FUTURE OF ASIAN SPACE POWERS

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ABSTRACT

This paper is primarily a conceptual and empirical overview of some of the important Asian space powers, and addresses the issue in regards to the relevance of space technologies in Asian architecture in the near and distant future. It offers a view on the past and present status of the space programmes of China and India. It also informs about the investments made by a few other Asian states in the space arena and the purpose behind making them. The author expounds on the issues related to space weaponisation and the likely role of some of the Asian players in shaping it. This paper offers certain predictions about the future of Asian airpowers for next two to three decades as backdrop of present status of various space faring nations in Asia, their stated future plans, geopolitical realities, and the existing and likely fault-lines within the region.

INTRODUCTION

The rise of Asia is expected to bring in a significant global transformation. The process of the modernization of Asia (substantial parts of Asia) is almost getting completed by the beginning of 21st century. Half a century ago, there appeared to be mainly two modern societies in Asia, namely Japan and Israel. However, the states within the region, particularly those geographically and culturally close to Japan, were quick to learn from the Japanese success. South Korea, Taiwan, Hong Kong and Singapore started emulating Japan [1]. On the other hand China also understood the advantages of modernizing. The growth of China during the last three to four decades has been phenomenal and is presently known as the fastest growing economy of the world. Along with the 'rise of China', another country to witness the exponential growth in the region is India.

The Asia's stride to modernity could be said to have various tenets from the opening of their economies, creating global markets for their projects, making western economies dependent on them (not necessary done by design but may have happened as a default) on one hand, to the progress made towards expansion of various infrastructural projects, developments in science and technology, and making trained manpower available globally to the others. Furthermore, it is important to note that the five of the world's nine nuclear weapons states are from Asia. This makes Asia one of the most 'vibrant' continents of the world strategically. However, the emergence of Asia should not be viewed only as an

incredible story. There are various pitfalls in the Asia's systemic at geopolitical, geoeconomic and geostrategic levels. However, in spite of such limitations, Asia as a whole is rising.

The future of Asia will depend on Asians. For that purpose, it is important for Asia to assert itself. Asian inventiveness, industries, management skills and governance needs to make its presence felt and should be in a position to provide models for the world. Asia has the potential to contribute toward the growth and development of continents like Africa and Latin America [2]. During last one or two decades, it has been observed that a few of the Asian states have made significant inroads into various areas of technologies, such as electronics, nuclear technology, information technology and biotechnology. In a few spheres of technology, such as electronics and information technology, the domination of Asia is global.

Space technology is another area where a few Asian states have made significant contributions, both in terms of innovation and infrastructure. In this area too, Asian states have been found to be collaborating with major western powers. A few of the Asian states are also involved in engaging powers in Africa and Latin America, and are helping them with the developments of their space programmes. In addition, some Asian states are found to be exploiting the commercial aspects of this technology successfully. This paper addresses the relevance of the space technologies in Asian architecture in the near and distant future. For the purpose of this paper, no specific definition of Asia has been used. Some states, such as Turkey, could be viewed to overlap into another continent. Russia and Ukraine were once parts of the Soviet Union and thus, inherited their launch capability. Few could also debate whether the states like Ukraine and Kazakhstan are to be considered as part of the Asian continent. However, for the purpose of wider understanding, the contributions of these states in the space area are referred at times.

THE SPACE ERA AND ASIA

It could be said that the 'space era' started with the launching of the erstwhile USSR's first vehicle Sputnik-1 into the earth orbit on 4th October, 1957. Since then, space technologies have been used for both civilian and military purposes for almost 55 years by various nation-states. The role of outer space application has evolved considerably throughout these years. Space technology has found its relevance mainly for education, meteorology, resources management and communications. On the other hand, the wars fought in the post Cold War era have brought to fore the importance of space technologies for militaries. Both, the Gulf wars and the Afghanistan conflicts have demonstrated to the world, the value of space assets towards controlling modern warfare. This has also led to the development of space doctrines for various nation-states.

During the last two to three decades, a marked increase in the development of indigenous outer space programs and related joint ventures have been observed. Various states in Asia are found to be investing on space technologies. In some cases, the space programmes are somewhat indigenous in nature, while many states are developing their

programmes mostly with the collaborations of the US, EU or Russia. Nonetheless, this expansion in the number of states possessing outer space technologies is also bringing the issue of duel-capable technologies to the fore.

The pre-1990s period can be viewed as the space war period between the two superpowers, the US and the USSR. Both had made significant investments in space-based assets. However, mostly their focus was to use space technology for the purpose of monitoring each other's nuclear assets. However, in the final analysis, it could be said that the Soviets could not sustain the space domination race, mainly because of economic compulsions. In regards to Asian states, it has been observed that their investments in space did not have the significant military or one-upmanship bias of the Cold War era. They were fully aware about the erstwhile USSR's experience of the space race engagement. At the same time, it is also important to note that states having vital strategic objectives, usually tend to modernise faster than others. Furthermore, states having developed missile capabilities tend to have advantages in the space arena (converse is also true). Asia hosts some of the shrewdest powers in the world. Naturally, their investments in space need to be viewed not in isolation, but at the backdrop of prevailing geopolitical realities.

Today, the Asian states could be divided into two broad groupings with regards to their space capabilities: satellite system holders based on borrowed technology and states with satellite launching capabilities. As, it is known that in today's world, it is not mandatory to possess all the technical capabilities to own a satellite. There are states owning satellites without having either launching capabilities or satellite manufacturing potential. This has become possible because of international collaborations either done at political or commercial level. Approximately, more than 15 Asian states have their own satellites placed in space. The states which have successfully demonstrated launcing capabilities till date are Japan, China, India, Israel and Iran. North Korea has made claims regarding successful orbital launching but not everyone is convinced about it.

Amongst the Asian states, mainly Japan, China and India have made significant investments in the space arena. Israel, to a certain extent, could be said to belong to this club, but their investments are much limited in resources. All these states are capable of designing and developing their own satellites and launcher. However, all of them do not have the capability to put heavier satellites (more than 3,000 kg) into the geostationary (36,000 km) orbits. Table 1 offers information in regards to the number of satellites in possession of individual countries in the region.

Amongst these, states like South Korea and Malaysia are keen to enhance their space capabilities and are demonstrating keenness to develop the programme in the near future. Unfortunately, South Korea has had to witness failures with regards to the development of launch technologies. States like Indonesia, South Korea and Saudi Arabia have ten or more satellites in space. However, it is important to note that there is no direct correlation between the number of satellites and the space potential. What essentially, this number could indicate is the interest of these states in this technology

and their wiliness to substantial investments. Most of these states in the region could be viewed to have a considerable requirement for satellite derived products, but they probably face technological and financial limitations to investment this technology. This could be the reason, for the limited investments by the states in this field.

Table 1: Number of satellites in possession by Asian states. (Adapted from [3])

Name of Country	Year of first launch	Payloads in orbit (2010)
Japan	1970	124
China	1970	102
India	1975	34
Indonesia	1976	10
Israel	1988	7
Pakistan	1990	5
South Korea	1992	10
Thailand	1993	6
Turkey	1994	5
Ukraine	1995	6
Malaysia	1996	4
Philippines	1997	2
Egypt	1998	3
Singapore	1998	1
Taiwan	1999	9
Saudi Arabia	2000	12
United Arab Emirates (UAE)	2000	3
Iran	2005	4
Kazakhstan	2006	1

States like Iran and North Korea are the states which probably use space launches as a technology demonstrator to implicitly inform the world about their ballistic missiles capability. However, it may not be totally correct to view Iran with only the 'missile' label, as they have demonstrated some significant achievements in the space sciences field too. Amongst Japan-China-India, the investments and assets of Japan and China far exceed that of India. Deep space missions (missions to the Moon and Mars) are one area where the journey of all these states could be more or less comparable to a certain extent. In recent times, China's progress has been most noteworthy, with their successful human spaceflights and their efforts towards launching an indigenous space station. China has caused a 'space tsunami' by successfully carrying out an anti-satellite test in 2007. This has brought the fore the issues related to the 'weaponisation of space' [4].

KEY ASIAN PLAYERS

To understand what the future will unfold in the space arena with respect to Asia, it is important to examine, whether Asian states will continue with the present pace of economic and technical growth, or lose momentum and disengage the transformation happening today at the regional and systematic levels of international politics. For any state, future growth in the technological area would be dictated by various nontechnical factors too. Apart from economics, the bilateral and multilateral arrangements undertaken by the state would play a greater role in the development of the space future of the countries in the region. From this perspective, it would be important to know about the past and present of the space roadmaps of the states within the region.

To build up a broad scale understanding about the investments and achievements of the Asian states in the space arena, the following paragraphs mentions the details about the space programmes of the few states. In regards to certain states, since their space programmes are still in the nascent stages, there is nothing much to examine. Mostly, this is because they have either hired the satellite services or have total dependence on other states to implement their space agenda. A few other Asian states are not mentioned in the above table (simply because they do not have satellites) are also attempting to develop space programmes. For example states, like Bangladesh, Sri Lanka and a few others, have established space agencies, and are in the process of developing space roadmaps for their countries.

The big three in Asia, Japan-China-India, have been in the business of space almost for four decades. Their yearly space budgets range from approximately USD 1,000 to 2,000 million (India has the lowest). It could even be argued that they view space as an important element of their comprehensive national power. Their investments in space are for national pride, growth of science and technology, and for the purposes of socioeconomic development. The strategic importance of these technologies, particularly in the 21st century when the states in the region are facing both conventional as well as asymmetric challenges cannot be overlooked. Out of these three major players, this paper will examine two powers, China and India, to appreciate how exactly the space agendas are being implemented in the region. Particularly, the rise of China in space field has also been unique. Hence, the case of China in discussed in a more detailed fashion. Some of the other regional players are also discussed with an aim to highlight where the smaller counties in the region stand today. The overall understanding about the current achievements of these states are important to appreciate and prognosticate the future of space powers.

China's Footprint in Space

China celebrated its 50th anniversary of space progress in the year 2006. Their space programme is an extensive arrangement for launching earth orbiting satellites for a large number of duties, expanding its human spaceflight abilities, and carrying out a multi-step programme of lunar and Mars. Currently, five of their different operational systems

are in service namely telecommunications, meteorological, earth remote sensing, as well as recoverable satellites and technology demonstration spacecraft [5]. China proposes to establish a space-based laboratory and to set up a permanent space station. These entire efforts look guided towards promoting the diplomatic interests of the state, and its national security interests, all in an effort to garner greater prestige [6]. China is aware that the role of satellites and overall space applications have evolved considerably over the years and naturaly the dual use of this technology is fast influencing the development of their military thinking.

China's space programme began in the late 1950s when the State Council implemented the "12 year development plan of science and technology", which included rocket programming, radio electronics, automatic control, and computer and semiconductor technology [7]. Over last five decades, China has established a well-balanced and coordinated infrastructure of space related institutions, including research and development centres, launching sites, tracking, telemetry and command stations and centres, and manufacturing plants. For the last decade or so, China is on a fast track into space exploration/programme. The achievements and announcements about launch timetables, space laboratories, shuttles, space stations, lunar bases and Mars mission has swiftly transformed the Chinese space programme [8].

China's space programme initially began with an agenda to promote its Maoist ideology. It has transcended that ideology's decline to become a major political symbol of Chinese nationalism, an important economic sector, and an effective dual-use technology collaborator with the Chinese military. In the 21st century, the programme has become more important than ever before to China's Communist regime [9].

China's civilian and military space programmes are tightly interwoven. The China National Space Administration (CNSA- established in June 1993) carries out the management and operation of China's space activities [10]. The organisational structure and evolution of China's space programme is complicated and constantly undergoing changes.

The China Aerospace Corporation (CASC), a subordinate to CNSA, is a state-owned corporation which directs five primary divisions, responsible for building military missiles and civilian rockets: the Academy of Launch Vehicles (ALV), which designs and manufactures the Long March rocket series; the Academy of Space Technology, which designs and manufactures satellites; the Academy of Solid-Fuel Rockets (ASFR); the Academy of Tactical Missile Technology; and the Academy of Cruise Missile Technology [11].

In the recent past, China has made considerable investments in the manned space flight programmes. This programme has its roots in an ambitious project that was formulated in early 1992, and was initially known under the code name 921 [12]. CASC, has general authority over manned space flights and Long March series rockets. However, ultimately the military (specifically the Second Artillery Corps) controls the

Chinese space programme. Although specific efforts have been made towards separating the military aspects from civil / commercial aspects, China, like Russia, did not initially bifurcate its programme as did the US [13]. CNSA, is specifically designated as the Chinese counterpart to work with other international space agencies. In reality, CNSA personnel have been dual-hated with the China Aerospace & Technology Corporation [14].

At present, China is capable of launching various military satellites as per its own requirements. China has developed an impressive range of launch rockets to support its military and commercial space assets [15]. Launch vehicle technology is one of the foundations of China's ambitions space programme. With its Long March (LM) series of launchers, it has achieved a great deal of launcher autonomy. The Long March series includes 14 kinds of launch vehicles and 12 types of carrier rockets. The first launch (LM-1) vehicle had successfully launched the first Chinese satellite, Dongfanghong 1 (173 kg), into orbit in 1970 [16]. As of August 2010, 128 launches have being carried out using various versions of this vehicle. China is developing one of its most powerful rockets to date - Long March-5 - that with support engines with the thrust of 120 tonnes and is expected to be operational by 2014. When operational, the Long March-5 is expected to deliver up to 25 tonnes of payload, into the low orbit of the earth, and up to 14 tonnes into the geostationary transfer orbit, where most communications satellites are released after launch [17].

Communication satellites are a high priority for China because of its commercial utility. The development of China's communications satellites started at the beginning of the 1970s. China's first experimental geostationary orbit communications satellite was launched successfully in 1984 [18]. China has been successfully using such satellites for the purposes of TV transmission, education, long-range telephone and telegraph, data transfer in finance, and air and railway traffic. Their communication satellites have launched various programmes which include the Apstar, AsiaSat, SinoSat and Zhonxing series'. One of their most useful programmes in recent times is the SinoSat series satellite. The first satellite in this series is SinoSat-1 which was launched in 1998. SinoSat-2 was launched in 2006, but malfunctioned because of its failure to deploy its solar panels and communication antennae. SinoSat-6, which was launched successfully on 5 September 2010, now serves as a substitute for SinoSat-3 (launched on 1 June 2007) [19]. The next generation of communication satellites are expected to carry C, Ku, Ka and L band transponders.

The Chinese leadership understands the importance of the dual-use nature of space technology. Jiang Zemin, on 7 June 1991, issued instructions that it is not necessary to use separate military systems for civil and military uses. Presently, China has various national and commercial communication satellites in space. The Chinese Space White Paper (2000) mentions that efforts are being made to distribute very small aperture terminal (VSAT) communication services. China launched its first military communication satellite in January 2000. This is supposed to be China's first advanced spy satellite.

China also uses space technologies for gathering Electronics Intelligence (ELINT), Communications Intelligence (COMINT) and Imagery Intelligence (IMINT). The Chinese military is exploiting the importance of remote sensing technologies towards building information superiority. In these areas of intelligence gathering and reconnaissance, China is depending, both on indigenous space capabilities as well as on commercially available international space satellite constellations. With regards to Signals Intelligence (SIGNT), China's major investments are in modern aircraft platforms and not satellites.

It is interesting to note that China started with the FSW (Fanhui Shei Weixing, Recoverable Test Satellite) satellite series for military reconnaissance purposes. However, in the late 1980s, the design was employed for earth resources photography, and experiments in crystal and protein growth, cell cultivation and crop breeding. It should also be noted that China is the third country in the world to master the technology of satellite recovery. Currently, China is working towards developing a new generation of photo-reconnaissance satellite, the FSW Series (1 m or less resolution). They also have the Yaogan series satellites which was started in 2006, and is used for the purposes of remote sensing. The latest in this series, Yaogan X, was launched on 12 August 2010.

Navigational satellite systems are another area where China has major plans for both commercial and military purposes. In early 1980s, China began to utilise, other countries' navigational satellites and developed application technologies of satellite navigation and positioning, which is now used for land survey and ship and aircraft navigation. At the moment, China has its Beidou Navigation Satellites (BNTS) programme. This three/four-satellite system is an all weather and round the clock operation system. All these satellites are in the geo stationary orbit. It is expected that this technology must be of great use for the 2.5 million strong People's Liberation Army (PLA). This system is a regional positioning system, mainly covering the country and its neighbouring areas, thus making vertical positioning impossible while limiting the number of users. A global navigation satellite system (GNSS) is a space infrastructure that it is essential for China to possess if it is to be a space power in the 21st century [20]. China has got plans to develop its GNSS system on the lines of the US Global Positioning System (GPS) constellation. The Compass (Beidou 2)-Global system is expected to offer China a global reach. This system would have total a of 35 satellites, out of which more than 10 satellites are to cover China and the entire Asia-Pacific region by 2012. As of November 2010, six satellites for Beidou 2 have been launched. This GNSS system should be fully operational by 2020 [21].

The Chinese quest for a global navigation system does not end here. China is also a major partner with Europe which is developing its own satellite navigation and positioning system called Galileo. This system comprises of 30 satellites orbiting at a height of 15,000 miles and promises accuracy within one meter. However, China does not have the 'right to entry' to Galileo's military applications. China will not have the access to Galileo's public regulated service (PRS), which is an encrypted signal to be used only by European security and emergency forces [22].

China's space programme has withstood stages of rough beginning, reform and revival, and untrustworthy international cooperation. Over the years, the Chinese space industry has been developed almost from a non-existent industrial infrastructure and scientific and technological level to a modern business. After 50 years of struggle, China today is ranked among the fastest advancing countries in communication, remote sensing, reconnaissance and navigation field. They have made considerable progress in areas like manned spacecraft, satellite recovery, multi-satellite launch by a single rocket, cryogenic propulsion, strap-on boosters, geostationary satellites, satellite tracking and control, remote-sensing, communications, navigation satellites, and micro-gravity experiments [23].

Microsatellites is one area where the Chinese scientific community has major interests. Since early 2000, China appears to be giving major emphasis to this technology. A Russian Booster launched the first satellite in this category, Tsinghua 1, on 28 June, 2000 [24]. It was a joint project of Tsinghua University of Beijing and Surrey Satellite Technology Limited. It is a 50 kg microsatellite and its launch put China into the selected bracket of countries, which can design and operate micro and nano sized satellites. This success has implications for, both China's scientific programmes as well as for enhanced military satellite capabilities.

Small satellites can avoid detection; they also have the potential to be used as ASAT (anti-satellite) space mines. In April 2004, China launched two new indigenously developed research satellites, including a nano-satellite (Experiment Satellite I and Nanosatellite I) weighing 25kg. What the capabilities of these satellites are, however, and how much they are constrained by size, remain questions to be answered [25].

It has been reported that Experiment Satellite I transmits remote sensing data for mapping while the Nanosatellite was designed to perform unidentified technology experiments. Such small, cheap satellites could provide China with an easier path to attaining some space capabilities, and provide the potential for asymmetric warfare in space. The cost advantage of micro-satellites could, if properly handled, allow China to compete at some levels with larger and more expensive US systems without having to match the US dollar for dollar [26].

China has developed a new generation of small satellite launch vehicles, Explorer I, which uses solid fuel. It has been designed to take small or micro satellites into space, and compliments the Long March group, the country's large-scale liquid fuel space launchers. Explorer I will be able to carry loads weighing less than 100 kg. The low costs and high thrusts of solid fuel rockets make them important for commercialisation of the space industry [27].

In the wake of China's successful spacewalk which was conducted during the Shenzhou-7 (SH-7) mission launched on 25 September 2008 (it was China's third human space flight mission), a micro satellite was released during the mission called the BX-1. This Companion Sat was a very small cube, approximately 40 cm on a side,

and weighing around 40 kg. Technically, this satellite was developed to provide images of the Shenzhou-7 capsule and demonstrate the ability to inspect the orbital module and conduct some limited proximity operations. It also carried out a data relay experiment. However, some observers have concluded that this satellite was meant to test some of the capabilities required for a co-orbital ASAT attack [28].

China started preliminary work on advanced manned spaceflight in July 1985. The decision came against a background of vigorous international space activities, in particular the then US President, Ronald Regan's pet project 'Strategic Defense Initiative'. The erstwhile USSR had programmes like the Buran shuttle system, and the Mir and Mir-2 space stations. Europe was developing the Hermes space plane. Hence, for China it was necessary to take action in regards to its space activities to remain as a centre of attraction.

