## Aims and Scope

The Journal of Defence and Security is a publication of the Malaysian Institute of Defence and Security, MiDAS. The journal publishes original papers and reviews covering all aspects of defence and security. It is a platform to promote awareness on the capabilities and requirements of modern defence & security technologies and policies, covering topics in the areas of, but not limited to, Evolution of Military Information & Communication Systems, Smart Weapons, Modern Vehicle & Aerospace Engineering Challenges, Intelligence, Surveillance & Reconnaissance, Biological & Chemical Terrorism Countermeasures, Personnel Protection & Performance, Military Medicine, Emergent Naval Technology, and Defence & Security Strategic Management.




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## FOREWORD

The complex security environment with a multitude of internal and external issues poses security challenges for Malaysia in both the near and future. This complexity creates uncertainties in many ways that has led to a need to search for analytical and conceptual clarity. In view to this, Ministry of Defence recognised the need to have an institution that can address this requirement and has thus set up the Malaysian Institute of Defence and Security (MiDAS).

MiDAS is established as a professional body with primary objective of generating knowledge in the field of defence and security, both locally and internationally. It also aims to promote information sharing among researchers, practitioners and academia, and carry out policy research for the Ministry of Defence as well as the government of Malaysia.

It gives me a great pleasure to congratulate MiDAS on its first publication of The Journal of Defence and Security (JDS). The objectives of JDS are to bring together researchers, scholars and policy makers to address the current defence and security issues. The journal publishes articles whose contents and approaches are of interest to a wide range of researchers, scholars and policy makers. In the future, JDS will play a greater role in the advancement of scholarly knowledge by encouraging discussions and information sharing among all branches of defence and security.

I would like to thank the editors and the management of MiDAS for their tenacity and dedication to make the first volume of JDS a success. I would like also to extend my gratitude to all contributors for their articles on this inaugural volume. Last but not least, I would like to welcome local and international researchers and academia to contribute for the future publications of this journal. I hope the ideas shared in the journal would be the source for creating awareness on defence and security and the need to promote peace and stability.

**DATO' SERI DR. AHMAD ZAHID HAMIDI**
Minister of Defence Malaysia

# EDITORIAL FOREWORD

As the cold war receded and the superpowers relationship that support and orchestrate international interactions in so many part of the world crumbles, regions have to confront these global transformations and the disruptions that bring to the current existing pattern of relations. Association of South East Asian Nations (ASEAN), being one of the most strategic economic caucus, no less than any other region in the world has been greatly influenced by these events.

The post cold war sees ASEAN growing from a tightly knit community of six states (ASEAN-6) of Indonesia, Malaysia, Phillippines, Singapore, Thailand and Brunei, to a broader grouping of ten states (ASEAN-10), with the inclusion of Kampuchea, Laos, Myanmar and Vietnam. As ASEAN-10, an ASEAN consensus can no longer be expected over all issues as members are from states of widely different historical experience, political system, economic status, military doctrines, development and foreign policy orientation. Furthermore, ASEAN will have to absorb new conflicts and disputes of the kind that has been largely defused amongst the original ASEAN members.

With the shift in the defence and security focus from the post cold war traditional threat, ASEAN members can now play significant roles in addressing and managing non-traditional security issues like humanitarian assistance, disaster relief, peacekeeping operations and maritime security. ASEAN member nations moreover, similar to any other nations, are faced with emerging threat of international terrorism with complicated and highly organised mode of operations. The new area of threats will continue to bring ASEAN members to communicate and work together to solve common problems besides presenting similar voice over issues of the same interest. With the current development of the defence and security, the whole spectrum of tackling the issues has become much more complex and needs new approaches.

Given the current transformation of ASEAN and the emerging threat perspectives, The Journal of the Defence and Security is an attempt by the Malaysian Institute of Defence and Security to foster meaningful discourse, to promote awareness and to bring together policy makers, defence and security agencies, experts in related fields, academicians, and industry players within and outside the region to contribute to the sharing of knowledge of contemporary defence and security changes in policy, strategy, cooperation and technology.

The journal publishes original research and review papers addressing the changes of these multiple aspects of relationships. The first issue of the journal will present to the readers papers contributed by personalities within the Malaysian defence and security circles covering various issues from mapping and geospatial, analysis on biological and chemical threats, leadership and moral, regional strategy, technology and defence system acquisition offset program.

The editors of this journal welcome research and review articles on defence and security from local and abroad.

Col Dr Shohaimi Abdullah
Editor-In-Chief

# COMBATING AND REDUCING THE RISK OF BIOLOGICAL THREATS

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## ABSTRACT

*Life science, in particular biotechnology, is burdened by the dual-use dilemma. While legitimate research on pathogens and the diseases they cause can lead to prevention, diagnosis, and treatment for the benefit of humanity, such research can also be used to develop biological weapons against humanity. More technical possibilities will arise in the years to come that can be abused for hostile purposes. Therefore, we must ensure that this great potential is kept from the hands of those who would use it to do us harm. We need to prioritise what can and should be done. We must develop oversight frameworks for safety and security that will provide firm foundations for collective and collaborative work in biological sciences. Preparedness efforts to detect and respond to biological terrorism will have the added benefit of strengthening the capacity for identifying and controlling injuries and emerging infectious diseases.*

## INTRODUCTION

In 2004, newspapers and internet sites around the globe ran stories concerning the release of a concerning report in the British Medical Association (BMA) on biological weapons (bioweapons) [1]. It stated that "*Bioweapons that target selected ethnic groups could become part of the terrorists' arsenal…*", and "*The threat from bioweapons has outstripped that from chemical and nuclear arms because of the 'riotous' progress of biotechnology*." Such media provides an interesting perspective on the unique challenges associated with efforts to address the threat of bioterrorism [2, 3]. Viruses and other microorganisms tailored to detect the differences in the DNA of races could offer war makers and terrorists of the future a new means to carry out "ethnic cleansing". Such designer weapons would be based on the growing ability of scientists to unravel and compare human DNA. Some analysts have ranked genetically engineered microorganisms as potentially the most dangerous of all existing weapons technologies, nuclear weapons notwithstanding [4-6]. However, as yet, treaties, international agreements and political pursuits have not been able either to control bioweapons development.

## DEFINING BIOLOGICAL AGENTS, BIOLOGICAL WEAPONS AND BIOTERRORISM

### Biological Agent

A biological agent is a bacterium, virus, prion, fungus or biological toxin that can be used in biological warfare or bioterrorism. Some eukaryotes (such as parasites) and their associated toxins

can be considered as biological agents. Biological agents have the ability to adversely affect human, animal and plant health in a variety of ways, and can be found in water, soil, plants and animals [7].

### Bioweapons

Bioweapons is defined as the intentional cultivation or production of pathogenic bacteria, fungi, viruses and their toxic products, as well as certain chemical compounds, for the purpose of producing disease or death [8]. Bioweapons denote the hostile use of biological agents against an enemy in the context of a formally declared war. Living organisms, chemical products of living organisms (including biological toxins), manufactured substances that mimic the action of biological substances [9], and genetically modified organisms [10-12] are some example of biological agents that could be employed as bioweapons.

### Bioterrorism

Terrorism has been defined as deliberate acts or threats committed by an individual or group for political or social objectives [13]. Bioterrorism is defined as the threat or use of biological agents by individuals or groups motivated by political, religious, ecological, or other ideological objectives. Terrorists could also develop and deploy a cocktail involving multiple biological agents or a combination of biological and chemical agents, severely impeding efforts to identify the cause of illness and to provide effective treatment. However, biological attacks carried out by individuals or small groups for non-weapon or non-political purposes (especially for economic objectives) are more properly described as bio-crimes [14].

## BIOLOGICAL WEAPONS/BIOTERRORISM AGENTS

The most effective bioweapon agents would be highly infectious, communicable and lethal; efficiently dispersible; easily produced in large quantities; stable in storage; resistant to environmental degradation; and lacking vaccines or effective treatments [15]. Biological agents may be targeted directly against humans either through injection or topical application; deployed against agricultural crops, livestock, poultry, and fish; applied as a contaminant of food or drinking water; disseminated as an aerosol; or introduced through a natural vector such as an insect [16]. The ability to manufacture biological threats is relatively much easier and many believe any future bioweapon attacks by terrorist might be similar to anthrax [17]. Motives of such threats may include commission of selective or mass murder; incapacitation of enemies; achievement of political goals; undermining of social stability or creation of mass panic; or pursuit of economic objectives through destabilization, blackmail, extortion, or market disruptions [18].

A bioterrorist attack has occurred and could occur again at any time, under any circumstances, and at a magnitude far greater than we have thus far witnessed. The use of microorganisms as agents of bioweapons is considered inevitable for several reasons, including ease of production and dispersion, delayed onset, ability to cause high rates of morbidity and mortality, and difficulty in diagnosis.

Silent, invisible, microscopic, and odorless, biological agents can be introduced and strike without warning. A tiny amount of pathogen, properly introduced, can quickly cause a devastating infection. An infection in the host can then be transmitted rapidly to nearby members of the population. An infection may go undetected or undiagnosed for days; thus, a major disease outbreak could be well be under way before medical, veterinary or agricultural authorities are alerted.

Biological agents that have been identified as posing the greatest threat are *variola major* (smallpox), *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), *Clostridium botulinum* toxin (botulism), *Francisella tularensis* (tularaemia), filoviruses (Ebola hemorrrhagic fever and Marburg hemorrhagic fever), arenaviruses Lassa (Lassa fever), and Junin (Argentine hemorrhagic fever) [19]. However, not all microbes can be used as weapons. Several characteristics are required to make an organism an ideal biological agent that can be used as a potential weapon of mass destruction (WMD) or for bioterrorism. These pertain to virulence, infectivity, lethality and ease of production, stability in environmental conditions and post-dissemination retention of features, availability of a susceptible population, and lack or inadequacy of tools to prevent or treat the disease [20].

It should be noted that as toxins are not alive and cannot multiply, they therefore share several traits associated with chemical agents. Other types of possible biological weapons include the use of fungi and protozoal parasites, although it is doubtful that non-state actors would use these against human beings. Certain fungi may be used by non-state actors in anti-crop attacks [20].

While hundreds of pathogenic microorganisms have been investigated for their potential use as biological weapons, around 40 biological agents have been found capable to be used as bioweapons. Even though the list of agents is short, if acquired and properly disseminated, it could cause a difficult public health challenge in terms of our ability to limit the numbers of casualties, and to control the damage to our cities and nation [14, 21].

The Center for Diseases Control and Prevention (CDC), USA, have further categorised biological agents that are possible to be used as bioweapons or bioterrorism agents into three categories, depending on how easily they can be spread and the severity of illness or death they cause (see Table 1). Category A agents are biological agents with high potential for both adverse public health impact and large-scale dissemination. Category B agents have potential for adverse impact, while Category C agents are agents that could pose future threats to human populations [21].

When the potential agents are reviewed, anthrax and smallpox are the two with the greatest potential for mass casualties and civil disruption:

**Table 1. CDC classification of agents which can be used as biological weapons [21].**

| Category | Characteristics | Agents/Diseases |
|---|---|---|
| **A** | High-priority agents include organisms that pose a risk to national security because they:<br>– Can be easily disseminated or transmitted from person to person;<br>– Result in high mortality rates and have the potential for major public health impact;<br>– Might cause public panic and social disruption; and<br>– Require special action for public health preparedness | – Anthrax (*Bacillus anthracis*)<br>– Botulism (*Clostridium botulinum* toxin)<br>– Plague (*Yersinia pestis*)<br>– Smallpox (variola major)<br>– Tularemia (*Francisella tularensis*)<br>– Viral hemorrhagic fevers (filoviruses [e.g., Ebola, Marburg] and arenaviruses [e.g., Lassa, Machupo]) |
| **B** | Second highest priority agents include those that:<br>– Are moderately easy to disseminate;<br>– Result in moderate morbidity rates and low mortality rates; and<br>– Require specific enhancements of available diagnostic capacity and enhanced disease surveillance. | – Brucellosis (*Brucella* species)<br>– Epsilon toxin of *Clostridium perfringens*<br>– Food safety threats (e.g., *Salmonella* species, *Escherichia coli* O157:H7, *Shigella*)<br>– Glanders (*Burkholderia mallei*)<br>– Melioidosis (*Burkholderia pseudomallei*)<br>– Psittacosis (*Chlamydia psittaci*)<br>– Q fever (*Coxiella burnetii*)<br>– Ricin toxin from *Ricinus communis* (castor beans)<br>– Staphylococcal enterotoxin B<br>– Typhus fever (*Rickettsia prowazekii*)<br>– Viral encephalitis (alpha viruses [e.g., Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis])<br>– Water safety threats (e.g., *Vibrio cholerae*, *Cryptosporidium parvum*) |
| **C** | Third highest priority agents include emerging pathogens that could be emerging pathogens that could be engineered for mass dissemination in the future because of<br>– Availability;<br>– Ease of production and dissemination; and<br>– Potential for high morbidity and mortality rates and major health impact | – Emerging infectious diseases such as Nipah virus and hantavirus |

1) Both are highly lethal: the death rate for inhaled Anthrax, if untreated before serious symptoms develop, exceeds 90%, and in the case of Smallpox, up to 30% for people who are not immunised for the disease [22].

2) Both are stable for transmission in aerosol and capable of large-scale production. Anthrax spores have been known to survive for decades under the right conditions [23]. The World Health Organization (WHO) concerned that smallpox might be freeze-dried to retain virulence for prolonged periods [24].

3) Use of either agents would have a devastating psychological effect on the target population, potentially causing widespread panic. This is in part due to the agents' well-demonstrated historical potential to cause large disease outbreaks [25].

4) Initial recognition of both diseases is likely to be delayed. For anthrax, this is secondary to the rare occurrence of inhalation anthrax. For smallpox, given that few physicians have any clinical experience with the disease, many could confuse it for more common diseases (e.g., varicella and bullous erythema multiforme) early on, allowing for second-generation spread [26, 27].

5) Availability of vaccines for either disease is limited. There is limited availability of the anthrax vaccine for use in the civilian population. Routine smallpox vaccination was discontinued in 1971 [26].

## THE BIOLOGICAL WEAPONS CONVENTION (BWC)

The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction, usually referred to as the Biological Weapons Convention (BWC) or the Biological and Toxin Weapons Convention (BTWC), is the first multilateral disarmament treaty banning the production of an entire category of weapons. The BWC was opened for signature on April 10, 1972, and entered into force on March 26, 1975 when twenty-two governments had deposited their instruments of ratification [27]. Currently, 171 states had signed the treaty and they are committed to prohibit the development, production and stockpiling of biological and toxin weapons. Malaysia signed the Convention on April 10, 1972 and ratified it on September 6, 1991.

States Parties to the BWC undertake to "never in any circumstances to develop, produce, stockpile or otherwise acquire or retain: (i) microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes; (ii) weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."

The BWC sits at the nexus between science and security. It was created to ensure that life sciences are used only for the benefit of humanity. It matches prohibitions (ensuring that life sciences are not used for malign purposes) against protections for scientific freedom (enshrining the right to conduct scientific activities for peaceful purposes) [28].

The BWC is important because it represents the international community’s will to prevent biological warfare and the deliberate use of diseases as weapons. It is the first disarmament treaty to completely ban an entire class of weapons. The Convention is an indispensable legal and political instrument that reinforces the widespread condemnation of biological weapons. The BWC complements the Geneva Protocol, which banned biological warfare methods in 1925.

Certain materials and equipment are suitable for both biological warfare (BW) programs and legitimate commercial activities; absolute verification is next to impossible. Even so, many countries believe that it would be possible to devise a system of declarations and inspections to increase the transparency of treaty-relevant facilities and activities, thereby increasing confidence in BWC compliance. However, efforts to strengthen the BWC through comprehensive declaration and verification measures failed in 2001 due to US resistance. The Convention that has successfully developed a norm prohibiting the development of biological weapons but without formal verification, it has been almost impossible to enforce.

Additionally, the BWC is more difficult and complex to monitor than international treaties controlling nuclear or even chemical arms:

1) Chemical weapons must be produced in multi-ton quantities, while relatively small amounts of BW agents can be militarily significant.
2) Chemical warfare (CW) agents, such as sarin and mustard gas, have no legitimate uses and can be banned outright, whereas dangerous biological pathogens or toxins have a number of peaceful or defensive applications. In addition to the use of pathogens and toxins to make protective vaccines, several toxins with a history of military development are employed as tools in biomedical research, and a few toxins (such as botulinum) have therapeutic value in medical practice.
3) The BWC prohibits the possession of biological agents for offensive military ends while permitting their use for peaceful scientific, therapeutic or defensive purposes, judgments of treaty compliance may hinge on subjective assessment of intent.
4) As fermentation technology continues to improve, detection of clandestine production of BW agents at dual-capable facilities, such as vaccine plants, will become even more difficult. Continuous fermentation tanks can produce militarily significant quantities of a pathogen from a seed culture in a matter of days.
5) Advanced biopharmaceutical plants use “clean-in-place” systems that flush fermenters, and pipes with microcidal chemicals and hot water. Such systems could eliminate all traces of a BW agent in a few hours. Thus, even short-notice inspections may not turn up conclusive evidence of illicit production.

## IMPACT OF ADVANCED TECHNOLOGY ON BIOLOGICAL WEAPONS

*". . . and he that will not apply new remedies must expect new evils; for time is the greatest innovator. . . ."*

*The Essays by Sir Francis Bacon, 1601*

The pace of advances in biosciences and biotechnology continues to quicken, creating possibilities that were unimaginable just a few years ago. With these developments also come the risk of the misuse of biological agents, materials, technology and knowledge for hostile purposes. Genetic engineering can contribute to offensive bio-weapons programs in a variety of ways. With genetic manipulation, classical biowarfare agents, such as anthrax or plague, may be made into more efficient weapons. Barriers to access to agents such as smallpox, Ebola or the Spanish flu are being lowered by genetic and genomic techniques. Completely new types of weapons are also becoming possible, including the use of food crops as tools for biological warfare. Even ethnically specific weapons, hitherto thought to be impossible, have become a real possibility [29].

Biotechnology capacity is spreading to all areas of the globe. More and more people have access to advances in biology. One of the major challenges of this century will be to ensure that these powerful new capabilities yield as many benefits as possible, while minimizing the potential for malign use.

Scientists have recently expressed concern that terrorists could exploit the potential for the creation of life forms using new knowledge about the gene sequences of living organisms. This technology could result in the manufacturing of genetically engineered pathogens, toxins or synthetic superbugs, which could be employed as biological weapons or even programmed to target specific ethnic groups [30, 31]. A former member of the Knesset (Israeli parliament), Dedi Zucker, caused a storm when he claimed that the Israel Institute for Biological Research (IIBR), was "trying to create an ethnic specific weapon", in which Arabs could be targeted by Israeli weapons [32].

The threat of bioweapons proliferation and terrorism is evolving, largely as a result of rapid advances in biotechnology and the dramatic expansion of public and private bioscience worldwide. While these trends offer tremendous opportunities for improving human health and well-being, they also increase the risk that bioscience could be exploited by individuals or groups intent of causing harm. Today, there is a real danger that terrorists could acquire the necessary means from the legitimate bioscience sector to perpetrate bioterrorism. Scientists with the expertise necessary to misuse biology can be found internationally in nearly all areas of life sciences. Important advances in biosciences, many of which could be exploited to cause harm, are published almost every day in scientific journals, research publications and patents, and on the internet.

Given the technical hurdles involved in obtaining virulent microorganisms from natural sources, it would be far easier for potential bioterrorists to purchase or steal samples of dangerous pathogens from academic, industrial or commercial labs. This option is viable as microbes reproduce rapidly in commercially available equipment, such as a stainless steel fermentation tanks, a seed culture can be grown into a large amount of agents in a matter of days or weeks. Thus, even small vials containing dangerous pathogens pose a security risk. Moreover, many experts believe that only sophisticated, state-sponsored bioweapons programs can overcome the significant technical challenges involved in

"weaponising" biological agents so that they can threaten large numbers of people. Unlike many other weapons, bioweapons typically take two or more days to affect their victims, and contagious agents can spread beyond the population initially infected [33].

It has become clear to members of the BWC that because of the pervasiveness of biotechnology and the rapidity of development in the biosciences, governments alone cannot confront the threat of bioweapons in the traditional arms control sense. No government or international organisation can hope to monitor the tens of thousands of small biotechnology facilities spreading around the world. The number of facilities and the capability of the technology are ever increasing, while the cost and size of the equipment drops steadily. To meet this challenge, the members of the BWC developed a new approach to incorporate all complementary efforts; not only those of the defence and security sectors, but also those found in public health, agriculture, law enforcement, and education sectors, as well as the international scientific community and commercial industries [29].

## DUAL-USE TECHNOLOGY

The fundamentally "dual-use" nature of all the technical building blocks of biological weapons, materials, technology, and expertise, not only provide ample opportunities for terrorists to exploit but also make imposing controls extremely difficult. Moreover, it is noteworthy that many terrorist organisations are active in parts of the world that are experiencing both rapidly expanding biotechnology and frequent outbreaks of highly infectious diseases, such as Avian Influenza H5N1, Nipah virus, Meningococcal disease, Dengue Fever/Heamorrhagic Dengue Fever, Chikungunya virus, Tetanus, Acute Neurological Syndrome, Leptospirosis, SARS, Japanese Encephalitis, Coxsackie virus, Typhoid Fever, Hand, Foot and Mouth Disease, new Influenza A (H1N1) strain etc.

It also possible that scientists may be conducting research on organisms or diseases without realising that their results, or even their facilities, can be used by unscrupulous terrorists for the development of bioweapons. It is difficult to draw the line between relatively innocuous research, and what is in very real terms, "dangerous" research since any research on pathogenic agents and the diseases they cause are capable of dual-use. On the other hand, no scientist wants to be too severely limited in conduct of research, or in the choice of topics to work on, for the sole reason that such research may be used for the development of bioweapons. The dilemma lies, therefore, in how much risk should be accommodated in the interest of research, and in the interest of peace.

Due to advances in biology and other disciplines, the situation for preventing the spread of dangerous dual-use technologies is vastly different today. Unlike nuclear weapons, almost all of the tools needed to design and make biological weapons have important civilian applications and can be purchased from legitimate suppliers over the internet [29]. The gene synthesis industry has been making artificial DNA for pharmaceutical research and other lifesaving applications since the late

1990s. At the same time, academic researchers have used synthetic DNA to confer vaccine resistance on pathogens. They have even used synthetic DNA to "resurrect" the 1918 influenza virus that killed roughly 50 million people worldwide [30]. While these experiments were done for legitimate scientific reasons, the new technology's weapons potential could hardly be clearer. How easy would it be for terrorists to acquire synthetic DNA?

## PREPAREDNESS IN COUNTERING BIOLOGICAL THREATS

Even though the threats of bioterrorism are minimal in our country, the risk does exist. One way or another, national security is vulnerable and can be threatened by the easy availability of biological agents to terrorists and disgruntled individuals who have no qualms about using them. When and where such attacks will occur is difficult to predict.

We know that biological agents have been used for biological warfare and terrorism, and their potential for future use is a major concern. Therefore, we must be prepared to respond appropriately if they are used. The technology and intellectual capacity exist for well-funded, highly motivated terrorist groups to mount such an attack. Even though, only a handful of pathogens are thought to have the ability to cause a maximum credible event to paralyse a large city or region of the country, such an attack can cause high numbers of deaths, wide-scale panic, and massive disruption of commerce. Diseases of antiquity including anthrax, smallpox, and plague, notorious for causing large outbreaks, still head this list. In addition, other agents, such as botulinum toxin, hemorrhagic fever viruses and tularemia, have the potential to do the same. By focusing on a smaller list of these low-likelihood, but high-impact diseases, we can better prepare for potential intentional releases, and hope to mitigate their ultimate impact on our citizens.

Preparedness can make all the difference to the outcome of a bioterrorist attack. There is the possibility to mitigate the effects of a biological attack through measures, including rapid detection, treatment with antibiotics, vaccination and quarantine. One simulation of an anthrax attack conducted by the Center for Nonproliferation Studies (CNS), for example, showed that the difference in the ultimate mortality figures between a poorly coordinated and ill-prepared response, and a polished and efficient response was 120,000 deaths opposed to 35,000 [2].

One would assume that a thorough understanding of the threat underlies the difficult policy decisions associated with such preventive and response-related measures, which often involve resource limitations and tradeoffs between programs. Yet, this has repeatedly been shown not to be the case [2]. At every level, from local to national to international, the approach to countering bioterrorism has often been partial, piecemeal and distorted by political or parochial institutional concerns.

The utmost urgency is needed to cast the issue of response in an appropriate framework that captures the attention and understanding of policymakers and the public to garner sufficient and sustainable support for response initiatives. Such understanding would recognise that the protection of the nation's health is essential in ensuring national and global security. The gaps in the public health infrastructure and countermeasure capabilities must be filled to assure rapid and effective response to bioterrorist attacks [34].

The nation's biodefense science and response capabilities is still lagging, with the striking insufficiency of vaccines and therapeutics, and local public health departments struggling with limited resources. In this matter, three major components are required for action prioritisation or consideration, which are vaccines and therapeutics; research needs; and response infrastructure.

Response infrastructure involves an up-to-date communication technologies and information, greater laboratory capacity, disease detection and surveillance with more facilities, equipments, and trained personnel, and local response. It requires:

1) Building up the domestic biosafety and biosecurity capacity to mitigate biological threats. We must ensure that biology and biotechnology make progress in safe and secure environments.
2) Strengthening the national plan for a comprehensive response and enhanced capacity, and encouraging funding to improve response capability to biological threats. Also, strengthening the cooperation amongst stakeholders, especially from government and private sectors.
3) Indentifying domestic gaps in preventing, detecting and responding to biological threats, and proposing appropriate solutions.
4) Implementing regular training to update laboratory researchers on the latest best practices for (i) preventing biological threats; (ii) detecting and identifying biological threats; and (iii) controlling and responding to biological threats. Effective biological threat mitigation practices will have benefits across the full spectrum of biological threats, including natural, accidental and intentional infectious disease events.
5) Enhancing international cooperation on biological threat mitigation and on transfers of technology in enhancing capability to respond to biological threats.
6) All related laboratories should have accreditation procedures on how the human health and veterinary sectors can interoperate; on joint public health and law enforcement investigations can be conducted; on how mitigation of biological threat can be incorporated politically in defense policies without immediate threats; and on the effectiveness of past training programs.

Many other pathogens can cause illness and death, and the threat list will always be dynamic [35]. We must, therefore, have the appropriate surveillance system and laboratory capability to identify other pathogens, and we must improve our public health and medical capabilities to respond to the short list of the most dangerous naturally occurring biological pathogens that could be used as

bioterrorism weapons. Thus, more comprehensive approaches on addressing important public health and national health security needs include:

1) Ensuring that the nation's public health system is capable of addressing all public health needs, including infectious disease outbreaks.
2) Increasing support for the basic tools necessary for public health surveillance and epidemiology, including skilled personnel, public health laboratories, and data collection, management, analytical, and information-sharing systems.
3) Enhancing animal disease surveillance and response capabilities, and their integration with public health systems, which would improve the ability to rapidly detect and diagnose both animal and zoonotic infections and disease outbreaks, whether natural or deliberate.
4) Improving disaster preparedness and response capabilities, especially medical surge capacity. The capabilities needed to respond quickly and effectively to an event that produces a large number of casualties are similar whether the event is a natural disease outbreak, a bioterrorism event, or a natural disaster such as an earthquake or tsunami.
5) Strengthening research on new diagnostics, antibiotics, and antivirals for emerging or established diseases that cause significant mortality or morbidity. The ability to rapidly develop, test and verify the safety of new vaccines after an epidemic or pandemic is also important.

## REDUCING THE RISKS

Reducing the risks of biological threats, presented by either the deliberate or accidental release of a biological agent, requires the use of all instruments of national power, close coordination among all sectors of government, and effective partnerships among public and private institutions both nationally and internationally. Hence, for the nation to be prepared and able to counter any kind of biological threats, it is necessary to have and establish a strategy. The strategy should:

1) Highlight the beneficial nature of advances in life sciences and their importance in combating infectious diseases of natural, accidental and deliberate origins.
2) Outline how the risks associated with misuse and potential consequences of a biological attack require tailored actions to prevent biological threats.
3) Be able to prevent such incidents by reducing the risk of the misuse of the sciences in using biological agents which can cause harm to public, animal and plant health.
4) Improve global access to the life sciences to combat infectious diseases regardless of cause.
5) Establish and reinforce norms against the misuse life sciences.

In the context of building awareness and developing policies pertinent to dual-use research issues, and considering the National Science Advisory Board for Biosecurity's (NSABB), National Institute of Health, USA, suggestion on "Strategic Plan for Outreach and Education on Dual-Use Research

Issues", there should be policies and requirements for the oversight of dual-use life sciences researches of concern [36].

Among the key message points that should be highlighted and conveyed in building awareness about the issue (through briefings, seminar, conferences and presentations) are:

1) Research in life sciences is a critically important national endeavour that yields tremendous benefits to agriculture, medicine, public health, environment, economy and national security.
2) The value of life sciences research notwithstanding, knowledge and technologies in the life sciences have evolved to a point where individuals who intend to apply them maliciously could inflict extraordinary harm to public health, agriculture, environment, economy and national security.
3) Life scientists and others in the research community have an exceedingly important responsibility to minimise the potential for this misuse of the information and technology associated with their research when such potential exists.
4) The dual-use potential of life sciences research is not always immediately evident, and scientists have a responsibility to be mindful of this potential, and handle dual-use information and technologies responsibly. In particular, scientists need to consider the dual-use potential of emerging technologies, such as synthetic genomics and synthetic biology.
5) Scientists should engage, and as appropriate, educate others about dual-use research issues. Audiences should include not only their own laboratory staff, but also colleagues, federal officials, members of parliaments, and the public.
6) If even only a few scientists fail to attend to their responsibilities to handle dual-use research appropriately, the results could be extremely damaging to public and agricultural health, the economy, national security, and public confidence in science. Therefore, it is incumbent upon life scientists and their professional organisations to initiate and continue dialogue on this matter to maximize awareness and appreciation for the significance of concerns related to dual-use research.
7) The future of research depends heavily on public trust, and even one incident involving the misapplication of dual-use information or technologies could threaten that support and the future vitality of the life sciences enterprises.
8) If someone is intent on doing harm, he or she will most likely be able to do so; thus the intent of an oversight system is to assist those who behave responsibly and to avoid inadvertently aiding those who seek to do harm.

