Power is define as a defence capability projected by an independent Air Force such as RMAF that encompasses the use or denial of the use by foreign armed forces, of the air or space for military purposes, by or to vehicles capable of sustained and controlled flight beyond the geographical boundary and the range of the immediate surface warfare (Lambert and Williamson, 1996; Chun, 2001; RMAF, 2002).

RMAF current organisation and business practice are still hierarchical in nature and confine to bureaucratic flow of command and control. The organisation establishment is base on traditional military organisation structure and division, on the notion that it is suitable for wartime effectiveness rather than peacetime efficiency. Defence budget allocation remains the driver for RMAF operation and development (Haji Sutarji bin Haji Kasmin, 2009). Besides the economic considerations, budgetary constraint is more restrictive due to the current environment where major war or conflict is no longer imminent (Spear and Cooper, 2007). Therefore the situation requires RMAF to seek other means to justify its roles and mission (Hammond, 1996).

In recent years, RMAF traditional assigned support functions have also been delegated to other government agencies. Already established are the 'air wing' in the Army, Navy and Fire Department. The 'Maritime Enforcement Agency' similar to the United States coast guard has been established in 2004, while the Custom Department has expressed interest to set-up own unmanned aerial vehicle (UAV) unit that may in future with its own organic air wing (Bernama, 2007). These development, combined with the tendency to see the Armed Forces in non-combat type missions, pose serious challenges to the armed services profession and in particular RMAF. This raised the question of how can the RMAF reconcile its need to prepare for war effectively, conduct MOOTW and at the same time respond to the changing national defence needs.

With no imminent threat, RMAF focus is now towards capability building rather than countering any specific perceives threats (RMAF, 2007). Air combat capability is deemed strategically important for the defence of Malaysia, because control of the air over Malaysia territory and maritime approaches is critical to all other types of security operation and national interest (Haji Sutarji bin Haji Kasmin, 2009). The primary objective is to maintain RMAF air combat capability at a level at least comparable qualitatively to any in the region (RMAF, 2002). That is an Air Power with sufficient margin of superiority to provide an acceptable likelihood of success in warfare (Chun, 2001). At the same time, it is in the national interest that RMAF has developed capabilities to perform MOOTW roles as Malaysia growing significant in the international arena and world affairs (Balakrishnan, 2009).

The need to acquire state-of-the-art technology is one of RMAF strategic objectives in RMAF strategic plan, named RMAF Strategic Readiness System (RMAF, 2007). Technology is an essential enabling factor to produce combat potential and military effectiveness of the Air Force (Meilinger, 2000; Chun, 2001; Gray, 2006). Thus, when an Air Force is in the RMA, applications of new technology into the systems combine with innovative concepts and force structure could shape the utility of Air Power capabilities and potential in warfare (Meilinger, 2000). Considering budgetary constraints with a more restrictive control over defence technologies and the long-lead time in technology acquisition, it is necessary to be more selective in the choice of technology rather than bagging all on offer (Cochran, 1974; Chen, 1996; Sage, 2000).

However, issue of concern is that RMAF ongoing capability development still lingered upon the development and procurement of conventional war assets and capabilities (Balakrishnan, 2009; Hj Sutarji bin Hj Kasmin, 2009). Although acknowledged, MOOTW remains a secondary role without clear concept of operations (RMAF, 2002; RMAF, 2007). Existing and ongoing development merely produced the intended effect; RMAF force structure still lock in the old security setting and not suited for Malaysia defence and security needs in the post September 11 global environment (Sloan, 2008). Under current circumstances,

RMAF continuously become dependent on the original equipment manufacturer (OEM) proposal and availability for its capability development.

As technologies improve, the boundaries between the traditional roles of Air Power become increasingly blurred (Hammond, 1996; Chun, 2001). This reflects the continuing flexibility of Air Power and its influence on other forms of combat power, which can be capitalised to shape RMAF future competitive position and strategy. The technology needs are the technologies that are critical to maintain, support and enhance RMAF Air Power capabilities across the security and defence spectrum. That encompasses both traditional and non-traditional security threats as well as those that concern regular and irregular warfare (Baylis *et al.*, 2007; Collins, 2007).