In early spring 1986, a proposal for seven projects under the Project 863 plans to accelerate Chinese technical development was made. Astronautics plan 863-2 included section 863-204 space transportation system, which would service the 863-205 space station. It was estimated that two years would be needed for concept studies. An expert group was established for the 863-204 shuttle. The final 863-204 Expert Commission report in July 1989 advocated building the manned capsule, with a first flight date of 2000. However, the report failed to impress the Chinese government. Chinese leader Deng Xiaoping rejected this plan. Subsequently Deng stepped down as Chairman of the Central Military Commission in 1989. In his absence, the Chinese military decided it could safely lend its critical support to a manned space program. In January 1991 the Air Ministry established a manned space programme office. The final plan was approved on 21 September 1992, and Project 921 to create a Chinese manned space capability began in earnest [29].

It took a decade's preparation for China to realise its dream of Chinese visiting the space. By October 2003, China successfully launched and recovered its first manned space mission. This Shenzhou 5 mission was preceded by four successful unmanned Shenzhou launches. Reports about these missions suggested that China used the Shenzhou missions for electronic and imaging intelligence gathering. Space Daily reported that the Shenzhou 1 - Shenzhou 4 test flights likely to have carried military payloads in the form of electronic intelligence or imaging reconnaissance equipment [30]. It is also inferred that the primary mission of China's first manned spaceflight might have been imaging reconnaissance. However, it is important to note that carrying out operations like imaging reconnaissance either by manned or unmanned space vehicle is not is a good option. Even a simple satellite could this job in a better option. Hence it would be incorrect to assume that such missions are carried out only for the purposes of imaging reconnaissance.

Today, China is only the third country in the world to send a man into the space. In its report on China's military power, the US department of Defence has stated, 'While one of the strongest immediate motivations for China's manned space programme appears

to be political prestige, China's efforts will contribute to improve military space systems in [the] 2010-2020 timeframe' [31].

China's Shenzhou design is a replica of Russian design (Soyouz), but has more additional features, which are more of military relevance. Chinese craft consists of an orbital module, a re-entry vehicle that carries crew back to earth, and a service module for propulsion and for performing retro fire sequence. But unlike Soyuz, the Chinese module could detach from the re-entry capsule and remain in orbit for several months, acting as robotic mini space station, using its solar panels to power instruments and experiments. However, the unit is not a re-entry vehicle and burns up while entering the atmosphere [32].

Chinese Army strictly controls the Shenzhou programme. One indication of Shenzhou military operations was likely electronics carried on nose of the Shenzhou 3 orbital module that functioned autonomously in space for six months following the return to earth of the decent module after seven days aloft in March 2002. As per few analysts Shenzhou III mission could also have carried a significant electronic intelligence eavesdropping payload. The system could have recorded UHF and radar emissions applicable to a variety of military uses including ocean surveillance [33]. Shenzhou 5 also had left its orbital module aloft, unmanned, likely again carrying military relevant equipment.

On 12-17 October 2005, China launched its spacecraft, Shenzhou 6, carrying two astronauts, and secured its smooth return to the earth after a 115-hour and 32-minute flight in orbit. This event has reaffirmed China's raising stature in the space arena [34]. The establishment of a landing system for manned space flights implies that China has succeeded in building a complete and matured spacecraft tracking and control network. Such networks are capable of carrying out accurate tracking and control of satellites and missiles. With this breakthrough, China is in a position to fly into space, return to the earth, manage synchronization with a fixed point, operate one network with multiple satellites, manufacture internationally compatible space systems and successfully manage spacecraft recovery [35]. China successfully undertook the spacewalk which was conducted during the Shenzhou 7 mission launched on 25 September 2008.

The extent to which this manned activity will translate into a military advantage for China remains debatable. Most benefits to the military from the manned programme will be indirect or a function of improved Chinese technical abilities, generally in an area such as computational analysis, systems integration, and miniaturization [36]. It also could be argued that notwithstanding that both the US and Soviet militaries have been unable to identify important advantages of a man in space over unmanned systems, the Chinese seem determined to explore that premises for themselves, likely through the use of orbital module at some later date.

The most eye-catching event then to put the human in space is to put the human on a different planet. One of the main (undeclared) agenda of China to undertake deep

space missions is to challenge the US supremacy of undertaking manned moon mission. Any activity conducted in space about 100,000 km and beyond about earth's surface is generally known as deep space activity. China's long-term goals in space exploration include sending a satellite into lunar orbit, followed by a robotic explorer and an eventual moonwalk. China also has plans to build a space station on the Moon. In addition, in Aug 2003 China concluded an agreement with Russia to pursue future joint space exploration efforts [37]. Subsequently, on 26 March 2007, China and Russia signed an agreement for joint exploration of Mars. Further details about their plans are not known. However, it is likely at that first attempt they would send a satellite towards Mars to study its surface and collect information for future programmes.

China has drafted a multi-step program for lunar exploration. By 2013, China space planners will be landing a rover on the Moon surface. In 2017, China's lunar exploration plans call for robotic lunar sample return missions [38]. It is also expected that by 2020 to 2025 China could plan a manned moon mission. China has successfully, completed its first lunar mission. Under this mission it had sent a satellite in the close vicinity of the moon's surface to take observations of moon's surface. This satellite was launched on 24 October 2007 (Chang'e-1) [39] and the mission was scheduled to continue for a year. The mission was extended for more consideration. China has successfully completed the stage one of its moon mission. Cheng'e-1 fully completed its mission on 1 March 2009. This spacecraft has deorbited and it impacted the moon. During this mission China has explored the space environment between the earth and the moon. This understanding would help in planning their further missions. They have also completed the three-dimensional survey of the moon's surface and have carried out the analysis of the distribution of elements on lunar surface. Their aim was to know more about the availability of the Helium-3 on the moon's surface. It has been predicted that the Helium-3 on the moon can significantly meet the energy needs for human kind.

China, on 1st October 2010, launched its second lunar probe Chang'e-2. This probe would monitor the moon's surface within 15 km of the moon. This unmanned probe will conduct various tests over a six-month period in preparation for the expected launch in 2013 of the Chang'e-3, which China hopes will be its first unmanned landing on the moon [40]. China is also studying the feasibility of designing a powerful carrier rocket for making a manned moon landing and exploring deep space further. The rocket is envisaged to have a payload of 130 tonnes, which would be more than five times larger than China's capabilities as of 2011. As per China's three-phase moon exploration plan, the first phase got over with the launch of Chang'e-2. The second will be completed when Chang'e-3 lands on the moon in 2013. By 2017, China expects that they would be in position to get a moon rock sample to Earth [41].

Most of the space missions are dual use in nature, but there are few missions with only military applicability and Anti-satellite (ASAT) mission is one of them. For many years speculations were ripe in regards to China's plans for space weaponisation. All these interests were put to the rest when on 11 January 2007, China destroyed its own aging weather satellite (FY-1C) by firing a rocket towards it. This satellite had a mass of

750 kg and was orbiting at an altitude of 850 km. In order to kill this satellite, China used an anti-satellite weapon using a non-explosive called "kinetic kill vehicle (KKV)". This weapon was nothing but a metal piece mounted on the top of the KT-2 missile which destroyed its target simply by colliding with it. This Chinese act has created significant amount of concerns globally about the likely weaponsation of space.

For the last couple of years, Chinese interests in developing and testing various methodologies for carrying out anti-satellite operations are being debated. There are reports that China has completed ground tests of an advanced anti-satellite weapon called the 'Parasitic satellite'. It is likely to be deployed on an experimental basis and enter the phase of space tests in the near future. These satellite systems are probably already ground tested. This ASAT system can be used against various types of satellites such as communication, navigational and early warning satellites in different orbits. The cost of building this satellite system is 0.1 to 1% of typical satellite [42].

According to a Pentagon report, *"PLA is building lasers to destroy satellites and already has beam weapons capable of damaging sensors on space based reconnaissance and intelligence systems. Consequently, China could blind the US intelligence and military space equipment systems vital for deploying US military forces in current and future warfare"* [43].

India's Space Programme

In 1963, India's entry into the space field made a nascent beginning from a small church in Thumba village in the southern part of India. It started with the launching of sounding rockets in 1963. The location of the village was important because the geomagnetic equator passes through this region and the only available building in that village at that time was the church [44]. During last four to five decades, India's space programme has made significant progress and is today globally recoganised as one the most successful programmes in recent times [45].

India became a 'spacefaring' nation on 18 July 1980 with the launching of Rohini satellite by using its indigenously made satellite launch vehicle. At the time, India was only the seventh nation to achieve such success. The fundamental aim of India's space programme has been to use space technologies for socioeconomic development. Its key focus was to use space technologies for the purposes of communications, meteorology, science, education and natural resource management. In 1962, the Indian space programme started as the tutelage of the Department of Atomic Energy. A body called the Indian National Committee for Space Research (INCOSPAR) was made responsible for the development of the space agenda. It was the INCOSPAR Chairman, Dr. Vikram Sarabhai, who articulated India's space vision.

Later, the Indian Space Research Organisation (ISRO) was formed under the Department of Atomic Energy in 1969, and was subsequently brought under the Department of Space in 1972. A Space Commission was also set up in the same year

,which reports directly to the Prime Minister. Over the years, the ISRO has done a commendable job and successfully undertaken various missions of national importance. The most significatent contribution towards the development of India's space programme has been that of Prof Sathish Dhawan. Over last four decades, ISRO has established various units in specific fields of technology that are directly or indirectly related to satellite manufacture, launch vehicles systems and ground infrastructure. They have developed significant expertise in the arenas of propulsion, telemetry and tracking and communications systems. Today, India is in a position to launch satellites in the weight category of approximately 2,000 kg. Over the years, ISRO has established a strong infrastructure for remote sensing and communications satellite systems. In 1992, a commercial outlet called the Antrix Corporation was established by ISRO. This organisation looks after the commercial aspects of ISRO, for both the launch market as well as telecommunications products, and also makes satellite derived data available at a price.

During 1980s, the focus of India's space programme was mainly concentrated towards experimental, low capability projects. Some amount of foreign assistance was also taken to learn the nuances of the rocket science and also to launch satellites. A few Indian scientists, who were trained abroad in states like the US, Russia (erstwhile USSR) and France, have made their own contributions towards the growth and development of the Indian space programme. Few of the early satellites launched by India were the Aryabhata (first Indian satellite, 1975), Bhaskara-I & II (first and second experimental remote sensing satellites, 1979, 1981), and the Ariane Passenger Payload Experiment(APPLE, first experimental communication satellite, 1981).

By the early eighties, India's scientific establishment realised that they have to focus more towards the development of indigenous launch vehicles if they were to expand their role in the area. Since mid-1980s, ISRO started designing and developing the polar orbiting satellite launch vehicle (PSLV), and its successor, the geostationary satellite launch vehicle (GSLV). These vehicles were required to launch the indigenously developed Indian Remote Sensing (IRS) satellite, and a meteorology and telecommunications 'Indian National Satellite' (INSAT). PSLV commenced its operational launches in 1997, and since then, it has been regarded as the most dependable workhorse. Till to date, with the help of this vehicle, India has launched 41 satellites into various orbits and out of this, more than half are for other countries. Particularly, for the low earth orbit missions, PSLV has proved its worth beyond doubt. A variant of PSLV was also used for the first Indian moon mission too.

GSLV vehicles are deigned to launch satellites into the geostationary orbit which is 36,000 km above the earth's surface. Such vehicles are also used for the launching of heavy satellites usually in the range of 2,500 to 5,000 kg. On 2nd September 2007, ISRO launched its INSAT-4CR geostationary satellite with the GSLV F04 vehicle. Success of this launch has proven India's capabilities to put satellites weighing around 2,500 kg into the geostationary orbit. India's GSLV technology has a PSLV component too. The first two stages of these GSLV vehicles are derivative of PSLV technology. ISRO has

ambitions in designing and developing the Geosynchronous Satellite Launch Vehicle Mark III (GSLV Mk-III) vehicle, which would be an entirely new launch vehicle and is not based on PSLV or GSLV-Mk-I/II technology. GSLV Mk-III is expected to launch 4,400 kg satellites to GTO (Geosynchronous transfer orbit) with a growth potential of towards a 6,000 kg payload capability through minor improvements.

On 28th April 2008, with the success of the PSLV-C9 mission, ISRO succeeded in placing in space ten satellites, in a single mission. In 2009, ISRO launched a few missions with multiple satellites in a single launch. This multiple launching of satellites together, indirectly demonstrates the possibility of India's progress towards to developing multiple independently targetable re-entry vehicles (MIRVs) technology [46]. Such technology, when fully developed could add teeth to India's nuclear deterrence. This technology has the potential of making any missile defence configuration employed against the incoming nuclear threat meaningless.

India's cartographic series of satellites namely CARTOSAT 1, 2, 2A and 2B are satellites with the best resolution in the world. They offer stereoscopic imagery and make terrain mapping easier. The resolution of the recently launched satellites (2A and 2B) matches the best in the world (the American satellite QuickBird is the world's highest-resolution commercial satellite and offers a resolution of 60 cm) [47]. Such satellites have significant defence utilities too.

The year 2008 demonstrated India's reach into deep space by undertaking its first moon mission. On 22 October 2008 India successfully launched its first satellite probe towards the Moon, named Chandrayaan-1. India's lunar probe succeeded in finding the presence of water molecules on the surface of the Moon. Apart from its first successful moon mission, India also has various other interesting programmes. A few years back, India successfully received a space capsule back after sending it into the space. It could be viewed as a first step towards their human space programme. However, India's plan for a human space flight programme remains still in very early stages of development. India is expected to launch its second moon mission, in collaboration with Russia by 2013 when a rover (robotic instrument) is expected to land on the moon. India also has plans for developing its own regional navigational system by launching satellites in to the geostationary orbit in near future.

The basic limitation for the Indian space programme comes from the fact that the country is still devoid of cryogenic technology. For launches of heavier satellites, a third stage called the cryogenic stage is required. India has yet to mature this technology. In 1992, the then Russian President Boris Yeltsin was to transfer this technology to India, but was pressured by the then US administration not do so, fearing that India could divert this technology for its missile programme. Subsequently, Russia sold six cryogenic engines to India.

It is its GSLV technology which is giving ISRO a few nightmares. The year 2010 witnessed two significant failures for ISRO. On 25 December 2010, ISRO's GSLV-F06

mission with the GSAT-5P satellite onboard failed. The vehicle broke up 53.8 seconds from lift-off. Surprisingly, the launch failed in the "first stage" of the launch process itself. Earlier on 15 April 2010, its first attempt to use an indigenously made cryogenic engine with its GSLV-D3 to launch the GAST-4 satellite had failed. It may take ISRO more time to test this technology again.

Other Asian States

States like South Korea and Malaysia have limitations in regards to development of rocket technology, but appear to have a significant political desire to excel. Malaysia's entry into space domain was in 1996 via a private route with a launch of Mea SAT, the first Malaysian privately owned satellite. Presently, this three satellite geostationary satellite network provides television broadcasting, as well as general communications services over a very wide area covering almost 70% of world's human population [48]. Malaysian space activities caught the attention of the world when first Malaysian astronaut reached ISS on 10 October 2007 with Russia's help [49]. During June 2009, a Russian Zenit-3SLB carrier rocket has put Malaysia's Measat-3a communications satellite into orbit. This satellite serves C-band markets throughout the Asia Pacific region with a global beam; while its Ku-band beams is serving direct-to-home broadcasting markets in Malaysia and Indonesia [50].

South Korea has an ambitious plan for space development. Around the year 2000 the then South Korean President Kim Dae Jung had set a five-year initiative to design, build and launch a commercial space cargo rocket, and to use the rocket to create a commercial launch business in South Korea [51]. However, till date all South Korean satellite launches (more than ten in number) have happened only because of foreign assistance. In 2008, a Russian Soyuz spacecraft carried South Korea's first astronaut to the space station for an approximate cost of USD 28 million [52].

For the last couple of years, South Korea has been attempting to develop its independent space programme. Their Korea Space Launch Vehicle-1 (KSLV-1) was not able to deliver a satellite into the orbit in 2009. South Korea is attempting to develop launch capability with Russian help. All its attempts so far to launch satellites using KLSV (known as Naro) have failed, the most recent being on 10 June 2010 [53]. However, the South Koreans are confident of overcoming these failures in near future and have major ambitions. It proposes to develop a large-sized rocket capable of carrying 300 tons of freight into space by 2017, and intends to begin construction of a space shuttle launching system in 2020 and intends to land a probe on moon's surface by 2025 [54].

The attempts by Iran and North Korea to undertake satellite launches using their indigenously developed rockets are being viewed by many as an attempt to hide their testing of ballistic missile systems under the cover of satellite launches. North Korea first attempted to place a small satellite into earth orbit on 31 August 1998 but failed. Its subsequent attempts (the latest in April 2009) have also failed to put satellites into the orbit. The state has officially announced that the 2009 attempt was a success but no

independent tracking facility was able to locate the satellite. Many experts in the world do not agree with their claims and are of the opinion that it was testing a Taepodong-2 missile [55].

In respect of Iran's ambitions in space, it could be a bit incorrect to solitarily view them as an attempt to use a civil space programme clandestinely to manufacture longer–range missiles. Iranian efforts to exploit space began under the Shah who tried to improve his country's scientific standing. In 1959, Tehran became a founding member of the United Nations' Committee on the Peaceful Uses of Outer Space (UNCOPUOS) [56]. After a few initial failures, Iran launched its domestically built Omid (Hope) satellite on the Safir-2 rocket in February 2009. This was the first time that Iran placed an indigenously made satellite into orbit, joining the ranks of eight other nations that successfully orbited their domestically built objects. They propose to launch seven more satellites mostly in LEO. In August 2008, Iran's space agency announced its plans to send an astronaut to space within ten years [57]. In 2010, Iran unveiled three new communications satellites, plus a domestically produced carrier, Simorq, which can take a 100-kg satellite into orbit. Within a year's time, President Mahmoud Ahmadinejad announced a plan to launch several home-built satellites by March 2012. In February 2011, he unveiled four national satellites, Fajr (Dawn), Rasad (Observation), Zafar (Victory) and Amirkabir I, and a satellite carrier Kavoshgar 4 (Explorer 4). The first-stage and second-stage engines of the Safir-e-Fajr satellite carrier, and a space recycling and environmental station were also unveiled [58].

The Indonesian space programme is another programme which has a long history. It started almost four decades ago but has not shown much progress, probably for reasons of technology and finances. The official space agency, known as the National Institute of Aeronautics and Space (LAPAN), was established on 27 November 1964 by the former Indonesian president, Gen. Suharto. They have made investments, mainly into telecommunication satellites, but the progress was slow. During 2008, Ukraine and Indonesia signed an intergovernmental space cooperation agreement, which includes space research, rocket technology, satellite launches, earth remote sensing, and other uses of space for peaceful purposes [59]. It is expected that this agreement could help the state to leapfrog in this field. However, it would take some time for them to get into the mainstream, because basic infrastructure still needs to be created.

Many other Asian states have understood the importance of the space technologies in the development of society, as a whole and are making sincere efforts towards gaining an access to them. After 13 years of continuous efforts, Vietnam succeeded in launching its first satellite in April 2008. This 2.6-ton medium-sized satellite, Vinasat-1, was successfully launched to its geostationary orbit position from French Guiana. This project was first approved by the Vietnamese government in 1995, with an aim to serve increasing local demand for better communication services with lower cost. It needs to be noted that by 2008, Vietnam was spending approximately USD 15 million annually to rent satellites of foreign countries such as Russia, Australia and Thailand [60]. Realising that the demand for satellite capacity is high due to Internet development as well as

access to media services, Vietnam has decided to launch its second telecommunications satellite at a cost of USD 350 million in 2012, with France supplying the technology [61].

Turkey is also showing interest in the space arena for more than a decade. They are expected to launch their second remote sensing satellite, RASAT, in 2011 via a hired vehicle Dnepr LV from an airlift base in southeast Russia. Their first remote sensing satellite, BİLSAT, was launched in September 2003. This new satellite has a high-resolution optical imaging system and new modules, which are being developed by Turkish engineers. This is the first Earth-observation satellite (7.5 m resolution) designed and manufactured in Turkey [62]. Most of the states in the region are found to be depending on states outside the region to further their space agenda. However, some space that projects are found to be occurring is changing this attitude. For example, China is helping Laos to build and launch a communications satellite, and is also providing assistance to construct a satellite control centre [63].