Increased awareness in the science and technology (S&T) community could reduce the inadvertent spread of knowledge that may aid terrorists, and there shall be a fine balance that must be achieved so as to not quash legitimate exchange of scientific information [37]. In addition, the education of young scientists is an important step in the elimination of WMD. For that reason, in the first-year of science

graduate course, students should take at least one course on the essentials of treaties, laws, regulations and other programs designed to control biological warfare. Hopefully, this approach will raise the ethical consciousness of bioscientists, increase their awareness of the potential for hostile or dangerous exploitation of biotechnology, and persuade them of their responsibility to take action whenever possible to prevent it [38].

As yet, there is no verification protocol for BWC, and hence, it is necessary for the government to review, and where necessary, enact or update national legal measures to ensure effective implementation of the BWC prohibitions and to enhance effective security of pathogens and toxins.

## CONCLUSION

The threat and potential impact of the malevolent use of biological agents for political, social and economic reasons continues to be real. Knowledge and technology are widespread, and access to biological agents that can be weaponised is relatively facile. As a nation, we should adjust our current position on the time-risk continuum from reaction, response and recovery to anticipation, dissuasion, interdiction, disruption and containment. Sustained preventive systems are needed, and should be designed to identify and resolve problems while they are small and containable, ideally well before they amplify to catastrophes. As part of the new approach, the government, academia and the private sector must work in concert to give greater attention to scientists who do and could work with dangerous biological materials, and those who otherwise have access to them. Scientists, researchers, and those closely associated in positions of public or corporate trust should expect to live and work under more restrictive and intrusive systems of control, that are not so oppressive and debilitating as to prohibit proper scientific research from being conducted and managed.

Although there are gaps in the scientific understanding of many potentially deadly biological agents, and in the technological advances needed to anticipate and respond to their release, reliance on purely scientific or technological solutions would be misguided. A much more inclusive effort is needed to build a seamless system of preparedness and response; one that can exercise the best available tools to counter biological threats. Preparedness is essential not only for countering bioterrorism but also for facing the constantly evolving threat of infectious diseases. Serious, sometimes deadly, outbreaks of infectious diseases continue to occur naturally around the world. Even when they are treatable, these diseases take their toll in pain and suffering, inconvenience, disability, lost time from work and lost wages, and cost to the health-care system and the economy.

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# FROM PAPER MAP TO DIGITIZED BATTLEFIELD

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## ABSTRACT

*Paper maps have been a traditional medium to portray information about topography that includes natural and man-made features on the earth's surface. However, today's armed forces require digital information of paper maps, the so called geospatial information, to augment the use of paper maps in the field. The Malaysian Armed Forces (MAF) has placed emphasis on the importance of geospatial information in the modernisation of weapons and command & control systems towards Network Centric Operations (NCO). This in turn emphasises the requirement of a proper framework for geospatial information to underpin our future digitised battlefield environment. The Directorate of National Mapping Malaysia (DNMM) through the Defence Geospatial Division (DGD) has been playing a major role in providing integrated geospatial support to MAF planning and operations. Being an integral part of NCO in the future, decision makers and users shall be able to have online and real time access to geospatial data, information, systems and services just as easily as accessing Google services. In addition to the Web services, DGD will introduce field geospatial support capability to ensure that the commander in the field receives advanced geospatial support that includes rapid response and terrain analysis products.*

## INTRODUCTION

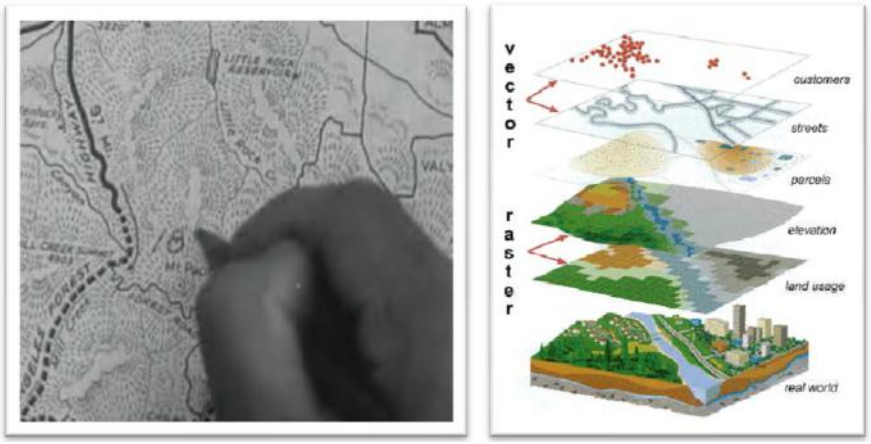
Maps have been utilized in the battlefield for a long time and are vital for mission success. The significance of maps was endorsed by the great military genius, Sun Tzu (500 B.C.), in the Art of War. According to his philosophy, by knowing our own and enemy forces, the war outcome would not be at risk. However, by knowing the terrain and natural conditions, the victory would be total [1].

In the past, paper maps have been widely used in the military operations, and have been the traditional medium to portray information about topography that includes natural and man-made features on the earth's surface. With the advancements in information & communication technology (ICT), today's armed forces require more information than just those portrayed in paper maps, instead seeking maps in digital form to support their weapons and command & control systems. They are now demanding information superiority over their adversary in order to gain decision superiority and act quickly. The requirements would be more complex since most armed forces in the world have been embracing a new concept of warfare that is called Network Centric Operations (NCO). Since the NCO concept is joint environment in nature, the maps that used to support this concept must be jointly agreed upon in principal. For example, NATO has inherited the British Recognised Environmental Picture (REP) that underpins their Common Operation Picture (COP) [2].

The aim of this paper is to highlight the development of mapping and geospatial data to support current and future Malaysian Armed Forces (MAF) planning and operations. This would cover the provision of traditional paper maps to the future requirements of geospatial data, systems and services to underpin the digitised battlefield.

## MANUAL CARTOGRAPHY VS DIGITAL CARTOGRAPHY

It is important to understand the basic of geographic information that forms maps. Maps are the abstraction of the real world, and in the past, map production was carried out manually by cartographers. The manual cartographic process took a longer time than the one carried out digitally. This also applied to the updating process, where the manual cartographic process has to start from scratch, whereas digital cartography, which is also known as the digital mapping process, can be updated from the latest map production exercise. However, there are still no tools that can fully automate the cartographic process. Instead, cartographic intervention is still needed for the final map production. Digital mapping has a different approach for data management than manual cartography in that the geospatial information can be stored in hundreds of layers and attributes (Figure 1).




(a) (b)

**Figure 1. (a) Manual cartographic process (modified from [3]) and (b) geospatial information in layers (modified from [4]).**

## THE ROLE OF THE DIRECTORATE OF NATIONAL MAPPING MALAYSIA (DNMM)

The Department of Survey and Mapping Malaysia (DSMM) embarked on the development of digital mapping in the early 1990s [5]. Since then, the process of creation and maintenance of digital data were implemented more effectively. DSMM has databases containing natural and manmade basic information, such as road networks, vegetation land covers, surface drainage, contours and utilities. DSMM, through a

controlling body known as the Directorate of National Mapping Malaysia (DNMM) has established a national database for large to small scale mapping which ranges from 1:500 for utility mapping to 1:50,000 for topographic mapping.

DNMM was established in 1965 and one of its objectives is to obtain and provide maps to the MAF. DNMM comprises of a civilian element that is currently known as Mapping Division, and a military element that was recently upgraded to the Defence Geospatial Division (DGD). Both elements are commanded under the leadership of the Honorary Director of Military Survey, with the rank of Honorary Colonel in the Malaysian Royal Engineer Regiment Corps, who is also the Director General of DSMM. Figure 2 shows some samples of geospatial products that are provided to MAF defence systems through DNMM.

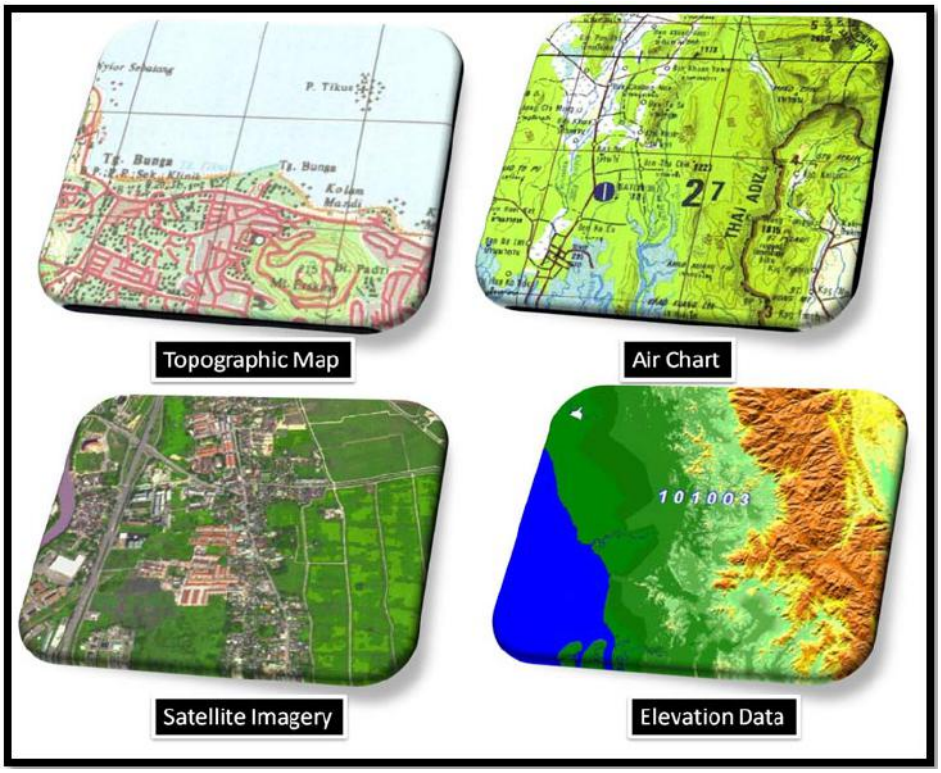



**Figure 2. Samples of geospatial data provided by DNMM**

## GEOSPATIAL SUPPORT FOR THE MAF

DNMM has supported digital mapping data to the MAF since the early 1990s with the establishment of the Fast Mapping System (FMS). This project was aimed to providing digital mapping products to support several MAF projects, such as Command, Control, Communication and Intelligence (C3I), Intelligence System, Hawk knee board map, flight simulator, and Mission Planning System (MPS). Since

2000, defence procurement for advanced weapons and defence systems has increased, and most of them require digital mapping data to operate. Based on the technology at particular times and business security, the defence systems were designed as bespoke systems requiring proprietary formats for digital mapping. This means the same digital mapping data has to be converted to a number of defence systems in deferent format for map installation. This process is rather time consuming and will not able to meet the requirements for NCO operations in the future. The future requirements of geospatial data are dynamic, timely, accurate and seamless, and must be able to support responsive requirements. Figure 3 shows a sample of satellite imagery in 3D perspective over Penang Island that can be used to support responsive requirements.

**Figure 3. Geospatial data in 3D perspective.**

## IMPLEMENTATION OF DEFENCE GEOGRAPHIC INFORMATION SYSTEM (DGIS)

As NCO requirements for geospatial data and the requirements for improving geospatial support for the MAF were anticipated, the government has reorganised the military element of DNMM to DGD. The establishment of DGD is important to carry out the vision "to be a credible military geospatial organisation" [6]. This vision is in line with and to support MAF vision that is "to be a credible armed force" [7]. Therefore, the mission of DGD has been revised which is to provide geospatial capability in order to enable the delivery of combat ready forces [6]. The DGD mission was developed based on the MAF mission, that is to protect national sovereignty, integrity and interests [7].

The establishment of DGD is considered new, and many aspects of the core business of geospatial supports are still lacking and need to be looked into. A thorough study on how the DGD would operate in enterprise environments beyond 2011 was implemented in 2009 through a project called "Defence Geographic Information System (DGIS)". This project was approved by the government in the Mid Term Review of the 9$^{th}$ Malaysian Plan (RMK9). It was initiated in order to ensure that the supply, delivery, site preparation, development, installation, integration, testing, commissioning and training of geospatial information capability of the MAF is effectively implemented. The methodology involved an iterative process of customer, user and stakeholder engagement in gathering information, analyzing it, and presenting the results to the customer. There are two phases involved in this project. Phase One involved the development of user requirements for geospatial data, information, systems and services, from which other information could be derived, such as User Requirement Documents (URD), Key User Requirements (KURs), Single Statement of User Need (SSUN), Concept of Employment (CONEMP) and Concept of Use (CONUSE) [6]. At the time of writing, Phase One had been completed, and Phase Two was about to commence. Phase Two involves technology investigation and the development of an Enterprise Management Plan. The Enterprise Management Plan is critical for the 10$^{th}$ Malaysian Plan (RMK10), and will consider Through Life Capability Management across the Defence Line of Developments (DLODs).

## FIELD GEOSPATIAL SUPPORT

While present works have addressed future user requirements for data, systems and services, the government has also approved the initial field geospatial support capability in the Mid Term Review of RMK9. By the end of 2010, DGD will commission two geospatial systems that will able to be deployed in the field. The MAF will then be able to utilise this capability for operations and trainings. This system

will become an integral part of NCO in order for other defence systems to exploit the geospatial capability within the network. Products that can be generated from the systems are terrain analysis to support Intelligence Preparation of the Battlespace (IPB), map enlargement, geospatial data replication and installation, up-to-date geospatial data, and rapid response products. Sample outputs of terrain analysis products, such as mobility analysis, that can be generated as shown in Figure 4.

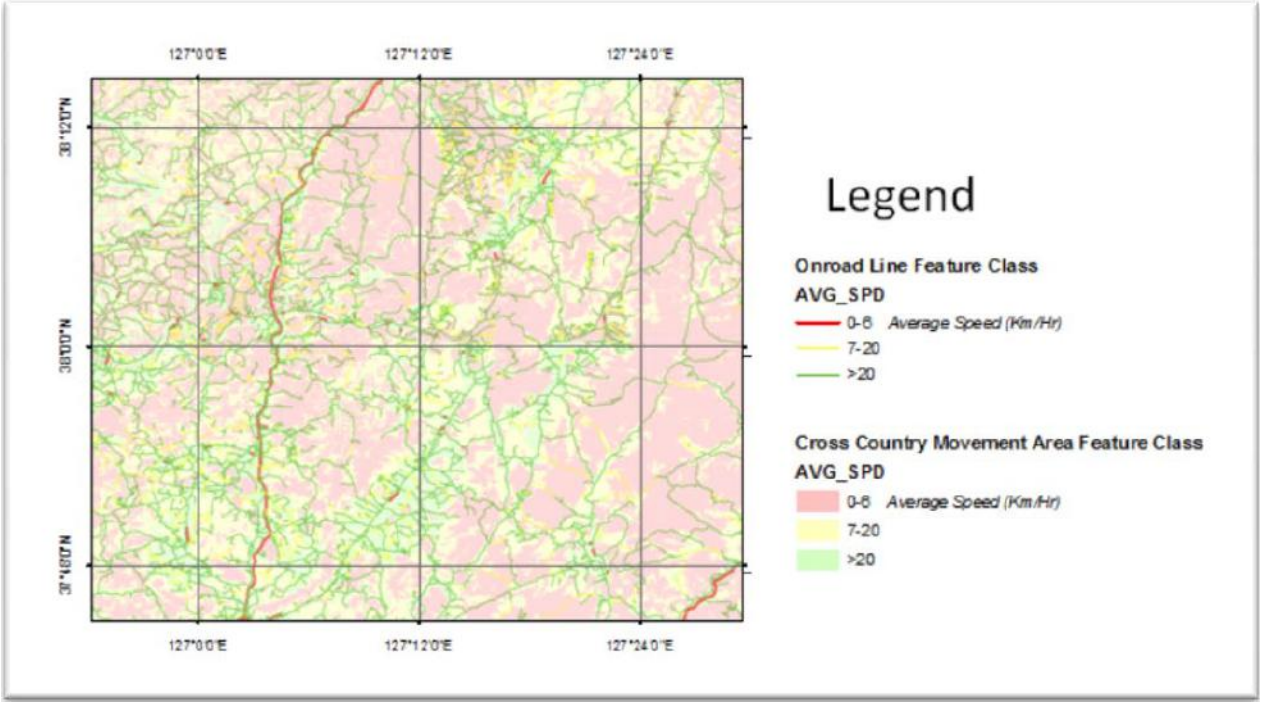



**Figure 4. Output of mobility analysis**

## CONCLUSION

In conclusion, there has been a revolution of the development of geospatial support for the MAF since the mandate granted by Cabinet in 1965. Advanced weapons and defence systems to support NCO requirements are the main factors that have contributed to the revolution. Although DGD is still considered as a new organisation, proper management plans for Enterprise DGIS should bring about the maturity even faster.

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# SCALE BASED UNCERTAINTY MODELLING

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## ABSTRACT

*In this paper, it is proposed that the mapping of the three predominant physiographic features, mountain, basins and piedmont slopes, extracted from multiscale digital elevation models (DEMs), and their uncertainties be performed using concepts of Boolean and fuzzy set theory. Multiscale DEMs are generated via the lifting scheme. Using the extracted physiographic features, for each scale, four change classes are identified; landform gain (non-landform pixels that are converted to landform pixels), landform loss (landform pixels that are converted to non-landform pixels), landform maintain (landform pixels that remain as landform pixels), and non-landform maintain (non-landform pixels that remain as non-landform pixels). For each change class, the fuzzy membership at each location can be given by the average of Boolean memberships of that class over the scales of measurement. The uncertainty of the extracted physiographic features is measured by dividing the maximum entropy generated by the fuzzy memberships of the mountain, basin and piedmont slope maintain classes. By comparing the uncertainty map with the physiographic features extracted from the original DEM, a definite pattern is observed in the uncertainty of the three physiographic features, with well identified pixels occurring in association with basins, and poorly defined pixels associated with mountains. This occurs as the elevational accuracy of DEMs is greatest in flat terrains, and decreases in steep terrains. This paper demonstrates that fuzzy certainty maps provide a better reflection of landform character than Boolean landform maps alone. In terms of sensitivity to noise, the methodology is able to identify narrow bridges and spurious landforms, and assign these errors with low certainty values. However, it is unable to identify spurious modifications to the mountain shape, with these errors being assigned high certainty values. Ground truth maps are required to identify these errors.*

## INTRODUCTION

Scale variations can constrain the detail with which information can be observed, represented and analyzed. Changing the scale without first understanding the effects of such an action can result in the representation of patterns or processes that are different from those intended [1-6]. Hence, feature detection and characterization often need to be performed at different of scales measurement. Wood [7, 8] showed that analyses of a location at multiple scales allow for a greater amount of information to be extracted from a DEM about the spatial characteristics of a feature. The term scale refers to combination of both spatial extent and spatial detail or resolution [3, 5, 9].

It is assumed that at any particular scale, landforms are Boolean objects. This scheme of mapping is based on Boolean division of terrains inherited from traditional maps and cartographic conventions, which has remained embedded in much thinking about spatial information [10]. Hence, for any particular landform, the terrain $L$ at location $x$ can be belong either to the landform class or

the non-landform class. $L_x$ has a value of 1 for landform classes, and a value of 0 for non-landform classes.

The assignment of any location to the landform or non-landform class is not necessarily stable under repeated observation at different scales. Thus, if $L_{X|S1} = 1$ for a particular landscape, it does not follow that either $L_{X|S2} = 1$, or $L_{X|S3} = 1$, where $s_1$, $s_2$ and $s_3$ indicate different scales of measurement. This creates uncertainty in the extracted landforms.

Uncertainty has been a subject of much research in remote sensing and geographic information systems (GIS) [11-18], with the main focus of such work being the assessment of classification accuracy. This focus has led researchers to recommend that the spatial output of GIS systems should be at least twofold; a map of the landform of interest, and an uncertainty map, which provides an assessment of uncertainty in the landform map.

In this paper, it is proposed that the mapping of the three predominant physiographic features of terrains, mountains, basins and piedmont slopes, extracted from multiscale digital elevation models (DEMs), and their uncertainties be performed using concepts of Boolean and fuzzy set theory. Physiography (also known as land surface characteristics) is the study of the physical features and attributes of the earth's land surface. The detection of the physiographic features of a terrain is the first phase involved in the classification of the various landforms of the terrain.

In Boolean set theory, if an object belongs to a set, it is assigned an integer value of 1 as membership for that set. If the object does not belong to that set, it is assigned with a membership of 0. In fuzzy set theory, a core concept is defined and objects which exactly match that core concept are assigned with a class membership of 1. The membership is assigned a reducing real number for objects as they are increasingly dissimilar from that core concept, when the membership is assigned a value of 0 [19-22]. Fuzzy set theory is a suitable tool to represent and handle the uncertainty of the landforms as it allows for landforms to be defined as regions in the continuum of variation of the surface of the earth, rather than strictly as Boolean objects.

In previous researches [23-28] the modelling of uncertainties of landform extracted from multiscale DEMs was performed using the average of Boolean memberships of the landforms extracted over the scales of measurement. The disadvantage of this approach is that it only provides an overall view of landforms extracted from multiscale DEMs without taking into account the specific changes that occur at each scale.

This paper is aimed at addressing the flaws of this approach. This is done by classifying the specific changes that occur to each physiographic feature at each scale to generate fuzzy uncertainty

maps. This will allow for a more effective method of classifying landform character, in particular for military mapping applications.

## METHODOLOGY

### Generation of Multiscale DEMs

In this paper, multiscaling is performed using the lifting scheme [29-30]. The lifting scheme is a flexible technique that has been used in several different settings, for easy construction and implementation of traditional wavelets and of second generation wavelets, such as spherical wavelets. It has proven to be a powerful multiscale analysis tool in image and signal processing [31-33], which has received recent attention in geospatial analysis [34-36]. Lifting consists of the following three basic operations (Figure 1):

**Step 1: Split**

The original data set $x[n]$ is divided into two disjoint subsets, even indexed points $x_e[n]= x[2n]$, and odd indexed points $x_0[n]= x[2n+1]$.

**Step 2: Predict**

The odd and even subsets are often highly correlated. This correlation structure typically local and hence, it is possible to accurately predict the wavelet coefficients $d[n]$ as the error in predicting $x_0[n]$ from $x_e[n]$ using the prediction operator $P$:

$$d[n] = x_0[n] - P(x_e[n]) \quad (1)$$

where

$$P(x_e[n]) = \frac{1}{2}(x_e[n] + x_e[n+1]) \quad (2)$$

**Step 3: Update**

Scaling coefficients $c[n]$ that represent a coarse approximation to the signal $x[n]$ are obtained by combining $x_e[n]$ and $d[n]$. This is accomplished by applying an update operator $U$ to the wavelet coefficients and adding to $x_e[n]$:

$$c[n] = x_e[n] + U(d[n]) \quad (3)$$

where

$$U(d[n]) = \frac{1}{4}(d[n-1] + d[n+1]) \qquad (4)$$

These three steps form a lifting stage. The lifting scheme scans 2D images row-by-row. Using a DEM as the input, an iteration of the lifting stage generates the complete set of multiscale DEMs $c_r[n]$ and the elevation loss caused by the change of scale $d_r[n]$.

The DEM in Figure 2 shows the area of Great Basin, Nevada, USA. The area is bounded by latitude 38° 15' to 42° N and longitude 118° 30' to 115° 30'W. The DEM was rectified and resampled to 925m in both *x* and *y* directions. The DEM is a Global Digital Elevation Model (GTOPO30) and was downloaded from the USGS GTOPO30 website [37]. GTOPO30 DEMs are available at a global scale, providing a digital representation of the Earth's surface at a 30 arc-seconds sampling interval. The land data used to derive GTOPO30 DEMs are obtained from digital terrain elevation data (DTED), the 1-degree DEM for USA and the digital chart of the world (DCW). The accuracy of GTOPO30 DEMs varies by location according to the source data. The DTED and the 1-degree dataset have a vertical accuracy of ± 30m while the absolute accuracy of the DCW vector dataset is ±2000m horizontal error and ±650m vertical error [38]. Tensional forces on the terrain's crust and thins by normal faulting cause the formation an array of tipped mountain blocks that are separated from broad plain basins, producing a basin-and-range physiography [39-43].

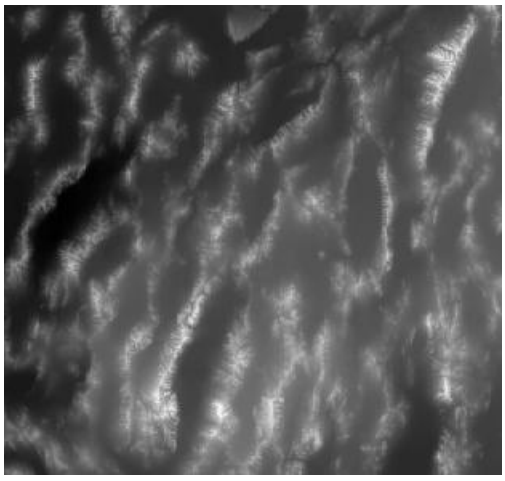
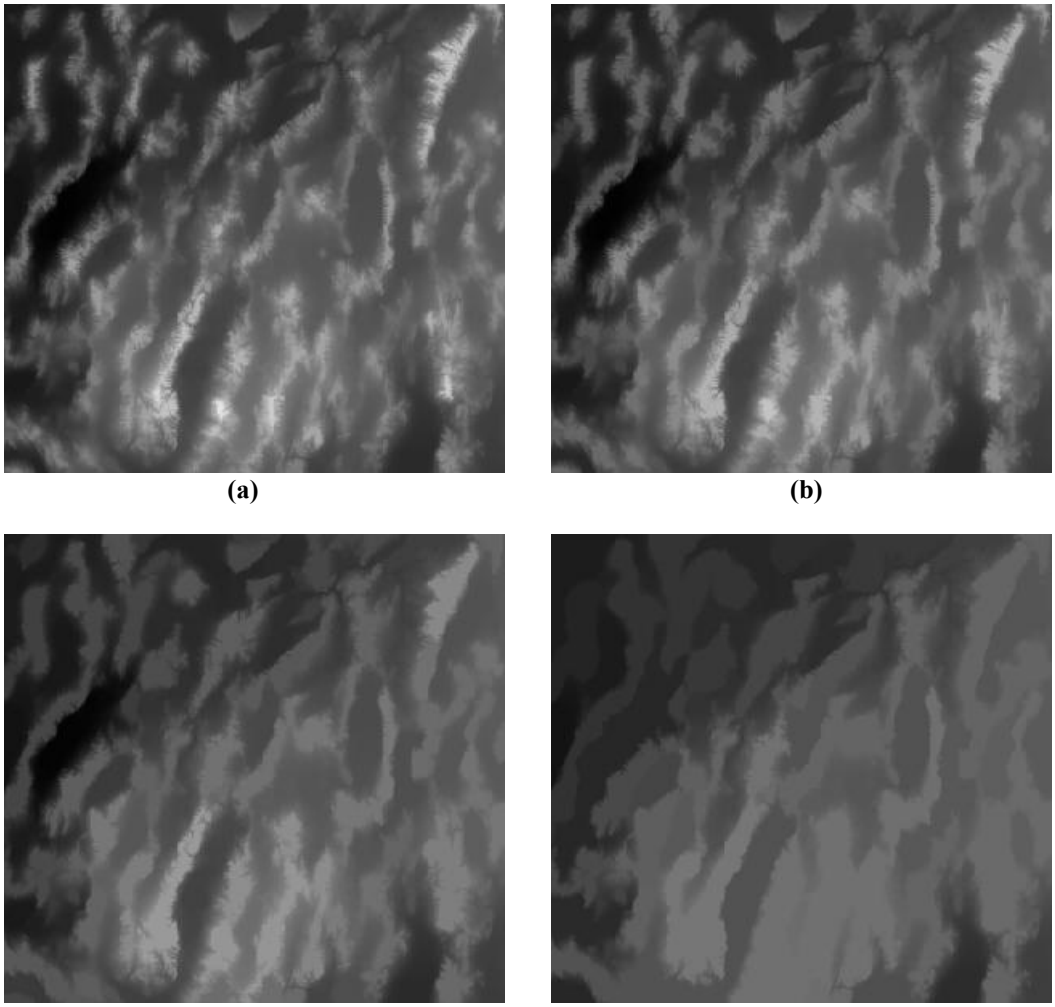


**Figure 1. The GTOPO30 DEM of Great Basin. The elevation values of the terrain (minimum 1005 meters and maximum 3651 meters) are rescaled to the interval of 0 to 255 (the brightest pixel has the highest elevation). The scale is approximately 1:3,900,000.**

Multiscale DEMs of the Great Basin region are generated by implementing the lifting scheme on the DEM of Great Basin using scales *r* of 1 to 20. As shown in Figure 3, as the scale increases, the merge of small regions into the surrounding grey level regions increases, causing removal of fine detail in the DEM. As a result, the generated multiscale DEMs possess lower resolutions at higher degrees of scaling.