Acknowledging the more unfamiliar nature of uncertainties in the future, where any vision of it will be severely limited (Van der Heijden *et al.*, 2002; York, 2003). Thus, reflect that a different Air Power paradigm for the 21st Century is needed (Hammond, 1996; Chun, 2001). Highlight the need to look into the future posture, and prepare for uncertainties in view of the fast changing and uncertain environment. It raised the necessity to envision the future, examine the security environment, evaluate the capabilities required and identify the technology needs of RMAF as a credible Air Power.

1.4   RMAF Future Challenges

In view of the unfolding events, future security environment could be more unfamiliar and less predictable (Baylis *et al.*, 2007; Evans, 2008; Nye, 2009). Future events could be full of uncertainties and challenges that one has not even thought (Van der Heijden *et al.*, 2002; York, 2003; Osinga, 2007). Consequently to

RMAF as the national Air Power, its future role and posture in national defence could be much different from what is known and perceived up to now. Further to that, one of the outcomes of the new security environment and technology dynamic could be that, one competitive position and relevancy in the next change of event could also be uncertain (York, 2003).

As a national defence entity, RMAF need to re-evaluate its strategic and operational environment, the doctrine and concept of operations that govern its Air Power capabilities. Thus far, RMAF capabilities development with the goal to be a credible Air Power, despite all the efforts in its strategic planning, has been too heavily rooted in experiences and lessons learned which have now lost much of their original relevance (Sarkesian and Connor, 1999). As such, the credible Air Power that RMAF envision to be and sustain in the future has to address national defence and national interest in the future security environment perspectives that are different from the past.

A further challenge is not to adopt the Western and advanced Air Forces especially United States (US) view of the global security environment and the technology solution associated to RMAF capability development. Available literatures and studies, while global in scope remains dominated by Western thought (Collins, 2007). Generally concern and from the perspective of industrialised and advanced states in the Western World, US, Russia, China, Australia and regional defence organisation such as North Atlantic Treaty Organisation (NATO) (Sloan, 2008). Although scientific and technological research may be universal or global in nature, its application and influence across different regions is not (Gray, 2006). Thus, while this study makes reference to major studies from US, United Kingdom and Australia, this study does not merely accept those viewpoints on the future scenarios and their impact on Air Force capability development. Simply that Malaysia outlook and subsequent requirements differ in its own national security and defence context.

Acknowledging the challenges of such future ahead that any vision of it will be severely limited, it raised the necessity for RMAF to envision the future, develop strategies, identify key technologies for competitive advantage and ultimately remains relevant in context of national defence. This study presents RMAF future scenarios develop through scenario planning, a methodology that offer understanding of the range of future possibilities that present themselves to RMAF in the fields of Air Power in the year 2020. Between now and the focus period of this study, the year 2020; is a long way off and just around the corner.

1.5   Problem Statement

In recent years the world has moved from the reasonably confident assumptions of the Cold War setting to a global security environment with crisis and conflict throughout the world. National security and protecting one national interest and sovereignty remains critical concerns that all states share (Collins, 2007). However, strategic planning regarding national security and the utilisation of Armed Forces are at a crossroads (Baylis *et al.*, 2007; Collins, 2007; Nye 2009). The changes in the post Cold War security environment and further heighten by the event of September 11 that replaced the Cold War security setting are now being shaped by both states and non-state actors (Baylis *et al.*, 2007; Collins, 2007). National security has now concern both traditional and non-traditional threats (Baylis *et al.*, 2007; Collins, 2007). Globalisation, information revolution and rapid technology development has been changing the nature of global security environment (Collins, 2007; Nye, 2009). Overlapping and blurring the boundaries on national security, defence and the role of the Armed Forces as well as the utility of an Air Power.