EXPECTATIONS FOR ASIA

The art of imagination and creativity allows us to get a sense of the future. However, for the purposes of any realistic and logical analysis, it is important to study the trends in the past. The above discussion is relevant from this perspective. It is also important to recognise the fact that space technologies could have different credos for different states in the region. This is one technology that offers various benefits, directly and indirectly befitting to the mankind. Relevance for the socioeconomic development is one of the important facets of this technology. For last two decades, the development and reach of ITC (informational and communication) technologies has widened significantly in the region. Education, disaster management, entertainment and communication have emerged as the major facets of this technology. For bigger players the technology is offering various commercial advantages too.

As discussed, the interests in space technologies are far and varied for the states in the region. States like Laos, Bangladesh and few others are beginning to realise the relevance of this technology in the process of state building, while for China, space could be an instrument for maintaining the strategic balance of power in the region. For major players, issues related to space also include wider arms control and disarmament connotations at the global level. They understand that space technologies are not only about development, but have large-scale geopolitical connotations too. The major powers, such as the US on one hand and Russia / China, on other have different concerns about the weaponisation of space. Their individual concurs have prejudices, mainly because of their differing policies in regards to the establishment of the missile defence architecture.

The geopolitical landscape of the world in general, and Asia in particular, have shown major undulations in the recent times. Most of the events which have brought significant

changes in the policy, perspectives of the states in the region were never predicted. In physical terms, 9/11 did not happen on Asian land, but the region is paying heavily as an aftermath of this attack. The 2004 Indian Ocean Tsunami and the 2011 Arab uprising have proved to be game changers for the region. Economic predictions for the region's future are very bright. In 2010, China emerged as the second largest economy in the world surpassing Japan. India is expected to emerge as the third largest economic power in the world within the next two to three years. During global financial crisis of 2008, the big three states from Asia, along with states like South Korea, Taiwan, Singapore and few others, succeeded in avoiding any major economic downturns. In the field of science and technology, the progress made by Asian states is remarkable and the future appears to be bright.

It is an important factor in the above reasons to anticipate Asia's future for the space field. In addition, it is important to note that most of the space faring states in the region have already articulated their roadmaps for next two to three decades. This also offers a basis for any futuristic assessment. There is also a need to remember that the future will not always evolve based on present events. One rational form to articulate the future is to undertake the method of scenario writing which offers a range of alternative futures derived from the range of important drivers. However, this method is subjective in nature and suffers from various process and content traps. The assessment of future carried out over here is mostly based on analysing the present status of various space faring nations in Asia, their stated future plans, geopolitical realities and the fault-lines within the region. The predictions are carried out keeping the next two to three decades timeframe in mind.

It is expected that the big three Asian states, namely Japan-China-India, will continue to grow their space programmes. China is expected to take a major lead over the others. China would also manage a bulk share of the revenue for the global commercial space market. Presently, China is also helping a few states, such as Nigeria and Laos, with their space agenda. This number is going to increase in the future, and China will use space as an instrument to develop and display its soft power status. China will offer a stiff competition in the field of global navigation, particularly to the GPS.

In the field of deep space missions, Japan and China will overtake India. In regards, to manned space missions, China will emerge as a leading player in the world. Japan is expected to attempt more robotic missions. China will have its own space station operational in space. With the US retiring its present space shuttle fleet and NASA not offering an counterpart option, the International Space Station (ISS) programme may suffer and instead of depending totally on Russia, the managers of the ISS programme could also look at Chinese shuttles as an option to put astronauts on the ISS. During next ten to twenty years, the big three will gain definitive knowledge about the nature of minerals available on the moon and Mars surfaces, including Helium3. India will be in position to launch satellites weighing more than five tonnes and will emerge as a major play in the launch market. South Korean and Malaysian presence in this field will start becoming evident. Indonesia will also develop indigenous satellite launch capability.

This country has geographical advantages and could possibly start to exploit them in association with states like Ukraine and China to capture the launch market, at least for small satellites. China is expected to make significant progress towards developing "launch on demand" facilities. Japan is expected to have certain tangible technologies available in regards to exotic fields such as space elevators and space solar power.

Space tourism is expected to become a reality in the coming few years, particularly in the low earth orbits (LEO). Significant amount of regional and global cooperation is expected in this field and emerging powers, such as South Korea and Malaysia, and even Singapore, could play a role along with the big three states. Smaller countries in the region, such as Sri Lanka, Bangladesh and few others, will also have their own satellites in space, and particularly, the external actors helping to develop their space programmes will just not only be state actors, but also private global industries, which will start making their presence felt. In particularly, small satellite industries (micro/nano/pico variety) would rule the market and participation of the student community will be visible in developing and experimenting new technologies. Any major breakthroughs in material sciences, nano technology or information technology (quantum computing) will revolutionise the space industry.

Weaponisation of space is likely to become a reality, and in addition to satellite killing technologies, such as the kinetic kill vehicle (KKV), the states in the region may opt for jamming techniques. Increasing usage of space technology will be visible in the military field too. Space technology will also find significant utility in the Asian theatre towards establishing confidence building measures (CBMs) amongst the nation states. Like the defence industry, the space industry will also become a strategic, diplomatic and economical tool in the hands of states like China, India, Japan, Turkey, Indonesia and Iran. China will present the biggest spectacle in the world in the coming two to three decades; manned landing of on the moon.

In an overall assessment, it could be said that currently, the control space allows mostly the US to observe, converse and function globally. They can use satellite guided precision munitions during war or peace time at their will. They are able to carry out various global strategic and commercial activities safely because of their "space infrastructure". Their assets in space are relatively safe because space weaponisation is yet to become a reality and they have so far succeeded in blocking emergence of any globally accepted space regime under the United Nations (UN) rubric. In coming years, Asia will challenge the US 'Space Unilateralism'.

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DEFENCE RESEARCH AND DEVELOPMENT: NATIONAL INDUSTRIALISATION TOWARDS ACHIEVING SELF-RELIANCE

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ABSTRACT

This research attempts to study the impact of defence research and development (R&D) towards the achievement of self-reliance in the national industrialization. Specifically, the aim of the study is to evaluate the role of defence R&D with respect to budget allocation, policy and guidance, organisation and infrastructure, human resources and technology and collaboration in the whole process of industrialization. It is also to investigate the effect of political will as intervening variable to the relationship of role of defence R&D and industrialization. The defence R&D is defined as either design changed on tangible product, manufacturing improvement in MRO (maintenance, repair and overhaul) or system integration. The unit of analysis of this research is organization. Research data is gathered through in-depth interviews from 12 respondents of CEO level or equivalent. Generally, this study revealed four situations. Firstly, to progress further on defence industry, concerted effort on defining concept of defence R&D and self reliance and prioritising defence R&D activities. Secondly, the way ahead for allocating fixed annual budgeting on defence R&D need congruence efforts among political masters and government decision maker. Thirdly, to move faster, a drastic action should be taken in optimizing local experts and scientists to plan, invest and execute defence R&D activities. Fourth, capitalizing defence industry strength and revisiting defence industry challenges shall be worked out towards the original blue print of defence industry and the national defence policy.

INTRODUCTION

Research and Development (R&D), often referred to technological innovation, has been made known to the public and military strategist from the beginning of twentieth century. Eventually, in the third world country or developing countries and ASEAN [1] in particular, the emphasis and importance on R&D is not a priority. However, according to Garnett [2], in contemporary strategic thought, technology is important, since technological innovation is probably the most significant driving force behind it.

The Southeast Asian region's involvement on substantial arms modernization or arms build-ups, unless properly handled, could result in unnecessary tensions, suspicions and instabilities [3]. However, Taik-young [4] argues that arms build-ups themselves are not the answer to the call for self-reliance. This defence spending have been an important component of government expenditures, both for highly industrialized developed countries, and for less developed countries and has been a subject of controversy [5]. The interdependence between military spending and economic growth is one of the most interesting research, because military spending may be an important ingredient in the economic and military development of a nation.

Strategists are interested in the question of whether technological innovation in weaponry is a manageable or controllable process, or whether it is a haphazard thing, largely beyond the control of either government or individuals [6]. In the present context, R&D can be thought of as any innovative activity aimed at increasing the effectiveness of spending on security, enhancing intelligence and improving capabilities. In this relation the defence R&D seems to have a direct impact to national security as a whole. As shown by the United States throughout the post-war period, federal funding on defence related R&D has constituted a large fraction of all R&D spending in her budget [7].

The government of Malaysia in the 2010 National Budget Strategy has emphasized the importance of prioritizing allocation for R&D. The strategy document states that in order for the nation to become a high income economy, the government is required to do basic research activities, with strong R&D and commercialization [8]. Malaysia's emphasis on the importance of R&D and innovation in the process of economy and social development can be witnessed in the formulation of the Knowledge-Based Economy Master Plan [9]. As Malaysia continues to move forward in achieving a developed nation status by year 2020, the need to be able to protect and defend itself has become more crucial. Hence, expansion and improving its defence capabilities in terms of manpower and technology is a priority, as security is the main criteria for building peace and prosperity. In essence, Malaysia's defence policy [10] has identified peace and security as one of its component to preserve and achieve national interest [11]. The fact is national interest is best achieved through self-reliance by means of having nation industrialised. Defence R&D which covers design and manufacturing, maintenance, repair and overhaul (MRO) and system integration is part of a bigger picture of industrialization [12].

THE NEED FOR RESEARCH

It is a known fact that the local defence industry presently lacks the support structure to conduct R&D. It is further understood that defence industry have not embarked on sufficient R&D, to achieve the larger objective of defence self-reliance. Why is the local defence industry unable to undertake R&D? Firstly, is it so because the concept of self reliance is not understood and not fully disseminated. There is a lack of understanding on what it means to defence self-reliance and how to relate it to defence product. Secondly, the government itself is not clear of what it wants? This relates to the larger issue of industrialization policies. Defence sector is only one part of industrialization and seems not integrated into the larger host of industrialization. What need to be informed is to put emphasis, or to establish some kind of capabilities in terms of defence industrialization. It is not an end of it, but it is part of a larger goal. It is about whether, or not the country is interested to involve itself in developing capability and capacity to produce military hardware.

In this relation we need to establish some kind of capability. As compared to Singapore, there is no equivalent in Malaysia. Singapore's defence industry is very clear cut. They have more than 1,000 research scientists in the defence industry sector. The

industry is willing to spent money and the government fully backed up the industry by having 51% of its shares [13]. In Malaysia, government here does not give money as much as being expected or requested, because they have no clue on what they exactly want. Nevertheless, manufacturers have not responded to the call by government because there is no market need. In return, the government of the day has to respond to the situation. Currently, the defence industry in Malaysia has progressed at a slow pace. Local industry is overly dependent on Original Equipment Manufacturer (OEM) and foreign repair station. In the context of defence R&D role in the process of nation industrialization, this paper will be looking into the capability development on manufacturing, MRO and system integration. The question is to what extent has defence R&D contributed to the nation's industrialization despite self-reliance is not understood and not disseminated enough and the government is not clear about what it wants.

The objective of this study is to investigate the extent of attributes of the role of defence R&D in the process, policy and the whole activity of national industrialization to achieve the larger objectives of defence self reliance. Specifically, the objectives are to evaluate the role of defence R&D with respect to budget allocation, policy and guidance, organisation and infrastructure, human resources and technology and collaboration in the whole process of industrialization. It is also to investigate the effect of political will as intervening variable in the relationship of role of defence R&D and industrialization.

CONCEPTUAL FRAMEWORK

The conceptual framework of this research is based on the proposed model as shown in Figure 1.

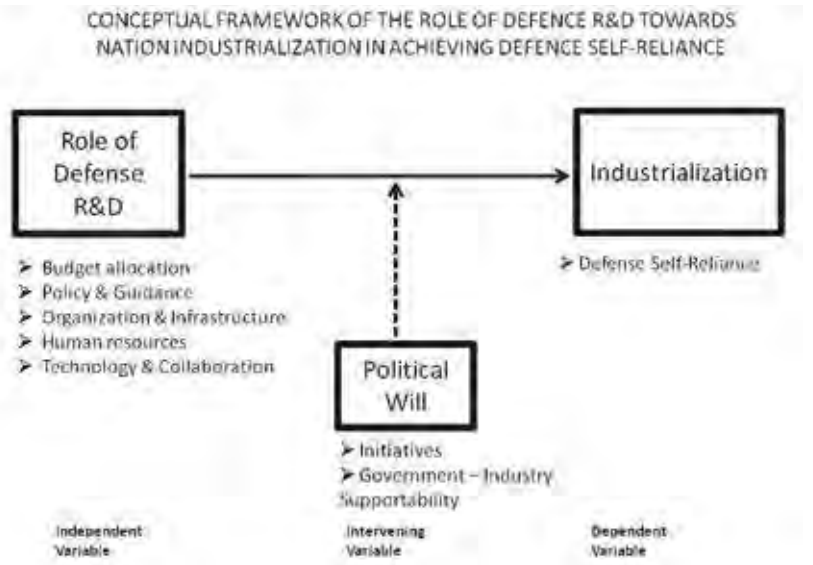

Figure 1: Conceptual framework of the role of defence R&D towards nation industrialization in achieving defence self-reliance

RESEARCH METHODOLOGY

Data collection for this study is primarily obtained from in-depth interviews. The total selected respondent are twelve, considered as the target key informants to this study. The government sector represented by the defence research organizations and government agencies are Science & Technology Research Institute for Defence (STRIDE), National Defence University Malaysia (UPNM), Malaysian Industry-Government Group for High Technology (MIGHT) and Defence Industry Division of Ministry of Defence Malaysia (DID). The industry comprises companies chosen selectively from four out of six industrial working group of the national defence industry. They are the aerospace working group (AIROD Technopower, ATSC, CTRM, SJSB and ZETRO), the maritime working group (Boustead), the automotive working group (DEFTECH) and the ICT working group (HeiTech Padu).

The key informants at the level of Chief Executive Officer (CEO) or equivalent are the right personnel who are familiar with the current policies, progress and current status of the development of defence R&D and defence industry in Malaysia. The in-depth interview conducted ascertained the level of knowledge, skill and working attitude in implementation of defence industry key informants [14]. All the data obtained were analyzed qualitatively to address the problem statement and to achieve the research objectives.

FINDINGS AND DISCUSSIONS

The Importance of Budget, Policy and Political Will

On budget allocation, the research found that most of the companies in the defence industry sector has allocated certain percentage of budget from their revenues for R&D activities whereas most of the government sector has not allocated any grant or budget annually for R&D activities. Slightly more than half of the organisation researched allocated less than 10% of their revenue for defence R&D activities. The quantum of percentage means different thing to different sectors of industry. For the government, defence R&D allocation is given only to STRIDE. However it is considered small and only in the development budget which is to cater for the buying of equipment and infrastructure development.

The research also revealed that more than three quarters of annual military expenditure goes to operating costs. There is also a necessity of having a fixed quantum or percentage in the annual operating and development budget to all defence research bodies. This is important for an immediate inspiration and motivation. However, the newly published NDP has stresse that defence financial allocation shall be based on the government affordability and will not be based on GDP. On policy and guidance, the research finding shows, more than three-quarter (83%) of the respondents do not have policy, or guidance on defence R&D, whereas the balance of 17% represented

by the government bodies have the policy but in different forms. It was perceived that the concept of defence self-reliance is absence and the local defence industry is still in trial and error stage. There is no proper guidance or policy on the implementation of defence R&D. This is in line with Suhaimi [15] findings that the organisations do not have common understanding of the concepts.

The STRIDE technological plan is just a plan and cannot be a help to practically guiding the industry to enhance R&D activities. The concept of self-reliance need to be clearly defined and the area of defence R&D need to be prioritise. The issue needed serious attention now, is the concerted view of defence R&D and defence self-reliance and prioritising defence R&D activity. These findings concur the needs pointed out by Shahrudin [16] for meeting the objectives of achieving self-reliance. On political will, all respondents perceived political will could generally influence the defence R&D towards national industrialization. About half of the respondents (42%) perceived that political will could influence policy on defence R&D towards the nation industrialization, whereas a quarter of the respondent (25%) perceived that political will could influence budgeting on defence R&D towards the nation industrialization.

Each component of defence industry has its own specialty, and focus which is significant to the development of nation's industrialization. These initiatives need strong government support and political will to make them happen and be able to compete internationally. The issue now is how to make the political connection and decision maker in agreeable mode with regards to policy matters and budget distribution. These findings conform to the earlier study by Cars [17] and Haan [18] with respect to the political and strategic consideration

The Effectiveness of Organisation and Collaboration

On organisation, the government bodies (STRIDE, MIGHT, DID and UPNM) remains critical as part of the eye, ear, arms and hands of the nation industrialization especially in the defence R&D area. The industry agreed that only government could proceed as the key role player in enhancing the defence R&D. As Suhaimi [19] pointed out, there is yet a single organisation in existence to coordinate the efforts of the players for the synergistic outcome. The issue need attention now, is the effectiveness of such organisation in executing the defence R&D activities.

On infrastructure, most of the industry players perceived infrastructure as their strength and are happy with the existing infrastructure available. STRIDE takes infrastructure as the main challenge due to its incompleteness. From the industry perspective, the defence R&D is a government role. Government has to drive self-reliance program, but the industry has to make the policy of self-reliance a reality. The government has provided good facilities, support and opportunities. It is high time for the industry to play their role.

On collaboration, most of the respondents have collaboration with other organisations especially the local universities. On technology, more than half of the respondents (58%) do not have IPR (Intellectual Property Right) due to the expensive nature in the investment. The fully IPR owned are for MRO nature of industry. With no IPR, local companies are not recognized internationally and still dependent on overseas designer and manufacturer. With the present collaboration, it signifies that the development of local defence industry is on-going. In the relation to the new NDP, the R&D collaboration is among the listed objective of offset programme which shall be adhered to. It should involve strategic partnership internationally which shall contribute to the development of local industry and enhancing the experts potential, capability and marketing the national defence industry.

Enhancing Privatisation for Defence R&D Development

The research finding has shown that the defence R&D is actually progressing in the same direction as the nation is driving its industrialization program in line with the aim of having a defence self-reliance status. The enhancement of the defence R&D today could be attached to the spirit of national privatisation program. In his "Malaysia: The Way Forward" [20], Dr Mahathir points out that privatisation will continue to be an important cornerstone of our national development and national efficiency strategy.

In this relation, the privatisation programme has been accelerated, covering projects in R&D. In order to facilitate the implementation, strategy of facilitating technology transfer by promoting R&D in major privatised companies has been emphasized. In the defence industry in particular, the scope of the defence R&D has actually moved from a dimension of the so-called "tangible R&D" to the "intangible R&D". It is high time that the government and the industry seriously focus on the software type of R&D, which includes integration works on all fighting systems of airspace, maritime and land.

Capitalizing Defence Industry Strength

Malaysia's defence industry today contributes to a growing supply of MAF requirement such as the military assault rifles, small calibre ammunition, aerial recon vehicle, patrol vessels, ICT based solutions and military gear and apparel. It has the capability to manufacture components and parts for both local and foreign markets. However, there is much to be done in enhancing indigenous defence capability. This is largely prompted by the economic factor, taking advantage of the availability of supplier ever ready to come into licensing, technology transfer and other arrangement to boost the sales or export markets. Politically, the objective is to gain self sufficiency, to reduce dependency on foreign suppliers and as an assurance against embargoes that may be imposed by supplying nations.

Therefore, local defence industries would ensure availability of necessary weapons and spares, whenever required to maintain operational readiness. MIDES and DID forms the main agencies that are responsible to shape and steer the local defence industries

towards its designated path. STRIDE and other government agencies would provide the technological and economics drives to the defence industries in enhancing its capabilities and competencies. By capitalizing the present defence industry strength, Dr Ahmad Zahid Hamidi, as the Defence Minister emphasizes that the second pillar of defence underpinning Malaysian defences and security policy, that is, "to develop self-reliance defence capability complimented by total defence" could be materialised [21].

Revisiting the Industry Challenges

Much has been said about challenges in the literature of local defence industries. Among others are the high capital investment, lack of R&D itself, absence of uniformity in procedures and regulation, lack of competencies, rigidity of specification and lack of promotional and marketing activities. There have also been issues on the quality of locally produced defence product such as ammunition. Marketing has not been successful due to high pricing and quality matters. Whether these challenges a reality with effect to the R&D activities is an issue to be further discussed and deliberated.