**(a)** **(b)** **(c)** **(d)**

**Figure 2. Multiscale DEMs generated using scales of (a) 3 (b) 5 (c) 10 (d) 20.**

## Extraction of Physiographic Features

The mountains, basins and piedmont slopes (Figure 3) of the generated multiscale DEMs are extracted using the mathematical morphological based physiographic segmentation algorithm proposed in Dinesh *et al.* [44]. Ultimate erosion is used to extract the peaks and pits of the DEM. Conditional dilation is performed on the peaks and pits of the DEM to obtain the mountain and basin

pixels respectively. The pixels that are not classified as mountain pixels or basin pixels are assigned as piedmont slope pixels.

As shown in Figures 4 to 6, the merge of small regions into the surrounding grey level regions increases and removal of fine detail in the DEM cause a reduction in the area of the extracted mountains, and an increase in the area of the extracted basins. In general, the area of the piedmont slopes remains fairly constant, but the pattern of the piedmont slope pixels changes significantly based on the change in pattern of the mountain and basin pixels.

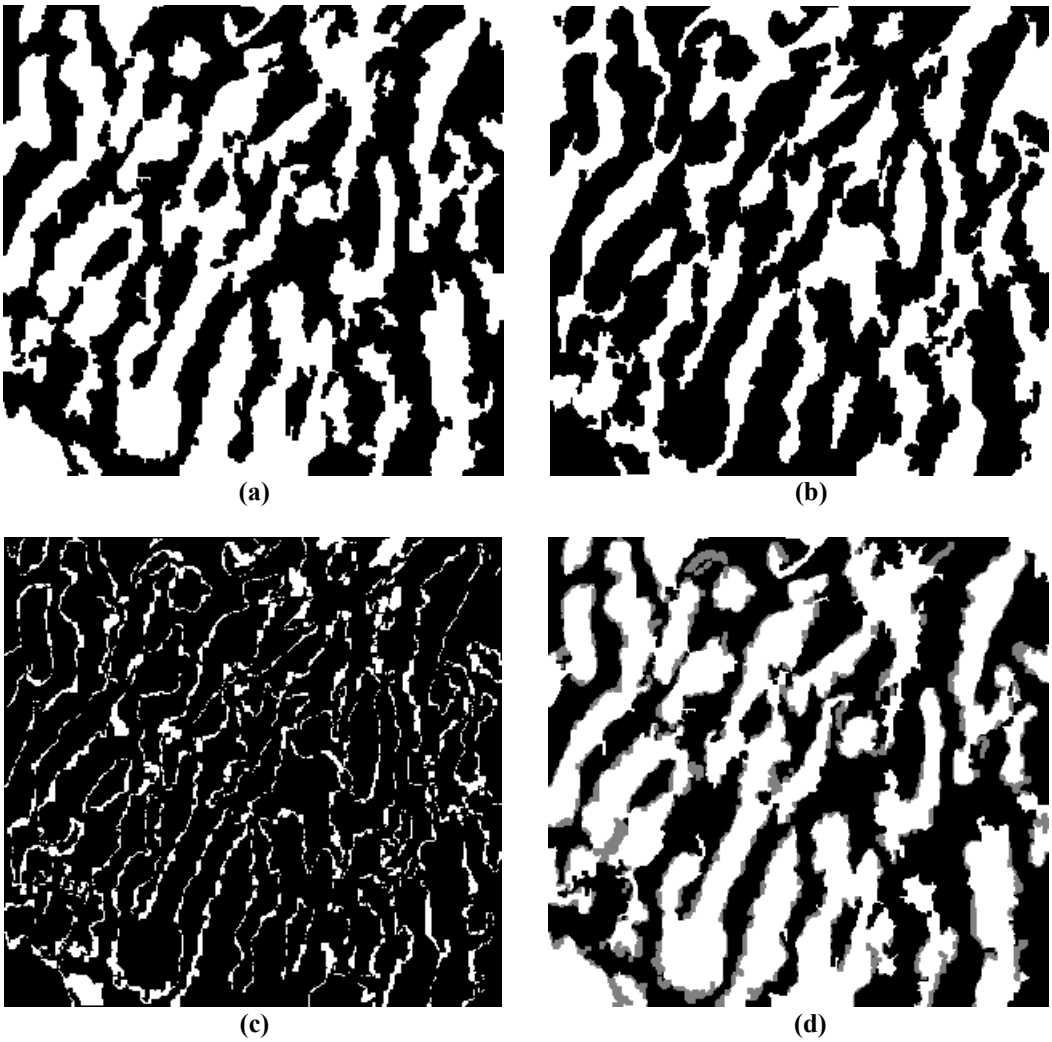
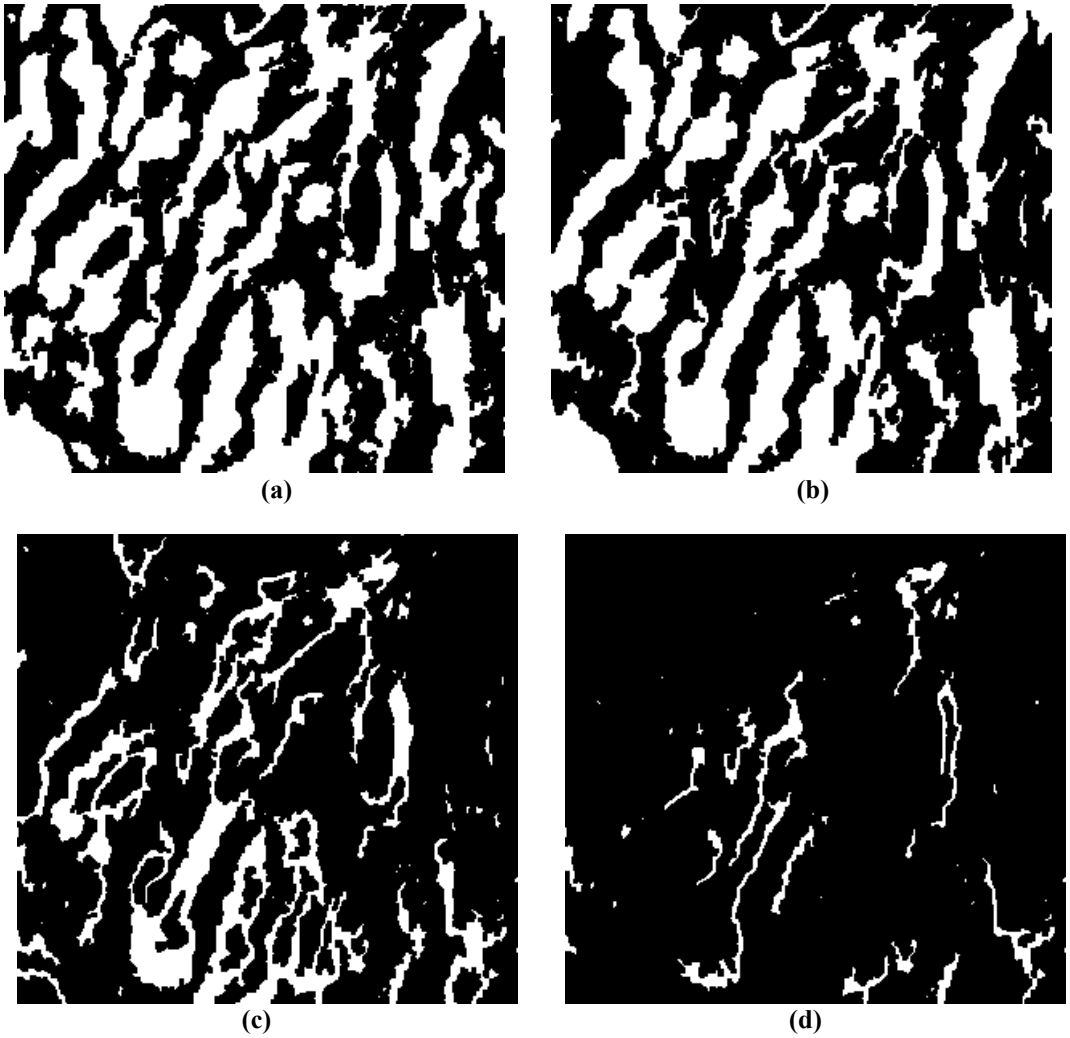
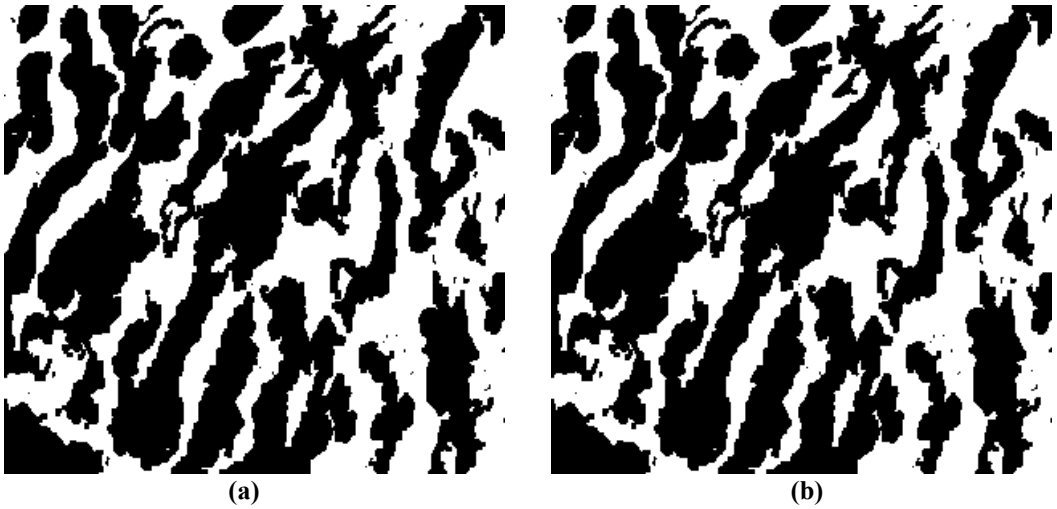



**Figure 3. Physiographic segmentation of the terrain of the DEM. (a) Mountains (b) Basins (c) Piedmont slopes (d) The physiographically segmented DEM; the mountains pixels are the in white, the piedmont pixels are the pixels in grey and the basin pixels are the pixels in black.**

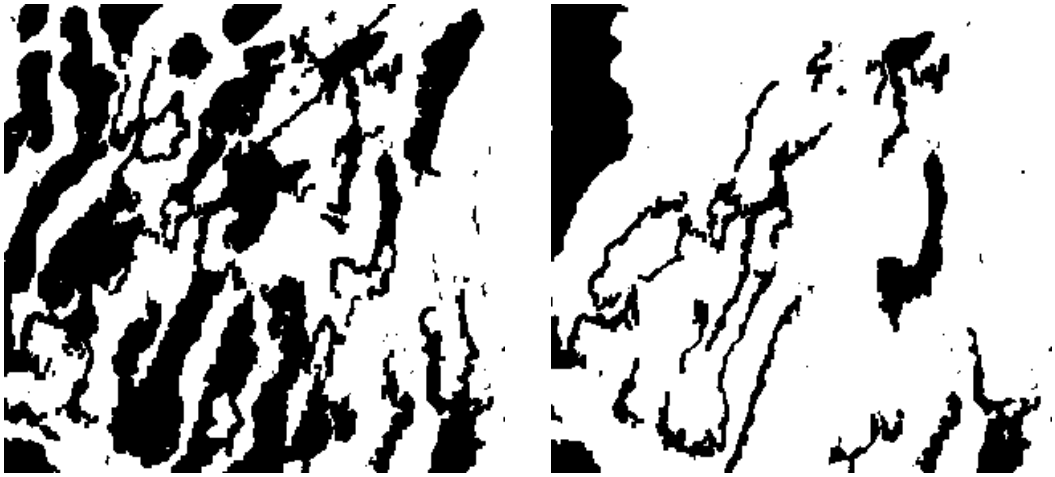


**(a)** **(b)** **(c)** **(d)**

**Figure 4. Mountains (the pixels in white) extracted from the corresponding multiscale DEMs in Figure 2.**

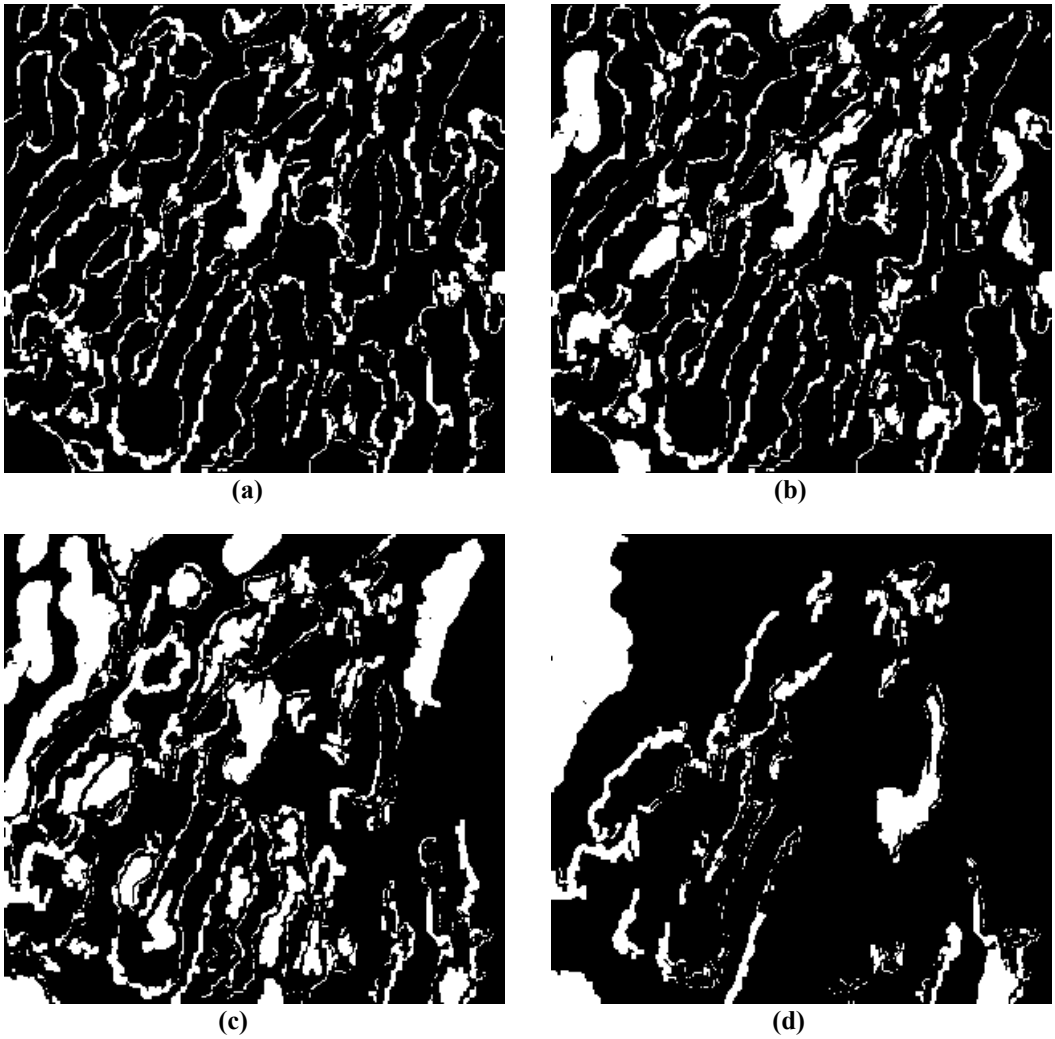


**(a)** **(b)**



(c) (d)

**Figure 5. Basins (the pixels in white) extracted from the corresponding multiscale DEMs in Figure 2.**



(a) (b)

(c) (d)

**Figure 6. Piedmont slopes (the pixels in white) extracted from the corresponding multiscale DEMs in Figure 2.**

**Identification and Fuzzy Classification of Change Classes**

Using the extracted physiographic features, for each scale, the following change classes are identified:

- **Landform Gain:** Non-landform pixels that are converted to landform pixels
- **Landform Loss:** Landform pixels that are converted to non- landform pixels
- **Landform Maintain:** Landform pixels that remain as landform pixels
- **Non-landform maintain:** Non-landform pixels that remain as non-landform pixels.

For each change class, the fuzzy membership $\mu_P$ at location $x$ can be given by the average of Boolean memberships of that class over the scales of measurement:

$$\mu_{p_x} = \frac{\sum_{r=2}^{20} m_{p|s_r}}{19} \tag{5}$$

**Uncertainty computation**

The uncertainty of the each extracted landform $U_x$, which is scaled between 0 (complete certainty) and 1 (complete uncertainty), is measured by dividing the maximum entropy generated by the extracted landform's change classes:

$$U_x = \frac{\sum_{j=1}^{4} \mu_{p_{j_x}} \log\left(\mu_{p_{j_x}}\right)}{\log\left(1/4\right)} \tag{6}$$

The certainty of each extracted landform is computed by subtracting the uncertainty from the landforms extracted from the original DEM. Boolean landform maps only show the locations of landforms, without providing any information on the landform's character, nor the uncertainty of the extracted landform. The certainty map provides a higher level of certainty for the centre portions of the landforms, as compared to the sides, giving users a better reflection of the landforms' characteristics.

The uncertainty of classification of the three physiographic features is computed by the entropy $E_x$, which is scaled between 0 (complete certainty) and 1 (complete uncertainty), by dividing the maximum entropy generated by the certainties of the three features:

$$E_x = \frac{\sum_{j=1}^{4} U_x \log(U_x)}{\log\left(1/3\right)} \quad (7)$$

The computed entropy values are shown in Figure 7. By comparing the entropy map with the physiographic features extracted from the original DEM (Figure 6(b)), a definite pattern is observed in the uncertainty of the three physiographic features, with well identified pixels occurring in association with basins, and poorly defined pixels associated with mountains. This occurs as the elevational accuracy of DEMs is greatest in flat terrains, and decreases in steep terrains [45, 46].

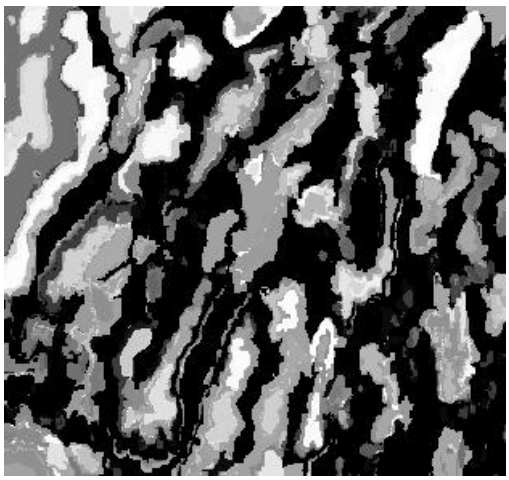


**Figure 7. The computed entropy values. The entropy values (ranging from 0 to 1) are rescaled to the interval of 0 to 255 (the brightest pixel has the highest entropy value).**

## RESULTS AND DISCUSSION

The proposed methodology hinges on the accuracy of mountains extracted from each singular scale DEMs. While this study is specifically aimed at modelling uncertainty that caused by variation of scale, it is important to note that DEMs are subject to errors caused by input data error, interpolation procedures, and the limited horizontal and vertical resolution of DEMs, which results in further uncertainties in landforms extracted from DEMs.

In order to test the robustness of the proposed algorithm, model DEMs with mountains of various shapes and sizes (Figure 8) are empoyed. The original model DEM is be used as a benchmark to test the methodology's robustness to three forms of errors observed in mountains extracted from real DEMs; narrow bridges, spurious mountain regions, and spurious modifications of mountains. From the results obtained (Table 1), it is observed that for errors in the form of narrow bridges and spurious mountains, the methodology is able to identify and assign these errors with low certainty values.

However, for spurious modifications to mountains, it is unable to identify these errors, and erroneously assigns them with high certainty values. Hence, the reliability of the generated certainty map needs to be ascertained by comparison with a known ground truth.

Figure 9(b) shows a physiographic map of the Great Basin region, entitled "Landforms of California and Nevada", which was obtained from Atwood [47]. This map is of significant importance as it depicts the physiographic features in the study area based on fieldwork and visual interpretation done by a reknowned geomorphologist. The generated certainty map of the mountains extracted from the Great Basin DEM (Figure 9(a)) generally assigns high levels of certainties to the mountains in Atwood's map; however some discrepancies were observed. There are high levels of uncertainties assigned to non-mountains regions in Atwood's map, while the mountains defined by certainty map's transition zones are wider and have more distinctive shapes compared to the mountains in Atwood's map. It is also noted that certain parts of single mountain ranges in Atwood's map are assigned with high levels of uncertainty.

These discrepancies arise due to the different methodologies of which Atwood's map and the certainty map were derived. Atwood integrated fieldwork and human expertise, and was capable of connecting isolated mountaintops and broken ranges (areas of which DEMs are most suspect to error, due to their limited vertical resolution) into singular entities. Atwood noted that visual interpretation of mountains features was derived mainly on the discrimination of mountaintops and it was difficult to visually quantify the variations in shape of the mountains, causing the mountains in Atwood's map to have more generalized shapes. Extraction of mountains from DEMs is done on the basis of automated mapping based on certain objective rules. The certainty map is a measure of uncertainty of mountains extracted from the generated multiscale DEMs, rather than the ground truth. It is important to note the generated certainty map is only a measure of uncertainty caused by variation of scale, and does not take into consideration inherent errors in DEMs, which propagate to the extracted mountains.

## CONCLUSION

In this paper, concepts of fuzzy set theory was employed to perform the computation of the uncertainty of physiographic features extracted from multiscale DEMs based on the changes that occur to the landforms at each scale. While Boolean landform maps only show the locations of landforms, without providing any information on the landforms' character, fuzzy certainty maps provide users with a better reflection of the landforms' characteristics. In terms of sensitivity to noise, the methodology is able to identify narrow bridges, and spurious landforms, and assign these errors with low certainty values. However, it is unable to identify spurious modifications to the

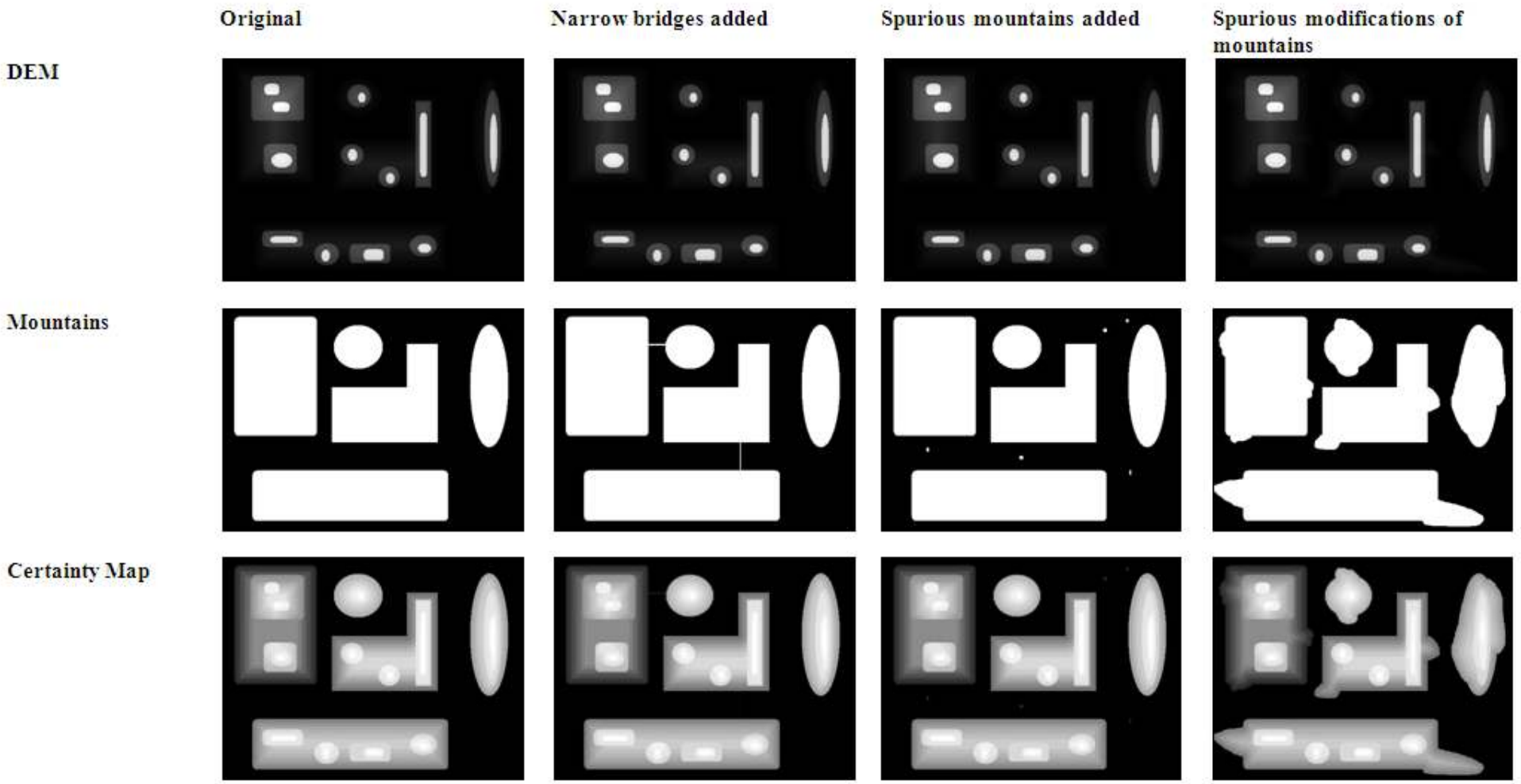
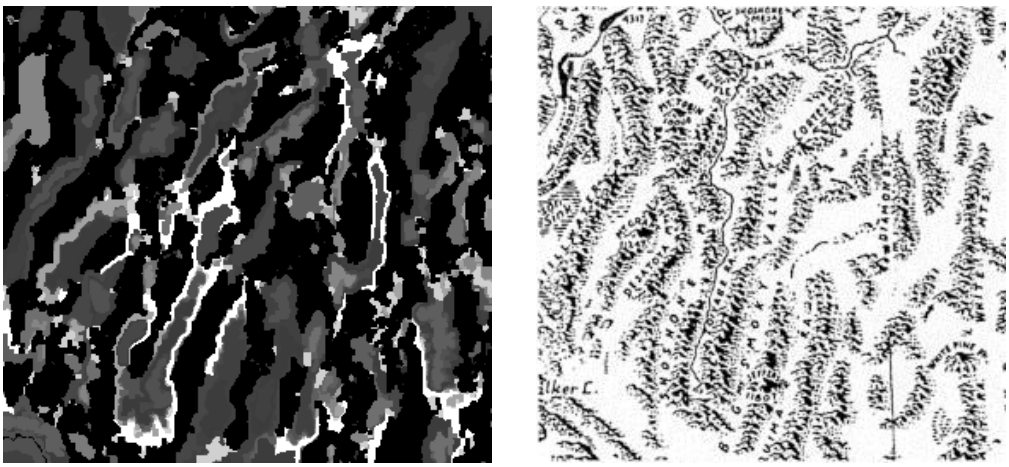



**Figure 8. Testing the methodology's robustness to three forms of errors observed in mountains extracted from real DEMs; narrow bridges, spurious mountain regions, and spurious modifications of mountains.**

**Table 1. Distribution of pixels based on their certainty values, for the mountains extracted from the original model DEM in Figure 8(a), and the model added with errors in the form of narrow bridges, spurious mountains and spurious modifications to the mountains.**

| Certainty range | Frequency (pixels) | | | |
|---|---|---|---|---|
| | Original | Narrow bridges | Spurious mountains | Spurious modification |
| 0.0-0.1 | 131839 | 131839 | 131615 | 118873 |
| 0.1-0.2 | 3028 | 3028 | 3849 | 3919 |
| 0.2-0.3 | 10224 | 10224 | 10224 | 10593 |
| 0.3-0.4 | 1569 | 1569 | 1569 | 1707 |
| 0.4-0.5 | 7965 | 7965 | 7965 | 8800 |
| 0.5-0.6 | 21950 | 21950 | 21949 | 26341 |
| 0.6-0.7 | 18050 | 18050 | 17454 | 21096 |
| 0.7-0.8 | 18715 | 18715 | 18715 | 21612 |
| 0.8-0.9 | 20743 | 20743 | 20743 | 21525 |
| 0.9-1.0 | 16040 | 16040 | 16040 | 16347 |



**(a)** **(b)**

**Figure 9. Comparison of (a) the computed certainties of the extracted mountains with (b) a physiographic map of the region obtained from Atwood (1965).**

mountain shape, with these errors being assigned high certainty values. Ground truth maps are required to identify these errors.

For the purpose of demonstration and illustration, the proposed methodology was implemented on the three predominant physiographic features; mountains, basins and piedmont slopes. However, the proposed methodology can be applied to any other geomorphological landform which the user intends to

investigate. Nevertheless, it is important to remember that while quantification of uncertainty caused by scale variations is important, attention should also be given to uncertainties caused by errors in geospatial data captures.

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# AUSTRALIA'S NATIONAL INTEREST IN EAST ASIA: ENGAGING CHINA

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## ABSTRACT

*This study pertains to how states pursue their national interests against the backdrop of a host of constructivist and realist approaches in a globalised era in the East Asian region which is rife with potential conflicts. Even more complicating are alliances which are threatened by diverging interests. China has risen to be Australia's indispensible trading partner. China's military rise may change its behaviour to be more assertive and ultimately challenge United States (US) supremacy and dominance in the region. As an American ally, Australia is bound to assist the US in the event of a conflict with China. Herein, lays the dilemma for Australia. The objectives of this study are to explore how Australia secures it economic and security interests, and how Australia redefines its present alliance with the US. The study has found that Australia's strategy for advancing its national interests is by hedging on the rise of China as well as the possible decline of the US as a regional hegemony. The study concludes that Australia's relations with China will depend on the Sino-US relationship.*

## INTRODUCTION

National interests are a country's goals and ambitions whether economic, military, or cultural. The notion is important in international relations where pursuit of the national interests is the foundation of the realist school. Primary is the state's survival and security. Also important is the pursuit of wealth and economic growth and power. The study will show how Australia balances its foreign policy with an adversary in safeguarding its national interests in the wake of a principal ally and how it conceptualizes its security, political and economic interests in the context of a rising China. It uses hedging and other balance of power techniques but it also shows Australia's difficulty in abrogating its alliance with the US which in effect becomes more important in the face of a rising China.