The growing technology complexity and pace of change in the security environment, has make it more important to base decisions about the future on systematically gathered information (Drucker, 1999; York, 2003). The traditional

ways of thinking, analysing, and organising base on familiar facts are no longer adequate (Day *et al.*, 2000). In view of the more dynamic and unfamiliar character of the environment forces shaping the future, a different approach to RMAF strategic planning is required. Traditional forecasting techniques best fit problems with well-defined parameters and a high degree of certainty (Goodman and Lawless, 1994; Van der Heijden *et al.*, 2002). As such, RMAF need to create thorough visualisation of the future systems and security environment. That is through understanding the nature of the future security environment, threats, security concerns and warfare, which require a different approach to be sought.

At the moment, there is no policy guideline on the range and type of technologies relevant to the RMAF roles and capabilities as an Air Power. Ongoing RMAF capability development has been based on available system and technology on offer, while technology acquisition and absorption that include off-set arrangement takes long lead time to materialise (Chen, 1996; Sage, 2000). On the other hand, basing the concept of operation derived from the equipment or system country of origin or other Air Forces may not be the answer. Similarly, with different national security context and perspectives, interest and resource allocation, basing the force structure development of other advance Air Forces would not provide the right capability package needed by RMAF.

Thus far, RMAF capability development has also been based primarily on conventional assets procurement, for conventional war roles (Hj Sutarji bin Hj Kasmin, 2009). This reflects a clear mismatch between the roles and force structure needed in the contemporary security environment. Considering its importance, the fit between technology and organisation strategy that does not usually get enough scrutiny, need to be addressed (Goodman and Lawless, 1994). Therefore, it is necessary for RMAF to envision the future and identify the technologies for future competitive advantage. A systematic and coherent approach with a clear end state is needed with regard to identification of RMAF future technology needs.

The challenges to national security and interest emanating from the new security environment are a dynamic one with many new and emerging technologies that complicates RMAF long-range planning efforts. This presents unique challenges to RMAF to evaluate the required roles and capabilities in future security environment. The need to address national defence against emerging threats and new security issues vice traditional Air Force posture, raise the concern on which technologies should be pursued?

1.6   Scope of Study

The scope of study is to evaluate the environmental forces of future security environment, RMAF future roles and capabilities, and examine the technologies associated to RMAF Air Power projection. The global security environment is examined base on the influence and effect of its driving forces, and the emerging technology should be relevant to RMAF future roles and capabilities, realistic to that Malaysia is a small developing country. The future scenarios envision would be surrounding RMAF as a national Air Power entity in the year 2020. In context of global security environment and Southeast Asia regional affairs, and on the basis of Malaysia 'defensive' defence posture. The identified technologies shall be based on the plausible future scenarios developed, projected future RMAF roles and capabilities.

1.7   Objective of Study

The objective of the study is to identify the technology needs of the RMAF as a credible national Air Power. This study will focus on the application of

foresight as a strategic planning tool to develop future scenarios in year 2020 and identify RMAF key technologies so as to realise its vision as a credible Air Power and become dominant in all capabilities (RMAF, 2007).

The study objectives are as outline below:

(a)   Examine global and regional security environment.

(b)   Assess the RMA in context of an Air Power.

(c)   Develop RMAF Future Scenarios.

(d)   Evaluate RMAF future roles and capabilities.

(e)   Identify RMAF technology needs.

1.8   Research Questions

Acknowledging the fact the future is uncertain and the nature of future defence environment and warfare is continuously changing, lead to the objective of this study to address the following research questions. These research questions were formulated through interviews and viewpoint of RMAF executives about the future security environment and Air Power in relation to RMAF, and are as follows:

(a)   How is the future security environment going to be and might be likely?

(b)   What are the key driving forces and to what extend will they shape the security environment?

(c)   What would be the future roles of the Armed Forces?

(d)   What are the likely roles of the RMAF in the future?

(e)   What are the capabilities required of RMAF as a credible Air Power in the future?