The Malaysian defence industry is still far from its true potentials as compared to other leading sectors such as electronics, oil and gas and automotives. An absence of long term commitment on procurement programme by the government may discourage local defence industries to participate in high capital investment because of non-guarantee returns. This old mentality of business, a non-risk taker is a true challenge for the nation. Often, it has been said that STRIDE is not providing the necessary assistance to the local defence industries. There is also a distinct lack of cooperation and collaboration between government agencies, users, local defence industries and defence related organisations. All these need to be revisited.

The Government Role in Promoting Defence Self-Reliance

The research revealed that the government has a greater responsibility in developing defence industry, particularly in R&D activities, despite the fact that it has done enough to the industry. The government should provide a clear direction and working mechanism between key players on all components of defence industries, to the extent of allocating budget and incentives for the defence R&D. The DID is lacking in capacity and authority to encourage MAF procurement to the local defence industries. The role and effectiveness of DID should be strengthen on directing and supporting the R&D activities, development of specific local industry production and coordination on procurement.

The government needs to prioritise the defence R&D activities, develop on core competencies and strategic technologies with the emphasis on R&D, design, manufacturing and system integration sectors. The industries, research centre and government bodies need to further seek international collaboration with developed countries or international defence manufacturer. What has been achieved and done so far is not enough and need further efforts.

Annual allocation should be distributed to research organisations to motivate and inspire researchers. The policy and guidance of the defence R&D need to be re-conceptualized. The science and technology policy of STRIDE need to be updated and aligned to the national defence policy of creating defence self-reliance. The common understanding of defence self-reliance and the priority of defence R&D activity should be put in-place by the government.

The role of defence R&D remains vital in enhancing the MAF self-reliance at present and the future, especially in the system integration works, software, UAV, composite application and TOT (Transfer of Technology). The role of defence industry in developing the socio-economic dimension of the country needs to be recognized as stipulated in the NDP. To support Malaysia's defence capability, the two elements: local defence industry and defence science and technology should be well addressed. The contribution of these sectors is vital in ensuring Malaysia's goal of achieving defence self-reliance.

CONCLUSION

Generally the research objectives have been achieved. This study has made the researcher understand the process and policy of defence industry and industrialization as a whole, and the relationship of the concept of national security and self-reliance, R&D and technology. The concept of self-reliance could be perceived differently but it all goes to the same meaning, ability to produce and maintain locally, without outside assistance. The process and policy critical to the industrialization is basically anchored to the financial constraint and the national aspiration. All independent variables have an effect on the relationship of the role of defence R&D and the industrialization. The budget allocation, policy and guidance of defence R&D, the organisation and infrastructure, human resources and technology and collaboration has its own peculiarity to the relationship. This study has also revealed qualitatively the impact of political will on the relationship between the defence R&D and industrialization.

This research has addressed the importance of the defence R&D, in particular to what extent defence R&D has been developed through collaboration, work force, infrastructure and the government role. It should provide clarity to the decision makers to have due consideration for appropriating defence R&D allocation in the national budget strategy. This study has enhanced the understanding of the concept of defence R&D and the attributes in the achievement of defence self-reliance. The research has also provided authentic data obtained primarily from the industry in the reflection of the relationship between the key actors of the defence industry. This study has also served as a source of reference on the subject matter in the Malaysian context. It is suggested that future research of defence R&D, could focus on detailed comparative study of defence R&D between neighbouring countries in the SEA region. The study should focus on the development, progress and lesson learned that could drive our local industry player roles in the enhancement of our defence R&D to achieve self-reliance in defence.

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MILITARY FORECASTING AND PLANNING (F&P): AN OVERVIEW

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ABSTRACT

Nations strategise and plan their forces to protect and defend their territories and interests against adversaries. Decision makers and planners are always in dilemma to find the right balance in future force options to meet new and emerging threats, with needs often conflicting in nature. The nature of force planning nowadays is increasingly constrained due to decreasing budgetary and limited resources. Planning paradigm has changed and the current military transformation and technology-driven Revolution in Military Affairs (RMA) are making forecasting in future military capabilities indispensable. This paper reviews military Forecasting and Planning methodologies and techniques for the development of future forces.

INTRODUCTION

Forecasting and Planning (F&P) is now becoming prominent in organisational decision making. The liberating peace, the world enjoyed after the Cold War ended in 1991, marked the beginning for defence decision makers and planners to evaluate national objectives, and new and emerging threats; weighing those against resources; and drafting new strategies for new and emerging conditions [1]. With the exception of the US, the contention between 'guns and butter' issues cuts in weapons procurement, armed forces restructuring and downsizing have effectively reduced the overall world defence spending during the post Cold War era.

The 9/11 terror attack will be a constant reminder, that threats in the 21st century are changing, and evolving to include non-state actors that may use asymmetric methods. The aftermath of 9/11 created a sense of urgency for transformation in capability planning that requires some form of preparation for uncertain future environment. This requires the armed forces to strategise and plan how they are going to fight in the future. In the US 2001 Quadrennial Defense Review (QDR), the strategy is to acknowledge uncertainty and contend with surprise, which requires moving away from threat based planning to Capability Based Planning (CBP) [2].

AN OVERVIEW OF FORECASTING AND PLANNING (F&P)

Forecasting has evolved planning of the 21st century military capability to continually adopt a proactive strategy. F&P are future-oriented decision making activities that depend on intuition of human judgment [3] and experience [4]. F&P originate from predictive management theories that involve making assumptions [4, 5], and must aim, not only at describing and explaining the past, but also at predicting the future [5]. Forecasting is dependent on the time frame, the existence of patterns and a number of variables related to the subject under study [6]. Long range forecasting (two years or more), will indirectly, involve planning [3]. Planning provides inputs to forecasting process. When a planning decision is made explicit, it is clearly a forecast [7]. Mitchell et al. [8] argue that forecasts are necessary for practically all good planning, but in themselves, forecasts are not plans and hence, are only part of planning. The strategic planning model takes shape when the long range planning and the environmental scanning models are merged [9], and is presented in Figure 1.

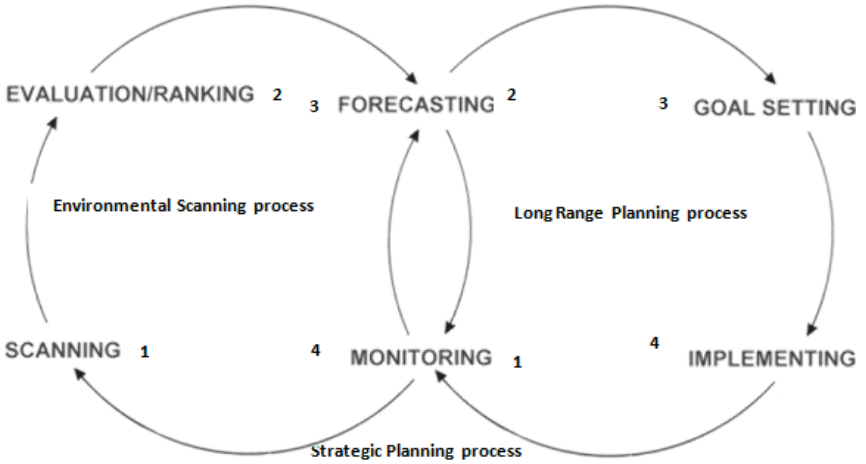

Figure 1. Strategic planning process [9].

Based on Figure 1, the long range planning cycle begins by monitoring trends of interest to the organisation, then forecasting the expected future of those trends using trend extrapolation; for example using regression analysis from historical data. The desired future is then defined by setting organisational goals in the context of the expected future. The last step is to develop and implement specific policies and actions in order to reduce the differences between the expected future and the desired future, and monitoring the effects of these actions and policies on the selected trends [9].

The environmental scanning cycle, as described by Renfro and Morrison [9] begins with scanning the external environment for emerging issues that pose threats or opportunities to the organisation. As part of this step, trends are specified that describe

the issues and can be used to measure changes in their nature or significance. Each potential issue or trend is then analysed (evaluation / ranking) as to the likelihood that it will emerge, and the nature and degree of its impact on the organisation if it should actually materialise. This stage produces a rank ordering of the issues and trends according to their importance to current or planned operations. The next stage, which is forecasting, focuses on developing an understanding of the expected future for the most important issues and trends. In this stage, specific forecasting techniques may be used. Once the forecasts are made, each issue and trend is then monitored to track its continued relevance and to detect any major departures from the forecasts made in the preceding stage. Monitoring, in effect, identifies areas for additional and continued scanning. For example, subsequent monitoring may begin to suggest that an original forecast is no longer credible, which would imply the need for more focused scanning, forecasting, and analysis to develop a more credible projection.

There are many literatures on F&P and strategic planning. Their characteristics, structure, and limitations are discussed by many [10-16]. Issues with F&P normally roots to failure in human judgment in decision making process, accuracies and biasness that resulted to failure in getting the desired results [11-15]. These issues include limitations in processing information and biases, the "illusion of control," accumulation of redundant information, failure to seek possible disconfirming evidence, and overconfidence in judgment that may induce to serious errors in F&P [3]. Forecasting must therefore be used to identify sources of uncertainty in the environment, and planning should be concerned with developing policies which acknowledge the uncertainties [3]. Betts [17] suggests while some conflicts are anticipated, it is risky to predict the future on the basis of current trajectories of events as changes in international and domestic conditions could be novel.

An ideal forecasting system comprises of several important attributes. The attributes developed by the Committee on Forecasting Future Disruptive Technologies [18] are presented in Table 1.

According to the Committee on Forecasting Future Disruptive Technologies [18], data sources should come from broad range of experts and participants, sources and formats. Key metadata should be captured, such as where, when, and how they were sourced, as well as quality, measurements of interests and resolution of data. To ensure data accuracy, reliability, relevancy, timeliness and frequency, multiple methods are used, and the data should be characterised and stored in a way that makes them interchangeable / interoperable regardless of format or source from which they were gathered. Historical, trends, and key reference data can be used for comparison and analysis for new sets of data. A variety of qualitative methods such as workshop, games, simulation, opinions, or results from other technology forecasts are used for qualitative data gathering, while quantitative data are sourced from a variety of data sets and types. Multiple forecasting methodologies reduce bias and enable researcher to capture the widest range of possible forecast futures. An ideal forecasting method should also employ novel methods and utilises qualitative and quantitative methodologies. The forecasting team should be of

diverse backgrounds and expertise, and may use culturally appropriate incentives to maintain required level of participation. Data should also be readily available, exportable and easily disseminated, while the output should be presented in a way that is informative and intuitive. Last but not least, raw quantitative and qualitative data and interpretive elements should be readily available for further analyses.

Table 1. Attributes of an ideal forecasting system [18].

Category	Attributes
Data Sources	Diversity of people and methods Diversity of sources Metadata Data liquidity, credibility, accuracy, frequency, source reliability Baseline data Diversity of qualitative data sources Diversity of quantitative data sources
Forecasting methods	Multiple forecasting methodologies Novel methods Qualitative Quantitative
Forecasting team	Expert diversity and ongoing recruitment Ongoing recruitment Public participation
Data output	Readily available Intuitive presentation Quantitative and qualitative

FORCE PLANNING

Force planning is part of the formal strategic planning of the armed forces. The term ‘strategy’ is used in military planning to describe the grand plan for winning a war. The creation and maintenance of military capabilities in short to long term is central in force or military planning activities [19]. Planning activities for complex systems such as weapons and military equipment are broken down into phases, coined as System Life Cycle [20] is illustrated in Figure 2.

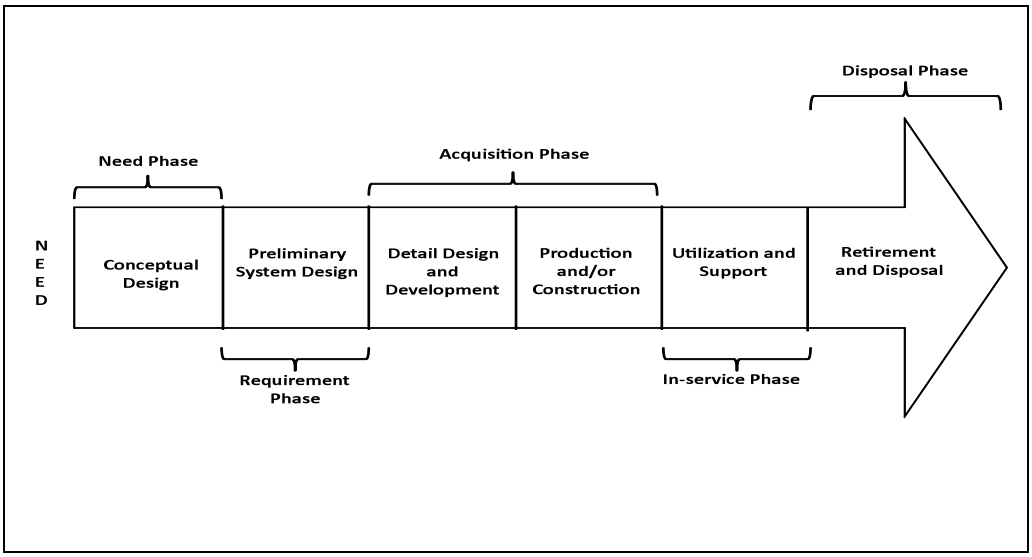

Figure 2. The system life cycle [20].

Capability systems 'life cycle' begins with the identification of a need to address a current or prospective capability gap. In defence environments, capability development activities are represented by phases as shown in Figure 2, while the boxes represent the life cycle of equipment as described by 'System-of-System' (SoS) approach or system engineering discipline. From the need phase, the requirement is further developed and progressively translated into a working capability system which is acquired, brought into service, operated and supported until it is ultimately withdrawn from service. Once a capability is withdrawn from service, the associated physical and personnel assets can either, be disposed of (for physical assets), redeployed or reallocated as an offset for another capability [21].

At the end of any major war, military leaders and planners continually review and re-formulate doctrine and planning for future warfare. The current notion of Revolution in Military Affairs (RMA) can be associated in advances in technology in terms of supporting the broad concept development and technology investment in period of 10-25 years through qualitative and subjective analysis based on forecasting and professional military judgement [22]. While technology forecasting is difficult, such projections are required to guide decisions on basic research, investment and military security [23]. In the past, planning in the World Wars and the Cold War were built around fixed threats. During those days, the core concept in formulating defence planning was guided by the bounding threats which dictated capability requirements [24]. By using one or two point scenarios, defence planning has evolved with the use of bounding-scenario method, thus, creating a short cut in threat based planning. Point-scenario planning is characterised by a fixation on particular enemies, particular wars and particular assumptions about those wars [24]. Today, F&P in future force planning is institutionalised in the Capability

Based Planning (CBP) framework and joint warfare concept, both driven by the strategy of military transformation.

Capability Based Planning

The planning paradigm after the Cold War era is now advancing into a holistic approach. The US-designed military transformation led many armed forces to adopt joint operations and Capability Based Planning (CBP). The shift was introduced by the US Department of Defense (US DoD) in the 2001 Quadrennial Defense Review, in which CBP 'focuses specifically whom the adversary might be or where a war might occur. Early theoretical studies on CBP were carried out by the RAND Corporation, which describes the new vision of operational oriented defence planning, that capture flexibility, adaptiveness, and robustness (FAR) concept in uncertain environments [25], and many other works focus on developing CBP architecture and analysis in strategic planning approach [24-28]. The framework Capability Based Planning [29] is presented in Figure 3.

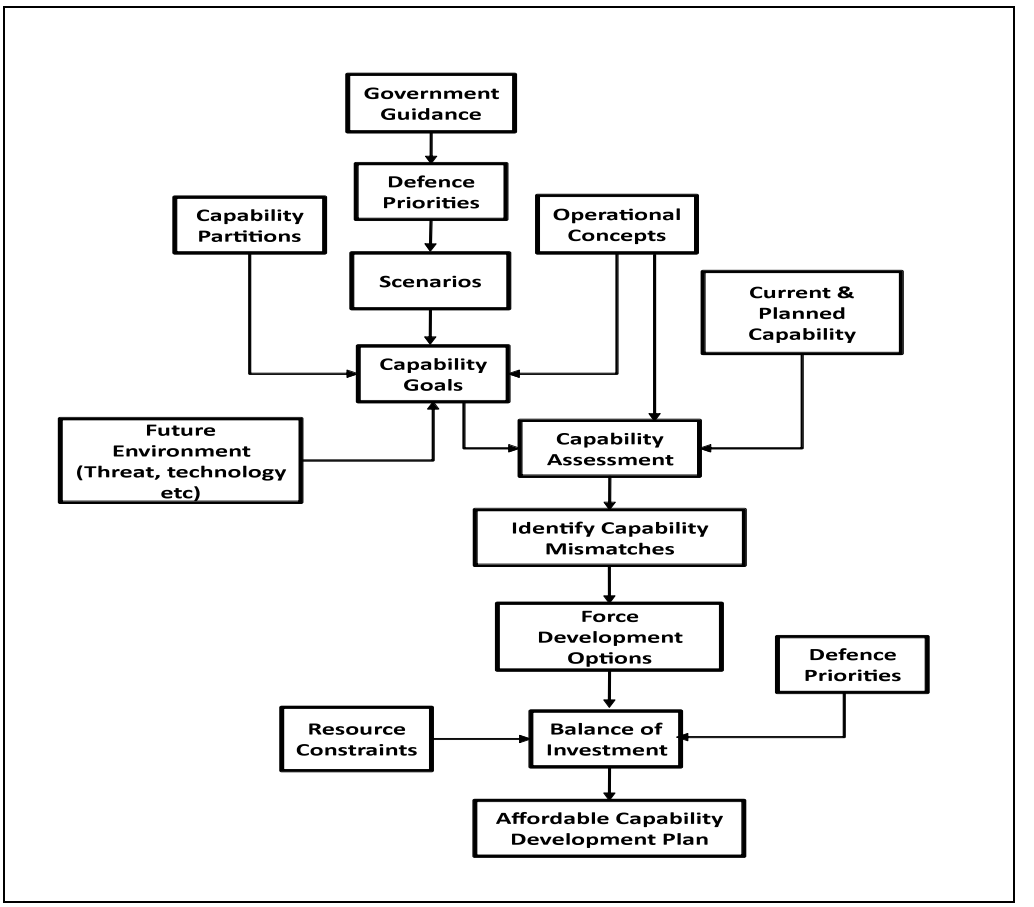

Figure 3. Generic capability based planning process [29].

Capability goals and objectives are derived from government guidance, such as policies and strategies, which are bounded by the government priorities for national planning. Joint operations of the future force will be guided by plausible scenarios based on the capability of the objectives set forth in the task of a specific joint operation missions. Other inputs to capability goals, and objectives, are future environment that influences the future direction of the armed forces capability planning, the future operational concept, that describes how the armed forces is going to operate, in the future planning, and lastly capability partition that divides capabilities into several areas to avoid duplication. The US DoD partitions military capability into nine areas, known as joint capability areas, namely, force support, force application, logistics, command and control, network centric, protection, building partnership, and management and support [30]. The gap analysis between current and the need of a future force are assessed to find capability mismatches. The options of a future force are identified and analysed in terms of operational and cost effectiveness to realise an affordable capability plan.

The strategy of CBP is aimed at providing the most cost effective capabilities to meet a wide range of modern day challenges, offers flexibility through various options to meet capability requirements. Systems life cycle considerations of capability options, capability trade offs as well as risk assessment earlier in the planning (need and requirement) and interoperability and integration of platforms and personnel later in the in-service stage are indispensable. The key elements of CBP as described by Davis [24] are, first, CBP provides a conceptual framework for planning under uncertainty by emphasising flexibility, robustness, and adaptiveness of capability. Second, it is an analytical framework with three components; understanding capability needs, assessing capability options at the level of mission or operation and choosing the capability levels and choosing among capability options in an integrative portfolio framework that considers other factors, for example, force management, different types of risk, and economic limitations. Third, CBP is a solution framework that emphasises "building blocks". Clearly defence planning nowadays, reflects the all-inclusive characteristics as represented by these elements. Since CBP is output-oriented, it also provides the framework for making decisions on future capability.

Comparing between threat based planning and CBP can be confusing, because CBP is also concerned about threats. The difference between both types of planning is rather with dependence on a specific bounding-threats that uses specific and very few point scenarios in threat based planning [24]. An example by Kristensen [31] is given in Figure 4, where the focus of how, both threat based planning (in underlined red) and CBP (in green) differs.