China, technically an adversary to Australia by the nature of US – China rivalry, has risen to be Australia's second biggest trading partner after Japan, and will probably surpass it in the near future. Therefore, China is very important to Australia in securing and furthering its national interests in East Asia. It is said that East Asia will be the next economic hub of the world, and ASEAN and China are steering the way towards the creation of an East Asian Economic Community. China has been observed to have increasingly expanded its military capabilities, afforded by its economic wealth. China's military

rise may change its behaviour to be more assertive and ultimately challenge US supremacy and dominance in the region. Since the end of the Cold War, the US-China rivalry has taken a new form. Though peaceful at the outset, the legacy of the Cold War still looms. The issue of reunification in the Korean peninsula has taken a twist to be a potential nuclear threat and Taiwan's attempt to gain independence is a ticking time bomb. Another potential flashpoint is the conflicting claims in the South China Sea. All of these potential conflicts involve China. More precarious to Australia is the attempt by any rival power to dominate Southeast Asia, Australia's frontier to its north, which will erode Australia's role as a regional power, and ultimately, present a threat to the Australian continent itself. The only power that has the capacity to do so is China.

Since the Cold War, Australia has been an ally and protected by the Americans under the Australia, New Zealand and United States Security (ANZUS) treaty. As Australia has a huge economic stake in East Asia, especially in China, its national interests are also at risk if the balance of power in the region changes, or as a result of a conflict between China and the US. As an American ally, Australia is bounded to assist the US. Herein lies the dilemma for Australia, having to choose: any which way but lose. Dibb brought out another aspect of the US-Australia alliance. Current trends indicate that Australia's defence force is structured to operate alongside and in most instances subservient to US forces. Therefore, it also faces the dilemma that the trend may eventually lead to jeopardising its own concept of defence self-reliance [1].

Capie and Evans brought out one theoretical treatment of engagement that can be used to explain Australia's approach in engaging China which implies adjustment on the part of status quo powers to the legitimate interests of a rising power. In this approach, conflict is minimized and peace maintained because existing powers recognize that the balance of power requires the rising power to be peacefully incorporated into the international system. Stability is maintained because the established powers 'engage' the interests of the rising power that is they allocate it enhanced global responsibilities commensurate with its new capabilities [2].

The other imperative for Australia has been to try to separate the Sino-Australian relationship from the turbulent US – China relationship. However, Wesley stresses the more lucrative and significant the ties between Australia and China become, the more collateral damage Australia stands to suffer in each bout of tension between the US and China [3]. Therefore Australia's national interests in East Asia are dependent or a function of its interdependence with the region i.e. the relationship between Australia and East Asia, especially China, can be intervened by the relationship between the US and China which inevitably will cause Australia's alliance with the US to be at risk.

## AUSTRALIA'S ECONOMIC INTEREST IN EAST ASIA

With the end of the Cold War, a number of observers argued that economic issues would become more central in world politics. The network of economic interdependence that spans the globe has increased [4]. Interdependence refers to situations in which actors or events in different parts of a system affect each other. Simply put, interdependence means mutual dependence. Lloyd stated that when states invest more and more in foreign areas or increase their trade with another state, they become increasingly dependent on the economic and political stability of the foreign state specifically and the region in general [5].

It has been predicted that the weight of the global economy will shift to Asia in the next few decades. The region stretching from India to Japan will then account for well over half of world production and consumption, and will constitute the world's largest middle-class consumer market. China is already the second biggest economy in the world and by the middle of this century is expected to be the biggest [6]. Within the Asia Pacific, Australia's most substantial interests are with the region's three major powers and largest economies i.e. the US, Japan and China, and with no less importance, the South Korea, Taiwan and ASEAN [7]. China's growing economy has forced it to trade with Australia, Japan, South Korea, Southeast Asia, and even the US, the 'adversary', and Taiwan, it's so called 'renegade province', thereby making China interdependent towards them and vice versa. In the eyes of the Chinese, as quoted by the eminent Professor Zhang, "*Australia is a special partner, a special neighbour …*" This statement invariably is very tempting. Australia already is America's special friend, and now, China. However, on the contrary, at the moment, China is America's 'special' enemy [8]. Tow believes that China's acceptance of Australia's role in East Asia may be motivated by its importance as an energy supplier to China, and the manner in which Australia can help the US in stabilizing Sino-US relations [9]. The ongoing Global Financial Crisis has illustrated the significance of China to Australia and how it saved the Australian economy while others plummeted [10]. Australia's trade with China is getting better. With the world's largest source of uranium, exports to China will double its current levels [11].

In line with its 'New Security Concept' (NSC), China signed the Treaty of Amity and Cooperation (TAC) in 2003 and bilateral agreements with individual Southeast Asian states. The East Asia Summit (EAS) is set to be the possible successor forum for the ASEAN plus Three (APT) which will shape the future East Asian economic community. As China's economic cooperation with East Asian countries grows, there is a fear that Australia might be sidelined through China's influence over the other countries. Previously, Australia had not been very successful in joining the East Asia Summit because of its refusal

to sign the TAC and through opposition from China [12]. Australia was finally allowed to participate in the EAS – thanks to Japan and Singapore, allies and security partners of the US, and it gladly signed the TAC in 2005 [13].

## AUSTRALIA'S SECURITY INTERESTS IN EAST ASIA

Balance of power is probably the oldest concept in the study of International Relations going back at least to the work of Thucydides. Balance of power behaviour is central to conceptions of the national interest and to alliance policy. If successful, it preserves individual states and the anarchic structure of the system as a whole. Realists conceive balance of power as an automatic tendency in state behaviour [14]. As noted by Waltz, some believe that a balance of power is the best guarantee of the security of states and the peace of the world; that has ruined states by causing most of the wars they have fought [15]. According to Bull, as a condition, state of affairs, or situation, the balance of power refers to a roughly equal distribution of power existing between two or more states. In a system with three or more actors, the development of gross inequalities in power among them does not necessarily put the strongest in a position of preponderance because the others have the ability to combine against it [16].

Capie and Evans stated that most advocates of balancing behaviour seem to argue that states tend to prefer 'hedge' strategies against future uncertainty, based partly on arms modernisation and the continuation of close relationships between the US and its friends in Asia, and partly on the use of multilateral institutions such as the ASEAN Regional Forum (ARF). Balance of power policies usually hinge upon self – help or the formation of alliance or collective defence relationships. Because balance of power policies are predicated on the centrality of competitive power politics, they are generally not considered to be hospitable to co-operative multilateral organisations [17].

The remarkable economic growth of East Asia has enabled countries to increase their military expenditure. China's economic and military rise will inadvertently disrupt the balance of power in the region. It has also pushed China on the scramble to secure natural resources and energy to feed its hungry industries. The more the economy grows, the more its military power will increase and ultimately there will be concerns that China will be more assertive especially in the face of diminishing American hegemony. More precarious are built-in security issues in the present geopolitics of the region [18]. However, contrary to many analysts, China has instead embarked on its New Security Concept which Chinese officials describe what they believe to be the most appropriate way for organizing security relations in the Asia–Pacific in the wake of the Cold War. It reflects efforts to seek new ways and means to maintain a lasting peace and stability in the region. Realizing that it does not have the capacity and a

direct confrontation with the US is too costly, China has transformed itself to be the gentle giant and turned to the political and economic front instead. A secure and peaceful neighbourhood is what China needs at the moment in order for its economy to go full steam ahead [19].

Realizing that China is winning in the multilateral front, the US has reengage ASEAN with the view that China's soft power projections should also be constrained [20]. As China reinforces the great wall with its Central Asian friends via the Shanghai Cooperation Organization (SCO), the US and allies are already chipping it away by building up more alliances against it through the Trilateral Security Dialogue (TSD) which involves the US, Japan and Australia, and the possible participation of India [21]. Therefore, it is China that is being pushed up against the wall. To the frequent suggestions that China's development is sharply altering the balance of power in East Asia and changing the relative power of the major actors in East Asian international politics so that the dominant power, the US, will be less dominant; Morgan in effect suggests that the balance of power is becoming more balanced [22].

Australia likewise the US is actually one step ahead in engaging China. Knowing China's strength and influence in the region, Australia has utilized multiple prongs in its strategy of active engagement. It does not however resort to containment which Australia is incapable of. It too has utilized multilateralism in securing its economic and security interests. By doing so, Australia has killed two birds with one stone. By engaging ASEAN, it now has a level playing field to deal with China on equal terms. However, suspecting China's unpredictability and uncertainties of US commitments, Australia, other than strengthening its alliance with the US, has built up its own alliance with Japan, and further enhanced ties with India and particular ASEAN countries [23]. In spite of all these, Australia is boosting its own military capabilities so much so that Australia is armed to the teeth [24].

## AUSTRALIA'S ALLIANCE WITH THE US

Approaches to security focused on states have long dominated international relations, thinking because states have been the central actors in international affairs and security has been considered their most important concern [25]. Realists see states as preoccupied with physical safety, autonomy and treat development as a means for sustaining and strengthening autonomy and safety, and rule competently enough to meet foreign challenges. Realists have found international politics distinctive because of anarchy. Therefore, governments lack a strong sense that they are a part of a larger entity in international politics [26]. Thus, Australia's concerns over its inferior position in its alliance with the US are only

natural and genuine as states will always place their national interests on top of their foreign policy agendas.

According to Tow, alliances have been traditionally been understood as a security commitment between two or more states to support each other against a commonly understood external threat by aggregating their military and other relevant power capabilities [27]. Nye gave a clearer definition of alliance which is useful in assessing the US-Australia alliance. According to Nye, alliances are formal or informal arrangements that sovereign states enter into with each other in order to ensure their mutual security. Alliances collapse for many reasons, but in general, states cease to ally when they come to see each other as irrelevant or as threats to their security. Referring back to Nye's explanation on alliances, we can first of all understand that the US-Australia alliances were formed in order to ensure their mutual security interests. They can be assumed to be motivated by military concerns especially so during the Cold War era. The alliance has also benefitted Australia in terms of access to sophisticated weaponry and technology, and other capabilities that Australia does not possess. However, as Nye explains, alliance are only permanent when they share the same ideology, see each other as relevant and probably stay on so long as the benefits outweighs the negative aspects of each other's mutual relations. In the case of Australia, it has always been the smaller partner, it has always been dependent on the US, and it has always been the subservient military force [28].

In the absence of real threats towards it, coupled by its abundance in natural resources, Australia has been able to progress and pursue its own interests which may be divergent from the US. Lovell noted that '*It is a useful rule of thumb that nations follow their interests in foreign relations. But we should not allow that assumption to blind us to the fact that 'interests' can be a self fulfilling hypothesis, and that interests can change by our own intervention. We should not rely on the notion of 'national interest' unthinkingly. The 'national interest' is not something fixed and given, but something that develops and evolves*' [29].

However after 9/11, Lovell pointed out that the US has been very assertive and demanding on its partners, including Australia, on its war on terror [30]. This situation has prompted Australia to rethink its alliance with the US. History has taught Australia that having great powers as allies does not necessarily be in its best interest. In its alliance with the US, similar questions have arisen. According to Cotton, Australia have hard choices to make considering the looming and potential conflict between China and the US over Taiwan. Again, China and Taiwan are amongst Australia's important trading partners [31].

The argument is further illustrated by Van Ness that the US and China are without doubt the two most important states in the Asia-Pacific region. Australia has good relations with both and is eager to improve

these relationships. As American hegemony declines, the two most likely futures for the region are either a multilateral security mechanism or a new Cold War between the US and China which would bring pressure on all of the other countries in the region, including Australia, to choose sides [32]. After Australian involvement in the 2003 Iraq war, some quarters of Australian society have called for a re-evaluation of the relationship between the two countries. Several polls were conducted in order to gauge public responses towards the major aspects of the alliance, such as the historical ties of the alliance between Australia and the US, the historical baggage of Australia continually undermining its own independence, perception towards the US and China, and the relevance of the alliance in the present day. Results indicate that Australians should have a more independent foreign policy. However, the majority of Australians also feel that Australia still requires US protection [33].

## CONCLUSION

The implications of the discussion in the geopolitics and balance of power in the region bring forth the most important challenge for Australia, which is to ensure that shifts in the geopolitical balance in East Asia do not undermine the basic security of the region. No matter how calm the situation is today, the conflicts in the Korean Peninsula and Taiwan, though dormant, still is potentially dangerous and can erupt at any moment. Ultimately, these are the conflicts that will put Australia's loyalty to the test with regards to its alliance with the US. Therefore, it is crystal clear that a shift in the balance of power in East Asia will certainly affect Australia's economic and security interests in the region.

The nature and extent of growth in Asia, and especially China, over the next decades will have a major impact on Australia's economic prosperity. In view of China being Australia's second biggest trading partner, who the Australian government is very optimistic will continue at relatively higher levels, Australia and the countries of East Asia, and China will become even more interdependent as trade and investment partners. Thus, there is no doubt that East Asia is very important to Australia in terms of its economic interests. Australia's successes in joining regional institutions is part of Australia's strategy of active engagement which will enable it to engage China and ASEAN, and at the same time influence and shape the region to best serve its economic and security interests.

Despite concerns that Australia may have second thoughts of its alliance with the US, there seems to be an increase in ties between the US and Australia. Australia can be seen to be making major reconciliation to its defence policy in terms of force capability so that it will have some elbowroom and to have the choice to call its own shots as opposed to be subservient to the US. However, there is no dispute that Australia still requires the protection of the US, and the alliance will endure. Australia acknowledges

that China is its most important trading partner in the region after Japan but at the same time implicitly views China as its biggest threat that can undermine its national interests in East Asia, and also potentially dangerous is China's influence and domination of Southeast Asia that has repercussions to the defence of the Australian homeland itself. Australia's concept of defence self reliance is a tall order considering its current and future military projections. Explicitly, Australia has distinctively acknowledged at great length that its alliance with the US is of paramount importance and its alliance with the US will continue to be the pivot of its defence for a long time to come.

Australia's strategy for advancing its security interests is based on a pessimistic assessment of the security of the Asia Pacific region. Its key components are maintaining a strong national defence capability, the alliance relationship with the US, expanding Australia's bilateral, regional and multilateral security links, and strengthening Asia Pacific-wide regional security institutions. Australia's national defence capability is its ultimate means of defence which will also contribute to regional stability. Other than its alliance with the US, Australia is building up its own network of alliances with and within the US alliance to ensure that China will not encroach into its periphery. This mix of national, bilateral and regional approaches can be interpreted as Australia hedging on the rise of China as well as the possible decline of the US.

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# ASEAN Security Cooperation: Challenges and the Way Ahead

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## ABSTRACT

*On many occasions, the Association of Southeast Asia Nations (ASEAN) leaders have raised and voiced out the importance of formal ASEAN military-security cooperation, but they finally "shied away" and ASEAN security role is pursued through "informal mechanisms". Even though in the early years, it is unlikely that ASEAN would consider a de facto military pact, however, since the invasion of Cambodia and the development of the global and regional security environments, has led ASEAN policy-makers to rethink their options for security cooperation. There are many possible approaches and mechanisms towards achieving ideal security cooperation, but the central question is, whether ASEAN states have sufficient common security interests to provide beyond the existing bilateral arrangements.*

## INTRODUCTION

> *".....we are all conscious of our responsibility to shape our common destiny to prevent external intervention and interference...."*
>
> *Tun Abdul Razak bin Haji Hussein – 1967* [1]

The Association of Southeast Asia Nations (ASEAN) was established on 8 August 1967 at a meeting in Bangkok between the Foreign Ministers of Indonesia, Singapore and the Philippines, and the Deputy Prime Minister of Malaysia. It was envisioned to be a diplomatic association for political and security cooperation that concentrates on conflict avoidance and management, driven initially by the goal of regional reconciliation. Although security was uppermost in the leaders' minds, it was not conspicuously addressed [2]. However, security cooperation was not completely ruled out in the future. The first Malaysian Prime Minister, Tunku Abdul Rahman stated that, *"the initial thrust of ASEAN should be economic and cultural matters and if these initiatives proved successful then efforts could be made towards establishing a far reaching organisation which could extend to political as well as security fields"* [3]. Meanwhile, Tun Abdul Razak, the then Malaysian Deputy Prime Minister, was reported to have said following the ASEAN inaugural meeting that it was possible for ASEAN to have defence arrangements *"once we have become good friends with a common interest and destiny"* [1].

The evolution and changes in ASEAN can be divided into three periods. During the early stage of its consolidation, ASEAN had been through several periods of inter-state conflicts that threatened the

stability and security of the region. Despite its sub-regional scope and a modest record of economic cooperation, ASEAN has displayed a quality political cohesion and diplomatic accomplishment. It began to attract international attention and respect since 1975 when ASEAN states responded to the successes of revolutionary Communism in Indochina by registering a common political identity and purpose. Since January 1979, the governments of ASEAN have undertaken a sustained diplomatic challenge to Vietnam's invasion and occupation of Cambodia, and this resulted in ASEAN become more significant internationally. During this period, the ideas of multilateral security cooperation and an ASEAN military pact, were raised and voiced out by ASEAN leaders especially over the concern of Vietnam's "domino theory". However, the respective ASEAN governments later toned down the ideas and multilateral security cooperation, beyond exchanges of military intelligence, does take place among member states but on a limited bilateral basis.

ASEAN went through an enlargement phase with the expansion of its membership to include Brunei on 8 January 1984, Vietnam on 28 July 1995, Laos and Myanmar on 23 July 1997, and finally, Cambodia on 30 April 1999. Since then, ASEAN generally was 'divided' into two groups, in relation to disparity in economy, military, security, political stability and pluralistic.

The reconsolidation period started from the 1997 financial crisis till up to the present time. This is when the capacity of ASEAN in managing a series of seemingly unending lists of regional challenges, such as the replay of economic uncertainties triggered by the regional health crises of infectious diseases, including Severe Acute Respiratory Syndrome (SARS) and Influenza A(H1N1), the threats of terrorism, and the come-back of financial crisis, are being tested.

ASEAN's first explicit commitment to security cooperation only came with the 1976 Declaration of ASEAN Concord and Treaty of Amity and Cooperation (TAC), and in the 1992 Singapore Declaration during the fourth ASEAN Summit Meeting. The 1976 Declaration of ASEAN Concord stated *"the continuation of cooperation on a non-ASEAN basis between the member states in security matters in accordance with their mutual needs and interests"* [4]. Although not a security organisation itself, ASEAN can be regarded as an umbrella under which member states may take up bilateral or multi-lateral security activities [5]. Bilateral border and maritime security agreements between two or three members have become common practice since the early 1970's.

Facing uncertainties in global and regional environments, and complex nature of challenges, ASEAN states adopted the Vientiane Action Programme that included the ASEAN Security Plan of Action for establishing ASEAN Security Community (ASC) at the 10$^{th}$ ASEAN Summit held in 2004. Hence, to achieve the ASC themes [6], ASEAN must analyse the existing security cooperation and other activities in relation to the regional security matters, and then formulate appropriate approaches and mechanisms that need to be implemented in relation to security cooperation among the member states. However, the central question is whether ASEAN countries have common security interests

and wills sufficient to provide a basis for security cooperation beyond the current bilateral arrangement.

## SECURITY COOPERATION IN ASEAN

The ASEAN security role has evolved through three challenges [3]. First were the withdrawal of United States from Indochina and the establishment of communist governments in South Vietnam, Laos and Cambodia. These developments provided the motion of the Declaration of ASEAN Concord (also known as Bali Concord) in 1976, which marked a concrete step in regional security agenda. The second challenge, the Vietnamese "invasion" of Cambodia in December 1978, provided the real and meaningful factors to ASEAN political and security cooperation. This had prompted security concerns among ASEAN leaders and was expressed in terms of deliberation over possible contingency assistance in the event of aggression by Vietnam. As Thailand would be the frontline state for ASEAN in the "domino theory", Malaysia, Indonesia and Singapore pledged to provide aid to Thailand against a Vietnamese attack. Although no specific kind of aids were stated nor a military alliance to face the possible threats was ever raised or discussed, this shows the major shift in ASEAN leaders thinking on security cooperation. The third was the increasing strategic links between erstwhile Soviet Union and Vietnam, including their presence in the South China Sea and Cam Ranh Bay in Vietnam. In addition, the development of the global and regional security environments *vis-a-vis* the expansion of Chinese, Indian and Japanese navy, has led ASEAN policy-makers to rethink their options for security cooperation. This prompted calls for new levels of security cooperation via multilateral military exercises among the ASEAN states. It also made ASEAN policy makers to rethink the needs to review ASEAN's political character and the needs for formal security cooperation among ASEAN states.

Although facing challenges on bilateral issues, intra-ASEAN bilateral defence and security ties have undergone a rapid expansion. Started with information exchanges on border insurgencies, it had developed into joint operations against insurgents on common borders, regular contacts and intelligence exchanges between high-level military and security officials. From the early years, most ASEAN states have developed some form of bilateral military ties with one another. Malaysia and the Philippines, even though locked in a dispute over the latter claim on Sabah, managed to tone down the issue and agreed upon bilateral military cooperation, especially naval patrols in Sabah and Southern Philippines sectors. Meanwhile, bilateral army exercises between Singapore and Malaysia, and Singapore and Indonesia were held for the first time in 1989. Indonesia also later offered their air force and army training facilities to Singapore. This bilateral military ties along with intensifying cooperation suggest the emergence of what the then Indonesian Armed Forces Commander, General Try Sutrisno, has aptly referred to as a "defence spider web in ASEAN" [3].

Generally, with the exception of intelligence exchanges, the principal mode of security cooperation within ASEAN states will always be in the form of bilateral security cooperation. The four major forms of bilateral security cooperation are border security arrangements, intelligence sharing, and joint military exercises and training.

**Border Security Cooperation**

The first border security cooperation was between Malaya and Thailand in 1949 during the First Malayan Emergency, which lasted from June 1948 to July 1960 when communist terrorist activities were at their peak [7], for the purpose of controlling the Communist Party of Malaya (CPM) operations on both sides of their land border. The second border security cooperation prior to the establishment of ASEAN is an agreement between Indonesia and the Philippines to check illegal activities on their maritime border. Meanwhile, the Bangkok Agreement paved the way for cooperation between Malaysia and Indonesia to suppress the CPM on their common land border (Sarawak-Kalimantan). Since 1970s, bilateral border security cooperation was standard arrangements between Malaysia and Thailand, and Malaysia and Indonesia.

The most successful bilateral border security cooperation is the 1976 Malaysia-Thailand Border Agreement, which was regarded as the most extensive institutionalisation of joint military action between two ASEAN states [5]. This agreement agrees on the establishment of a combined task force headquarters and combined as well as unilateral operations. It includes a joint and coordinated patrols and field actions against the Communist Terrorists (CTs) along the border Malaysia-Thailand. It also provides the rights for both military forces to pursuit the CTs into other's territory. This is the oldest bilateral security cooperation in ASEAN and had provided the basis for wider security understanding between the two countries.

Border security cooperation between Malaysia and Indonesia, meanwhile, has wider security implications. The 1972 border security agreement was the result of common concern on border insurgency especially against the remnants of North Kalimantan Communist Party (NKCP) [7]. As a follow up to the agreement, the two countries launched a combined operation, code-named *Operasi Seri Aman*, in 1974, which led to the surrender of 500 NKCP members, including their high-ranking leader, Bong Kee Chok. The second combined operation, *Operasi Kemudi*, was conducted in 1982. In 1985, under a new agreement, the scope of cooperation was expanded to include the maritime border of Straits of Malacca and redefining the term "common enemy" to include smugglers, drug traffickers and counterfeiters [3].

The nature of Malaysia-Thailand border security cooperation differs from that of Malaysia-Indonesia border security cooperation. Malaysia-Thailand border security cooperation was plagued

with two crises during the 1970s and early 1980s. The first crisis was on the issues of the right of hot pursuit granted to Malaysian security forces, based on 1959 agreement, and the presence of Malaysian Police Field Force (PFF) units in Betong, Thailand. This had sparked a protest by the Thais on the ground that it compromises Thai sovereignty. In 1965, a new agreement was signed, where the right of hot pursuit was only given to the Malaysian PFF. However, in May-June 1976, a demonstration instigated by the CPM was held in Betong, which forced the Seni Promaj government to ask for the full withdrawal of Malaysian PFF from Thai territory. The situation changed after the October 1976 coup in Thailand, which led to the signing of a new agreement, which resulted in the launching of combined operations against the CPM in January 1977, the *Daoyai Musnah* (Big Star) and *Cahaya Bena* (Sacred Light) [8].

The second crisis which caused more damage in security relations arose in 1982-1983 when the then Thai Fourth Army Commander, General Harn Lenanond, accused Malaysia of supporting Southern Thai Muslim separatists [3]. The strained relationship was reflected when there were no combined operations during this period. The relationship was later revived when Harn was replaced by General Wanchai Chitchamnong. A new coordinated operation was launched where an offensive was carried out by Thai troops in Thai area and Malaysian troops were deployed in their area to trap the Thai separatist insurgents [3]. However, combined operations between the two countries were never resumed since then.

Hence, the record of Thai-Malaysian cooperation is illustrative of the sensitivities and suspicions that affect bilateral security cooperation in ASEAN, but on the contrary, the record of Indonesia-Malaysia cooperation reflects how the imperative of security collaboration has helped ASEAN members to overcome these sensitivities and strengthened the norms of conflict-management in ASEAN.

**Trilateral Security Arrangement**

The only trilateral security arrangement among ASEAN states is the coordinated patrol of Straits of Malacca. Due to the increase of piracy incidence in the straits, in 2004 the three littoral states (Malaysia, Indonesia and Singapore) undertake the tasks of patrolling the Straits of Malacca. Although this operation has successfully contained the piracy incidence, there are some problems, with the main issue being lack of trust. Hence, with Kuala Lumpur's initiative, an agreement was reached on the coordinated patrols of warships and "Eye in the Sky" aerial surveillance flights by the three states, which took effect on 13 September 2005. The operations are coordinated by Malaysian authorities, and Malaysia contributed most of the assets for the operations. Both operations go as planned and the piracy incidence at the Straits of Malacca was reduced to almost 'nil'. On 21 April

2006, the Malacca Straits Sea Patrols and "Eye in the Sky" were subsumed under one overarching framework called The Malacca Straits Patrol.

Even though this security arrangement only actively involved three member states of ASEAN, the Malacca Straits Patrol operation had successfully showed that member states of ASEAN can work together to achieve regional security and stability. This operation can be the benchmark and future reference for any multilateral security arrangements within ASEAN.

**Intelligence Sharing**

The only "real" ASEAN multilateral security agreement is on intelligence sharing and exchange. The intelligence sharing covers both tactical matters, and strategic and policy issues, including threat assessments. The needs for bilateral intelligence sharing arrangements arose in the late 1960s and 1970s due to the unpredictable situation in Indochina and the rise of communist struggles, most significantly in the Malaysia-Thailand and Malaysia-Indonesia borders.

The Bali Summit had widened and strengthened intra-ASEAN intelligence sharing and cooperation. Today, intelligence sharing plays a critical role in dismantling the ASEAN terrorist organisations, such as *Al-Jama'a al-Islamiyya* (JI), *Darul Islam (DI)* and *Kumpulan Militan Islam (KMM)*, especially in Malaysia, Singapore and Indonesia.

**Joint Military Exercises**

The military exercises between Malaysia and Thailand, and Malaysia and Indonesia were the first bilateral exercises within ASEAN. The number of exercises had increased since then and conducted with much greater regularity and frequency. Starting with bilateral exercises of the Army, now it involves all three branches of the armed forces, though conducted separately. Probably due to suspicions and mutual threat perceptions, naval and air exercises are much more common than land exercises. This may also be due to the fear that land exercises could be used as terrain familiarisation by the other state.

However, bilateral military exercises between Malaysia and Indonesia were conducted without any fears or suspicions. The first bilateral military exercise between the two countries was the naval exercise, *Ex MALINDO JAYA*, which started in 1973. This was followed by *Ex ELANG MALINDO*, an air exercise which was held since 1975, and *Ex KEKAR MALINDO*, a combined army exercise, since 1977. Hence, bilateral exercise programmes between Malaysia and Indonesia are the most comprehensive in ASEAN.

For the rest of ASEAN countries, perceptions on bilateral land exercises began to change in late 1980s. In May 1989, Malaysia and Singapore conducted the first bilateral land exercise named *Ex SEMANGAT BERSATU* and in December 1989, Indonesian and Singapore armies held a command post exercise named *SAFKAR INDOPURA.* These exercises indicate significant changes in mindset and increase in mutual trusts between ASEAN states.

### Military Training

The success of bilateral military exercises was complemented by growing intra-ASEAN bilateral security cooperation in military trainings. This were categorised into two types of activities: the willingness of ASEAN states to allow other ASEAN state armed forces to use their field training facilities for trainings and exercises; and exchange of military personnel either on attachment or attending courses in other member state countries' military institutions.

Cooperation in sharing field training facilities is Singapore-centric. They maintain two army camps in Thailand and one in Brunei. In 1989, Singapore and Indonesia joint-developed a 10,850 hectare joint air weapons testing range in Siabu, Sumatera. Mutual participation in each other's military institutions has also significantly increased. The most significant of this is the mutual participations at Command and Staff College, Defence College, Special Forces training and other specialised trainings.

## CHALLENGES

### ASEAN-10: A United or Problematic ASEAN?

The noble intentions of expanding ASEAN are tarnished by the problems of the expansion from a tightly knit community of six states (ASEAN-6) to a broader grouping of ten states (ASEAN-10). As ASEAN-10, an ASEAN consensus can no longer be expected over all issues as members are from states of widely different historical experience, political system, economic status, military doctrines, development and foreign policy orientation. Furthermore, ASEAN would have to absorb new conflicts and disputes of the kind that has been largely defused amongst the original ASEAN members.