(f)   What are the technologies needs of RMAF in the future as a credible Air Power?

1.9   Methodology and Description

This study is a qualitative research; as such the literature review has been rather descriptive as well as narrative on the global security environment, development of technology, the construct of an Air Power, and associated Armed Forces activities in context of national defence. This is to facilitate deduction to be made from the environmental drivers and factors that shape the future security environment and further identify the attributes of an Air Power in order to evaluate RMAF roles and capabilities. The primary and secondary sources of this study include scholarly journal articles and published assessments pertaining to global security environment, emerging technology and Air Power.

Individuals on specialised job functions related to defence and armed services in particular RMAF within and associated to MINDEF were interviewed as informants to obtain views and further information on the subject of this study. Key concepts identified enable the construct of the study conceptual framework. The descriptions on the methodology selected are as follows:

(a)   Literature Review, to scope and establish relationships of global security environment, RMA, Air Power and emerging technology.

(b)   Scenario planning, a strategic thinking tool to envision the future that facilitates development of RMAF future scenarios to promote appreciation about future challenges and background for Delphi survey.

(c)   Delphi Method, a systematic interactive procedure for soliciting and organising expert view based on independent inputs about the future through a series of questionnaires. This method would enable correlation to be established between RMAF roles and the emerging technologies to realise the projected capabilities envision in the future.

(d)   Interviews, to ascertain viewpoint about the future and establish the relationship between RMAF future posture and the required capabilities.

(e)   Limitation.   Nuclear, biological and chemical (NBC) technologies and warfare are not addressed in this study, since it may be more appropriate to consider them in a broader context than within Air Force roles. Similarly, subjects related to international politics and economic issues or on defence procurement and technology acquisition discussed are intended to support the study, without any further analysis on the subject or issue raised.

1.10 Organisation of Chapters

To achieve the objective of the study, this thesis will discuss the following in subsequent chapters:

(a) Chapter 1. Introduces the background of Malaysia security environment and briefly describes RMAF in its current posture. Followed by the thesis problem statement, scope, objectives and methodology are outlined.

(b) Chapter 2. Discusses literature review; encompasses the global security environment and philosophical basis of strategic planning, technology foresight, RMA and Air Power.

(c) Chapter 3. Presents the conceptual framework used and the operational of concept applied in the thesis.

(d) Chapter 4. Explains the research methodology encompasses the discussion on the purpose, process and the conduct of the methodology.

(e) Chapter 5. Presents the results: plausible future scenarios, RMAF future roles and capabilities, and the technology needs for the RMAF.

(f) Chapter 6. Presents the analysis of the results; that encompass examinations of the results and limitations of the study. Followed by discussions and recommendations.

(g) Chapter 7. Draws the conclusion of the study and provide the necessary recommendations for continuous improvement related to the subject of this study.

1.11 Study Outcomes

The outcomes of the study are the identification and determination of the full range and types of technologies associated to RMAF roles and capabilities as a credible Air Power in the future. The study has developed four plausible future scenarios set around year 2020 and named it against a familiar theme to RMAF namely; Blue Sky, Hazy, Hail Stone and Thunderstorm. The future world ranges from a scenario of organised setting dictated by economic and political driving forces, to evolutionary setting driven by technology and a chaotic social scenario.

The future scenarios of year 2020 highlighted three critical environmental forces that shape key uncertainties of the scenarios. These are:

(a) The rate of change and the spread in technology development can range from constrained to exponential.

(b) The nature of the environmental driving forces: Political, Economic, Social, Technology, Ecology, Legal and System (PESTELS) ranging from concentrated to disperse.

(c) The last is Malaysia national posture, could range in focus from domestic to regional and global.

The scenarios developed highlights future uncertainties that spans with trends that involve shifts in relative emphasis in the following areas:

(a) Humans will move from being more 'in the cockpit' to be more 'in the loop'.

(b) The medium for military operations will move from the 'battle field' to towards 'battlespace'.