For threat based planning the focus is on intent, for example, Russia (in red) has the most capabilities, but is seen as the least threat, whereby, terrorists (in red) have the least capabilities but are seen as the the greatest threat. For CBP on the other hand, the focus is on capabilities, for example, Russia (in green) has the most capabilities and therefore, the greatest effect, whereby, terrorists (in green) have the least capabilities and therefore the least effect [31].

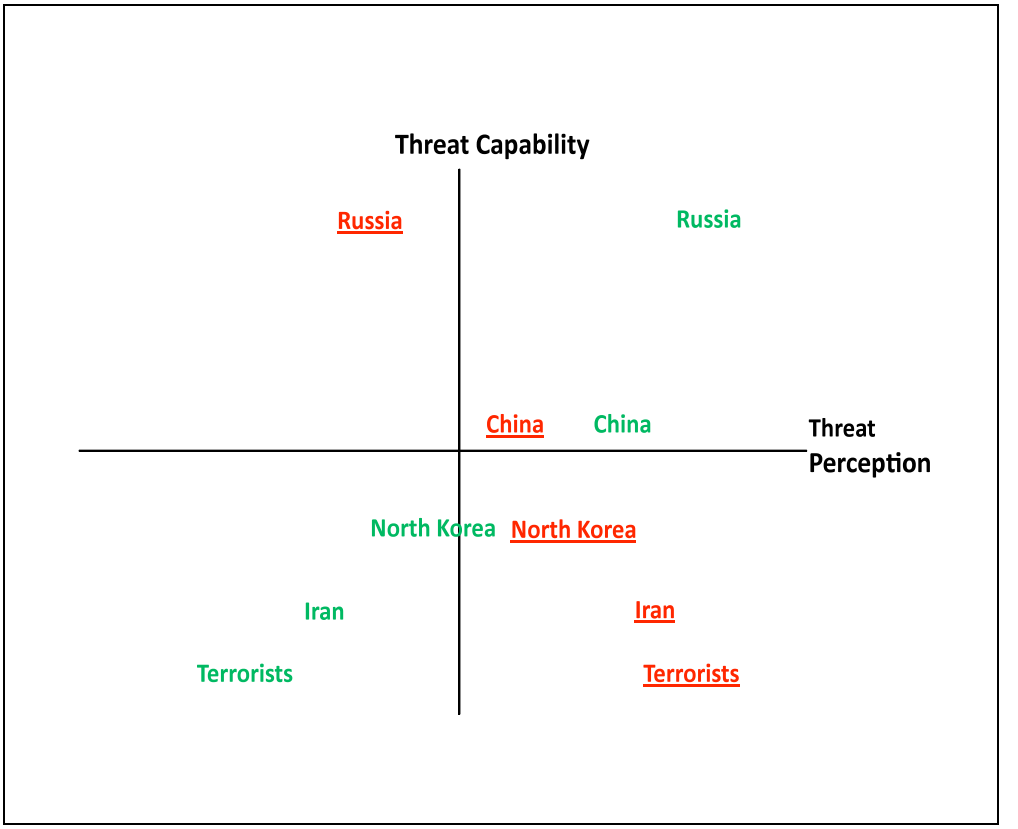

Figure 4. Difference between threat based planning (red) and capability based planning (green) [31].

Today, many countries use CBP to plan, forecast, and continually review and evaluate their planning to ensure it does not only meet current needs but also provides a rational basis in the longer terms. For the US, both concepts are continually evolving since early 1990s to the aftermath of 9/11, and in recent and on-going conflicts. Other countries that followed suit have their versions of understanding in CBP. Nonetheless, they are unique and specific to the meet each government's strategic objectives and offers practicable lessons. While the future remains uncertain, CBP conducted in a joint approach is seen to be relevant for the development of future force for many years to come.

JOINT OPERATIONS

Joint operations are becoming central to military activities. The concept that was developed in the late 1980s by the US represents the degree of which, land, sea and air environments are integrated in their operations, structure and process [22, 32]. The need for joint operations is to leverage individual service capabilities and unique strengths

to reduce requirements for multiple, possibly redundant, military acquisition programs. This effort in turn, seeks to optimise budget resources without compromising overall war fighting capabilities to meet the threats [22]. Joint operations planning requires more than just singular decisions, such as which service's platform to use or which service is to be deployed during contingencies. It needs to remove the stove-pipe or service-centered approach to planning.

For many decades, force structures of armed forces are characterised by single service entities of army, navy and air force. While joint warfare is not new, a doctrinal change or adaptation to meet the increasing roles for joint operations is highly challenging. Organisational and doctrinal changes require twenty to thirty years to take root, mature and evolve into new capabilities [33]. Joint concept developed by the US DoD, which is gaining momentum with, both success stories and failures [2, 34], are currently being implemented by other armed forces such as the Malaysian Armed Forces (MAF). With current progress it may shorten the period of maturity of these changes. Integration and interoperability are the major issues in joint operations. Technological interoperability can be associated with current capabilities of each service not being integrated and interoperable with each other. One of the problems faced by many armed forces is that they cannot communicate with each other, thus impeding command and control function between commanders and the units. While technological interoperability is a major issue, other aspects of interoperability such as culture, organisational structure, procedures and training can significantly influence the effectiveness of interactions between systems, units or forces in joint forces [35]. In addition, there is an issue on interservice rivalry, driven by technological change, competition for defence budget, and both the scarcity and expanding of defence funding [36]. Interservice rivalry, which can also be associated with one or several services, asserts a dominant role based on historical success in combat operation [37].

MILITARY TRANSFORMATION FOR SMALL NATIONS

Military transformation is a paradigm shift that is making waves in the modernisation of armed forces. Transformation is an on-going process that anticipates and creates the future, and deals with the co-evolution of concepts, processes, organisations, and technology [34]. Current military transformation is associated with technology-led RMA [38]. In the past, doctrinal, societal and military industrial complex-RMA has changed the conduct of war [38]. In the advent of information technology, the driving force behind military transformation is due to changes in information superiority, precision weapons and joint operations [38]. The continuing insurgency in the post-Iraq War has demonstrated that the success of technology-driven RMA in the 1991 Gulf War does not easily translate in the notion of military transformation involving a more agile and deployable units. The US experience shows that it is even more difficult to deal with peacekeeping operations and low intensity conflicts (LICs) with over extended capability systems, implying that military transformation is rather evolutionary than revolutionary [39].

There is an important consideration to take on when embarking on military transformation. Small nations need to decide whether the transformational change they wish to engage will bring them to its strategic value given the kinds of security challenges they face, the economic resources they can devote to transformation, and the kind of armed forces they will have post-transformation [38]. Determining the 'right path' for the journey of transformation is as important as the processes. In terms of technology, the notion of experimentation and failure is involved; an inevitable aspect of scientific progress [38] and as such, military transformation is an expensive business for small and medium powers and hence they may not be able to afford 'to get it wrong'. Value for money (VfM) – translated into cost effectiveness for defence equipment is targeted on achieving both economy and efficiency of resource usage [40]. Military transformation is not just about throwing money for acquiring cutting edge technologies, without having a clear view of what transformational changes may involve [38]. Qualitative issues that determine and shape the culture of the organisation are as important as the quantitative processes [41].

METHODOLOGY FOR CAPABILITY PLANNING

In order to be effective, planning requires a distinct kind of forecasting methodology [8]. For clarification of terms, Creswell [42] discusses research methodology, design and methods. A methodology refers to philosophical framework and the fundamental assumptions [43], and because the framework influences the procedures of research, methodology is defined as a framework that relates to the entire process of research [42]. Research design such as survey research, refers to the plan of action that links the philosophical assumptions to specific methods [44]. Methods are techniques of data collection and analysis, such as quantitative standardised instrument or qualitative theme analysis of text data [43, 44]. For Operations Research (OR), these methods are refered to as tools and techniques.

Military planning have evolved over the years with the increasing roles of OR or Management Science techniques in solving complex military problems. OR seeks to formulate complex, real world problems and utilise this understanding to predict system behaviour and improve system performance [45]. Tomlinson and Dyson [46, 47] state that OR has a role which interacts between, both management and analytical processes, and these can lead to effective implementation of F&P. The role of OR analysts in developing analytical models may have impact in F&P that can go as far as determining policies [46]. Tomlinson [48] describes the effective contribution of OR analysts in strategic planning that includes; first improving the process by which decisions are made; second, improving the methods and tools, and their usage during the process; and third, improving the understanding of the participants in the process. Before these can take place, the problems must be first, understood, and modelled, before the suitable tools for the problems are finally identified [46].

A new field of study known as 'system-of-systems' (SoS) is an emerging technique and some thoughts on CPB on SoS is presented. Hodge [48] claims that the answer to capability planning would be to understand systems thinking of the Defence enterprise that is structured to contribute to national power of 'influence' and 'combat power'. 'Influence' is described within the context of national interests with regards to global, regional and national influences with which, the effects of any of these influences vary according to the environment that mediates them and the use of plausible security scenarios to articulate the implications of future influences. 'Combat power' describes national capability that is adaptable to an uncertain future which is highly complex, expensive, time consuming, and may involve risks. Hodge also suggests the use judgment for future capability development that connects with strategies, assumptions and criteria in planning and decision making processes.

Future planning analysis uses the top-down approach in terms of appreciation of security context, the bottom-up approach to consider future warfare concepts, and the judgment assessment on the impact of technologies in shaping the concepts of future warfare [48]. The middle-out approach looks into future military objectives through plausible scenarios within global, regional and national context and future warfare concepts [48]. These approaches are linked through joint workshops and war gaming seminars that are qualitative in nature [48]. The integration between all is done through capability assessment while the whole-of-capability analysis [48] of 'influence' and 'combat power' is linked by capability goals. The decision making process includes prioritisation of capability development activities, adapted from Smith Kline Beecham laboratories [49], that involves generating the alternatives and potential new capability area, valuing the alternatives, creating a portfolio of capabilities and allocating resources and finally the process must be highly interactive between the teams within each defence capability area and between those teams and defence executives.

The proposed approach by Hodge of DSTO, Australia is drawn from the same thinking and practice of Defence Evaluation and Research Agency (DERA) of the United Kingdom. Systems thinking are used by the Australian Defence Forces to support activities such as Joint Forces capability planning and management. The central approach is that of systems thinking. This approach is applied to develop a set of core concepts associated with strategic planning for future capabilities. In particular the idea of a portfolio is introduced as a management tool for future capability planning. The concepts developed are presented as elements within a system of ideas designed for the activities of long term planning for Australia's Joint Force capabilities, and the assessment and day-to-day management of these capabilities [50].

MIXED METHOD RESEARCH

Mixed method research is evolving and gaining prominence for solving complex problems. In a mixed method research, both qualitative and quantitative data are

collected throughout the stages of the study [51]. As a methodology, a method focuses on collecting, analysing, and mixing qualitative and quantitative data in a single study or series of studies [42].

Qualitative analysis is used to explore problems which are difficult to quantify. In its own right, it has no theory or paradigm. Specific approaches and methods for collecting and analysing empirical materials are connected to strategy of inquiry, that comprises the skills, assumptions and practices used by a researcher. Strategies of inquiry such as the case study, ethnography and participant observation, phenomenology, grounded theory are some of the examples. The case study is not a methodological choice but a choice of object to be studied, in which, it is the process or a population of cases is the main interest, and not an individual case. Etnography, relies primarily on participant observation through collection of relatively unstructured empirical materials. Phenomenology approach is concerned with reality-constituting interpretive practices by examining how human beings construct and give meaning to their actions in concrete social situations [52]. Force planning may fall into this category, where CBP is the current interest in the armed forces in capability planning operated in a joint approach.

Because of the importance of qualitative factors, the role of quantitative analysis in decision making process can vary [53]. Combining both qualitative and quantitative methods improves accuracy by removing biasness in the results [3]. The method that originates from 'triangulating' or cross examining in, either one of the method to the other in two or more ways found many applications in social sciences and behaviour research [54]. Triangulation is not aimed merely at validation but at deepening and widening one's understanding. Triangulation establishes credibility that it provides confidence the results obtained are valid [51]. Denzin [55] argues that qualitative research offers an alternative to validation. It also includes diverse information from various inputs and 'corroboration' means that a researcher has a superior evidence of the results [56]. Also, triangulation complements one set of results with another, expands a set of results as well as eliminates missing data, if only qualitative or quantitative approach is used. Capturing qualitative data is very important as forecasting using human judgment is fraught with biasness that may subsequently affect accuracy of the results [3]. While humans have limitations in processing information, they are also adaptive [3]. In this matter, the tendency to modify opinion due to 'bandwagon effect' is high. The bandwagon effect is commonplace in panels of expert technique when one person's viewpoint clouds the opinions of others and plausible alternatives never get proper exposure [8].

OPERATIONS RESEARCH (OR) METHODOLOGY

Quantitative analysis, for example using OR or Management Science techniques, follows a systematic process. It begins with problem identification in which addresses the broad area of the study and draws from it, a specific research problem that requires improvement [57]. The steps are presented in Figure 5 [53].

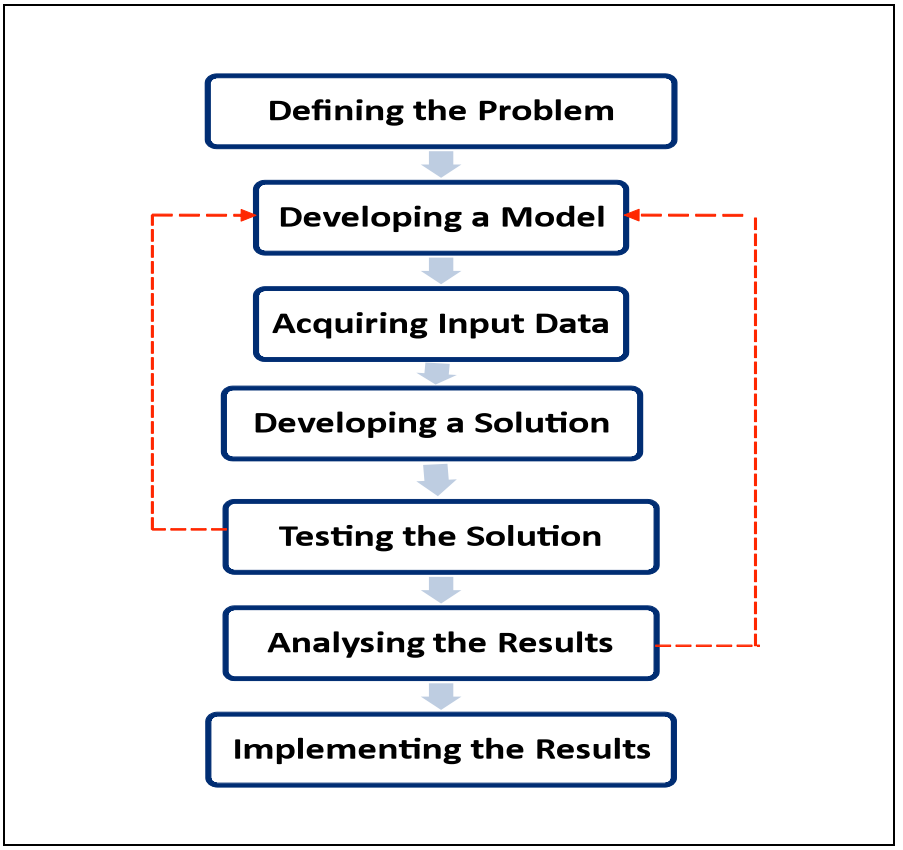

Figure 5. Quantitative analysis approach [53].

Morse and Kimball [58] state that, like any other branch of science, OR studies must use theoretical methods to progress further, to rapidly transform empirical data that it collects into generalised theories which can be manipulated by mathematical methods to obtain other results. He further suggests that theoretical method should begin with a simplified representation to understand them, and be compared with actualities before further complexities can be included in. For OR studies, they are conducted in the approach best suited to their specific problems. Orrel and McSharry [59] suggest complex systems such as defence requires a multidisciplinary approach to problem solving. OR uses quantitative analysis to support managerial decision making [54].

Like force planning, research methodology has evolved from purely extrapolations of historical data to include human inputs termed as 'soft technique' in terms of priorities and values [8]. This has given rise to a mixed method research. The soft and hard approaches combined, will provide a comprehensive representation of people and process intermingled together in quest for the desired future effect or outcome [60]. The discovery that people disagree about what is desirable for the future (together with the truth that stated policies often are not the policies of fact) also points to the need for more sophisticated approaches to defining a range of possible futures [8]. Taylor [6] states that

management judgment, expertise and opinion are the fundamentals in pure qualitative forecasting.

Once the problem is identified, the development of a model takes the form of an accurate representation of the problem, and subsequent course of action in forms of a conceptual framework. The conceptual framework forms the foundation of making a logical sense of the relationship [57] between the variables to realise a positive output, the very reason a research is undertaken. Structural Equation Modelling (SEM) models complex real life problems to establish the relationships between 'web-like' independent and dependent variables. Most common SEM models include Path Analysis or causal modelling, Confirmatory Factor Analysis (CFA) and Structural Regression Models [61]. There is a difference between social sciences approaches and OR approaches in relation to the establishment of research design. Social science approaches emphasis research design for making rational decision making choices [57], in which OR methodology may benefit.

For data collection, an accurate input data to the model is essential to represent the reality for the problem under study. Sources of secondary data from literatures provide theoretical perspectives and previous research findings, while primary data may come from interviews and survey questionnaires. Both, focus group and panels consist of experts, and while, focus group is a one-time group session, the panels usually meet more than once. When collecting data, population and sampling will determine whether the data collected provide the correct answers to the problem. There are two types of sampling, probability and non-probability sampling, in which describes chances of being selected as sample subjects [57]. Finally, data collected is prepared, tested prior to analysis in terms of manipulating the model to arrive at the best optimal solution [54]. For force planning problems, the forecasting tools or techniques (or methods) are extensive. They can be grouped into three basic categories; time series and projections, models and simulations, and qualitative and holistic methods [8]. Mitchell et al. [8], elaborate on the distinction between forecasting and planning, because some techniques do not produce forecasts, although they are very useful in planning, and some others may produce insights for planning, but they are not primarily forecasting methods. Some literatures on the approach, techniques and previous works done are discussed in the next section.

TECHNIQUES AND PREVIOUS WORKS

The are many OR techniques that have been used for developing future force. However, it is useful to look at the level at which the tools or techniques are applied. Within the context of a nation, decisions made at the operational level are made to achieve the strategic goals [62]. For the Malaysian Ministry of Defence (MOD) and the Malaysian Armed Forces (MAF), decisions for future force planning can be considered at the strategic level. Mitchell et al. [8] provide a comprehensive source of information from basic forecasting to those of allied techniques.

OR techniques used to support decision making are evolving. Weir and Thomas [62] state that linear and integer programming are used at the strategic and operational level throughout the military in various studies. This work was originally designed by Dantzig in 1940s in planning large-scale operations, uses tools for determining the impacts of budget changes, force structures, target allocation, amunitions inventories, and combat attrition rates on a nation's war-fighting capabilty. Multi criteria decision making (MCDM), goal programming and multiple objective linear programming (MOLP) are used for large-scale campaign models for various objectives, and the decision variables reflected the combination of platform, weapon and target. Another technique, that is widely used in OR problems is simulation, such as Monte Carlo, discrete events and agent based simulation, in which many of the processes are modelled with mathematical programming. Agent based simulation models autonomous and heterogeneous agents capable of adapting and learning are used to predict future events as well as past processes [62]. There is a phenomenal growth to judgemental forecasting after almost 30 years in terms of attitude of the researchers to the role judgement [13]. The first applications of the Delphi method were in the field of science and technology forecasting. The objective of the method was to combine expert opinions on likelihood and expected development time, of the particular technology, in a single indicator.