The expansion also caused restraints on the decision-making process of ASEAN. The principle of non-intervention is seen to be one of the major attractions for the new members (Cambodia, Laos, Myanmar and Vietnam - CLMV) to join ASEAN. This principle can keep them with totalitarian or authoritarian and relatively closed political systems from foreign interventions in their domestic affairs. It is almost impossible to strike a balance between the existing norms and the non-

intervention principles. As a result, there will be divergence between the CLMV and the ASEAN-6 that initiate and promotes the idea of security cooperation.

The economic disparities between ASEAN-6 and CLMV, meanwhile posed a dilemma and questions to what CLMV can contribute towards security cooperation. Furthermore, with distinct difference in political systems, military doctrine, training, military hardware and lack of funds, it is impossible for ASEAN-6 to be able to work out a security cooperation with these new member states.

ASEAN solidarity and cooperation was tested and hailed as ASEAN's great achievement during the Cambodian conflict where member states supported each other, not only by military means, but diplomatically and politically, in order to preserve a united front. However, can the same unity of purpose be replicated in the future, especially over the South China Sea issues? Hence, with the expansion, ASEAN is facing more challenges and will take more time, effort and resources to create new sets of security cooperation.

**Intra-ASEAN Conflicts, Mistrust and Suspicion**

Intra ASEAN conflicts, mistrust and mutual suspicion amplify relationship problems between ASEAN member states. Ethnic and territorial disputes, of which some are more than 30 years old, are historically and still a sensitive issue, which become the main obstacle for substantive multilateral security cooperation. Some of the unresolved issues are Thailand's relationship with Vietnam and Cambodia, Singapore's distrust of Indonesia and Malaysia, and territorial disputes between Indonesia and Malaysia, and Malaysia and Singapore.

The historic rivalry between Thailand and Vietnam was obvious in ASEAN's policy toward China. Traditionally, Thailand has had a friendly relationship with China and continues to develop its security relationship with China [9]. By virtue of this, Bangkok is capable of offsetting Vietnam's weight in ASEAN. Meanwhile, relations with Cambodia are full of strenuous border issues. Both Thailand and Cambodia are claiming the historic Preah Vihear temple and four square kilometres of territory near the shrine. The border clash between Thai and Cambodian forces on 15 October 2008, which killed two Cambodian soldiers and wounded seven Thai soldiers, nearly brought the two countries to war. However, talks between the two countries have eased immediate tensions but failed to resolve their underlying causes.

The claim by the Philippines over Sabah remains one of the unresolved intra-ASEAN disputes that will limit intra-ASEAN security cooperation. Although the "ASEAN spirit" led former President Marcos to publicly drop the claim during the 1977 Kuala Lumpur Summit, the final resolution of the dispute has proven to be elusive. Further attempts by President Aquino's government to secure the necessary legal basis for dropping the claim had been foiled by the Philippines Senate.

Another case of bilateral tension in ASEAN is within the "sub-ASEAN triangle" involving Malaysia, Singapore and Indonesia. Malaysia-Singapore relationships have been historically in "turbulence" from the day Singapore was expulsed from Malaysia in 1965. The main issues were mistrust, suspicions, territorial and ethnic. Singapore has been portrayed as "a Chinese nut in a Malay nutcracker" [10]. Any widespread of internal instability in Malaysia, especially ethnic issues between the Malays and the Chinese will directly or indirectly threaten Singapore or its extensive economic investments in Malaysia. Hence, Singapore would probably intervene militarily with the reasons of "protecting their interests" [10].

Malaysia's objection to Singapore's offer of military facilities to the U.S. in 1989 was partly coloured by the lingering suspicions concerning the Republic's military posture. Tun Abdullah Ahmad Badawi, the then Defence Minister, reminded Malaysians that Singapore continued to perceive Malaysia *"...as a threat to [its] existence..."* and in this context, *"the [Singapore] offer...[might be] directed as a deterrence directed against us"* [3]. A series of strenuous events after this incident, reflect how racial and ethnic factors continue to thwart efforts by their leadership to improve political and military relations. The visit by Israeli President, Chaim Herzog, to Singapore in 1986, invoked a widespread protest in Malaysia. Malaysian political leaders accused Singapore of being *"oblivious to the sensitivities and feelings of the Muslim communities in the region"* and stressed the damage caused by the visit to ASEAN solidarity in general and Singapore-Malaysian relations in particular [11]. Another incident was the remark made by Singapore's Second Defence Minister in February 1986 underscoring the policy of not assigning sensitive positions in the Singapore Air Force to officers of Malay ethnic background, which was construed by Malaysian Foreign Minister as *"a hint that Singapore could be regarding Malaysia as an enemy"* [3].

However, in 1989, the relationship of the two countries made a giant leap with a major bilateral land exercise which was held for the first time in Malaysia in October 1989 [11]. However, this positive progress was brought to a sudden halt in the late 1989 with the arrest of nine alleged spies by the Malaysian government. This incident resulted in the suspension of the just started bilateral military exercise programme, and in 1990, the Malaysian government barred Singapore aircrafts from using Malaysian air space, alleging that it was used to conduct photographic reconnaissance [10].

Bilateral exercises between the two countries did not resume until 1992, and the relationship between the two countries remains guarded. In 1998, the relationship between the two neighbouring countries worsened due to the water issue and other related issues. Although Malaysia has never cut the supply of water, the threat felt by Singapore is reflected in its military posture [12]. This was followed by other disputes that rose in 2002 such as: Singapore land reclamation; Malaysia perception that Singapore was undermining its attempt to develop Johor into an international transit-cargo hub; and the issue of new road and rail link across the Johor Straits to replace the Johor Causeway.

Meanwhile, the issue of the Batuan Unarang Islands or the Ambalat, and some minor issues instigated and provoked by the Indonesian media, such as the Manohara incident, the Pendet dance and Kumpulan BENDERA, have developed into serious issues that have affected Malaysia-Indonesia relationship.

The Indonesia-Singapore tension was not about sovereignty or territories but differences in economic and environmental policies. The tensions did not aggravate until the resignation of President Soeharto. However, during post-Soeharto era, Indonesia had raised their dissatisfaction and worries about the reclamation works undertaken by Singapore, which affect the borders of the two countries.

## THE ASEAN NORMS

These norms can be classified into four core categories: the dealing with non-use of force and pacific settlement of disputes, concerning regional autonomy and collective self-reliance, the doctrine of non-interference in the internal affairs of fellow members, and the rejection of an ASEAN military pact and the preference for bilateral defence cooperation [3].

Even though opposed to any formal multilateral security cooperation, ASEAN leaders expressed their approval for the continuation of cooperation in security matters on a non-ASEAN basis between the member states in accordance with their mutual needs and interests. All this must be within the framework of the Declaration of ASEAN Concord and TAC. Bilateralism, according to the ASEAN leaders, offered several advantages over a formal multilateral alliance system. Since many aspects of the intra-ASEAN bilateral security cooperation were geared to managing border security problems, these can arguably serve as building blocks to multilateralism.

## THE WAY AHEAD

Bilateral security ties have come a long way, and provided a strong and solid foundation for multilateral cooperation. Presently, multilateralism among ASEAN states has evolved even though only in the field of intelligence and security information exchanges. Besides, of late, ASEAN policy-makers are no longer shying away from a public advocacy of greater security cooperation within the regional grouping.

However, ASEAN leaders continue to stress the advantages of keeping their defence links bilateral and preserving ASEAN's “non-military, non-provocative” identity. The prospects for ASEAN multilateral security cooperation appear even more unlikely in view of the recent developments in the region. In the environment of economic uncertainty and turbulence, the issue of

regional economic cooperation assumes greater significance compared to other issues especially security. Furthermore, emphasis on security matters could divert attention and resources from economic goals.

Nevertheless, ASEAN needs to seriously look at the importance of security cooperation, since a viable security cooperation arrangement will enable it to have the capability to provide assistance to it members in times of need. Presently, no ASEAN state has this ability since their armed forces, except Singapore, are based on national, rather than regional self-help. Furthermore, with present regional strategic environment, ASEAN states will have to take necessary efforts to enhance existing bilateral security cooperation. The new threats from the maritime environment in the region will provide the necessity for greater security cooperation. In addition, the dangers of a confrontation in the South China Sea involving the Chinese and ASEAN forces are bound to figure prominently in ASEAN's perspective on regional security. Thus, if in the early years of ASEAN, land based border insurgencies have initiated and shaped the emergence of bilateral security cooperation, in the future, problems in the maritime sphere could "force" ASEAN states to formulate a security framework, incorporating, possibly, beyond the existing bilateral arrangements.

## CONCLUSION

ASEAN's traditional approaches on security cooperation were successful especially during the Cold War in which ASEAN states have successfully developed a sufficient degree of national resilience, which enabled them to end the internal threat posed by communist insurgencies. In addition, by adhering to the principle of primacy in relationship, non-interference and abiding to the TAC, confrontation was successfully avoided.

Later during the end of Cold War and its immediate aftermath, ASEAN security thinking has evolved drastically particularly on the policy of excluding the major power in the region. This resulted with some member states to engage direct military cooperation especially with the U.S. At the same time, ASEAN states collectively agreed on the requirements to involve all major regional powers in a security dialogue which witnessed the formation of ASEAN Regional Forum (ARF), ASEAN Plus Three (China, Japan and the Republic of Korea), and others.

ASEAN has also developed a sense of common identity among its members and one important aspect is the common approach towards security issues, political and economic development. The practice of the ASEAN Norms, the "ASEAN Way" and the principle of regional autonomy constitute the basis of ASEAN common identity. Through these norms, all disputes within ASEAN especially security disputes can be solved via consultations and consensus, and thus, avoiding formal

mechanisms. Hence, ASEAN has contributed to conflict avoidance and management, and operated as an instrument to avoid the recurrence of conflict.

On the contrary, despite the history of successful long-term cooperation, intra-ASEAN relations have and will continue to be affected by persistent feelings of mistrust, intra-ASEAN conflicts and disputes, and contradictory strategic perspectives. Therefore, any formal security cooperation or multilateral security cooperation is seemingly impossible unless all differences, divergences and disputes are overcome and solved, and most importantly, all the ten member states must unanimously agree and come to a "solid" consensus in all security issues.

Nevertheless, security problems will persist in overlapping Exclusive Economic Zones (EEZs), competitive claims to the Spartly Islands, territorial dispute, terrorism, piracy, smuggling, human trafficking, illegal immigration and maritime resources disputes. Most of these issues, however, are exclusively local and can be resolved by mutual and bilateral cooperation of the affected states. These developments did not signify a common ASEAN security cooperation but rather its decomposition into smaller security subgroups. Therefore, collaboration on security issues among ASEAN states will be confined to those states who perceive common security challenges. For this reason, ASEAN security cooperation remains improbable and anything more than bilateral or trilateral arrangements between neighbours are unlikely.

As a conclusion, ASEAN security cooperation will remain at the level of regular consultations, bilateral security cooperation including military exercises and trainings, and the exchange of intelligence. The only form of trilateral and multilateral cooperation will be the "Eye in the Sky" and exchange of security/military intelligence, respectively. In an environment which is no longer dominated by cold war ideological conflicts, the impetus for military alliances weakens and ASEAN security cooperation will remain largely bilateral in nature. Conversely, despite being bilateral in nature and limited to the sub-region, the cooperation has been valuable for confidence building measures. This can be expected to develop and evolve further even though it is unlikely to produce a full-blown multilateral security cooperation involving all ten member states.

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# BODY MASS INDEX AND BODY COMPOSITION AMONG ROYAL MALAYSIAN NAVY (RMN) PERSONNEL

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## ABSTRACT

*Body mass Index (BMI) is currently part of the health indicators used by the Malaysian Armed Forces (MAF) health services. Prevalence of overweight and obesity appears to be increasing in the general population as well as in the military population. The aim of this study was to determine the prevalence of overweight and obesity among Royal Malaysian Navy (RMN) personnel and explore their association with key socio-demographic factors. Abdominal obesity and body fat percentage was also studied among the subjects. A cross sectional study, involving 909 RMN personnel aged between 18 to 50 years old, was conducted at three RMN bases in Peninsular Malaysia in year 2004. Anthropometric measurements included height, weight, waist and hip circumferences. Body composition was measured using the bioelectrical impedance analysis method (Tanita TBF-300A). Mean height, weight, BMI and body fat percentage were 167.5 ± 5.4 cm (range 7.8 – 45.1 cm), 67.2 ± 11.9 kg (range 46.5 – 108.7 kg), 23.9 ± 3.8 kg/m$^2$ (range 16.4 – 41.3 kg/m$^2$) and 22.5 ± 6.9% (range 7.8 – 45.1%) respectively. Based on BMI categories (WHO 1998), 3.6% of the subjects were underweight, 60.0% normal, 29.3% overweight and 7.2% obese. Overweight and obesity was found to be more prevalent among personnel of older age, higher rank, married, less educated, higher income and longer duration of services. It was observed that some 26% of the subjects had waist circumference values 90 cm or more, and are considered to be at greater risk for cardiovascular and diabetes diseases. It can be concluded that more than one-third of the RMN personnel were either overweight or obese, and a quarter of them were at greater risk of non-communicable diseases. In this respect, reducing overweight and obesity by targeting better dietary intake and increasing physical activity would be of great benefit in optimizing the health status of RMN personnel.*

## INTRODUCTION

Obesity is a major public health problem which is associated with increased morbidity and mortality. International organisations, such as the World Health Organization (WHO) and the International Obesity Task Force (IOTF), have recognized obesity as a worldwide epidemic [1]. It is the second leading cause of preventable deaths after tobacco [2]. At the population level, a high prevalence of obesity results from a complex interaction between changes in the populations' lifestyle, involving higher energy and fat consumption, and increasingly sedentary existence [3]. Obesity is not just a problem in developed

nations; it is now a global problem. Shifts in diet and activity are consistent with these changes [4]. In 2002, approximately 1.6 billion adults globally were overweight, with 400 million adults being obese [5]. Malaysia is no exception from this problem.

As Malaysia moves towards a developed country status, the health level of its population might deteriorate continuously [6]. Several previous studies have reported that obesity is prevalent among all age-groups [7] which showed that among adults; 21% were overweight and 6.2% were obese using the criteria set by WHO [3]. The study that was carried out by the National Health Morbidity Survey 1996 showed that the prevalence of overweight in adults as a whole in Malaysia was 20.7%, with a BMI between 25.0 and 29.9; a further 5.8% had BMI of > 30 [8]. The Malaysian Adult Nutrition Survey (MANS 2003) in its study found that 12.15% of adult Malaysians were obese and another 29.7% were overweight [9]. The Third National Health and Morbidity Survey (NHMS III) which conducted in 2006 showed that the prevalence of overweight and obesity in adults male in Malaysia was 29.7% and 10% respectively. It is noted that obesity prevalence of 14% in NHMS III and 12.7% in the MANS were approximately three times the level of 4.4% found in 1996 (NHMS II) [10].

Prevalence of overweight and obesity has also been reported among Malaysian Armed Forces (MAF) personnel [11]. It has been reported that more than 50% of Royal Malaysian Navy (RMN) personnel have BMI exceeding the required cut off point, of which 17% are from the obese group. This report may not reflect the actual situation as it was derived from a cross-sectional observation study among patients who attended primary care clinics at the Lumut Armed Forces Hospital in Perak, serving all three tri-services of the MAF as well as general population.

Maintaining desirable weight and body composition is an integral part of maintaining physical fitness, general health and military appearance [12]. The effects of excessive body weight are widespread and raise a variety of concerns relevant to the health and performance of members of the military [13]. Previous anthropometric studies among MAF personnel, as reported by Khoo et al. [14], were focused only on the personnel's physical aspects. Isa [15] conducted an energy requirement study which involved only a small group of MAF personnel. An anthropometric study which focuses on details of body composition among the MAF personnel has not yet been reported in Malaysia. This measurement is an important criteria in nutritional status assessment [16].

Body weight and height can be used in combination as simple and reliable measurements for evaluating nutritional and overall health status, and in screening for overweight [17]. The most commonly used measure of nutritional status for adults is BMI, which is computed as body weight (kg) divided by height (m) squared. High BMI values have been associated with high prevalence of hypertension [18]. While BMI is easily measured, recent conflicting evidence on its association with cardiovascular and

obesity related health risks has raised questions on its usefulness as a measure of obesity [19, 20]. There appears to be a perception that BMI may be a poor indicator of body fat percentage of military personnel. Poston et al. [21] reported that higher BMI values among military personnel are not necessarily reflective of greater adiposity, but a reflection of greater muscle mass. Public stereotypes of military personnel as highly muscular may create the impression that body fat percentage of most military personnel with high BMI is not at unhealthy levels [22].

Apart from body fat level, adipose tissue distribution is also studied because it also affects the risk of being overweight. Abdominal adipose tissue causes greater morbidity risk compared to adipose tissue surrounding the subcutaneous hip area [23]. Abdominal obesity (AO) is one of the key indicators of central fat adiposity in adults. It has been strongly linked with the risk of various chronic illnesses such as cardiovascular disease (CVD), diabetes mellitus and breast cancer [24, 25]. AO occurs when the main deposits of body fat (adipose tissue) are localised around the abdomen (intra-abdominal or visceral fat) and the upper body region [26]. In a large population-based study, waist circumferences (WC) measurement is the most commonly used method as it is convenient and inexpensive [27].

Traditionally, the MAF is highly concerned on body weight and body fat levels of its personnel. This is due to the fact that being overweight will affect the personality, physical performance, health and self esteem of a person. Previous studies on MAF personnel did not access anthropometry and body composition on a larger scale of population sample. Recognizing the importance of improving and maintaining body weight and body composition, the objective of this study was to evaluate physical characteristics and body composition in relation to socio-demographic characteristics of RMN personnel, in order to identify the target risk groups for nutritional intervention.

## METHODOLOGY

### Study Location, Study Design and Subjects

A cross-sectional study was carried out at three RMN bases in Peninsular Malaysia; (i) Lumut, Perak (ii) KD Sultan Ismail, Kota Tinggi, Johor and (iii) Markas Wilayah Laut 1, Kuantan, Pahang. It involved 909 RMN male personnel from various ranks aged between 18 to 50 years old. The survey utilised stratified random sampling according to base, unit and rank. The sample size calculation considered our best knowledge of the prevalence of overweight and obesity based on previous secondary data at 95% level of confidence and 5% margin of error. The study was approved by the Secretariat of Defence Research & Development, the Science Technology Research Institute for Defence (STRIDE).

**Data Collection**

A standardized questionnaire was used to collect the data on socio-demographic information. The questionnaire included data on age, unit, marital status, rank, ethnicity, household income, educational level, duration of services and health status.

**Anthropometric and Body Composition Measurements**

Anthropometric measurements were collected following standardised procedures. Parameters measured include height, body weight, waist circumferences (WC), hip circumferences, and body composition. The height of the subjects was measured without shoes using a SECA bodymeter 208 (Seca, Germany) to the nearest 0.1 cm. Body weight was directly measured for personnel in their uniform using the weighing function of a Tanita TBF-300A body fat analyser (Tanita Corp., Japan) to the nearest 0.1 kg simultaneously with body composition, from which BMI was computed as body weight (kg) divided by height (m) squared. The weight of the uniform was deducted during the measurement. A flexible, non-stretchable plastic measuring tape was used to determine waist and hip circumferences to the nearest 0.1 cm. WC was measured using a measuring tape at the mid-point between the inferior margin of the last rib and the iliac crest. Hip circumference was measured at the maximal gluteal protuberance from the lateral view over undergarments. Waist hip ratio (WHR) was calculated by dividing WC by hip circumference.

The subjects were grouped into BMI categories according to WHO [3] references: below 18.5 $kg/m^2$ (underweight), 18.5 – 24.9 $kg/m^2$ (normal), 25.0 – 29.9 $kg/m^2$ (overweight), and $\geq$ 30 $kg/m^2$ or more (obese). The subjects were also classified into body fat categories according to BIA criteria, TBF-300A. The range of body fat percentage that can be considered as healthy and optimal is 14 – 20% for the age group of less than 30 years, and 17 – 23% for the age group of 30 years and above. Percentage of body fat that is less or more than the healthy range is considered as lean and overfat, respectively. A WC greater than 90 cm based on the cut-offs recommended by the Asian Population [28] or a WHR greater than 0.9 based on the cut-off points by WHO [29] are considered to be at greater risk for cardiovascular and diabetic diseases.

**Data Analysis**

The data was analysed using Statistical Package of Social Sciences (SPSS) 13.0 (SPSS Inc., Chicago, IL). Descriptive statistics, such as frequency, mean, standard deviation and percentage, were used to describe socio-demographic and physical characteristics. The chi-squared test was used to determine

associations between categorical variables. Independent *t*-test and one-way ANOVA were used to compare the differences between and among group means respectively. Statistical probability level of $p < 0.05$ was considered as significant.

## RESULTS AND DISCUSSION

### Socio-demographic Characteristics

Out of the 1,200 subjects aged between 18 to 50 years old, 909 were measured, giving a response rate of 76%. The non-respondents were those who were absent. The distribution of subjects by socio-demographic characteristics is shown in Table 1. It was observed that majority of the subjects (70%) were aged between 18 to 30 years old. The subjects comprised 92.5% Malays and followed by Iban (27.3%), Indians (1.3%) and other ethnic groups (3.2%). A total of 59% of the subjects were married. A majority of 86%, were SPM/MCE holders while only 7.3% were STPM/diploma holders, 5.4% were SRP/PMR holders, and 1.3% were degree and above holders. Most subjects involved in this study were enlisted personnel, especially from the Laskar ranks, because this group comprises the biggest representation in the RMN service. The lowest income group of RM 1,000 monthly represents almost half of the total subjects. Most of those involved in this study have been serving between 6 to 10 years (29.5%) and 1 to 5 years (24.8%), while only a small percentage, 3%, have been serving for more than 20 years. This is because most of the personnel retire upon a twenty-year tenure.

### Physical Characteristics and Body Composition

Table 2 summarises the physical characteristics and body composition of the subjects. The mean age, body weight, height, BMI, body fat percentage, fat mass and free fat mass (FFM) of the subjects were 28.3 years old, 67.2 kg, 167.5 cm, 23.9 kg/m$^2$, 22.5%, 15.8 kg and 51.4 kg, respectively. The ANOVA tests showed significant differences on characteristics of subjects from three RMN bases ($p < 0.05$). However, the Tukey Test showed significant differences on all characteristics, except for subjects' heights between the Lumut and Kuantan bases, and FFM between the Kuantan and Kota Tinggi bases. Subjects from the Lumut base recorded the h\ighest anthropometric and body composition values, except for body fat percentage. The highest percentage of body fat was recorded by subjects from the Kuantan base. On average, subjects from all three RMN bases were within the normal weight category. However, the mean BMI and WHR of subjects from the Lumut base was approaching 25.0 (overweight) and 0.9 (at risk), respectively.

**Table 1. Socio-demographic characteristics of subjects (Σ*n* =909).**

| Characteristics | | No. of sample (*n*) | Percent (%) |
|---|---|---|---|
| Ethnicity | Malay | 841 | 92.5 |
| | Chinese | 4 | 0.4 |
| | Indian | 12 | 1.3 |
| | Kadazan | 5 | 0.6 |
| | Melanau | 1 | 0.1 |
| | Iban | 27 | 3.0 |
| | Others | 19 | 2.1 |
| Age (years) | 18-24 | 313 | 34.4 |
| | 25-29 | 237 | 36.1 |
| | 30-34 | 185 | 20.4 |
| | ≥ 35 | 174 | 19.1 |
| Marital status | Single | 375 | 41.3 |
| | Married | 534 | 58.7 |
| Educational level | SRP/PMR | 49 | 5.4 |
| | SPM/MCE | 782 | 86.0 |
| | STPM/diploma | 66 | 7.3 |
| | Degree and above | 12 | 1.3 |
| Rank | Officer | 50 | 5.5 |
| | Senior enlisted | 189 | 20.8 |
| | Junior enlisted | 670 | 73.7 |
| Household income | ≤ RM 1000 | 448 | 49.3 |
| | RM 1001-RM 2000 | 404 | 44.4 |
| | RM 2001-RM 3000 | 40 | 4.4 |
| | RM 3001-RM 4000 | 12 | 1.3 |
| | RM 4000 and above | 5 | 0.6 |
| Duration of services (years) | < 1 | 115 | 12.7 |
| | 1 - 5 | 225 | 24.8 |
| | 6 - 10 | 268 | 29.5 |
| | 11 - 15 | 143 | 15.7 |
| | 16 - 20 | 131 | 14.4 |
| | 21 - 30 | 27 | 3.0 |

This study revealed that the mean body weight and BMI of the subjects were 67.2 kg and 23.9 kg/m$^2$ respectively. Comparisons with MANS 2003 on local general male adults population found that the mean weight was 66.6 kg [9], which was slightly lighter compared to the studied subjects. The mean BMI of the studied subjects was within the normal body weight range. However, a study on 392 male soldiers

(combat and non-combat unit) with age more than 20 years in Melaka [30] revealed that the mean BMI of the subjects was 25.2 kg/m$^2$ (overweight) which was higher compared to this study. Nevertheless, the mean BMI of the general male population of 24.2 kg/m$^2$ (MANS 2003) was higher compared to the mean BMI of the studied subjects. The mean WC and WHR of the studied subjects were 82.2 cm and 0.88 respectively, which did not reflect the actual prevalence of risks of cardiovascular and diabetes diseases. This is due to the fact that the range of values between the subjects had vast differences. Subjects from the Kota Tinggi base showed the lowest values for all physical and composition characteristics compared to subjects of other bases. This is because the Kota Tinggi base is a centre for basic warfare training for new RMN recruits which consists of younger and more active subjects. On the other hand, subjects from the Lumut base showed higher values for all physical characteristics compared to subjects from the other bases, except for body fat percentage. This is because the Lumut base is the largest base, consisting of numerous senior ranked and middle-aged personnel of various expertises.

**Table 2. Mean physical characteristics and body composition of the subjects.**

| Antropometric characteristics and body composition | Lumut *n*=706 | Kuantan *n*=95 | Kota Tinggi *n*=108 | All Σ*n* =909 |
|---|---|---|---|---|
| Age (years) | 29.5 ± 6.2$^a$ | 25.4 ± 4.3$^b$ | 22.5 ± 5.4$^c$ | 28.3 ± 6.4 |
| Height (cm) | 167.8 ± 5.3$^a$ | 167.4 ± 5.7$^a$ | 165.3 ± 5.5$^b$ | 167.5 ±5.4 |
| Weight (kg) | 68.8 ± 12.0$^a$ | 64.0 ± 10.4$^b$ | 59.1 ± 8.1$^c$ | 67.2±11.9 |
| BMI (kg/m$^2$) | 24.4 ± 3.9$^a$ | 22.7 ± 3.3$^b$ | 21.5 ± 2.2$^c$ | 23.9±3.8 |
| Waist circumferences (cm) | 84.3 ± 11.1$^a$ | 78.8 ± 9.5$^b$ | 71.8 ± 7.0$^c$ | 82.2±11.3 |
| Hip circumferences (cm) | 94.4 ±7.5$^a$ | 91.2 ± 6.9$^b$ | 88.0 ± 5.1$^c$ | 93.3±7.5 |
| Waist : Hip | 0.89 ± 0.62$^a$ | 0.86 ± 0.52$^b$ | 0.81 ± 0.43$^c$ | 0.88±0.06 |
| Body fat (%) | 23.5 ± 6.8$^a$ | 24.2 ± 6.0$^b$ | 16.8 ± 5.3$^c$ | 22.5±6.9 |
| Fat mass (kg) | 16.9 ± 7.5$^a$ | 14.0 ± 6.1$^b$ | 10.2 ± 4.7$^c$ | 15.8±7.4 |
| Free Fat Mass (kg) | 52.0 ± 5.9$^a$ | 49.6 ± 5.2$^b$ | 48.5 ± 4.3$^b$ | 51.4±5.8 |

Values with different alphabetical tags show significant difference between groups: $p < 0.05$.

## Prevalence of Overweight and Obesity

Based on the BMI classification of WHO [29], Table 3 shows, out of 909 subjects, 60% were normal (BMI 18.5-25 kg/m$^2$) while only 3.6% subjects were underweight or had chronic energy deficiency (CED) (< 18.5 kg/m$^2$). The prevalence of overweight (BMI 25-29.9 kg/m$^2$) among the subjects was 29.3%, and 7.2% for obese (BMI ≥ 30 kg/m$^2$). In other words, 36.5 % of the subjects were either overweight or obese (BMI ≥ 25 kg/m$^2$). Observations based on bases showed the Kota Tinggi base

recorded the highest normal body weight (87%) and CED (5.6%) of its personnel compared to the other bases. The Lumut base recorded the highest percentage of overweight or obesity, totalling 42.3%. There was a significant association between BMI status and bases among the subjects ($p < 0.001$). This is may be attributed to the different lifestyle and physical activity of the subjects between the three bases.

The results of the study showed that RMN personnel had recorded a prevalence of overweight (29.3%) and obesity (7.2%) which reflected a trend among the local civilian population. Comparison to the study of male soldiers in Melaka showed that prevalence of overweight and obesity were 30.1% and 15.6% respectively, which were slightly higher than this study [30]. The prevalence of overweight and obesity among RMN personnel were almost similar to the prevalence of overweight (28.6%) and obesity (9.7%) among the civilian male adults (MANS 2003) [9]. MANS 2003 also found that overweight was more prevalent among army personnel. Another recent study (NHMS III) showed the prevalence of overweight and obesity among the civilian male adults were 29.7% and 10% respectively which are slightly higher compared this study [10]. The nutritional status of Malaysians is undergoing a transition [31] which combined with widespread decline in physical activity in most communities is resulting in rapidly rising rates of obesity [32].