(c)   Development of responsibilities for key technologies and capabilities will move from government towards industry.

(d)   Influence increasingly will be exerted by information more than by political and economic power.

The roles and capabilities of RMAF have broadened with the influence and effect of diverse environment forces shaping future security environment and raising new security concern to Malaysia as a nation state. RMAF as an Air Power no longer confine to the conventional war fighting role and the traditional national defence entity posture. The concept of an Air Power to a state has change with the change of security concern to national security and defence (Meilinger, 2000; Chun, 2001; Krepinevich, 2009). Accordingly, RMAF primary roles and capabilities that serve national interest need to include MOOTW.

Technological development will have significant implications for RMAF strategic policy for the future, and encompasses areas of command and control, operations, simulation and training, logistics and acquisition. Concepts such as information warfare, network centric operation and command and control would be enabled by the synergy in application of variety of technological advances (Chun, 2001; Courville, 2007; Jourdan *et al.* 2008). This study has identified range of technologies associated to RMAF as an Air Power, base on the generic capabilities of awareness, reach, power and support as developed for the Royal Australian Air Force (RAAF) (Ennett, 1999).

This study also offers an 'organisation strategic planning framework' to address future policy decisions, suited for dynamic and uncertain environment. For organisation competitiveness, this is a valuable contribution to the field of strategic and technology management, and contributes significantly to the understanding of an organisation important policy challenges. From a theoretical perspective, this analysis uses foresight tools as a vehicle to explore the environmental forces

interactions in the technology strategy. Technology needs is ideally suited for exploring the problem because besides addressing an organisational needs, it also captures both the national security and defence issues. This revolves around the relationship between an organisation capability building and competitive edge, as well as between national security and national posture in the international system.

1.12 Significant of the Study

The major significant potential of the study is the strategic initiatives in RMAF strategic plan; 'RMAF Strategic Readiness System' (RMAF, 2007), as well as for the development and review of RMAF Engineering business plan; 'Engineering 2010' (RMAF 2005). The study findings ensure that the RMAF doctrine and force structures are fully supportable by the required technologies needed of a credible Air Power. The identified technologies are also a key input into the national offset and defence industry blueprint. This study further offers and potentially be significant in the followings:

(a) The strategic planning framework developed and applied in the study, engages the external environment and accounts its forces effect on an organisation policy making with participations of RMAF managers and executives.

(b) The major involvement of managers and executives in the process is unique though challenging, but the output is a policy decisions shared and owned by the organisation. Most foresight programs has engaged outsider, although these are experts and professionals, but experience of 'United States Air Force 2025' project shows it lacks 'buy-in' (Hammond, 1996). As such this study has its own unique authority, legitimacy and credibility, fundamental to the success of foresight (Jewell *et al.*, 2004).

(c)   Introduce scenario planning, as a long-range planning tool that facilitates RMAF executives in the development of deeper perspective on the longer-term Air Power projection and national defence environment, and accelerates organisation learning.

(d)   Involvement and support of RMAF leadership on the study create 'the champion' of foresight in RMAF.

(e)   The identified RMAF key technologies would serve as a policy guideline in the review of RMAF doctrine, force structure planning and concept of operations formulation. As well as for RMAF operational, logistics and human resource in capability development and optimum employment of RMAF combat and support capabilities.

(f)   A strategic planning framework for RMAF operation, logistics and human resource policy formulation and capability development, for optimum employment of RMAF operational capabilities in the future.

1.13   Chapter Conclusion

This study has revealed that considerable implications for the application of Air Power in future security environment and even the very existence of an independent Air Force. Through the process to develop and use of future scenarios, RMAF can take actions to make or shape a desirable future to occur. An Air Force with well thought and suited technology package could quickly adapt to different battlespace conditions in unforeseen and unfavourable security environments. This study also proposes an 'organisation strategic planning framework' that could be a valuable contribution to the field of strategic and technology management, and contributes to the understanding of an organisation important policy problem.