Capability planning has also received significant attention. Norazman [63] uses a combination of techniques including Quality Function Deployment (QFD), Analytic Hierarchy Process (AHP), Situational Force Scoring (SFS) and Weapon Scoring or Neural Network Perceptron to develop the conceptual model for force structure before a comprehensive mathematical model is developed. Pinder [64] proposes hybrid, interactive, multiple attribute exploratory (HIMAX) processes to support high-level decisions by integrating military experts' opinions. Evaluation on diverse options is compared across a wide spectrum of missions to produce a mix of capabilities. The HIMAX process uses multiple attribute decision making to determine force effectiveness, system and operational characteristics contribution to each attribute and the importance of system characteristics for each system role. Analysis is performed in two time frames; near and far term. Future force planning is prioritised using Analytic Hierarchy Process (AHP). Nichiporuk [65] uses morphological forecasting technique in the Alternative Futures in the US Army Force Planning. Force size, structure and design are based on six alternative futures for the 2025. Complex, adaptive real world problems such as organisational decision making can be modelled and simulated using agent-based modelling (ABM) [66]. ABM, also known as multi agent system or multi agent simulation uses computational modelling that supports hierarchical planning to simulate decision making entities or known as agents and assesses various behavioural patterns they represent within the system or organisation [66, 67]. ABM may combine elements of neural networks, evolutionary programming and game theory. Tangen [68] develops an agent-based constructive simulation to quantitatively assess doctrine together with materiel approaches. He uses life-cycle cost technique to assess cost effectiveness trade-off on future unmanned aerial vehicle design that produces lower cost compared to the evaluation of candidate technologies.

Baker et al. [69] propose capability engineering that supports rigorous engineering-based analysis of Systems-of-Systems (SoS) configurations. The SoS configurations addresses people, processes, and technologies that constitute military 'capability'. Capability Engineering is the approach used by Canadian Defence Forces that leverages on the US DoD Architecture Framework (DoDAF). The configurations and this planning framework is developed by The Technical Cooperation Program (TTCP) and adopted as framework for Capability Based Planning Process. Pagotto and Walker [70] use capability engineering to describe the high level process methodology viewed as 'system-of-system'. Strategic guidance is mapped using architectural models to articulate requirements of each capability. Metrics are applied to the models to assess their ability to deliver military capability outcomes through pre-defined tasks and force planning scenario. This work uses programming to forecast the composite mix of force structure and capability systems. This technique is implemented in Canadian Defence Forces.

CONCLUSION

Planning today's force to meet future needs is indispensable. Driven by the changing nature of threats, capability planning in the 21st century is characterised as having to seek innovation of future war fighting concepts, strategies and technologies. Military F&P has evolved from the approach used that replaces the traditional threat based planning to implementation of CBP in joint approaches. In the quest for transformational changes, the scale and level of change for small nations is, by and large, constrained by financial budgetary and resources. This requires a balanced approach in the methodologies and techniques to solve future force options. This literature presents previous works on military F&P. While there are several works done on capability F&P, the purpose, level, method and techniques however, vary from one another depending on research problems. Similar to the changing nature of threats, techniques used have also evolved from entirely 'hard' approach such as mathematical programming, modelling and simulation to those that consider rationale behind human decisions. The use of mixed methods is gaining prominence to reduce biases in human judgment and improve accuracy in capability analysis.

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POST-2002 DEVELOPMENT IN THE SOUTH CHINA SEA: SEEKING FOR CONFIDENCE BUILDING & REGIONAL COOPERATION

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ABSTRACT

The most recent development in the South China Sea since 2009 seems to be the driving force for stirring up this troubled water again after its calmness since 2002, when the DOC was signed by China and ASEAN states. This paper analyzes the recent events by looking into the external states' interests in this region and the disputes among the claimant states of the South China Sea. Based on the assumption that final settlement of the South China Sea dispute won't be an easy agenda for a short period, the author proposes a four-dimension model of enhancing confidence building and regional cooperation.

INTRODUCTION

In November 2002, China and the 10 member of Association of Southeast Asian Nations (ASEAN) adopted a Declaration on the Conduct of Parties in the South China Sea (DOC), laying a political foundation for future possible commercial cooperation between China and ASEAN countries as well as the long-term peace and stability in the region [1]. Though the DOC suffers from a number of weaknesses, as many argue, e.g. neither a binding treaty, nor a formal code of conduct, the signing of this document helps to keep the South China Sea (SCS) quiet for a couple of years, at least before 2009.

The year of 2009 has seen several major developments that stirred up controversy in the SCS all over again, and highlighted the difficulties of maintaining stability in the region. In mid-February 2009, the Philippines Congress passed a territorial Sea Baseline Bill, laying claim to Scarborough Shoal (sovereignty claimed by China) and a number of islands in the SCS. China and Vietnam respectively condemned this action. Another event is the clash on 8 March between Chinese vessels and a U.S. ocean surveillance ship "Impeccable" in China's EEZ, which is a similar area to where a Chinese fighter crashed after colliding with a USN intelligence collection aircraft in April 2001. Chinese officials did not deny the details of the incident, but characterized the American surveillance activities as fundamentally improper and arrogant. Chinese denunciations continued after the Pentagon ordered U.S. warships to escort the Impeccable and the other unarmed surveillance ships operating near China which again threatens the fragile US-Sino military relations [2]. The military exercises in the SCS among ASEAN and between U.S. and ASEAN member States in recent years also indicate a new round of tension in the SCS regions.

On 6 May 2009, Malaysia and Vietnam lodged a joint submission with the United Nations Commission on the Limits of the continental Shelf (CLCS) [3]. Vietnam also lodged a separate submission in relations to the northwestern part of the central SCS. These submissions provoked a furious response from China and the Philippines. The day after Malaysia and Vietnam delivered their joint submission to the CLCS, China lodged a strong protest with the UN Secretary-General. It alleged that the joint submission "seriously infringed China's sovereignty, sovereign rights and jurisdiction in the South China Sea" and "seriously requested" the Commission not to consider the submission. Submissions from other SCS littoral states are likely to follow. These extended continental shelf submissions have served to highlight existing disputes and appear likely to add an extra dimension to them. Indeed, there are already indications that the situation is escalating. China has said it will send more patrol ships to the disputed islands. The Philippines has announced it will improve military structures on the islands it claims [4].

In July 2010, US Secretary of State Hillary Clinton made a statement at the 10th ASEAN regional forum (ARF) that the disputes over the highly sensitive South China Sea were a "leading diplomatic priority" and now "pivotal to regional security" [5]. This backdrop certainly contributed to increasing concerns in Beijing, as interpreted by Foreign Minister of China, Yang Jiechi, who voiced his strong opposition to Clinton's declaration. Some scholars argue that Hillary's remarks may be in response to what many US Medias' report on China's recent statement in March when Beijing defined the South China Sea as one of its "core interests" [6], though China never officially confirmed this statement.

This paper aims at analyzing the recent development of the South China Sea issues from two aspects. External states' interests in the South China Sea will be unfolded, especially on the disagreement between US and China on the interpretation of the concept of "freedom of navigation". Disagreement among the claimant states in the SCS will be elaborated as well, adding to the old dispute a new dimension. Based on the assumption that the final settlement of the South China Sea dispute won't be an easy agenda for a short period, the author proposes a four-dimension model of enhancing confidence building and regional cooperation.

EXTERNAL STATES' INTERESTS IN THE SOUTH CHINA SEA

The United States remains not only a global, but also very much as regional player having lots of impact on the SCS. It maintains bases in Hawaii, Japan and the Republic of Korea (ROK), and previously also the Philippines, plus access rights in Thailand (U Tapao), Malaysia (Lumut), Indonesia (Surabaya) and Australia.[7] These are not merely designed for the defence of Hawaii and CONUS (Continental United States), but also for the defence of US allies, i.e. the ANZUS treaty members Australia and New Zealand and countries enjoying bilateral US security guarantees, i.e. Japan and the ROK and,

more ambiguously, Taiwan, to the defense of which the US retains some commitment, as evidenced by its behavior during the 1996 Taiwan Straits crisis [8].

In early June 2009, a Chinese submarine was found to be shadowing a U.S. Navy ship — possibly undetected by sonar equipment being towed behind the American destroyer. The SCS, where the collision occurred and where the U.S. Navy operates amid a complex patchwork of competing territorial claims, is also a familiar backdrop for such incidents. According to a Malaysian military media [9], that the frequent US military exercise in the Southeast Asia encourages its naval vessels become acquainted with the geography and war environment in the SCS, the objective obviously pointing to China. Chinese analysts hold that the U.S. warships' frequent presence in the SCS indicates its changing position from being neutral on the SCS dispute to maintaining the status quo with more claimant states being involved in the dispute.[10] While not every incident gets reported, analysts say evidence suggested they're happening more frequently as Beijing flexes its improved naval capabilities and asserts its objections to U.S. Naval activity in disputed waters [11]. However, the Chinese believe that U.S. military exercises in the Southeast Asia aims at blocking the passages for the Chinese submarines [12].

Japan is either the world's third or fourth largest military spender, depending on the PRC estimate [13]. The revised 1997 US-Japan defence pact [14] envisaged Japan assuming an expanded role in support of US operations in East Asia, seemingly including the Taiwan Strait – a plan to which the PRC did not respond favourably at all [15]. Moreover, under pressure from the United States, Japan has accepted greater responsibility for the defence of its own sea lands of communications (SLOCs), some of which run through waters also claimed as vital by the PRC.

While what Japan is presently doing may well be entirely defensively motivated, it also operates under the auspices of the security dilemma; hence its defensive steps may be regarded by others as threatening. As far as the SCS disputes are concerned, Japan has (fortunately) no territorial aspirations that would place it on a direct collision course with the PRC. On the other hand, it is also dependent on the free passage through the area that it would surely be forced to react to any further 'island grabs' by coastal states which might place its SLOCs in jeopardy [16]. In that eventuality, the stage would be set for a naval arms race between the two regional giants that would not bode very well for regional stability.

India has for some time been building a primitive blue-water capability, including aircraft carriers, and it has exhibited interest in extending its naval reach into the SCS, if only to contest the PRC hegemony. Some analysts view India as aiming for a role as a regional hegemony in the Indian Ocean region [17], an interpretation that is at least compatible with recent arms programmes. These will, in due course, provide India with a true blue-water navy as well as with longer striking range by means of missiles and aircraft [18], In view of its long-standing rivalry with the PRC, India might feel compelled to respond, if only defensively, to its perception of a growing Chinese reaching into the SCS as well as Indochina (especially Myanmar, almost on its own doorstep)

Such defensive steps as a more substantial peacetime presence in the area might, in the fullness of time, make India a significant player in the SCS, as would an expansion of its incipient military collaboration with Vietnam, the future direction of which is difficult to predict.[19] On the other hand, it is also conceivable that India will remain so preoccupied with, both the conflict with Pakistan and its domestic problems that it will (prudently) refrain from such a geopolitical contest with the PRC, remaining content with its recent acquisition of nuclear status.[20]

Russia is no longer a major player in the SCS, its recent attempts at regaining rights at the Cam Ranh base in Vietnam notwithstanding [21]. Because of the simultaneous absence of strong political interests in the region and the requisite military capabilities to exert any influence, it can safely be disregarded [22]. In conformity with its new focus on the 'near abroad', Russia retains an interest in Northeast Asia [23], but both Southeast Asia and the SCS fall beyond its perimeters. While Russia regularly attends ARF meetings, it has exhibited little real interest in the region [24].

Australia is urgently a potential relevant player in the SCS, it is only because of its historical ties and remaining geopolitical links to Southeast Asia [25]. However, while Canberra is thus very much politically involved (albeit on the sidelines), e.g. in both the ARF and Asia-Pacific Economic Cooperation (APEC) as well as with unilateral initiatives, there are no indications that it will come to play any military role in the foreseeable future.

Among all these external states that have interest in the South China Sea, US seems to be always ahead in the front, which is why it is always not welcome by some coastal states, e.g. China. Of course tensions between US and China are about more than the naval drills in this region jointly conducted by US and other coastal states. China has also argued against US access to its Exclusive Economic Zone (EEZ) in the South China Sea, while the United States for its part has refused to accept China's interpretation of the UN Convention on the Law of the Sea (UNCLOS). Though China, in many occasions, states that the dispute in the South China Sea does not affect the security of navigation in this region, US seems to still use the "freedom of navigation" as a ground for its engagement in the SCS issues.

The US cares about freedom of navigation in the region and apparently believes that sooner or later China will too. But there's some heavy historical baggage to bear on this issue. China feels uncomfortable with a dominant US Navy in its backyard, especially in the context of Taiwan—it is, after all, the US that has threatened mainland China's free access to the waters around Taiwan. China, in contrast, has never taken action to deny others access to the entire South China Sea, in particular in areas beyond its EEZ.

Beijing also has accused the United States of "internationalizing" the SCS. Such a policy could undermine its longstanding policy of engaging the claimant states on a bilateral basis. As argued by Beijing, on a wide geo-political front, China's policy of regional engagement has produced good dividends until the recent US gunboat

policy [26]. China views as provocations the deployment of aircraft carrier the USS George Washington to the region, the US-Vietnam Naval exercise in the SCS as well as discussion on nuclear-cooperation with Vietnam. The recent statement of US State Secretary Hilary Clinton at ARF raises a lot of concern in China as well.

DISPUTES AMONG CLAIMANT STATES

The disputes between the seven parties involved in the SCS dispute, China, Taiwan, Vietnam, the Philippines, Malaysia, Indonesia and Brunei, rest on the competition of sovereignty over the features in the SCS and the overlapping maritime claims over the jurisdiction in the region, such as EEZ and continental shelf.

As with many powers before it, China's growing maritime interests could overlap and even conflict with others. Yet it would be more precise to say that it's often others' claims that have overlapped with earlier Chinese claims. For example, in 1947, the Chinese government raised a claim over the South China Sea, a claim not made by some ASEAN states until as late as the 1970s or even 1980s.

The main point of contention is not whether China will discuss the SCS disputes with neighboring countries; it is whether discussions will be held in either a bilateral or multilateral forum. China has historically approached the problem using a bilateral approach to an international issue, while other countries involved are approaching the issue with a multilateral approach. Obviously, China will stick to bilateral approach in addressing the disputes with regard to sovereignty and maritime jurisdiction claims. In other aspects of the SCS issues, especially on many non-traditional security issues, such as piracy, marine environment protection, China is already open to multilateral approach. It joined the Indonesia Workshops on Managing Potential Conflicts in the SCS, the ASEAN-China Dialogue, and the ARF. The signing of the Memorandum of Understanding between ASEAN and China on Cooperation in the Field of Non-Traditional Security Issues at the 1st AMMTC+3 provides concrete and operational measures on cooperation in the field of non-traditional security issues between ASEAN and China.

The disagreement between China and disputant states has a new dimension considering the new development since 2009. Beckman argues that the claimant states appear to be taking steps to make their claims in the SCS consistent with UNCLOS is a very positive development [27]. However, fundamental differences remain. The continental shelf submissions have not resolved the underlying disputes on sovereignty over the islands. In addition, disputes are likely to arise on the issues of whether any of the islands are entitled to an EEZ and continental shelf of their own. There are also potential disputes on how to reconcile the overlapping maritime zones measured from the islands with those measured from the mainland.

CONFIDENCE BUILDING AND REGIONAL COOPERATION

The settlement of the territorial disputes and overlapping maritime claims in the SCS will not be an easy agenda, at least not for the short term. What is more important is to enhance confidence building among the claimant states and step forward for regional cooperation.

Environmental Security as a Driving Force of Cooperation in SCS

The SCS produces fish, sea grass and other living and non-living resources for one of the most populous regions in the world. In the Southeast Asian region alone more than 70% of the population live in coastal areas, and their dependency on the sea for resources and a means of transportation are high. Fisheries in the Southeast Asian region represented 23 % of the total catch in Asia, and about 10% of the total world catch in 1992. At the same time, high economic growth is overshadowing environmental problems like overfishing, destructive fishing methods, habitat devastation and marine pollution. The environmental security aspect is therefore pertinent in the SCS.

In general, marine environment problem is not at the top of the agenda of most SCS countries. Based on securitization theory of Copenhagen School, environmental problem should be now securitized if we wish to put it at the top of the agenda among the SCS countries and address it in an effective manner. If serious environmental problems were defined by the political actors as security matters, then they would most certainly be put higher up on the agenda. Then environmental security issues can be used as a driving force of cooperation in SCS. This driving force could be strengthened, as the link between the oceans and climate change is receiving greater international attention. At the opening of World Ocean Conference (WOC) in May 2009, the Inter-governmental Panel on Climate Change (IPCC) and other scientific sources have highlighted ocean changes associated with climates confronting small island and coastal communities, such as ocean warming, sea level rise, and changes to ocean circulations [28]. The gradual awareness of the critical link between marine environment and climate change, thus highlights the importance of securitizing marine environment in the SCS.

How can security considerations function as driving forces for regional cooperation? One very important aspect related to this is that driving forces cannot function as such without being perceived by the political actors as high politics. Hence the concept must be related to the general perceptions of the politicians. The actors must recognize and perceive the link between their high politics concern and marine environment security in the SCS. To a large degree, one may say that security questions have been a driving force for continued regional integration in Southeast Asia [29]. In the future, questions of environmental security may be playing the same role. The states around the SCS are to a large degree interdependent when it comes to questions of the marine environment. They are interdependent to the degree that if they fail to find common solutions to environmental problems they may end up in violent conflict against each other.

The dependency on the sea for its resources, as means of transportation and foreign exchange earnings, from fishing and tourism etc., and the fact that the states around the SCS are heavily interdependent in relation to the use of the resources, should imply that international cooperation is the only sensible alternative policy in the future. However, knowing that today, there is a perceived contradiction between environmental considerations and international cooperation on the one hand, and the emphasis on vital state interests and national sovereignty on the other, what does it take to make the political actors feel forced to cooperate? The concept of 'environmental security' may be part of the answer.

According to this concept there is no contradiction between international environmental regimes and vital national interests. Rather, international cooperation on environmental resources is the only way to secure vital national resources for the future. Dealing with environmental problems will normally require some pooling of state sovereignty on behalf of common ecological security. The linkage between political/ military security, and environmental security arises from the fact that we are living in an interdependent world. In our days, the destinies of nations are becoming intertwined in ever more complex ways. Sensitivity and vulnerability are two key concepts related to the phenomenon of interdependence. In general, the sensitivity and vulnerability of states in an interdependent world creates a need for policy coordination to reduce the effects of vulnerability and regain control. So far, this has been of importance primarily in relation to political/military security. However, the conceptualization is equally valuable, where environmental security is concerned. A trans-border ecosystem out of control, creates the need to create between states, so as to reduce further vulnerability and regain control [30].

On environmental security matters, states never have been, nor will they ever become fully sovereign. This is particularly evident when it comes to international policy on pollution. Trans-boundary pollution of waterways raises the question of whether polluting activities within the boundaries of one state should remain the exclusive jurisdiction of its government. Alternatively, is the sovereignty of a state compromised when its environment is degraded by pollutants emanating from neighbouring countries [31]? These are among the points that need to be emphasized by the scientific experts when asked for advice by the policy-makers in the SCS region. It all points in the direction of the need for further international cooperation [32].

Now let's turn to the main question—whether common marine environmental problems could be a driving force for further cooperation in the SCS, within ASEAN and between ASEAN, China and Taiwan. The recognition of strong environmental interdependence is one of the strongest driving forces for regional cooperation and integration today. We know that in organizations like ASEAN, and between ASEAN and China, pragmatic interests are not sufficient for the cooperation process to move forward. A driving force is needed. It is possible that, if defined as security matters, grave regional marine environmental problems could be the necessary driving force for the SCS cooperation in the future. For the political leaders of the SCS States to perceive

environmental problems as security matters, they must learn that they are. Teaching the political actors about the relationship between environment and security in the SCS region may therefore be an important task for the epistemic communities of concerned scientists in the region.

Fisheries Cooperation as a Start of SCS Disputes Resolution

As Kuen-chen FU puts it, conservation and management of the SCS fishery resources is a complicated issue, which is not possible for a single State among the SCS countries to resolve alone.[33] A joint effort is thus essential, particularly in consideration that the state of the SCS fisheries gets worsened, but the demand for fisheries has escalated. He suggests that there is an urgent need of a more effective regional cooperation scheme for fishery resources conservation and management. Wang argues that fishery cooperation could be the most feasible course of action for the littoral states since, through cooperation, fishery resources could be properly conserved and managed such that economic waste and over-exploitation may be avoided [34]. Without affecting jurisdictional boundaries as laid down in the UNCLOS, it is certainly possible to have regional joint fishery management in the SCS as the starting point for further cooperation. If all states in this region treat cooperation as a key step towards achieving mutual benefit, then the future for such a regional cooperation mechanism is assured.

It is obvious that some fishery resources of the SCS are still under-exploited, most are heavily exploited. Therefore, fisheries development should be accompanied by a rational resource management mechanism. To date, however, no single resource management method has emerged that would work efficiently in the whole area. Even within the zones of each littoral state's jurisdiction, rational resource management mechanisms are not apparent. One of the reasons for this is the problem of overlapping claims among the littoral states. The other reason is that none of the littoral states has sufficient stock assessment data available to support a rational resource management mechanism [35].