**Table 3. Distribution of BMI status according to bases.**

| BMI Category ($kg/m^2$) | Number of subjects (%) | | | |
|---|---|---|---|---|
| | Lumut | Kuantan | Kota Tinggi | All |
| Underweight (< 18.5) | 22 (3.1) | 5 (5.3) | 6 (5.6) | 33 (3.6) |
| Normal weight (18.5 - 24.9) | 385 (54.5) | 66 (69.5) | 94 (87.0) | 545 (60.0) |
| Preobese (25.0 - 29.9) | 238 (33.7) | 20 (21.1) | 8 (7.4) | 266 (29.3) |
| Obese (≥ 30) | 61 (8.6) | 4 (4.2) | 0 (0) | 65 (7.2) |

Comparisons with other studies in developed countries, such as the United States, showed that the prevalence of overweight among its civilian population and military personnel were far higher compared to Malaysians. The prevalence of overweight (BMI ≥ 25) among its civilian population in 1999-2000 had reached 64% [33], while similar prevalence of overweight experienced by its active military personnel

had reached 57.2% in 2002 [34]. Higher prevalence among US military personnel was reported in the previous study conducted by Lindquist & Bray [35] showed that 50% and 54% were overweight or obese (BMI ≥ 25) in 1995 and 1998 respectively. The prevalence of overweight and obesity among the Royal Australian Navy personnel were 45% and 10% respectively, and 45% and 8% respectively for the Australian Air Force [36]. Higher prevalence was also seen among the US Air Force with 46% overweight and 8% obese [37]. The prevalence of overweight and obesity was also higher among adult soldiers in Saudi Arabia, which were 37.5% and 43.9% respectively [38], while only 18.1% of the study population were within the normal range. A study conducted by Papadimitriou et al. [39] found that the prevalence of overweight and obesity among male Greek soldiers were 28.5% and 10.4% respectively. However, lower prevalence of overweight (27.1%) and obesity (4.5%) had been shown among Royal Thai Army compared to other studies [40]. The higher prevalence of obesity in the RMN personnel should be of concern since in addition to the risk for chronic diseases, obesity may also affect physical readiness and military appearance.

**Prevalence of Overweight and Obesity by Socio-demographic Characteristics**

Due to the great diversity in socio-demographic characteristics among RMN personnel, the classification of the BMI based on their socio-demographic characteristics was important to be determined. The BMI status of subjects by age is shown in Figure 1. Age-wise, distribution of the BMI categories revealed that the youngest age cluster had the lowest prevalence of overweight or obesity (11%) while the oldest group had the highest prevalence (78%). The youngest age group (18 to 24 years) showed the highest percentage of CED (6%) and normal body weight (83%) compared to the older age group. The age group of 35 years old and above did not show any CED records. This is an important finding with reference to the nutritional status of the age of the subjects. An interesting aspect that could be seen here was the percentage of CED and normal body weight had decreased proportionately to age, while the percentage of overweight subjects had increased concurrently with age. When stratified based on age groups, the mean BMI for age groups of 18 to 24 years, 25 to 29 years, 30 to 34 years, and 35 years and above was 21.6 kg/m$^2$ (normal), 23.9 kg/m$^2$ (normal), 25.0 kg/m$^2$ (overweight) and 26.7 kg/m$^2$ (overweight) respectively, which varied significantly ($p < 0.05$). There was a significant association between BMI status and age groups among the subjects ($p < 0.001$).

The younger age groups showed higher percentages of CED and normal body weight compared to the older age groups because younger subjects are much more physically active compared to the older subjects. This results were consistent with MANS 2003 which confirmed that the prevalence of obesity and overweight were also lower among the younger age groups compared to the older age groups [9].

Individuals who were classified at the overweight category, should be mindful of their food intake and life-style patterns. The BMI classification based on three major ranks (Figure 2) showed that only the junior enlisted group recorded CED (5%). The junior enlisted group also showed the highest prevalence of normal body weight (68%) and the lowest prevalence of overweight or obesity (27%). It was observed that higher-ranked subjects, such as officers and senior enlisted personnel, showed higher prevalence of overweight and obesity compared to the lower-ranked junior enlisted personnel. This was because a large number of the junior enlisted personnel were also from the younger age group. When stratified based on ranks, the mean BMI for officer, senior enlisted and junior enlisted were 25.7 kg/m$^2$ (overweight), 26.3 kg/m$^2$ (overweight) and 23.1 kg/m$^2$ (normal) respectively, which varied significantly ($p < 0.05$). There was a significant association between BMI status and rank groups among the subjects ($p < 0.001$).

BMI status of studied subjects by educational level is shown in Figure 3. In relation to educational level, subjects with lowest educational level (SRP/PMR) had higher overweight or obesity prevalence (51%) followed by STPM/diploma (50%), SPM/MCE holder (35%), and degree holder and above (25%). The group with tertiary education did not have any obese subjects and indicated the lowest prevalence of overweight. Higher educational attainment may have a positive effect on one's attitude toward body weight control, dietary pattern and healthier lifestyle. It also can be seen that subjects with STPM/diplomas and degrees did not show any records of CED. The fact that educational attainment is not a factor associated with obesity is clearly demonstrated by the finding that the prevalence of obesity was highest among those with just lowest secondary education and presumably with low knowledge in nutrition. There was a significant association between BMI status and educational level among the subjects ($p < 0.001$).

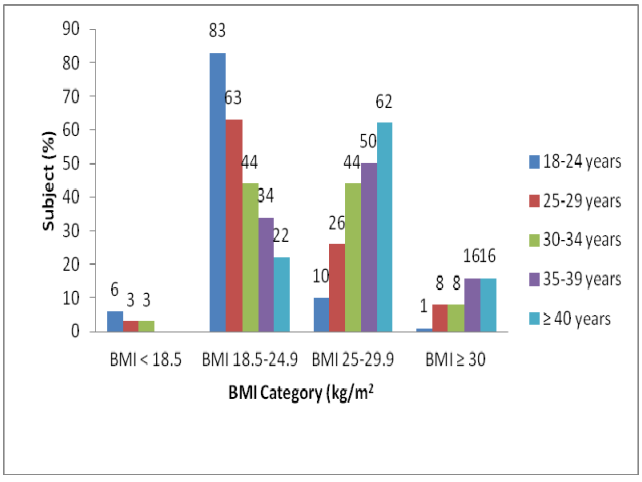


**Figure 1. BMI status of subjects by age**

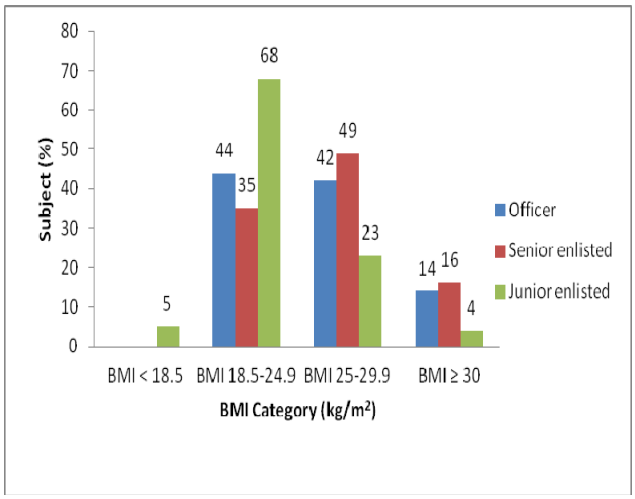


**Figure 2. BMI status of subjects by rank**

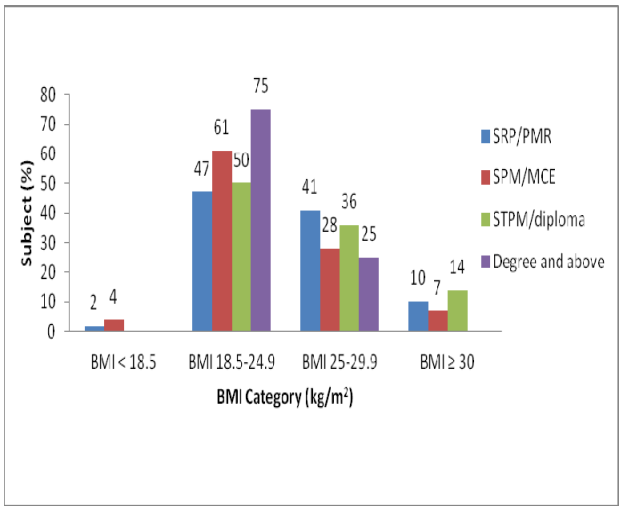


**Figure 3. BMI status of subjects by educational level**

Figure 4 shows the BMI status of subjects by duration of services. The figure shows that there were no CED and obesity subjects with duration of service of 16 years and above, and also no obesity among those with duration of service of less than a year. The prevalence of CED and normal body weight decreased concurrently with increase in duration of service, while the prevalence of overweight and obese increased tremendously. Subjects who served longer durations of services had higher tendencies of being overweight compared to subjects who served within shorter periods. There was a significant association between BMI status and duration of services among the subjects ($p < 0.001$).

When the income of subjects were broken up into two groups, with less than RM 2,000, and more than RM 2,000 (Figure 5), it was discovered that the group with higher income (59%) recorded a higher prevalence of overweight or obesity compared to the subjects with lower income (34%). This findings also confirm the earlier findings of MANS 2003, where overweight increased with household income [9]. Furthermore, there were significant differences in mean BMI between subjects with lower income (23.7 kg/m$^2$) and higher income (25.7 kg/m$^2$) ($p < 0.001$). According to Figure 6, prevalence of overweight or obesity (59%) was found to be higher among married subjects than among those who are not married (34%). Changes in lifestyle after marriage, reduced physical activity, psycho-social factors and dietary patterns may contribute to the higher prevalence in this group. There was a significant association between BMI status and household income and also with marital status among the subjects ($p < 0.001$).

In general, there was a significant ($p < 0.001$) relationship between BMI and all factors studied. These factors included age, rank, educational level, duration of services, household income and marital status. Therefore, BMI of the studied subjects increased with age, rank, duration of services, household income, and being married, but not with educational level.

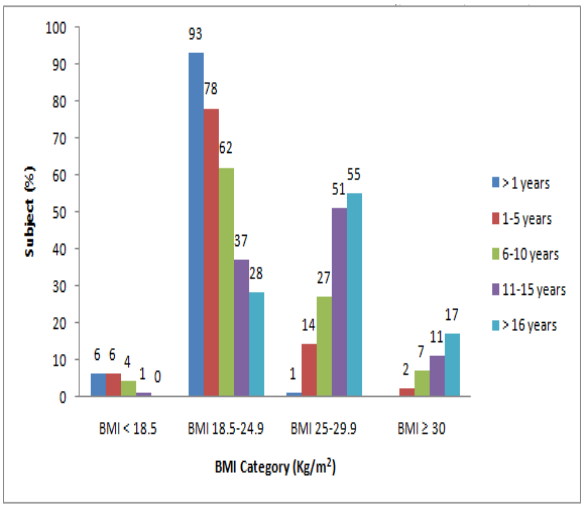


**Figure 4. BMI status of subjects by duration of services**

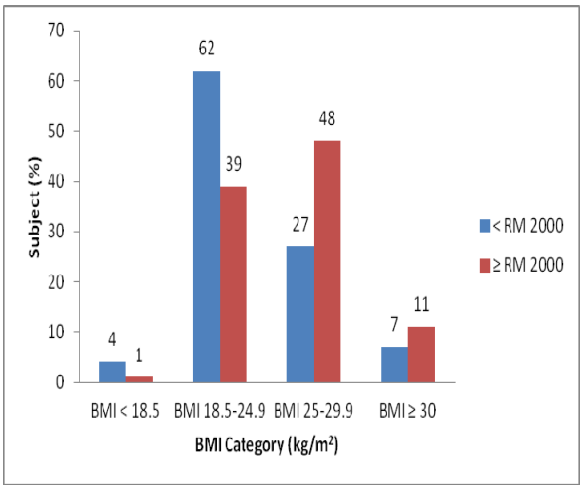


**Figure 5. BMI status of subjects by household income**

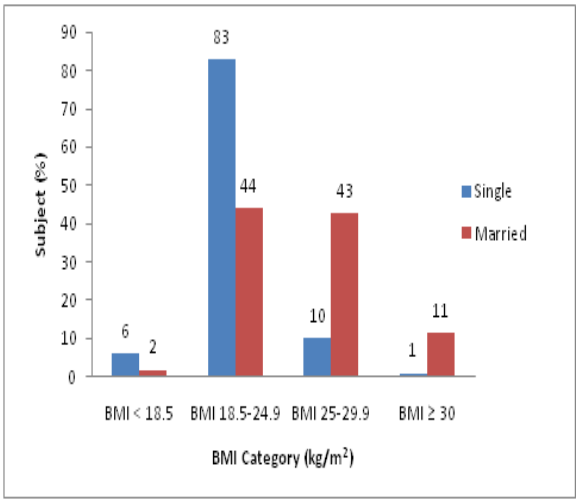


**Figure 6. BMI status of subjects by marital status**

## Abdominal Obesity (AO)

A total of 26% or one-fourth of the subjects had WC exceeding 90 cm (abdominal obesity) which is considered to be higher risks of cardiovascular and diabetes diseases, while subjects with WHR exceeding 0.9 recorded a percentage of 35.1%. Comparisons with the civilian population in Malaysia showed the prevalence of WHR for AO was slightly higher among the subjects (35.1%) compared to study conducted on adult civilian males (33.1%) [6]. Prevalence studies of metabolic syndrome conducted by Al-Qahtani & Imtiaz [38] on adult military personnel of Saudi Arabia showed that AO based upon WC greater than 102 cm was present in 33.1% of the subjects while WHR greater than one was found in 32.9% of the subjects. NHMS III household survey reported by Kee et al. [41] showed that the overall national

prevalence of AO among Malaysian adults based upon WC greater than 102 cm was 17.4%. When AO in this study was defined based upon WC greater than 102 cm, a different result was obtained which showed that the prevalence of AO was lower at only 4.9% compared to the other studies.

High WC signalled higher fat deposits around the waist which caused higher rate of overweight and obesity among the subjects. The situation was aggravated by the high prevalence of AO and percentage of body fat. This study revealed that the percentage of the subjects which showed the presence of high level of body fat coinciding with WC > 90 cm (high AO) were 97%, while no cases of AO were observed for lean subjects (Table 3). These results show that the usage of WC based on the risk level managed to estimate accurately a majority of subjects who had high levels of body fat. It can be concluded that almost all of the subjects which had high body fat level also had WC values $\geq$ 90 cm (AO) and are considered to be at greater risk for cardiovascular and diabetes diseases. There was a significant association between WC and body fat level among the subjects ($p < 0.001$). According to Kushner & Blatner [42], although military appearance is associated with body fat percentage, its association is more significant with abdominal waist. Therefore, AO cases experienced by the subjects, especially overweight subjects, should be given appropriate attention by MAF personnel. Overweight subjects with WC exceeding these limits should be strongly urged to pursue weight reduction, because it categorically increases disease risk for each BMI class [43]. Hence, RMN personnel should be cautious with cases of AO due to its implication on health in general.

**Body Fat Levels**

In general, more than half of the studied subjects (51%) had overfat levels, 36% had optimal body fat level or in the healthy range, and only 12% were considered lean in terms of body fat percentage. Another important finding was almost all of the subjects (99%) were in the obese category (BMI $\geq$ 30), and 92% of subjects in the overweight category (BMI 25 - 29.9) by the BMI criterion also had high body fat levels (Table 4). As expected, 88% subjects who were underweight (BMI < 18.5) had low body fat levels, 12% in the healthy range while no subjects were in the high fat level category. However, only 29% who had normal body weight actually had high levels of body fat and therefore would have had their obesity status misclassified based solely on BMI. There was a significant association between body fat level and BMI status among the subjects ($p < 0.001$).

Thus, BMI alone does not appear to accurately identify all cases of obesity, and this problem is most significant in individuals who may not appear particularly obese (i.e., BMI < 25 kg/m$^2$). This case may occur among personnel who may have high BMI due to unusual muscularity, but may not have high body

fat level. It is possible that some 8% of the subjects classified as overweight and obese in our sample had higher BMI because of increased muscle mass, not increased body fat percentage. The issue of whether excessive BMI values can predict body composition is important because body composition is a health risk that is more important compared to overweight [44]. This issue is always raised among military services because there is a perception that BMI may be not a good indicator for body fat percentage. However, the results of this study confirmed that BMI can predict the body composition accurately for this population study and it was not a poor indicator for body fat level, in which it was proven that almost all the obese subjects also had high body fat levels.

**Table 3. Percentage of subjects by waist circumference and body fat level.**

| Waist circumference (cm) | Body fat level | | |
|---|---|---|---|
| | Low (lean) | Optimal | High |
| < 90 | 16 | 48 | 36 |
| ≥ 90 | 0 | 3 | 97 |

**Table 4. Percentage of subjects by BMI status and body fat level**.

| BMI category ($kg/m^2$) | Body fat level | | |
|---|---|---|---|
| | Low (lean) | Optimal | High |
| < 18.5 | 88 | 12 | 0 |
| 18.5 – 24.9 | 15 | 56 | 29 |
| 25.0 – 29.9 | 0 | 8 | 92 |
| ≥ 30 | 0 | 1 | 99 |

## CONCLUSION

The RMN personnel studied have an alarming prevalence of overweight or obesity (36.5%) that may lead to adverse health consequences. Overweight and obesity place RMN personnel at greater risk of significant health problems including cardiovascular ailments, hypertension and type II diabetes mellitus, and also affects physical readiness and appropriate military appearance. This study revealed that socio-

demographic factors contributed to the development of overweight and obesity in the subjects. Overweight was more prevalent among those of older, higher ranks, married, less educated, higher income and longer duration of services.

These findings suggest that Malaysia is facing an increasing problem of overweight and obesity among MAF personnel. Efforts should be taken to improve the overall nutritional status of MAF personnel by targeting better dietary practices and increasing physical activity, especially those with weight problems. Interventions need to be carried out to targeted groups before more serious complications of obesity become rooted in this population. There is also a need to carry out an assessment of physical activity and dietary patterns of this community. Therefore, there is a need to include measurements of WC and body fat percentage to identify persons at risk of AO and high fat levels as a part of the routine fitness test besides BMI measurements. Nutritional status and physical fitness play an important role in ensuring the good health and physical readiness among MAF personnel in performing their duties for the sake of the defence and security of our country.

## ACKNOWLEDGEMENT

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# KEY COMBAT PERFORMANCE: THE LINKAGES BETWEEN LEADERSHIP AND MORALE

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## ABSTRACT

*The aim of this study is to examine the relationship between charismatic and individualised consideration leadership styles, and military morale. A cross-sectional field survey using a set of questionnaires to measure leadership (Charismatic and Individualised Consideration Leadership Styles) and morale was conducted on 200 subjects selected via stratified random sampling in two infantry battalions of the Malaysian Army. The result of Pearson correlation test indicated that there were positive and significant relationships between charismatic and individualised consideration leadership styles, and morale. Thus, charismatic and individualised consideration leadership styles are accepted as antecedents of military morale. The findings of this study contribute to the knowledge of military morale, specifically on managing key combat performance index.*

## BACKGROUND

*`X is the spirit of the army, the greater or less desire to fight and to face dangers on the part of all the men composing the army, which is quite apart from the question whether they are fighting under leaders of genius or not, with cudgels or with guns that fire thirty times a minute'* [1].

Before the word morale was found, it was known as `X` power. The interests to study `X` power or morale is simply because morale is one of the three elements of combat power after firepower and manoeuvres which determine victory or defeat of a military mission. The word morale is very synonymous with the military organization. Most definitions either in dictionaries or those coined by notable individuals such as Clausewitze [2], Hocking [3], Baynes [4], Walker [5], Manning [1], and Beck [6] symbiotically link the word morale with military will to fight - individually or by group/organisationally.

Boring [7] proposed that *`Of all the complicated machines that mechanized war employs, the most complicated are the men who operate the other machines – the tanks, planes, the guns. These other machines however do not start themselves; it always takes a man to do it.'* What starts the man and aims him? One of the answers to this question being studied is morale. Morale is often related to the exuberant spirit to achieve extraordinary goals through performance beyond expectation as suggested by Harre and Lamb [8]; *'High morale is reflected in positive feeling about the work – group and confidence that difficult goals can be attained.*

The importance of managing combat power is also noted in the Al Quran '*and make ready against them all you can of power, including steeds of war (tanks, planes, missiles, artillery, etc.) to threaten the enemy of Allah and your enemy, and others besides whom, you may not know but whom Allah does know. And whatever you shall spend in the cause of Allah shall be repaid unto you, and you shall not be treated unjustly'* (Al Anfal, verse 60) [9]. From one angle, this verse directly

proposes that we must always be prepared and ready for any conflict/war but from another viewpoint, indirectly it is actually meant to avoid war. Rationally, someone or a group of people/nations will always be prepared to defend themselves from any eventualities to avoid conflict that could lead to war. This is because adversaries would be more careful and respectful in dealing with those who are well-prepared. Potential enemies would think deeply and try to avoid being in confrontation with nations who are prepared and have high morale because they could risk heavy losses. This means that the preparation for war as proposed by the Islamic religion is not to encourage war, but instead to avoid one.

Without positive morale, a well-planned war strategy and tactics will not be able to determine victory in war, as mentioned by Baynes `*a brilliant plan of battle in the tactical sense can be a complete failure if morale is bad, while a poor plan can be made to work well if morale is good*[4].` Historians and organisational scientists studying organisational behaviour may analyse the combat appreciations, plans and orders for battles, but they miss two vital points: first, the plan will never reach the troops who are meant to carry it out; and second, the troops may not execute the tasks when they get their orders. This implies that morale has a strong relationship with combat performance (combat power). Thus, leaders must understand and manage their soldiers' morale, before (even in peace time soldiering), during and after war/conflict, and this is why morale is a topic by itself in many military appreciations and combat orders. Equally important, and in support to this argument, Napoleon (in Howard and Paret [2]) also said that morale contributes to one third of the determinant factor of victory in war, whilst the strength of personnel contributes to only a quarter of it.

## PROBLEM STATEMENT, OBJECTIVE AND HYPOTHESIS

The research on morale and its relationship with leadership styles (charismatic and individualized consideration leadership style) is relatively rare. This is because the word morale has taken a back stage since the 1960's with the inception of new concepts such as motivation, commitments and job satisfaction [10]. According to Aminuddin [11], leadership is not about the best style of leadership, but which leadership style is the most effective style. Although House [12] argues that there was a lack of empirical research on charismatic leadership styles, Bass [13] accepts the notion that charismatic leadership style has an effective power to influence followers to achieve the organisational mission. A Jewish chairman scholar, Klavan, (in Gibson [14]) said that charisma is more important to leadership in comparison to mass communication and moral integrity which will ensure a charismatic figure from demagogue. Charismatic leadership style is always being admired by subordinates and it seems to have the power to punish and reward effectively [13]. Thus, charismatic leaders are able to stimulate committed work spirit towards performance beyond expectation. Similarly, House [12] also suggests that charismatic leadership is capable to stimulate high degree of organisational commitment towards individual/followers because charismatic leaders themselves are

morally high, confident, competent and highly determined in managing opportunities in organisations. In a charismatic situation, followers believe in leaders and therefore, followers will work to overcome any obstacle to ensure and secure a group mission [13].

Stouffer et al.[15], in a study of American soldiers before, during and after World War II, found that many soldiers and units could continue their tasks gallantly although they faced a shortage of logistic support and had to work under social deprivation, because of their leaders' charismatic leadership style. It is said that small units which have good leadership are able to create coercive bonding that glues each of every unit's members as one entity. It seems that `*The men seem to be fighting more for someone than against somebody*'[16]. To some extent they may be negative or anti organisation but they continue fighting gallantly because of their immediate leaders that share a similar social deprivation. They would always obey their immediate leaders who understand and undergo the heat of the battle together with them. Confidence, style and power vested in the leaders also guarantee the future of their subordinates besides being able to influence them into believing that their mission is worth it for the well being of the nation's future.

It is quite difficult to achieve a charismatic situation without leaders paying attention to individual soldiers. According to Bass [13], individualised consideration leadership style could complement and enhance charismatic situations where each individual is treated accordingly to their capabilities, needs, strengths and weaknesses. Capability does not solely refer to tasks and responsibilities but more importantly the subordinates' career development and welfare – their holistic well being. These factors are said to be good conductors to overcome any uncertainty and unclear responsibilities within the units/regiments [17].

Zaleznik (in Bass [13]) believed that organisational culture of individualism could develop individualised consideration leadership style. A platoon or a company commander should be able to know their subordinates as quickly as possible. Soldier strengths, weaknesses and individual potentials (including family) should always be in the pocket of a commander. Specific to the family (spouse), Bough and Segal [18] also suggests that a soldier's wife has significant relationship with the soldier's morale to continue his military service. Bough and Segal further argue that, if wives have a positive perception towards a unit's family welfare policy, they will influence their husbands (soldiers) to be morally committed to military service. In short, there is a significant relationship between a wife's perceptions on the family welfare policy with the husband's morale in military service. Charismatic leadership style which gives attention to each individual and his family would be able to encourage loyalty, obedience and efforts towards performance beyond expectation [13].

The above discussion portrays that charismatic and individualised consideration leadership styles have a relationship to military morale. Hence, the problem statement arises from these leadership styles in relation to military morale, and is noted as; is there any relationship between charismatic and individualised leadership styles, and military morale? Indirectly, the above discussions on the research

problem showed an evidence of indicators that leadership styles (charismatic and individualised styles) have a positive relationship with morale. These indicators are tested in this study.

Empirically, the main purpose of this research is to understand the extent of the relationship between morale and leadership. Based on the issues and rationale discussed above, there are two hypotheses formulated in this study:

*Ha* 1 There is a significant relationship between charismatic leadership styles and morale.

*Ha* 2 There is significant relationship between individualized consideration leadership styles and morale.

## METHODOLOGY

This is a one shot cross sectional field research using a set of questionnaire which consists of 4 sub-scales;

1) Charismatic Leadership Style Questionnaire [13];
2) Individualised Consideration Leadership Style Questionnaire [13];
3) Combat Morale Readiness Questionnaire [1]; and
4) Personal and Service Demography Questionnaire.

The survey was conducted on 200 subjects selected randomly (stratified) in two infantry battalion of the Malaysian Army; a battalion each from Royal Malay Regiment and Royal Ranger Regiment. The distribution of sample is as in Table 1.

**Table 1. Distribution of research sample.**

| Unit/Battalion | Total Subject | % |
|---|---|---|
| 1x Battalion, Royal Malay Regiment | 99 | 49.50 |
| 1x Battalion, Royal Ranger Regiment | 101 | 50.50 |
| Total (2 Battalion) | 200 | 100.00 |

In ensuring the reliability and validity of the research questionnaire, a pilot study/test (pre test) was done on the 13th July 2008 on a group of infantry personnel in Kuala Lumpur. It was to ensure that all translated questions (from English to Bahasa Malaysia) in the survey could be understood and ascertained. This pilot study also tested the measurement tool's level of reliability, namely the measurement tools for Morale, Charismatic Leadership Style and Individualised Consideration Leadership Style. As shown in Table 2, the Cronbach's Alpha values for all 3 measurements tools was above the level of 0.80 [19].

**Table 2. Reliability index of measurement tools.**

| Measurement Tools | Cronbach Alpha |
|---|---|
| Charismatic Leadership Style | 0.92 |
| Individualized Consideration Leadership Style | 0.88 |
| Morale | 0.90 |

Both descriptive and inferential methods of statistical analysis were used in this study using the Statistical Package for the Social Sciences (SPSS) software, version 12.0. The descriptive statistics was used to understand the overall mean, percentages and the distributions of the data/score. Pearson's Correlation inferential test was used to test both hypotheses (*Ha 1* and *Ha 2)*.

## FINDINGS AND DISCUSSION

Pearson's correlation test was carried out to see the relationship between variables (intercorelation test). As shown in Table 3, all three variables in this study (Morale, Charismatic Leadership Style and Individualised Consideration Leadership Style) are significantly intercorelated between the levels of 0.536 to 0.794 ($p < 0.01$).

**Table 3. Intercorelation matrix scales for all samples (N=200).**

| Variables | 1 | 2 | 3 |
|---|---|---|---|
| Military Morale | 1 | 0.570(**) | 0.536(**) |
| Charismatic Leadership Style | 0.570(**) | 2 | 0.794(**) |
| Individualised Consideration Leadership Style | 0.536(**) | 0.794(**) | 3 |

$p < 0.01$

The significant intercorrelation shows a positive relationship between both leadership styles and military morale. It was discovered that the more an individual claimed that their leader practised charismatic and individualised leadership styles, the more it increased military morale. Inferentially, both charismatic and individualised leadership styles are positively and significantly related to military morale. Thus, charismatic and individualised consideration leadership styles are accepted as the antecedents of military morale.

**Linkages between Charismatic Leadership Styles with Morale**

Although there is no specific empirical study on the relationship between leadership and military morale, especially on charismatic and individualized consideration leadership styles, Stouffer et al. [15], Breen [20], Walker [21] and Aminuddin [11] however, did indirectly write and discuss the relationship between leadership and work performance, instead of leadership and military morale. Although these writers did not use the word morale, but basically its stressed the importance of leadership styles in increasing work motivation and work performance. Indirectly, these writers' works are congruent with the findings of this study, where leadership styles are interrelated to the development of military morale.