Wang suggests that, in view of the situation with respect to living resources in the SCS, cooperation towards management and conservation of fishery resources should start with defining and minimizing disputed areas [36]; then a joint committee could be established to manage the fishing-related issues [37]. In the meantime, definition and determination of fish stocks and allowable catch of living resources in the region should proceed.

In the SCS region, it is not difficult to locate opportunities for cooperation. Military cooperation, joint development on hydrocarbon resources, marine scientific research, marine environmental protection and fisheries cooperation are all options. To date, however, disputes surrounding possible hydrocarbon resources in the area and actions in favour of conservation and management of fishery resources have been delayed. Nevertheless, conservation and management of fishery resources could be the starting point for cooperation in this area and could have a 'spillover effect' on other areas of cooperation. Accordingly, the next step depends on littoral states' political will and determination to pursue cooperation in this matter.

In this respect, cooperating to manage and conserve fisheries resources is especially significant because fish are migratory, and often highly migratory. Moreover, overfishing is a serious and pressing problem in the region. In this regard, a maritime boundary cannot entirely protect a state's fishery resources from encroachment, because fishery resources can migrate beyond the state's territorial or fishing zones, and overfishing beyond its borders can also affect the fish stocks within its territorial boundaries. Therefore, a proper management mechanism, subject to natural conditions, is necessary for the coastal states to keep stocks at sustainable levels. This is especially important for the littoral states around the SCS. Because this region is a semi-enclosed sea, any change in the fishery policy-making could have far-reaching effects on the fishery resources in this area.

UNCLOS as a Framework for Ocean Governance in the SCS

UNCLOS provides an integrated legal framework on which to build sound and effective regulations to the different uses of the ocean [38]. It does not specify in detail when and how fishermen can harvest living resources in the EEZs of coastal States or what the terms of leases for deep seabed mining will be. What it does do, however, is to create (sometimes contentious) procedures for arriving at collective decisions about such matters. It is the principal legal instrument that provides the framework for the public order of the oceans and seas [39].

A regional system of ocean governance — which presupposes some concept of shared, rather than self-centered, sovereign authority, in this sense, would mean not only more intensive and transparent consultations among ASEAN members and China on a full range of ocean issues, but also a more ready willingness on their part to accept and institutionalize a strategic notion of regional security based on a comprehensive system of ocean security. By 'regional ocean governance' is simply meant that the comprehensive process of sustainable development of and for the oceans at the regional level. Its underlying premise reiterates the core principle of UNCLOS that "the problems of ocean space in a region are closely interrelated and need to be considered as a whole" [40]. Like ocean governance at the global level, regional ocean governance has two prerequisites: sustainable development norms and sustainable development institutions. While in the SCS there is no an overall policy on ocean governance *per se*, it could be said that the building blocks for this policy are already in place. A consideration of the normative framework for ocean sustainable development in the region would show that the regime of comprehensive security envisioned by UNLCOS process can find support in the ocean management regimes of ASEAN and China — enhancing, directly or indirectly, the substantive framework of sustainable development and/or comprehensive security embodies in UNCLOS. The elements of a regional regime of ocean governance consist of the several distinct strands of ocean management norms and standards which have become integral to the international law of ASEAN and China. Mention may be made, firstly, of DOC, which may be considered as setting forth the broad framework of regional cooperation which could very well be extended to the oceans, or applied in the context of expanded and integrated ASEAN+1 programme on marine affairs [41]. The

norms and standards elaborated under these agreements specify the concrete aims and the various forms of regional cooperation, as well as the norms and conflict-avoidance and peaceful settlement of disputes.

As Desilva points out, the first step to ocean governance is to draw up a Framework Agreement which will contain elements of the general principles and policies, of the special programmes and sub-regional and bi-lateral agreements [42]. It should be functional and effective in resolving environmental problems and fostering strong regional cooperation and coordination of appropriate cost effective actions. The framework instrument must include, among others: a) The use of sound science incorporated into policy making processes to foster ecological and economic soundness; b) Laws, policies and actions that are effective in terms of ecological improvements. Ecological ineffectiveness also results in waste of scarce financial resources. Ecologically effective actions must be based on sound science and not on perceptions or political considerations; c) Cost effective actions; d) Economic valuation of environmental goods and services as a tool for sound development planning; e) Decision-making after gathering all relevant knowledge/ information for the purpose. This improves the effectiveness of decisions and it also improves cooperation; f) Promoting and building a base on consensual knowledge. This is particularly true where progress on regional cooperation is stalled or slowed due to complexities or uncertainty surrounding the issue; g) Good communication both vertical and horizontal for effective cooperation; h) Periodic assessment and review and revision of actions as required, ensuring that they are effective. Where assessments indicate problems, they need to be revised; and i) Flexible approach that allows for the inclusion of new information [43].

DOC may be cited as such a Framework Agreement on ocean management in the region. The consistency with which it has been invoked in ASEAN and China does make it an authoritative basis for conflict avoidance and cooperation in the region: in addition to its call for restraint and a peaceful resolution of the overlapping territorial claims, the declaration invites all parties involved "to explore the possibility of cooperation in the SCS relating to the safety of maritime navigation and communication, protection against pollution of the marine environment, coordination of search and rescue operations, efforts towards combating piracy and armed robbery, as well as collaboration in the campaign against illicit trafficking in drugs" [44].

TRANSFORMATION OF WAYS OF THINKING AS A FOUNDATION TO LEAD POLICY AND RESEARCH DIRECTION

Patriotism and nationalism play a critical role in the SCS dispute development. The disputant states in the SCS are more or less indulged in national pride or nationalism sentiment. There are major 'stumbling blocks' that inhibit progress with functional cooperation and joint development in the SCS. Michael notes most of these, especially the strong element of nationalism that pervades the disputes [45]. Nationalism can become a strong 'stumbling block' to the resolution of disputes, and even functional

cooperation. Public expressions of nationalism destroy political will and militate against cooperation and Geoffrey Till has observed previously that "claims to the sovereignty of islands can be important symbolically, perhaps especially in times of national difficulty" [46]. The unrest in the Philippines over the Joint Maritime Seismic Undertaking (JMSU), because it appeared to weaken Philippine sovereignty claims, is a clear manifestation of nationalism at work [47]. The popular demonstrations of support in the Philippines for the Baselines Bill are another example [48].

Those who interpret China's claims in the SCS as a threat to the regional stability and the potential to use her increased military power to achieve her objectives in open conflict with its neighbours should read Chinese nationalism sentiment carefully before jumping to the conclusion. National humiliation [49] is a common and recurring theme in Chinese public culture. The discourse takes many forms: public histories, textbooks, museums, mass movements, romance novels, popular songs, prose poems, feature films, national holidays, and atlases. All these are part of a modernist narrative in its most basic sense of a linear progressive history that prescribes the unity and homogeneity of the nation-state. In the PRC, national-humiliation discourse is produced in the last refuge of one of the major institutions of modernity the Chinese Communist Party; but it is important to note that its Central propaganda Department is now concerned with promoting nationalist history. National humiliation seems to be a purely domestic discourse, but its notions of 'the rightful place of China on the world stage' continually inform Chinese foreign policy in both elite and popular discussions. Though national humiliation is considered in Western discussions of Chinese victimization that needs to be overcome for China to be a responsible member of international society, Chinese sources, on the other hand, stress how the outside world, particularly the prosperous West, needs to understand China's particular suffering.

Transformation of ways of thinking theory can be applied in pushing for positive utilization of China's nationalism in the SCS. In order to avoid triggering Chinese nationalism sentiment which might lead to the escalation of the SCS dispute and, Chinese government should carefully direct the trend of its nationalism movement, trying to lead to the affirmative nationalism, rather than aggressive nationalism. On the other hand, other disputant states in the SCS should also change their way of thinking — understand positively China's nationalism movement, and express sympathy for China's bitter history of "century humiliation" [50], since most SCS states had gone through similar experience of being invaded or colonized. Outsiders, such as U.S., should also play an objective role in the SCS dispute, rather than propagandising the 'China threat theory'.

China is not the only country whose foreign policy is affected by nationalism sentiment. Vietnam and China have much in common. They share a Sinitic cultural background, communist parties that came to power in rural revolutions, and current commitments (China since 1978, Vietnam since 1986) to market-based economic reforms [51]. Vietnamese, in their entire schooling, have been taught that Hoàng Sa (Paracel Islands), and Trường Sa (Spratly Islands) belong to Quảng Ngãi District. There are two famous museums in Vietnam, one of which is War Moemorial Museum to memorize the Vietnamese War, the other is titled as "Hoàng Sa and Trường Sa: Vietnames Islands". This

museum obviously intends to enhance the 'national land awareness' among Vietnamese, especially the younger generation. Incidents in the SCS do not now lead to the public confrontations that occurred even in the 1990s, but they are watched closely as signs of possible encroachment. More seriously, moves by China in 2007 to enforce its claim to sole sovereignty of the Paracel and Spratly Islands led to rare public demonstrations in Hanoi and Ho Chi Minh City [52]. Similarly China's development of a submarine base in Hainan stirred Hanoi to contract in April 2009 for six Russian submarines at an estimated cost of $1.8 billion [53]. These tensions in the relationship are magnified in the international media and by anti-regime activists among the overseas Vietnamese, but they do express a common uneasiness about vulnerability to China and a suspicion about China's motives.

'Transformation of ways of thinking theory' should be introduced to the policy makers and scholars on the SCS as a foundation to lead their policy and research direction. Diplomatic communities and academics need to change their tunes and reinterpret the situation at hand. Presently, there is not much research pending on the SCS disputes. The vast majority of material published either has as its purpose of glorifying (or vilifying) ASEAN efforts to manage the conflict or arguing whether China constitutes a threat to the rest of Southeast Asia. It might also help if those involved were able to turn out a few more realistic options for settlement [54].

On the policy line, the disputant states should step up their efforts to resolve their maritime border conflicts. In the past few years the two have signed the long-awaited DOC and China has largely settled its boundary disputes with Vietnam in the Gulf of Tonkin. The relative economic and political stability of the region presents a window of opportunity for renewed attempts at a final solution. This need not and should not indicate the sort of ultimatum negotiations that would drive China and others away from the bargaining table. The solution to this impasse is to transcend and include these malformed interpretations into a more integral model which takes account of the historical record and connections made by dispassionate common sense, just as much as it extracts the truths from within and without the prevailing theories. At the same time, claimants need to be motivated to move forward with negotiations, both by the production of resolution options springing from new conflict interpretations and by the launching of high-level, informal. In this manner the negotiations for the SCS disputes can progress at the pace of "bilateral or trilateral when necessary" way while still keeping an eye to the long term goal of complete conflict resolution.

In terms of research, academics and diplomats should step back and reinterpret the conflict at hand. Re-examine the SCS conflict, its origins and evolution, the roles of military confrontations and ASEAN multilateralism in that evolution, and behaviors and rhetoric of the countries involved. Most importantly, get the context straight on all levels [55]. By stepping away from the conflict with the freedom to sculpt opinions, new connections can be discovered and one can get a better glimpse of the big picture. In many ways, the misinterpretations inherent in today's prevailing theories are the very reasons for a lack of proposed solutions [56]. Therefore, it is necessary to exploit these new interpretations for all they are worth to see if any windows for resolution can be

found. When they are found, publish detailed plans of how to get there. Once a number of solutions become available, the disputants will break from their romance with the status quo. As that begins to happen, the prospects for resolution will finally come into view.

CONCLUSION

The most recent development in the SCS since 2009, including the submission to CLCS, US's gradual engagement in the SCS issues, seems to be the driving force for stirring up this trouble water again after its calmness since 2002 when the DOC was signed by China and ASEAN states. This paper analyzes the recent events by looking into the external states' interests in this region, especially the disagreement between the United States and China on "freedom of navigation" and the "internationalisation of" the SCS issues. The dispute among the claimant states of the SCS is also explored, adding to the old disputes a new dimension. The question is raised on whether these new development in the SCS helps clarity the claims or it make the situation even worse, and whether it is a progress or a set-back to regional cooperation in the SCS. Based on the assumption that final settlement of the SCS dispute won't be an easy agenda for a short period, the author proposes a four-dimension model of enhancing confidence building and regional cooperation: 1) Environmental Security as a Driving Force of Cooperation in SCS; 2) Fisheries Cooperation as a Start of SCS Disputes Resolution; 3) UNCLOS as a Framework for Ocean Governance in the SCS; 4) Transformation of Ways of Thinking as a Foundation to Lead Policy and Research Direction for the purpose of peaceful settlement of the SCS dispute.

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FOSTERING SECURITY COOPERATION IN OVERLAPPING MARITIME AREAS

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ABSTRACT

This paper provides three examples of overlapping maritime claims in the Timor and Arafura Seas, and Torres Strait. The first example is provided by the colonisation of Papua New Guinea by Germany in 1884 and its decolonisation by Australia in 1975. The overlapping claims in Torres Strait by Australia and Papua New Guinea produced three maritime boundaries and a joint defined protected zone. The second example deals with the emergence of Timor L'Est after control by first Portugal and then Indonesia. Timor L'Est became independent as a result of a referendum conducted by the United Nations on 20 October 1999. Supported by the United Nations, Timor L'Est achieved independence and, on 2 April 2003, the Timor Treaty, with Australia, entered into force. Since then a Joint Petroleum Development Area has been established. The third example concerns Timor L'Est and Indonesia. The two countries share the island called Timor. The smaller western part belongs to Indonesia, while Timor L'Est controls the larger eastern part of the linear island and a small rectangular territory, called Ocussi, on the north coast of the Indonesian part of the island. Timor L'Est complains that Indonesia's archipelagic baselines interfere with traffic to and from Ocussi. It also insists that Timor L'Est should be able to claim a triangle of sea north of its Pulau Atauro, between the Indonesian islands called Pulau Wetar and Pulau Alor. The problem faced by Timor L'Est is that Indonesia's archipelagic baselines are legitimate and have been recently approved by the United Nations. Furthermore, Indonesia has made it clear that it does not interfere with innocent passage by vessels of another country

DELIMITATION OF MARITIME BOUNDARIES IN TORRES STRAIT

In 1884, Australia and Germany divided the eastern mainland of Papua New Guinea, leaving the western sector to the Dutch. Britain and Germany divided eastern Papua New Guinea into northern and southern sectors. In addition, the German sector secured the Marquesas, Marshall, Caroline, Gilbert and Ellice Islands to the northwest.

Attention can now be turned to Australia's claims to islands lying north of Cape York. In 1868, the Governor of New South Wales was authorised to control islands lying as far north as latitude 10° South. Then, in 1872, the Governor was authorised to deal with all islands within 60 nm of Cape York, which included Badu Island. On 10 October 1879, it was proclaimed that islands between Cape York and the south coast of

Papua New Guinea belonged to Queensland and therefore to Australia. Figure 1 shows suggested boundary revisions in the 1890s.

In 1914, Australian troops invaded and captured German New Guinea and maintained the valuable palm plantations in operation. After the end of the war in 1918, the staple export commercial crop was copra. In 1932, a nominated Legislative Council was established. Then, in 1926, miners found gold and this transformed the economy. In addition, in 1926, Australian graziers occupied extensive fertile grass pastures. In most cases, education for the local inhabitants was provided by church missions. In World War II, Papua New Guinea was invaded by Japanese forces, but they were prevented from reaching the southern coast of New Guinea. Eventually, the Japanese were driven out of New Guinea and a civilian administration was fully established by 1946.

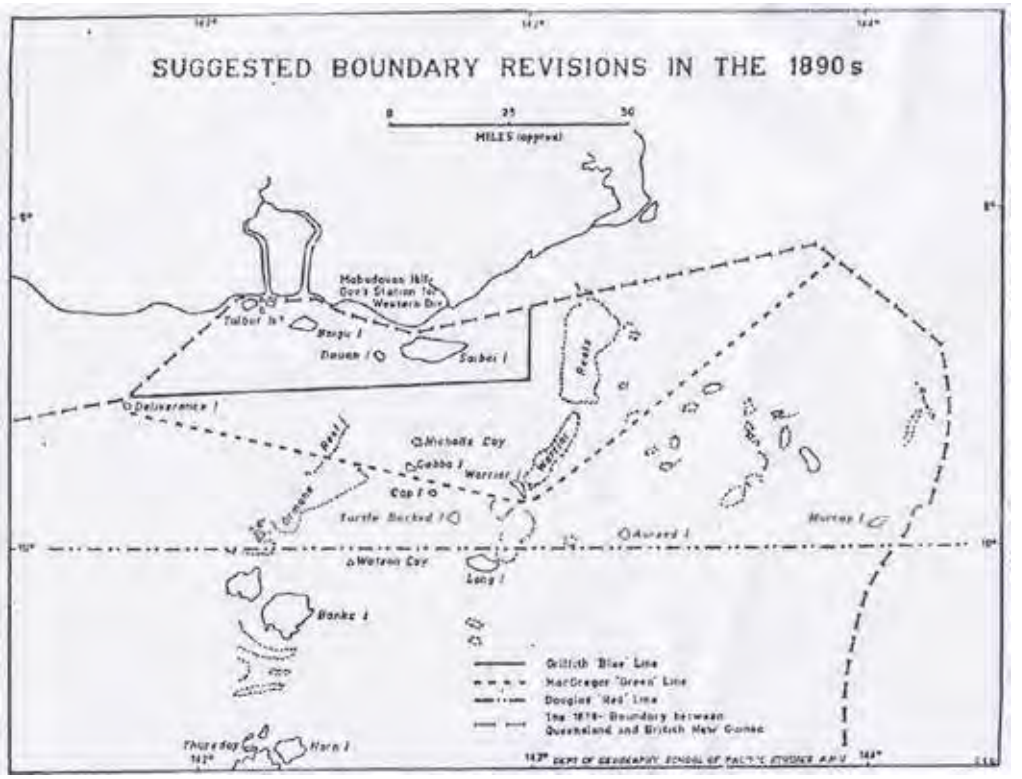


Figure 1: Suggested Papua New Guinea boundary revisions in the 1890s. (Reproduced with permission from [1]).

In 1960, the Australian government began to plan for the future independence of Papua New Guinea [2]. Then, in 1972, the Whitlam Labor government established self-government for Papua New Guinea. Independence for Papua New Guinea became reality on 16 September 1975. That government faced problems caused by shortage of trained personnel. Some secessionist movements started, but none were successful.

Australian authorities made a number of attempts to define a maritime boundary in Torres Strait, that marked the northern limit of Queensland territory, but none were successful. On 18 December 1978, a maritime boundary treaty was reached by the Australian and Papua New Guinean authorities. It dealt with boundaries delimiting four marine zones; territorial sea, seabed, fisheries and a protected zone for Torres Strait Islanders. Figure 2 shows the seabed jurisdiction line, the maritime boundary, the equidistant line and the fisheries jurisdiction line. This treaty consists of 32 Articles and 9 Annexes which governed sovereignty over offshore islands, protection of the marine environment, management and conservation of living resources, protection of flora and fauna, freedom of passage and overflight, and jurisdiction over the wrecks of vessels and aircrafts on the sea floor. The treaty was negotiated after six years and another six years were required to achieve ratification on 15 February 1985. Figure 3 shows the seabed resources delimitation line, the swimming fisheries resources delimitation line, the limit of the Protected Zone and the limits of the Australian territorial sea north of the seabed line.