The main factor that could explain why there is a positive significant relationship between charismatic leadership variable with morale is the degree of respect. Subsequently, the following discussion will focus on "why?" and "how?" this factor (the degree of respect) is positively and significantly related to military morale

Sense of respect should first exist amongst subordinates towards their leader before any execution of military mission. Sense of respect is a nutrient towards a sense of confidence and subsequently, confidence toward leadership is a factor that leads to the will to sacrifice or will to fight (morale). Without the appropriate degree of sense of respect, it is difficult to execute any extraordinary military mission that needs sacrifice (especially sacrifice of life) from each individual member of a unit or regiment. This is because in performing extraordinary (sacrifice of life) military missions, soldiers need to display a total sense of respect and confidence towards their leaders. Without this total respect and confidence, a well planned military mission could turn into a blunder. Vice versa, charismatic leaders of a unit/regiment who could mould and develop the right degree of sense of respect and confidence, could turn a bad military plan into success, as argued by Baynes [4]; *`a brilliant plan of battle in the tactical sense can be a complete failure if morale is bad, while a poor plan can be made to work well if morale is good'*. As further discussed by Baynes [4], there are two notions that lead to this argument. First, if sense of respect and confidence towards leaders is low, there is a possibility that the military plan will not reach to the troops. Secondly, and more severely, there is a possibility that soldiers will disregard the war plan received by them. This may be interrelated to the reason why Napoleon (in Kellet [22]) argued that one third of the war success determinant is the morale factor. Although Napoleon did not discuss in detail about sense of respect, but indirectly sense of respect is interrelated to self confidence towards leadership, and self confidence is interrelated to soldiers' will to fight (morale) as discussed above. In support to this argument, Zaleznik (in Bass [13]) also advocated that charismatic leadership style is suitable to manage difficult and extraordinary missions. As discussed above, charismatic leaders have the ability to influence their subordinates towards total respect that leads to confidence and loyalty to their leaders as well as their military mission – without question (blind respect) [13].

There are two possible reasons to explain this result; first is the absolute power and second is the knowledge power. Relatively, an absolute power of a military officer is bestowed directly through the commissioning citation by the King, the SPB Yang DiPertuan Agong, who is also the supreme commander of the Malaysian Armed Forces. The commissioning citation is the absolute power which provides extraordinary impact for military officers to plan and to execute extraordinary military missions. It is able to influence, direct and redirect subordinates' loyalty towards leaders, although in the form of compliance loyalty. This power is still being respected and plays an important role in managing discipline and commanding obedience and loyalty amongst all categories of soldiers (other ranks) towards their leaders. Similar to the arguments of Bass [13], charismatic leaders with absolute power could award direct rewards and punish their subordinates in accordance to situational military rules and regulations. Charismatic military officers have the ability to interconnect to the use of their absolute power with the regiment/unit objectives (organisational objectives), especially with ideal values within the main thrust of religion/Islam (to the Malay Regiment), nation dignity and sovereignty. Thus, the ability to interconnect between these ideal values and absolute power will develop mutual aspiration of fighting spirit (morale) to both leaders and subordinates.

The sub-factor of knowledge which can be divided into two; knowledge power and expert power. It is suggested that these two sub-factors are also the determinants of the significant relationship between charismatic leadership styles and morale. Additionally, these factors are also further strengthen the factor of sense of respect between subordinates and officers, as discussed above. The credibility of an officer is questionable and ineffective if the extraordinary absolute power awarded to a military officer is not congruent with the knowledge held by the officer, in accordance with the responsibility of an officer's rank, appointment, role and tasks (Bryman Situational Theory) [23]. Leaders who are knowledgeable and have the expertise on a specific field are able to reduce subordinates' discrepancies in executing their role, tasks and responsibilities. The ability of each soldier/officer to clearly understand their roles, tasks and responsibilities is vitally important and it could only be possessed through the combination of academic/theory, practical training and operational skills developed from past experience. A military officer is not only required to know how to use the extraordinary absolute power to direct or plan (through verbal and written directives), but he must also be able to execute/manage his plan or directive/instruction – knowing and doing what military officers do best.

A variety of ways and means have been taken to ensure that the standard of knowledge and expertise among infantry officers are seen as extraordinary by their subordinates, in line with the extraordinary absolute power posed by the officers. Similarly, to avoid intellectual and communication gaps between other ranks and officers, the other ranks also had undergone a variety of academic and practical training/courses. For example, if the qualification to enter recruits training is upgraded from Form 3 (PMR) to Form 5 (completion of SPM) and to pass 6 months of basic training, similarly cadet training for officer cadets in the Army College has been increased from 1 year to 18

months, inclusive of a diploma in management programme. In addition to the normal graduate point of entry, the establishment of the Malaysian National Defence University (*Universiti Pertahanan Nasional Malaysia* – UPNM), indirectly is also to accommodate the requirement of knowledge and expert power in line with the extraordinary absolute power bestowed upon them by the King. Consequently, to ensure military officers possess, and continually increase their knowledge and expert power, the Malaysian Armed Forces provides a tertiary education scheme that encourages military personnel to further their studies up to PhD level. In the past, military officers were known as jacks of all trades, and masters of none. However, today, this notion has changed to jacks of all trades, and masters of one or even two.

Generally, charismatic leadership can only exist when there is disparity between leaders and subordinates. The above discussions indicate that although the economic and social disparity between officers and other ranks have been reduced but charismatic leadership still exist and is significantly an effective antecedent of morale. Charismatic leadership style continues to exist due to the distinction of absolute power, knowledge power and expert power between subordinates and leaders. These factors will enhance the sense of respect, confidence and loyalty towards their charismatic leaders which link to develop willingness to fight and sacrifice, which is morale. Besides academic qualifications, the posting and promotion system that positively develop knowledge and expert power are always the priority so that subordinates will always be confident and ever ready to execute any given mission – equivalent to the Royal Commission bestowed upon them.

**Linkages Between Individualised Consideration Leadership Morale**

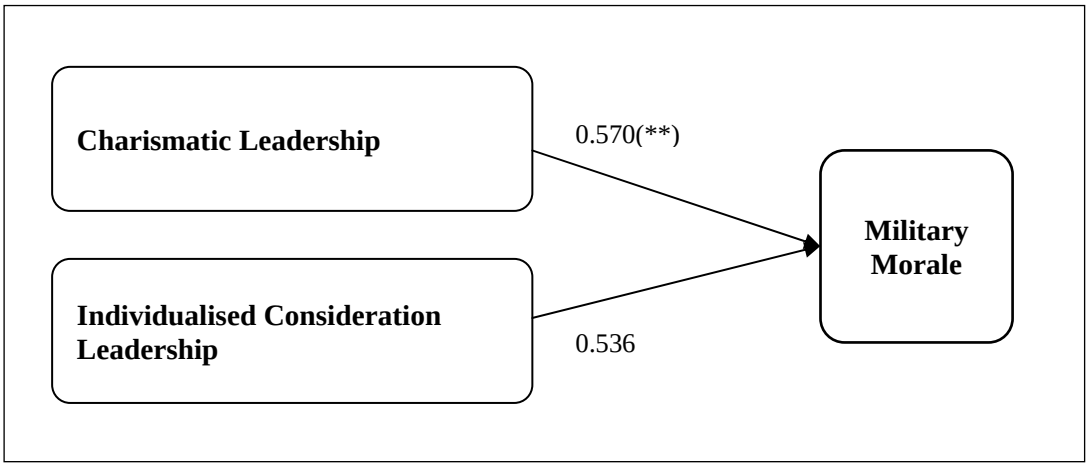
The main factor that could explain why there is a significant relationship between individualised consideration leadership style and military morale is the existence of cohesive emotional ties between subordinates and officers. According to Bass [13] and Stouffer et al. [15], officers/leaders that were considerate to their subordinate's individual needs will develop and enhance the feeling of affection amongst soldiers towards their leaders. Stouffer et al. further argues that the development of intimate relations between leaders and subordinates is that because they (officers and other ranks) share common social deprivation.

The nature of forward employment of the infantry military missions exposes both officers and other ranks with difficulties with regards to foods, drinks, sleep, and vulnerability to injuries and death, will generate feeling of love and devotion amongst organisational members towards their leaders. The cohesiveness of these emotional ties between officers and other ranks develop from equally confronting distressing social deprivation experiences of military missions. In these situations, soldiers will fight to defend the good name of their units/battalions, comrades and their considerate leaders (individualised consideration leadership styles). It may seem anti-organizational that although execution of tasks and missions simply come from the higher organisation or authority,

but soldiers are still highly motivated to carry out the military mission simply because of their immediate leader that has been considerate and together confronting social derivation. In World War 2, there were many cases of battle that soldiers' priority was not why they were fighting but with whom they fought – with those individualised consideration leaders.

## IMPLICATION OF THE STUDY

Summarily, the findings of this study have established the following model (Figure 1). The model summarises the relationship between charismatic and individualised consideration leadership styles with personal and service demographical factors toward military morale, as discussed above.




P < 0.01

**Figure 1: Summary of the finding model**

Figure 1 shows that both independent variables (charismatic and individualised consideration leadership styles) are important in influencing military morale. These independent variables are accepted as determinants and antecedents of military morale. Hence, if a unit/military organization wants to manage and enhance morale, efforts should first be focused to increase these leadership styles (charismatic and individualised consideration leadership). Inferentially, leaders in a military organisation should recognize these tools/leadership styles as vital factors in managing combat performance in the organisation – especially in managing military morale. Indirectly, it also indicated that military morale is a by-product of charismatic and individual consideration leadership style, meaning that managing and enhancing these types of leadership styles increases military morale. Furthermore these leadership styles are more contemporary concepts which can be objectively to be managed, compared to a more complex and ambiguous concept of morale.

The generalisation that can be made through these findings is that charismatic and individualised leadership style can be used as the antecedent to estimate soldiers' military morale. The findings

showed that the higher the charismatic and individualised leadership style of one's leader, the higher is the military morale of that particular soldier. Vice versa, the less a leader exercises charismatic and individualised leadership styles, the lower would be the military morale of the particular soldier.

There are two factors that explain why charismatic and individualised leadership styles contribute to a higher level of military morale; first, the power - absolute power, knowledge power and expert power, and second, is the decentralization of power (empowerment). The officer's absolute power, acquired through the commissioning citation, and strengthened with knowledge and expert power, make them efficient and effective in implementing charismatic and individualised leadership styles towards their subordinates. Firm and equal justice of human resource management that emphasises on individual and organisational objectives will make subordinates feel sense of security. Simultaneously, decentralization that delegates (empowerment) power of command proportionately according to organisation, rank, rules and regulations is part that would also promote a positive environment for officers to be humanistic oriented in nature (individualised leadership style). Reciprocally, this sense of security and positive environment will then develop the subordinates' feeling of respect and loyalty towards leaders, and vice versa from leaders toward subordinates.

Security protection does not mean that leaders should defend subordinates from all scary situations and matters that they will face. In the charismatic and individualised leadership environment, subordinates seldom expect their leaders can solve all matters/problems faced by them. What the subordinates want is for their leaders to be sincere, realistic and ever ready to face challenges and problems faced by individuals and organizations – the best effort that leaders could make. In this environment, subordinates and leaders feel that they have their own business within the organisational function.

This study provides self-awareness to military personnel that the Royal Commission bestowed upon military officers should not be misused. Officers should carry this given trust and responsibility by the King with respect, pride and responsibility, not for individual/personal benefit, but mainly for the welfare and well being of soldiers under his command. Relatively, as discussed in the research findings, the absolute power given through the Royal Commission should be a basis to develop charismatic leaders within the Malaysian Army to be more courageous in taking risks, either in executing military missions or in providing security to personnel under their command. This self-awareness will indirectly further promote the loyalty of both officers and other ranks towards the King and the country. Consequently, the absolute power of the Royal Commission bestowed upon them (officers) will be the valuable secret weapon that is extraordinarily respected from both (officers and other ranks) to execute extraordinary military missions.

Continuous efforts to increase expert power should be emphasized, especially in the knowledge and skills of combat for the Infantry Corps to perform their combat role to keep close to the enemy, to repel/attack, to seize and hold ground in all types of weather and terrain. As discussed before, a

combination between absolute power and expert power will not only make military officers *knowing* but also *doing*. Not only know how to talk (*knowing*) to direct and instruct subordinates just because of the absolute power given by the King, but also competent to plan, supervise and direct the execution (*doing*) of a given mission. Thus, this study has promoted that the military is not like some other public service organisations that may accept either one (absolute power or expert power). Military officers should strike a balance between absolute and expert powers, between theory and practice, between soft and hard knowledge, between academic qualification and work/combat experience – the congruency between *knowing* and *doing*. More importantly, these two powers (absolute and expert powers) are the important ingredients to develop, mould and shape charismatic military leaders who are also considerate in nature - focusing towards the security and well being of subordinates. Nevertheless, the promotion towards subordinate's involvement orientation will be restricted if the gap of expert power between officers and other ranks are wide. Thus, efforts to promote expert power should not be totally officer biased, but must be inclusive for other ranks too.

In addition, the findings also signalled the importance of having an institute which continuously and dynamically studies contemporary leadership styles and issues related to morale. The findings of these empirical studies should always be the basis for the officer cadet training syllabus.

## CONCLUSION

This study has achieved its aim to explore and examine factors that are related to military morale. Specifically, this study distinguished a significant relationship between leadership styles (charismatic and individualised consideration leadership) and military morale. Thus, indirectly, this study does not only recognise charismatic and individualised consideration leadership styles as the determinant of morale, but as the antecedents of military morale. The findings of the study contributed to the reawakening of awareness to the importance of military morale and its relationship with charismatic and individualised consideration leadership styles that had been ignored since the mid 20$^{th}$ century. Morale is the final objective that a military organisation should be looking forward to. Morale is not only able to enhance positive, proactive, creative and innovative behaviour, but more importantly performance beyond expectation - thus, it should always be the Key Combat Performance Index.

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# EVALUATING THE ROLE OF OFFSETS IN CREATING A SUSTAINABLE DEFENCE INDUSTRIAL BASE: THE CASE OF MALAYSIA

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## ABSTRACT

*Offsets, defined as an economic compensation package, is claimed to be a 'third way' to industrial and technological development. More than 80 nations around the world practice offsets in one form or another. Malaysia, a small developing nation, embraced offsets in the early 1990s' with a two prong strategy. Firstly, to develop a defence industrial base that will be able to support the Malaysian Armed Forces (MAF) attain a certain degree of self-reliance. Secondly, to develop Malaysia's high technology sectors. Offsets are leveraged mainly through defence procurement with a view to enhance skills, create employment in high technology related industries, and provide value-added activities, leading to indigenisation and exports. However, after two decades since the implementation of the Malaysian offsets policy, the question remains as to whether the nation has succeeded in realising its offsets objectives. Has Malaysia truly benefitted from offsets? This paper aims to answer this question through an empirical analysis as to whether offsets have worked in the case of Malaysia.*

## INTRODUCTION

Malaysia has moved from being a predominantly agricultural state into a vibrant industrialising nation in just over 50 years after independence from Britain. The nation's success story is attributable to two important components, being strong political leadership and a benign security environment. Indeed, at the time of Independence, and, for several decades thereafter, the principal threats to national security were internal rather than external. However, the 1990s witnessed a transition in this strategic posture, with Kuala Lumpur increasingly focusing on external threats, including preparedness to defend its territorial claims to islands in the Spratly Chain and the safeguarding of international passage in the Malacca Straits.

Malaysia's interpretation of 'national security' is based on the concept of Total Defence. As with Japan's comprehensive security and the Singaporean Total Defence framework, Malaysia views security as extending beyond defence, encompassing also the creation of strong and stable government, the promotion of social and ethnic

harmony, and the pursuit of industrial expansion and technological development; indeed, as illustrated in Figure 1, all the three 'S' elements constituting the 'iron-triangle' of country sovereignty: security, self-reliance, and sustainability. Since Independence, Malaysia has viewed self-sufficiency in defence as a vital constituent component of both broader-based security and national sovereignty, with emphasis on the importance of defending development. This was expressed through the government's resolute conviction, as expressed in the 1982 National Defence Production Policy (NDPP), that 'self-reliance' was an imperative for achieving not just security, but non-dependent, sustainable security.

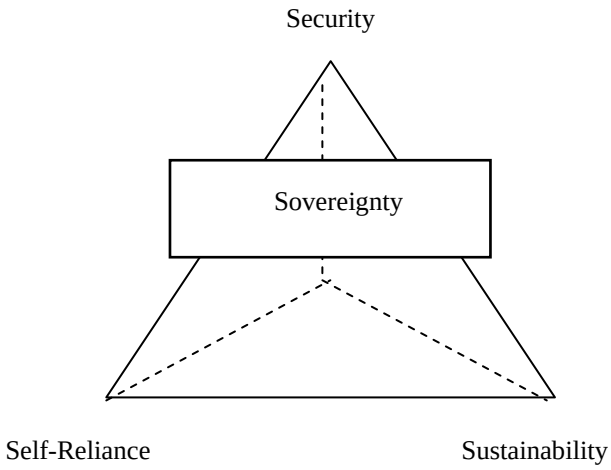


**Figure 1. 'Iron-Triangle' of National Sovereignty**.

The distraction of occasional crises, such as Malaysia's counter-insurgency 'confrontation' with Indonesia and the 1980's economic recession, have acted to derail progress towards defence-industrial self-reliance, but have not weakened the resolve to reduce dependence on foreign supply. Recognising both the importance of defence-industrial self-reliance and also the contemporary challenges of securing comprehensive capability, the NDPP categorised defence goods according to 'strategic', 'essential' and 'non-essential' criteria. This signalled a narrowing of the scope of non-dependent defence-industrial development. Additionally, the notion of

'sustainability' was re-emphasised in the 2006 Malaysian MINDEF Offsets Guidelines, endorsing the targeted promotion of strategic defence industries by reference to the policy objective of fostering world class specialist defence suppliers. Self-reliance, interpreted to mean sustainable indigenous capability in key sectors, reinforces Malaysia's constrained defence-industrial ambitions. This is perhaps inevitable, given relatively limited scales of military equipment production, low levels of research and technology investment and constricted international marketing networks. Arguably, however, Malaysia's more measured and pragmatic approach carries with it a greater likelihood of development success.

Since the early 1990s, the principal mechanism for promoting Malaysian defence industrialisation has been via defence offsets. Big ticket purchases of BAE Systems Hawk trainer/fighter aircraft, Russian MIG-29/SU-30 MKM fighters, US F/A-18s, French/Spanish Scorpene submarines and Polish MBTs have all been tied to technology transfer requirements through offsets. Major defence weapon systems purchases planned in the 9$^{th}$ Malaysia Plan (2006-2010); include A400M Heavy Lift Aircraft, Frigate Batch 2, Pilatus PC7MUII, Very Short Range Air Defence Systems and a Multiple Launcher Rocket System (MLRS). These ongoing high value defence acquisitions beg the question as to the contribution that offsets have made to the development of Malaysian 'indigenous' defence industrial capability. It is a field of enquiry that represents the thrust of this paper. The sensitivity of offsets means that there has been minimal empirical investigation of country experiences, and this paper represents the first in the context of Malaysia. This paucity of empirical study is surprising, not least because of the vaunted, but invariably unsubstantiated, claims by protagonists that offsets offer a 'win-win' trading arrangement for both the overseas vendor and the purchasing country; indeed, for the latter, the widely held view is that they represent a 'third-way' to industrial and technological development, more effective than either import-substitution or export-promotion.

## DEFINING OFFSETS

### What are offsets?

The definition varies. There is neither one specific terminology nor definition of offsets. Each country labels offsets differently. Figure 2 explains offsets as a subcomponent of countertrade. Offsets are also known as Industrial Participation, Economic Enhancement, Compensation Packages, Industrial Benefit Programmes and Countertrade Policy. Generally, offsets are defined as compensation practices that are required as a condition of sale or purchase. Offsets are an arrangement between a national government and a foreign arms supplier to direct some benefits of the contract back into the purchasing country as a condition of sale [1]. Offsets comprise an entire range of industrial and commercial compensation practices, plus inducements or conditions for the purchase of military goods and services. These include co-production, joint venture, buy-back, knowledge transfer, training, and investment, marketing assistance and counter-purchase. Offsets can be direct or indirect but other elements such as counter-purchase and structured finance have taken prominence of late. These definitions, suggest that offsets are mainly used to improve and further enhance economic development.

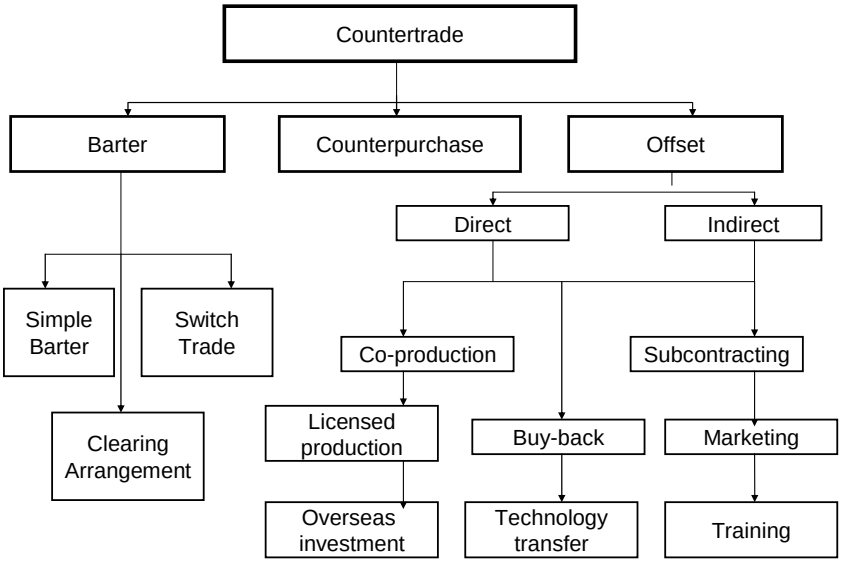


**Figure 2. Components of Countertrade**

Offsets thrive in contradiction: at one end of the spectrum, offsets are recognised as a tool for economic development contributing to technological and industrial growth. On the other hand, offsets are held to be in opposition to a free market approach, encouraging corrupt practices, market distortion and cost inefficiency [2]. The truth, however lies somewhere between the two extremes.

Offsets, fifty years ago were a complex blend of national pride, budget concerns, domestic politics and Cold War industrial policy. Offsets, at that time, were perceived as a tool to relieve economic deprivation. At the end of the Second World War, nation states were confronted with varieties of problems including domestic economic disarray and international trade crises. During this period, the US became concerned about the Soviet Union's military capabilities and decided to offer offsets to its allies as a means of increasing their industrial capability, to modernise as well as standardise military equipment between the allied forces. Offsets practices, which began in the late 1950s, especially amongst NATO members, were clearly aimed at promoting US weapons systems and fostering the reconstruction efforts of US allies.

This strategy changed in the 1960s and 1970s. A large number of industrialised Western European countries, recognised the increasing costs of advanced technology, and demanded offsets to maintain their defence effectiveness. The huge outflows of foreign currency were justified through economic development projects gained through defence offsets. Eastern European and other developing countries slowly emulated Western offsets practices aimed at raising their defence and economic capabilities. On the civil side, commercial offsets development can be traced back to the 1970s with the changing face of global industrial competitiveness.

**Why offsets?**

Offsets have become increasingly important especially in defence procurement. Unfortunately, quantitative data on offsets is generally scarce and the annual reports on "Offsets in Defence Trade" published by the United States Department of Commerce (US DoC) represent almost the sole source available. According to the data published on this site, US defence firms alone had entered into offset agreements valued at USD 60 billion, or the equivalent of 71.2 % of their related export contracts

value. By 2006, the offset percentage had doubled its value from 35 % in 1996 to 70%. It peaked in 2003 with offset agreements representing almost 125 % of the value of related export contracts [3]. There are a number of reasons for the increased importance of offsets [4].

The end of the Cold War left a security vacuum, creating a global reduction in defence spending. Nations re-prioritised their national budgets by reducing defence spending and at the same time reallocating spending into other sectors of development. This led to a massive dent in the growth and progress of defence industry.

On the whole, it became a buyers' market. The shrinking defence market, rising equipment costs, increasing demand on 'value for money' and the uncertainties of future defence procurement forced multinationals to pursue market consolidation to become internationally competitive. Against this background, defence contractors had to offer additional incentives, such as offsets, to stay competitive within the defence market. In the 21$^{st}$ century, offsets transactions have continued to grow, featuring as a key ingredient in the arms trade [5].

Offsets are complex. This practice is surrounded by multifaceted processes, clouded by secrecy, non-transparent data, and is highly sensitive. Offsets practices around the world vary in terms of objectives, requirements, strategies and processes. In such instance, for purchasing countries, offsets are often seen as a perfect solution for penetrating the defence sector which is still highly protected by market barriers, patents, intellectual property rights, controlled technology transfers and oligopolistic market structures.

For governments, offsets are also seen as an opportunity to ease the politics of major defence spending. They seem to promise technology transfers, research and development, and an enlarged industrial base, alongside investment and high-skilled employment

There are numerous claims of benefits and costs of offsets to both buyers and sellers. Offsets are claimed to contribute towards enhancing total or partial national self-reliance and enhance national defence industrial base. Besides, offsets have also built human resources such as local work force skills and capabilities. Furthermore,

the tool has also increased local skills in new areas due to exposure to new product requirements. Offsets may also benefit recipient firms in terms of training local manpower in areas of documentation, systematic industrial procedures and facilities management which are crucial in the defence or aerospace sectors. Furthermore, international compliance and certification have won overseas orders for many local companies [6].Further offsets have contributed to creating high value-added jobs, foreign direct investments, enhanced industrialisation and foreign exchange savings [7]. The politics of the offset purchase can overshadow completely the need or the desirability of the military acquisition. This also creates significant tension between the two different parts of the government involved – usually the Finance or Economics Ministry supervising the offset purchase and the Defence Ministry purchasing the military asset.

## MALAYSIAN DEFENCE OFFSETS SCENARIO

Malaysia's offsets objective is two pronged: firstly, the development of high technology sectors, mainly aerospace, and, secondly, the strengthening of the defence industrial base. The government is largely instrumental in ensuring that offsets are geared towards achieving these two objectives. Malaysia's Vision 2020 policy has been aimed at re-aligning its industrial focus from labour-intensive technology-based industries to capital and knowledge based industries. Malaysia has positioned itself within South-East Asia to develop high-technology sectors, particularly in defence and aerospace. Offsets have mainly been used as a platform to attract high technology capital-and service-based technology industries for achieving this purpose.

The Fourth Prime Minister of Malaysia, Tun Dr. Mahathir Mohammed, during an council platform, pleading for both OEMs and local companies to use offsets for sustainable collaborative technology development.

Malaysia's countertrade operations commenced during the economic recession of the early 1980s. Countertrade, particularly, barter and counterpurchase, were seen as a viable vehicle for entering into international trade [9]. The Countertrade Department at that time was under the supervision of the Ministry of International Trade and Industry (MITI). However, as economic conditions improved in the early

1990s, barter and counterpurchase types of activities were substantially reduced and eventually the countertrade policy was sidelined. Responsibilities for such activities were shifted to the Ministry of Finance (MOF).

Offsets only became popular in the 1990s when Malaysia bought its first set of Hawk aircraft from BAE Systems. As in many other countries, the defence sector played a significant role in leveraging offsets through procurements which were then mainly utilised to develop the defence industry sector.

MOF, however, decided to decentralise offsets implementation function to six key ministries in 2001 while still retaining the policy functions at the Treasury office. This decision was taken with the view that the implementing ministries would be able to monitor the development and progress of projects at first-hand. A formal defence offsets policy and guideline was finally introduced in 2006 to ensure a more coordinated approach to offsets in Malaysian defence [10].

## DEFENCE-INDUSTRIAL ORIGINS

Malaysia possessed little defence production capacity prior to Independence. Its economy at that time was mainly agrarian, with only pockets of small enterprises that were generally owned by the Chinese, and larger enterprises dominated by foreigners, mainly British [11]. Post-Independence, the authorities began to recognise the need for local defence industrialisation, primarily on the grounds of sovereignty, but also to bolster efforts to pursue strategic and foreign policy goals. Yet, progress was uncoordinated and *ad hoc*, with the Armed Forces' basic equipment requirements satisfied through 'in-house' military facilities geared towards the needs of the separate service branches. For instance, the Aircraft Repair and Overhaul Depot (AIROD) was established in 1976 to service Royal Malaysian Air Force (RMAF) aircraft. Additionally, the government-owned Syarikat Malaysia Explosives (SME) was established in 1972 to produce small arms, ammunition, hand grenades and pyrotechnics. The first two decades of Malaysian defence industrialisation, then, reflected a process of investment in key but basic sectors, with progress both gradual and non-ambitious. The principal objective at this time was the creation of a modest but credible defence industrial capability able to provide first-line logistical support to

Malaysian Armed Forces (MAF) in the form of through-life maintenance, repair and overhaul.

The 1982 publication of the NDPP provided greater direction to Malaysia's defence industrial planning. Importantly, the government-owned defence undertakings would henceforth take sole responsibility for the production of strategic defence items, whilst semi-government and private-sector enterprises would be encouraged to produce the essential and non-strategic defence goods. Although important policy structures were finally under construction, the mid-1980's recession led to declining defence expenditure, and, as a consequence, implementation of the NDPP was stalled. Parallel defence modernisation initiatives were also delayed, with the reduced defence funding channelled instead towards extending the shelf-life of existing weapons platforms, through upgrades and overhauls.

'Take-off' for Malaysian defence industrialisation finally occurred in the early 1990s. Several events combined to catalyse developments: to begin, Dr. Mahathir Mohamad came to power and energised the defence-industrial push, not least by substantially increasing defence budgets; next, expanded defence budgets actualised acquisition of a broad array of foreign weapons systems, linked significantly to increasingly robust demands for defence offsets; finally, there was a push for defence privatisation, in line with wider commercialisation initiatives. These events accelerated the development of a Malaysian industrial base, beyond the rudimentary activities begun in the seventies and eighties. Table 1 details the principal companies that have contributed to the development of Malaysia's defence industry over the extended period 1969-2005.

A sizeable proportion of Malaysia's defence budget has been devoted to supporting emerging aerospace companies [12]. SME Aerospace (SMEA), for instance, began operating in 1990, focusing solely on defence business. The company was formed through an offsets venture with BAE Systems to produce Hawk pylons. Since, SMEA has built-up its capacity and is presently producing aircraft parts, components and subassemblies, integrated into BAE Systems' global supply chain.

Since 2005, SMEA's workforce of 430 has also produced Airbus fixed leading-edge parts, sub-spar assemblies, aft pylon fairings and helicopter vertical/horizontal fins [13]. AIROD is another successful Malaysian aerospace company that began life

in 1976 as a repair and overhaul depot, providing first-and second line-service to the RMAF. AIROD was incorporated as a private company in 1984, combining Aerospace Industries Malaysia with Lockheed Aircraft Systems, employing 10 managers from Lockheed and 242 Malaysian personnel mostly from the RMAF [14].

**Table 1. Expansion of Malaysia's Defence Industry, 1969-2005.**

| Aerospace | Shipbuilding | Land Systems | Other Industries |
|---|---|---|---|
| Ikramatik Flight Simulation Systems, 1998 | Boustead Maritime Naval Dockyard, 2005 | DRB Hicom/DEFTECH, 1996 | Sapura Defence, defence simulator and electronic, 1995 |
| Astronautic Technology (ATSB), 1996 | MSET Shipbuilding, 2001 | Malaysia Mining Corporation (MMC) Defence, 1976 | Caidmark, IT and consultancy, 1980 |
| Aerospace Technology Systems Corp (ATSC), 1994 | Penang Naval Dockyard (PSCNDSB), 1995 | | Tenaga Kimia, explosives, 1976 |
| UPECA Engineering and Aerospace, 1992 | ME & O Fleet Support, 1985 | | System Consultancy Service, 1975 |
| Composite Technology Research Malaysia (CTRM), 1991 | Labuan Shipyard Maritime (LSE), 1972 | | Syarikat Malaysia Explosives Sdn Bhd (SME), 1972 |
| SME Aerospace, 1990 | Nautica Nova Shipyard and Engineering, 1969 | | |
| SME Aviation, 1990 | | | |
| Zetro Aerospace, Repair and overhaul of avionics, radar and communications equipment and systems, 1981 | | | |
| Aircraft Repair and Overhaul Depot (AIROD), 1976 | | | |

Source: Malaysian Defence Industry Council (MDIC), 15 May 2006; www.mod.gov.my

In 1995, AIROD became a fully Malaysian-owned company, and now employs more than 1,200 workers, mostly highly qualified and experienced engineers [15].

Since 1990, Malaysia's defence industry has progressively expanded and diversified. UPECA Engineering Sdn Bhd, for instance, was formed in 1992, initially as a purely civil-based oil and gas company. However, by 2007 UPECA had become dual-focused, producing machinery and equipment for precision manufacture of complex aero-structural parts requiring up to five-axis CNC machining, including high-precision parts for the A400M aircraft. Another 1990's entrant into Malaysia's expanding defence sector was Composite Technology Research Malaysia (CTRM). It too had commenced operations solely focused on civil production, producing, for example, the Eagle light aircraft, the Eagle Unmanned Aerial Reconnaissance Vehicle and the Lancair Columbia 300 light aircraft. In recent years CTRM has begun to specialise in the design and production of composite structures for both civil and defence aerospace customers. It presently designs and manufactures components for the Airbus 320 and 380, and is the sole supplier of fixed trailing edge panels for the B747, 757 Air Cargo, 767 and 777 aircraft [16]. In the defence field, CTRM has become a subcontractor for BAE Systems, commencing a 2005 programme for the design and production of USD 907 million worth of airframe parts for the A400M [17].

Another Malaysian defence company involved in services work is Aerospace Technology Systems Corp Sdn. Bhd. (ATSC) [18]. Established in 1994 with its Russian partner, RAC MIG (now called Rosoboronexport), ATSC was formed to provide the repair, overhaul, modification and upgrading services for Malaysia's newly acquired MIG-29 aircraft. The company's workforce were, and still are, largely ex-Royal Malaysian Air Force personnel, experienced in aircraft maintenance and engineering work. ATSC has cooperated with Germany and India in the provision of maintenance services for the MIG-29; this will likely continue, given that both Malaysia and India have acquired Russian SU-30MK fighters.

Similar development has occurred in the Land Systems area. For instance, in ordnance production, Syarikat Malaysia Explosives Sdn Bhd (SME) commenced operations in 1972 as a joint-venture company. Equity participation was between the government of Malaysia and two local Malaysian partners: Syarikat Permodalan Kebangsaan and Syarikat Jaya Raya Sdn Bhd, and two foreign partners: Germany's Dynamit Nobel and the Swiss Oerlikon Machine Tools Company. By 1974, SME had

become a wholly-owned Malaysian company, achieving private company status in 1990. At about the same time, SME signed an agreement with Austria's Steyr-Mannlicher to license-produce the Steys-AUG assault gun for the MAF [19]. SMEO is another specialist manufacturer of explosives, and, as with SME, is a subsidiary of the NADI Corporation. SMEO [20] has progressed from manufacturing solely small calibre ammunition to developing a portfolio of pyrotechnics, large calibre ammunition and engineering plastics products. In 1993, SMEO was approved as a preferred supplier of guns and ammunition to Royal Ordnance, BAE Systems.

Another major land systems company is DEFTECH. Established in 1996, this company has specialised in the production and maintenance of defence-related equipment, particularly soft-skinned vehicles below three tonnes [21]. DEFTECH exports trucks to countries such as Bangladesh and Brunei. The company was also the principal Malaysian partner in the year 2000 joint development and local assembly of 64 Turkish APC 300s. Another local Armoured Vehicles producer is MMC Defence. Formed in 1976, it has been involved in a wide spectrum of offset-related projects, including modernisation of the MAF Ferret Scout Car and development of the turbo-charged diesel engine integrated into the Chrysler A727. In 1993, the Malaysian Army awarded MMC a contract to overhaul 96 Thyssen Henschell German Radpanzer Condor 4x4s, and, later in that decade, a further contract for the overhaul of another 50 Condor 4x4s. In 1995, MMC participated in the upgrade of both the Scorpion and Stormer APCs. In 2000, the company was appointed as the Malaysian offsets beneficiary in the assembly of both the Korean Infantry Vehicle programme, also including fourth-line repair work, and the Polish MBTs. MMC is one of the few Malaysian companies that since inception has specialised solely on defence work [22].

Finally, in the Maritime sector, there is the Naval Dockyard. This company's roots can be traced all the way back to 1953 when it started life as the Malaysian Shipyard and Engineering Sdn Bgd (MSE). Originally a joint-venture between the Malaysian government and a consortium of local and foreign companies, MSE was re-invented several times. It became the Lumut Dockyard in 1984, was then privatised and renamed the Naval Dockyard in 1992, finally becoming Penang Naval Dockyard PSCNDSB in 1995. The present business, moreover, has had a chequered

history. In 1997, the government awarded a RM 5.35billion contract to PSCNDSB, in partnership with Germany's Thyssen Krupp, for in-country construction of 27 Offshore Patrol Vessels (OPVs) over a 10 year period [23]. However, the project ran into trouble through delays and technical difficulties, leading to costs soaring to 10 times budget [24]. To date, only two OPVs have been commissioned into service, with a further four under construction [25]. Due to this project's tortuous delays, the government-owned Malaysian property and palm oil Plantation Company, Boustead Holdings, had to bail-out PSCNDSB in 2005. Besides shipbuilding and repair capability, the newly named Boustead Naval Dockyard has a servicing and maintenance contract for all Royal Malaysian Navy (RMN) ships. Another Malaysian shipyard, Labuan Shipyard and Engineering (LSE), commenced operations in 1972. It is an engineering and construction company with a core competence in shipbuilding, repair and maintenance, and oil and gas fabrication (including power barges). In 2005, the government leased LSE's to Realmild, which is now responsible for managing the shipyard's operations on Labuan Island.

Defence industrial contracts have also cultivated a sizeable number of firms producing low-tech 'common-user' items for the MAF. These firms supply items such as ration packs, military boots, uniforms and parachutes to both the local and regional market. Glowtrade, for instance, provides parachutes to the MAF and exports them to Brunei and several other ASEAN countries; Pakaian Saling Erti produces uniforms and accessories; and Semenanjung Selatan supplies combat rigid hull inflatable boats [26]. Under the 8$^{th}$ Malaysian Plan (2001-05) government expenditure on such diverse items as uniforms and accessories, medical equipment, laundry, tailoring and footwear was worth RM89.66 million, spread across 98 contracts [27].

To expand the high value-added, high technology nature of Malaysia's defence value chain, the government created Small and Medium Industries Development Corporation (SMIDEC) in 1996. This semi-government agency operates under MITI, providing advisory services, fiscal and financial assistance, infrastructural facilities, market access and other services to facilitate the development of a local subcontracting base. This initiative represents just one example of a recent broad government push to promote defence-related vendor development programmes. A

major plank of this policy has been offsets. Through the procurement of Turkish APC 300 tanks, Polish PT91 tanks, South African G-5 guns, the Brazilian MIRS Astros 11 and EADS helicopters, efforts have been made to enhance the local content of foreign-supplied military equipment by creating industrial clusters of domestic small- and medium-sized enterprises (SMEs).

The promotion of local subcontractors through offsets has been aggressively pursued. BAE Systems, for instance, has been active in fostering local value-chains in Malaysia. Hawk aircraft subcontract work has been spun-off through offsets to domestic producers, with firms engaged in the production of pylons, wire looms and ground support equipment. Indeed, across the 15 year period to 2004, BAE Systems is reported to have subcontracted nearly USD 200 million worth of offsets work to the four big Malaysian aerospace companies, CTRM, ACT - a subsidiary of CTRM, SMEA and Excelnet. Some of this work has cascaded down to local SMEs. For instance, SMEA has subcontracted work to UPECA Engineering, acting as a fourth-tier manufacturer of machined mechanical components [28]. The exacting standards required for defence work has led to UPECA enjoying improvements in process control, internal quality processes and manpower skills in CNC machining [29]. UPECA has been able to exploit this technology-upgrading to create spin-offs in the development of non-defence, safety and quality measures for the oil and gas sectors. This has enabled UPECA to foster its own local supply-chain in secondary processing, including surface treatment [30].

Similarly, offsets work linked to the 2002 MBDA JERNAS procurement has generated several work packages for vehicle installation kits and stowed-equipment, benefiting both MMC Defence and SMEA. In fact, SMEA's subcontracts have supported the development of 12 civil subcontractors in Selangor, producing tools, drill-jigs and sub-assembly jigs. Also, Ikramatik – a local business linked to the MIG-29/SU-30 programmes – was awarded USD 350,000 worth of subcontracts in 2004, covering the production of a diverse range of generic outputs, such as wiring, lighting-generators, mechanical and electronic parts, and complete projects [31]. Similarly, Zetro Aerospace, a Malaysian company servicing the electronics integrated into the EADS acureil/Eurocopter helicopter, has subcontracted US 5m worth of work to local SMEs in uninterruptible power supply (UPS) and lighting protection

systems [32]. Eurocopter Malaysia itself has created 20 subcontractors, providing a further US 5m worth of offset work across 2002-2004 [33]. Much of this subcontract work has been in the commercial arena rather than defence, and, save for a small measure of design work, the bulk of these subcontracts has been low-level 'metal-bashing' and build-to-print activities [34].

## HURDLES ON THE ROAD TO DEFENCE-INDUSTRIAL SUSTAINABILITY

Across the 7th and 8th Malaysia Plans (1996-2005), 14 major offset programmes were agreed by MINDEF and offshore suppliers [35]. Within these programmes, 431 separate offset projects were established, of which 48 per cent have been completed, 30 per cent are ongoing and 20 per cent yet to begin [36]. Some 321 of the total 431 projects were focused on direct defence-related work, targeted mainly on job creation, training and skills enhancement [37]. In the main, offset activity was driven by technology transfer in the form of training, know-how, joint development, local production and sub-assembly. Table 2 demonstrates Malaysia's wide international supply base, spanning nine countries, and covering a spectrum of countertrade (counter purchase and offset) arrangements. Due to the absence of policy across the period 1996 -2005, there was a lack of institutional guidance influencing offset negotiations with foreign defence contractors. This led to a variation in offsets standards, such as the split between direct and indirect offsets, the threshold value triggering offsets requirements and the percentage offset targets.

One consequence of the lack of formal offsets guidelines was the frequent policy shifts regarding the composition of offsets. In the early 1990s, for instance, there was an increased policy emphasis on counterpurchase activities; this ebbed away, however, in the mid-1990s, only to become important again in the latter part of the decade. Malaysia's appetite for certain categories of countertrade appears to be strongly calibrated to the country's economic cycle. Thus, during the economic slowdown, post-1997, Kuala Lumpur sought a quick economic recovery through commodity production and trading, with counterpurchase featuring prominently. Indeed, across the period 1999-2003, the total counterpurchase value was approximately US 381mn, almost on par with the offsets value of USD 389 million

[38]. The offset deals, moreover, appeared to incorporate a rising proportion of indirect offsets, mainly targeted on foreign commercial technology ventures, such as GPS and IT projects [39].

The Malaysian Ministry of Defence (MINDEF) policymakers have expressed concern at the low value of direct offsets and the associated negative impact on the linked objectives of equipment supply sovereignty and local defence industrial sustainability. These big picture strategic concerns represent a coalescence of several incremental anxieties. In particular, Malaysia faces the following challenges:

To begin, there is the ongoing sore regarding difficulty of verifying additionality through counterpurchase, the latter causing distortions within the existing commodity market in the search for short-term gains. Moreover, MINDEF continues to face problems in proving additionality and causality in investment-related projects [40].

Secondly, there is a lack of defence technology absorptive capacity beyond the development of local maintenance, repair and overhaul capability. Whilst the Malaysian government must elevate investment into promoting domestic science and technology capacity, the offshore OEMs (Original Equipment Manufacturers) must also demonstrate greater commitment to the MINDEF's pursuit of defence-industrial self-reliance. OEMs are reluctant to transfer high technology packages, representing decades of expensive accumulated R&D; there being scepticism as to Malaysia's viability in becoming a defence platform or even subsystem manufacturer [41]. The economic reality is that the big global defence contractors perceive 'small' developing countries as economically inefficient, requiring large capital outlays, incurring long lead-times, and carrying much uncertainty in terms of recurrent volume and export performance [42].

A further problem is that advanced weapon systems have been acquired from a wide array of countries, including the UK, the US, Germany, Poland, Russia, France, Italy, Brazil, South Africa and Turkey. These purchases may or may not have reduced single-source vulnerability, but what is certain is that they have created a range of technical and logistical problems for both the military, at second and third level MRO, and local defence industry. Principal amongst these problems is the differing technology capabilities and requirements, from West and East, with varying technical standards and specifications that have created complexity in the integration and

interoperability of equipment across the MAF. The diverse equipment inventory has challenged the indigenous learning process, with defence firms and military maintenance personnel requiring familiarity with different manuals, standards and guidelines in order to be compliant with OEM operating procedures [43].

Malaysia's experience of diversified acquisition suggests there are increased costs due to the frequent need to adapt to differing supplier technology processes. A major factor forcing such adoptions is the need to modify infrastructure and hardware, such as jigs and tools, to conform to each supplier's requirements. Unsurprisingly, from the OEM's perspective, there is the view that this logistical complexity is high risk, not least because of fears of technology leakage to competitors via Malaysian partner companies [44]. As a consequence, the majority of offset deals focus on MRO activities, with manufacturing accounting for just eight per cent of Malaysian offsets, and integrated logistic systems for an equally lower five per cent [45].

Although technology transfer has progressed the pace and breadth of Malaysian defence industrialisation, the creation of local value-added component remains constrained. Around 38% of offset recipients continue to rely on foreign sources of technology, components, parts and process machinery [46]. Malaysia even exhibits a continuing import dependence on raw materials, such as high-speed steels and composites [47]. Overseas dependency also extends to the provision of consultancy services, with almost 50% of offset beneficiary companies dependent on foreign consultancy provisions [48].

Offset programmes, moreover, have not acted to promote research and development (R&D) activity amongst local beneficiaries. Around 70% of Malaysian defence companies spend less than 10% of annual revenues on R&D, almost 90% lack in-house R&D facilities, and a negligible number have patents [49]. The manufacturers blame this paucity of R&D endeavour on the government, arguing that there are insufficient financial incentives, such as tax credits for R&D expenditure. However, offsets have also failed to leverage local R&D investment. Minimal R&D activity has been sponsored through offsets, and where it has occurred, it has proved short-term, with most of the Malaysian partners participating on programmes that do not develop into future commercially viable opportunities. Most offsets-sponsored

R&D projects are abandoned after in-depth and extensive training has been provided, creating only 'one-off' superficial benefits [50].

Another problem is that technology transfer has not proved cost-effective, constrained by institutional and bureaucratic obstacles. The use of offshore vendor technology incurs expensive royalty payments, sometimes acting to deter local technological development. This was the case when facilities to assemble and test components for a Thermal Vacuum Chamber (TVC) were not available in Malaysia but the cost of using foreign TVC technology proved prohibitive [51]. Moreover, even when cost is not an issue, technology access may be constrained by export control regulations imposed by the supplier country's government. For instance, Malaysia often faces serious difficulties over sourcing technology from other developing country suppliers; this is because the latter almost never hold the intellectual property rights (IPR), invariably having to revert to the OEMs to seek sales authorisation. This happened when Malaysia bought 300 APCs from the Turkish company, FNSS Savunma Systems, which then became involved in a protracted process of referral with its US technology partner to ensure the US International Trade in Arms Regulations (ITAR), were not infringed [52]. The resultant delays were costly, not least because timelines extended beyond the critical path. A further example of export clearance controls stymieing efficient execution of Malaysian offsets projects has been in regards to the Russian MIG-29 programme. Here, a Malaysian company was nominated as the service centre for Malaysia's Russian fighters, but the local firm faced serious technology transfer problems and spare-parts management in its dealings with the Russians. Although RAC MIG (Rosoboronexport) did its best to smoothen the process of technology transfer, the Russian company was unable to expedite clearance through Moscow's labyrinth of technology export regulations [53].

Access to vendor 'core' technology remains a major tension point in offset-related technology transfer. Whilst OEMs are prepared to partner with local firms in the modification of systems supplied, including the sharing of developing costs, risks, through-life support and upgrades, the 'core' technology represents their IPR and this will unlikely be given away.

Even when Malaysia is able to gain unfettered access to foreign technology, the offsets package normally carries with it further additional costs. Principal amongst these extra, sometimes 'hidden' costs is the cost premium associated with Malaysian offsets projects, ranging from 4-15% [54]. The premium arises because of some or all of the following considerations: firstly, to a greater or lesser degree, offshore vendors seek to load transactional costs, including risk contingencies, into both the primary defence contract price and the offsets package value; secondly, amended or additional offsets demands raised late in negotiations will force offshore suppliers to raise premiums due to the heightened risk of non-fulfilment of obligations - these costs being increased, moreover, if direct offsets are required, as defence-related projects are associated with higher outlays of capital investment, with more distant returns on investment, and a higher risk of non-recurring 'one-off' production projects; finally, representatives of the Malaysian offsets beneficiary companies argue that Malaysia pays a higher price through offsets to obtain technology that is often available through open sources on the global market at lower cost.

Significantly, given Malaysia's stated policy objective, the authorities are also challenged in fostering manufacturing offsets projects that are sustainable. Long-term commercial viability demands production continuation, but this is no easy objective. For instance, Malaysia's 2002 purchase of modular suspension bridges from an offshore supplier was linked to a USD 3 million offsets package, enabling the local company, CTRM, to supply carbon composite launch rails for the modular suspension composite bridges [55]. As part of the offset package, US1.5m was spent on training the Malaysian workers and investing in the jigs and fixtures for the CTRM factory [56]. After completion of the launch rails, however, no further orders materialised. As a consequence, CTRM closed down its composite rail manufacturing facilities in 2005, transferring all workers to a different site [57]. A similar experience occurred with Malaysia's acquisition of the ACV300 APCs. The linked offset agreement stipulated that 146 APCs would be produced in Turkey, with a further 65 built in Malaysia; the latter requiring completely knocked-down (CKD) kits to be assembled at Malaysia's DEFTECH plant in Pekan, Pahang [58]. However, as with the previously cited CTRM experience, upon project completion, the Pekan plant was abandoned [59]. The foreign partner claimed around USD17.5 million

worth of offset credits from investment into infrastructure, jigs, tools and a test track at the Pekan facility, but the majority of this equipment now lies unused [60].

Finally, arguably the greatest deficiency in Malaysia's offset performance is in regards to the most fundamental economic objective of offsets, that of job creation. Economic diversification and technological deepening are important offsets goals, but job creation, particularly high-skilled jobs, is likely to be the priority objective for developing countries. However, a searing criticism of Malaysia's offset experience is that the number of local jobs created has been minimal. Across an admittedly limited time period, 2000-04, only approximately 100 jobs were created from the offset programmes then underway, and of equal concern is that the majority of these new jobs were mostly focused on low-end technology activities [61]. This is a particular disappointment to the government, given that one of the principal aims of defence offsets was the creation of jobs amongst the local Malays, referred to as *bumiputera*. The government's positive discrimination of *bumiputera* means that nearly 100% of Malaysia's defence companies are Malay-owned, employing mostly Malay workers [62]. The firms are principally small to medium size, with around 80% privately-owned, and 70% having business involvements in both the civil and defence sectors [63].

## FORMALISING MALAYSIA'S OFFSETS APPROACH

Malaysian defence modernisation has been associated with the search for greater self-reliance. Offsets have been viewed as contributing to this goal through inward technology transfer, impacting directly on efforts to indigenise defence production. The government 'implicitly' recognised the beneficial technology spin-offs arising from defence offsets with the 1991 publication of Malaysia's Vision 2020 policy; the plan to re-design Malaysia's economy away from labour-intensive industrial development and more towards the development of high-technology sectors, particularly aerospace. The 'Vision' statement was aimed at accelerating Malaysian technological development, enabling Malaysia to join the ranks of the advanced countries by the year 2020. Vision 2020 became the latest in a series of initiatives (including the New Economic Policy, Industrial Master Plan, the Five-Year Plans and

the Science and Technology Policy) to foster high technology development. Thus, whilst defence offsets were seen as a catalyst for Malaysian technological transformation, progress through the 1990s was hindered by a lack of policy direction on offsets strategy and implementation. What policy existed, related solely to counterpurchase, MITI having issued a document consisting of the terms and conditions for such deals. In the absence of formal offsets guidelines, the quality and content of offsets projects depended solely on the skills and experience of individual project teams. The situation changed for the better in October 1999 when MOF published a brief document specifying the offsets threshold value, as well as the objectives, definitions and various types of offsets to be prioritised. Whilst a committee was established within MOF to manage offsets programmes, the latter continued to operate on the periphery of Malaysia's industrial and technological development framework.

At the close of the 1990s, there was a growing sense that offsets had contributed little to Malaysian defence industrialisation due to the minimal progress in forging defence industrial self-reliance. Evidence of the slow pace of indigenisation is reflected by the fact that at the start of the new Millennium, local defence production of complete systems consisted of only multi-purpose vehicles, for civil and military use, along with a limited number of electronic simulation and support systems. Moreover, the then impending expensive defence acquisitions under the Eighth Malaysia Plan (2001-05), increased the pressure on government to reconsider the efficacy of its offsets management process. The central concern was the lack of a structured and comprehensive offsets policy, raising concerns as to whether Malaysia was getting value for money from its defence purchases. This led to the commissioning of a study in 2000 to evaluate the effectiveness of offsets [64]. The study's findings later prompted a 2003 Cabinet decision that MITI should review the appropriateness of Malaysia's rudimentary countertrade policy. The decision was taken for a number of reasons: firstly, because there was evidence that contract values had been inflated by up to 5 per cent due to the inclusion of countertrade agreements in government procurement; that offsets planning prior to equipment purchase was uncoordinated; that serious weaknesses had been exposed in the management of finance, manpower and technology transfer; and that, finally, there was a lack of local

capacity to effectively absorb foreign technology and OEM support to promote offset beneficiary technology exports [65].

The resultant MITI offsets report recommended that counterpurchase be de-emphasised in future government procurement, and that instead, a more structured and effective offsets policy should be established. MOD, as the largest departmental beneficiary of offsets, was given the task of designing a formal draft offsets policy, tailored to Malaysia's defence industrial priorities. The draft policy was completed in 2003, received final approval from MOF in 2005, and was announced in 2006. MOD was also tasked with implementing the policy. The policy objectives included: fostering of strategic international partnerships to enhance local enterprise; promotion of industrial capability and marketing potential; maximum use of local content; establishment of a sustainable defence industrial base, including strong logistical capabilities; promotion of inward technology transfer; increased collaboration in research and development projects; and greater cooperation in local human resource development initiatives, thus promoting a high-value Malaysian skill-base.

Malaysia's 2006 offsets policy captures all the conventional generic features of the offsets 'process', such as credit monitoring, tendering requirements, and timescales for completion. The policy, though, contains several more specific guidelines, as listed below:

1) Greater policy emphasis to be given to direct as opposed to indirect offsets.
2) Application, exceptionally, of multiplier credits, subject to the extent to which Malaysian companies, universities and R&D-based organisations are able to exploit the intellectual properties derived from joint projects.
3) Introduction of a procurement threshold of Euro 10m to activate offsets requirements.
4) Establishment of a countertrade target of 100% of the defence contract value, subject to a minimum of 50% of contract value; this to be split between counterpurchase and offsets, with offsets forming at least 50% of countertrade value, subject to review on a case-by-case basis.

5) Inclusion of a compensation requirement of 5% of the contract value to be paid to the Malaysian government at contract commencement, representing liquidated damages for any unfulfilled counterpurchase/offsets obligations [66].

Malaysia's offsets policy represents real progress in formalising practice and establishing consistency in approach compared to the hitherto *ad hoc* model, and the attendant uncertainties previously faced by offsets stakeholders. Yet, the policy was not introduced without criticism. For example, there has been a call for further detail and clarity in risk assessment and the assorted metrics determining project sustainability [67]. Moreover, in separate public pronouncements, MOD has indicated that offsets would be used to promote priority 'dual-use' technologies, such as biotechnology, nanotechnology and information systems, but there remains opaqueness as to the process of exploiting the potential for technological spin-offs moving from defence to the private sector as well as technological spin-on moving from the civil to the defence sector [68]. Additionally, it is common practise in other countries' offset policies to employ multipliers and pre-offsets as a means of encouraging foreign investors to channel funds into priority development fields, but the Malaysian offsets policy has little to say on these important issues.

Operational deficiencies must also be addressed. For a number of projects implemented over the last decade, offsets arrangements were seemingly an afterthought, and not included as part of the procurement tender. This meant that suppliers were only notified of the offsets requirement 'after' bids had been submitted, creating difficulties for both offshore suppliers and Malaysian defence companies, alike. Suppliers not forewarned of offsets requirements, thus failed to factor into their bids the costs of offsets investment. Potential beneficiaries, in turn, were not provided with sufficient time to plan for offsets work. A further problem associated with post-contract offsets demands was the loss of leverage in extracting from the vendor the best possible offsets package. The absence of bespoke offsets project teams participating in the initial stages of procurement planning exacerbated the problem. Procurement pricing and technical issues should be prioritised, but the quality of the offsets provision needs also to feature prominently in the initial procurement negotiations. This affords the opportunity for both government and the OEMs to plan the technology transfer as well as to undertake mutual auditing of

possible local technology beneficiary companies, ensuring the matching of local capacity with offset-driven technology transfer. Finally, to facilitate greater communication, coordination and awareness of Malaysian industrial capability a Malaysian Economic Offsets Committee (MEOC) should be established. The work of the MEOC would be pivotal in evaluating, approving and monitoring offsets projects.

## CONCLUSIONS

It is a truism that offsets strategy should not adopt a *one size fits all* approach. Each country's historical, cultural, strategic, economic, political and defence-industrial conditions are different. For several reasons, Malaysia's offsets practices have been in unregulated transition, morphing from a low key, uncoordinated *ad hoc* process to the present considered and formalised policy approach. The push for a tighter institutional offsets policy framework is a reflection of the disappointing progress made since the 1970s. Defence-industrial self-reliance – defined as the possession of design as well as production capability – remains a distant goal for Malaysia's policy-makers. Disappointment, however, should be tempered by the realisation that in the contemporary era of transformational warfare, comprehensive defence industrial self-reliance is beyond the reach of even the major industrialised nations and, thus, economically and technologically impossible for small countries. Yet, whilst offsets have not forged rapid indigenous technological transformation, they have exerted a positive impact on the local Malaysian defence industrial landscape. Measured success has been achieved in the creation of technological capability, but with 60 % of offsets projects targeted on training and through-life equipment support and a negligible local R&D focus, there is clearly more to be done with respect to the promotion of indigenous defence industrial capability. Offsets have contributed to skill enhancement, but job creation has been woeful. Industrial diversification has been impressive, yet much of it has been channelled into commercial activities (with numerous successful examples of civil diversification through defence offsets) rather than defence projects. Particularly in the aerospace and composites fields, offsets have facilitated specialisation, competitiveness and high value-added operations; the latter spliced into supply chains and strategic partnerships at the global level.

Offsets are a complex and controversial subject. Yet, even with all the revealed difficulties, most countries view offset as a core component of defence acquisition policy. As long as the arms market remains a buyers market, offsets are unlikely to diminish in importance. The challenge for arms purchasers, then, particularly emerging countries, like Malaysia, is to maximise the opportunities for robust technology transfer, but with sustainable development remaining the priority. In support of this process, government sponsorship has a powerful role to play: it is, indisputably, a critical element in the short-run search for national defence industrial security, and, arguably, also in the long-run pursuit of international competitiveness,

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Tucker, J.B., *In* Toxic Terror: Assessing Terrorist Use of Chemical and Biological Weapons, Cambridge, Massachusetts, MIT Press, 1999.

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