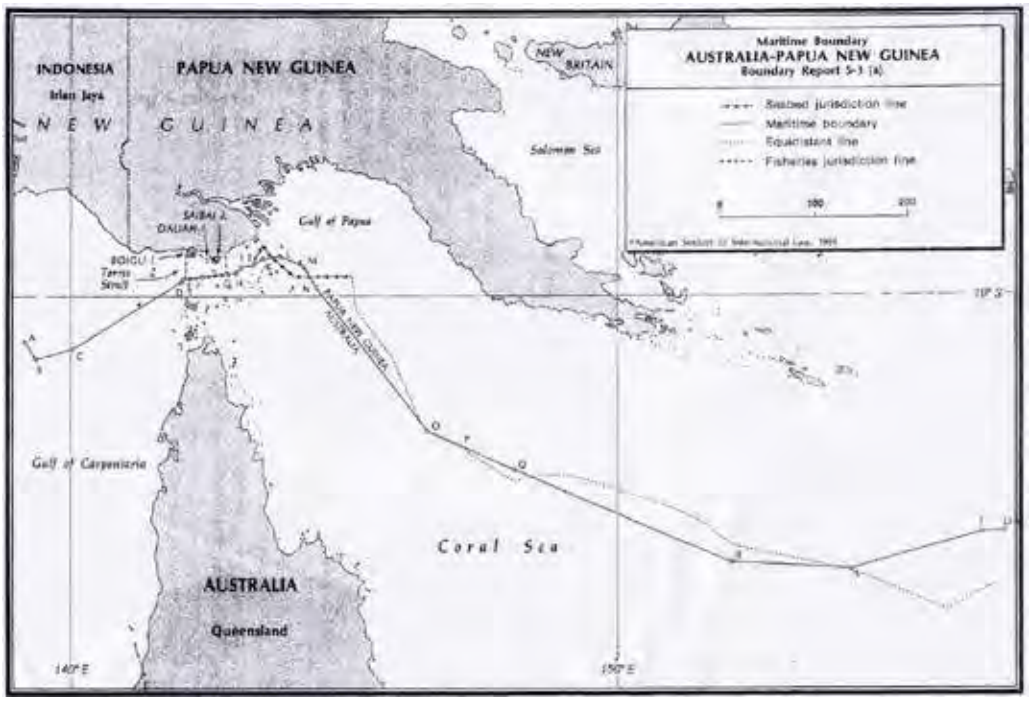


Figure 2: Seabed jurisdiction line, the maritime boundary, the equidistant line and the fisheries jurisdiction line determined by the maritime boundary treaty reached by the Australian and Papua New Guinean authorities on 18 December 1978.

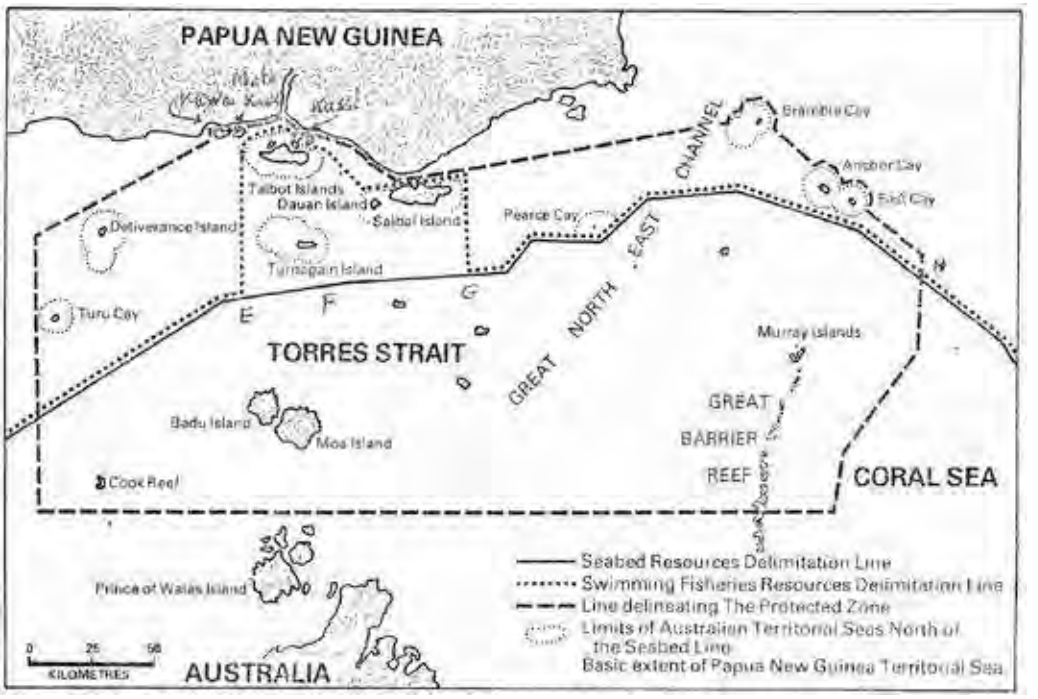


Figure 3: The seabed resources delimitation line, the swimming fisheries resources delimitation line, the limit of the Protected Zone and the limits of the Australian territorial sea north of the seabed line determined by the maritime boundary treaty ratified by the Australian and Papua New Guinean authorities on15 February 1985. (Reproduced from [3])

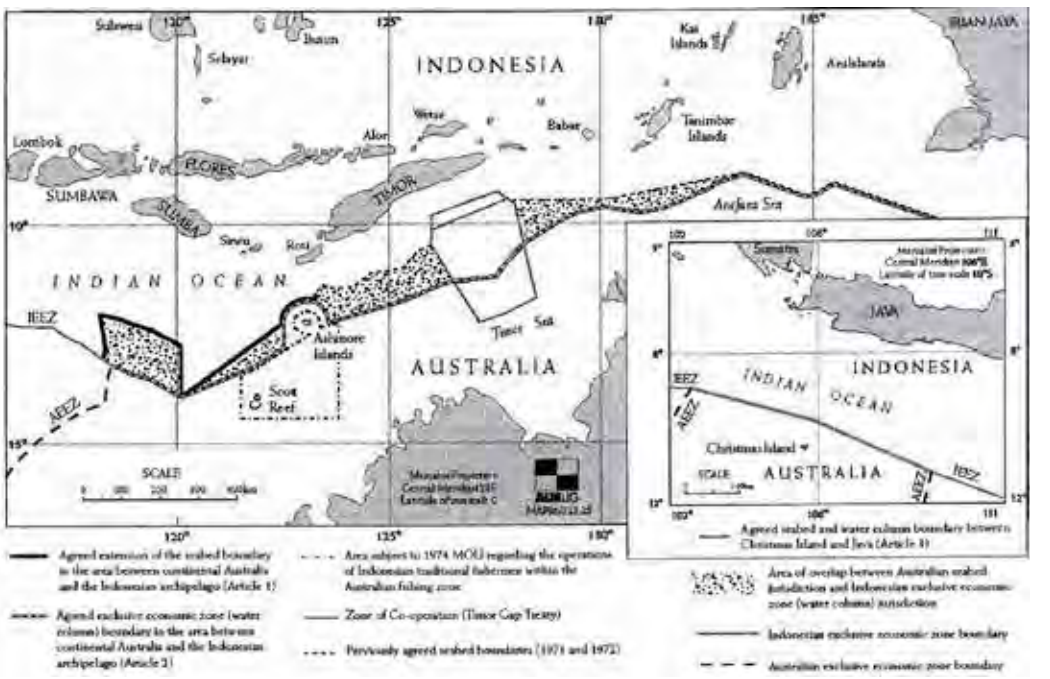
In the course of negotiating this treaty it was discovered that Australia had never owned the three most northerly islands in Torres Strait. The islets were and are called Kawa, Mata Kawa and Kussa. When negotiations occurred between the two countries, the author enquired of a senior Australian official whether Australia was going to relinquish its previous claims and administration, and especially the three northern islets, and was assured this was not possible. In fact, when the negotiations were completed, the three islets had been delivered to Papua New Guinea. On balance, the author cannot criticise the deception because it was both sensible and generous. The agreement delimited four boundaries related to seabed jurisdiction, fisheries jurisdiction, a combination of seabed and fisheries jurisdiction, and a protected zone enclosure [4].

There are four maritime agreements between Australia and Papua New Guinea. First, there is a maritime boundary extending from Point A in the west to Point U in the East. This line separates the seas and seabed attached to each country. It is evident that east of Torres Strait, this boundary tends to lie south of a strict line of equidistance, except east of Point S.

In Torres Strait, there is a defined protected zone, within which certain boundaries have been delimited. The seabed is divided by the Swimming Fisheries Delimitation Resources Line defined from Point E to Point N. Some Australian islands penetrate north of the maritime boundary; they are called Talbot Islands, Dauan Island, Saibai Island and Turnagain Island. Outside the delimitation line there are two Australian Islands to the west, called Deliverance Island and Turu Cay, and to the east the islands are called Pearce, Bramble, Anchor and East Cays.

THE EMERGENCE OF THE INDEPENDENT STATE OF TIMOR L'EST

When Australia negotiated maritime boundaries with Indonesia in 1972, it was assumed that the seas and seabed between Points A16 and A17 would be negotiated between Australia and Portugal, which controlled Portuguese Timor. That assumption ended when Indonesia acquired Portuguese Timor in 1975. The boundaries constructed then represented a compromise between Indonesia's view, that a median line was suitable to divide a single continental shelf, and Australia's position that the continental shelves of the two countries were separated by the Timor Trough. A compromise was reached to create a coffin-shaped zone on the seabed divided into three sections. Figure 4 shows the Australian –Indonesian maritime and seabed boundaries in the period after 1971.



(a) Maritime boundaries in the period after 1971.

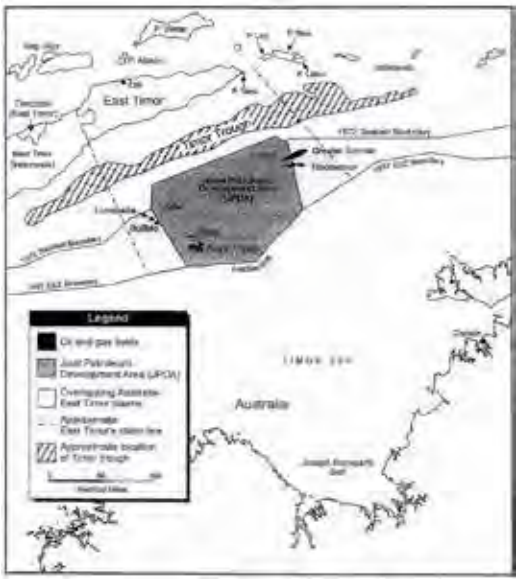
(b) Seabed boundaries in the period after 1971.

Figure 4: Australian –Indonesian boundaries (a-b) (source: [6])

The re-emergence of Timor L'Est resulted in Indonesia withdrawing from control of its former share of the Timor Gap. Figure 5 reveals boundaries negotiated between Australia and Timor L'Est.

Historical, political and legal considerations are important in explaining the development of the Exchange of Notes and the Memorandum of Understanding concerning Australia and the United Nations Transitional Administration in East Timor (UNTAET). These documents also concern the continued operation of the Treaty between Australia and Indonesia on the Zone of Cooperation, in an area between the Indonesian Province of East Timor and northern Australia, dated 11 December 1989. There was also a Memorandum of Understanding between the Government of Australia and the United Nations Transitional Administration in East Timor (UNTAET), acting on behalf of East Timor, on arrangements relating to the Timor Gap Treaty [5].

The Exchange of Notes and Memorandum of Understanding did not create a new maritime boundary. Their aim was to provide practical arrangements for the continuity of the terms of the 1989 treaty between Australia and Indonesia, that established a joint development in the Timor Gap, during the transitional period, for the benefit of the people of Timor L'Est. The Agreement, created by the Exchange of Notes, was without prejudice to the position of a future independent East Timor towards the 1989 Australian-Indonesia Treaty.



(a) Sea boundaries.

(b) Joint petroleum development and unit areas.

Figure 5: Boundaries negotiated between Australia and Timor L'Est. (a-c)

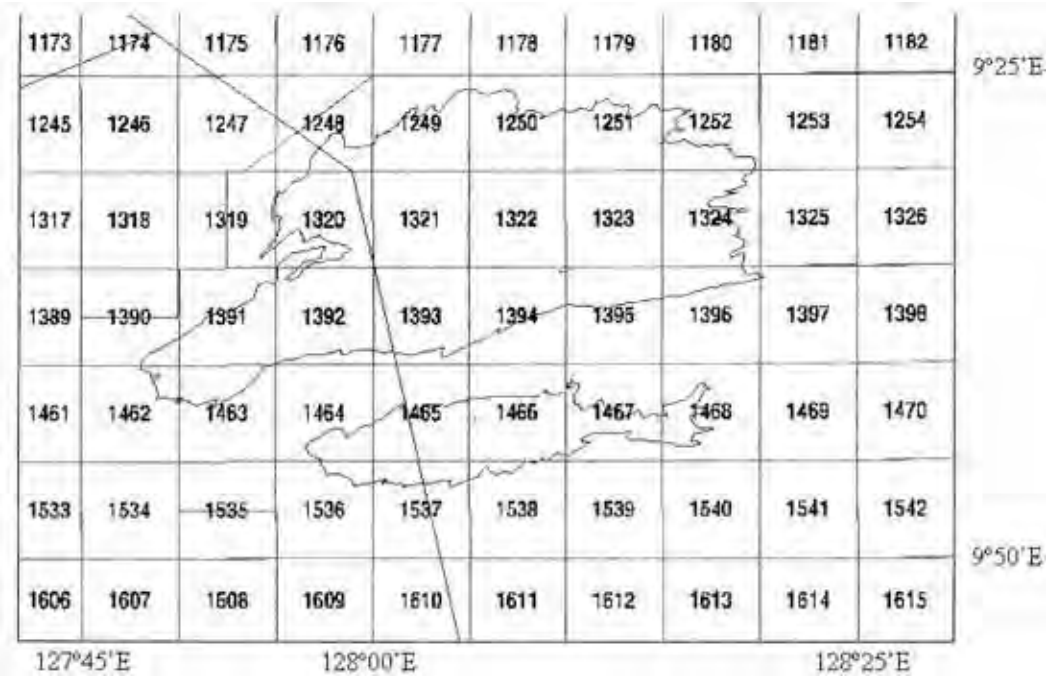


Figure 5: (c) Outline of the unit area and reservoirs.

The Notes exchanged provided that UNTAET, acting on behalf of Timor L'Est, assumes all the rights and responsibilities under the Timor Gap Treaty, previously exercised by Indonesia until the date of the independence of East Timor. It was stipulated that UNTAET, acting on behalf of Timor L'Est, might enter into subsidiary arrangements or agreements, relating to the continued operation of the terms of the Timor Gap Treaty. Finally, it was recorded that in agreeing to continue arrangements under the terms of the Treaty, the United Nations did not thereby recognise the validity of the integration of Timor L'Est into Indonesia. The Memorandum of Understanding deals with arrangements concerned with the continued applicability of the Treaty's legal regime, production sharing contracts, the Ministerial Council and the Joint Authority. Historical and political considerations are important in explaining the development of the Exchange of Notes and the Memorandum of Understanding. The historical considerations provide the context for those of a political nature.

In 1972, Australia and Indonesia delimited a seabed boundary in the Timor Sea. This agreement left a gap in the line to allow for the existence of Portuguese territory on the island of Timor. Attempts by Australia to negotiate a boundary, to close the Gap, were unsuccessful. In April 1974, the revolution in Portugal encouraged independence movements in all remaining Portuguese territories except Macao. Mozambique and Angola became independent in June and November 1975 respectively. In August 1975, the Democratic Union of Timor, in favour of continued but looser connections with

Portugal, staged a coup d'état. This action prompted a struggle with groups in favour of union with Indonesia and of full independence. By the end of August 1975, Portugal admitted it had lost control in Timor and Portuguese citizens were evacuated.

The detailed historical accounts of the next 24 years have aroused sharp disagreements amongst historians. It is sufficient for this analysis to compress the subsequent events into brief uncontroversial significant events and dates. Conflict continued, and on 7 December 1975, Indonesian troops successfully invaded Portuguese Timor. The territory was formally constituted as Indonesia's twenty-seventh Province on 17 July 1976 and was called Loro Sae. Australia formally recognised Indonesia's annexation of the Portuguese colony in December 1978, and eleven years later, the two countries signed the Timor Gap Treaty.

In mid-1998, Bacharuddin Jusuf Habibie became the third President of Indonesia, replacing Gen. Suharto. In January 1999, Indonesia agreed that it would respect a referendum amongst all East Timorese, aged over 17 years, on the question of independence for the territory. The election was held on 30 August 1999 and 78 per cent of voters supported independence from Indonesia.

The United Nations established the International Force for East Timor (INTERFET) and it arrived on 20 September 1999. INTERFET found widespread destruction of public and private buildings in the capital, Dili. Several thousand East Timorese were confined in refugee camps in East Timor. In addition, there was some delay in INTERFET exercising control in the small detached area of Timor L'Est called Ocussi, on the northwest coast of Indonesian Timor.

The Indonesian Parliament ratified the result of the referendum on 20 October 1999 and the United Nations assumed responsibility for the territory on 25 October 1999. INTERFET handed control to UNTAET on 1 February 2000. The historical background establishes that East Timor had always been a small, impoverished territory.

The Timor Sea treaty between Timor L'Est and Australia entered into force on 2 April 2003, eleven months after its signature on 2 May 2002. The Timor Sea Treaty does not create a new maritime boundary [7]. Rather, it maintains an interim regime for the joint development and sharing of resources in the area of the Timor Sea, now described as the Joint Petroleum Development Area (JPDA).

In order to ensure a stable legal regime for resource development, in the period between the independence of East Timor on 20 May 2002 and the coming into force of the Timor Sea Treaty, Australia and Timor L'Est reached an agreement. The Exchange of Notes, that confirmed Arrangements for the Exploration and Exploitation of Petroleum in an Area of the Timor Sea (Exchange of Notes), was also negotiated on the 20 May 2002.

This exchange of Notes provides that exploration and exploitation of Area A of the Zone of Cooperation "s*hall take place in accordance with the arrangements in place on 19 May 2002*", that is the day prior to the independence of Timor L'Est. These arrangements were those agreed in an earlier Exchange of Notes and Memorandum of Understanding between Australia and the United Nations Transitional Administration in East Timor (UNTAET) continuing the terms of the Timor Gap treaty 1989.

The Timor Sea Treaty replaced the Exchange of Notes between Australia and Timor L'Est and regulates all resource activities in the JPDA. Joint petroleum exploration and exploitation in the JPDA can be maintained, with relative legal security, under the terms of the Timor Sea Treaty. The two critical features of the Treaty are first, that it does not prejudice the respective juridical positions of either State regarding seabed delimitation in the future, and secondly, that revenues are to be apportioned on the basis that Timor L'Est and Australia share them 90 percent and 10 percent respectively.

Further, recent developments suggest that changes to the interim regime maintained by the Timor Gap Treaty may yet to be made. First, while Australia and Timor L'Est have agreed upon an International Unitization Agreement [Unitisation Agreement] for the petroleum deposits straddling the eastern lateral limit of the JPDA, known as Greater Sunrise, the agreement has not yet come into force. The Unitization Agreement was in many respects negotiated in tandem with the Timor Sea Treaty and they are politically related in significant ways [8].

Second, on 12 November 2003, Australia and Timor L'Est began talks for negotiations upon a permanent seabed boundary that could possibly replace the need for any unitization agreement to regulate straddling deposits or further reference to the JPDA. That such preliminary discussions should take place, within seven months of the Timor Sea Treaty coming into effect, reflects continuing concerns of Timor L'Est that the JPDA and associated arrangements are not in conformity with contemporary international law.

For the present, the Timor Sea treaty provides the operative legal regime for resource exploitation of the JPDA. It remains a workable interim arrangement for petroleum development to the mutual benefit of both Australia and Timor L'Est, pending agreement upon a permanent boundary.

Triggs [9] has written a definitive analysis on boundary arrangements linking Timor L'Est and Australia. Timor L'Est was persuaded to accept the linkage between The Timor Sea Treaty and the International Unitization Agreement for Greater Sunrise. This means that Timor L'Est only obtains 20.1 per cent under the International Unitisation Agreement. Australia secures 79.9 per cent of the revenue that lies within Australian sovereignty.

Schofield [10] has written an interesting account of East Timor's proposal for third party adjudication by the International Court of Justice, or an agreed neutral third party.

However, two months before East Timor became independent Australia withdrew from compulsory jurisdiction by the International Court of Justice. Schofield has also produced a useful map that suggests Timor L'Est may propose maritime boundaries with Indonesia, to the east and the west which diverge to increase the area secured by Timor L'Est.

CLAIMS BY INDONESIA AND TIMOR L'EST TO THE SEAS AND SEABED NORTH OF THE ISLAND OF TIMOR

We can now consider conflicting maritime claims by Indonesia and Timor L' Est. The north coast of Timor is smooth. In the west, Timor L'Est occupies about 29 nm of the coast called Ocussi, west of Ponto Bato Lisson. Then, proceeding eastwards , 29 nm of coast belongs to Indonesia. From this point, the coast tends northwards before turning eastwards again for 147 nm to Ponta Tei.

The straits called Selat Ombai and Selat Wetar are defined in the north and from west to east by Pulau Pantar, Pulau Alor, Ilha de Auroro, Pulau Liran, Pulau Wetar and Pulau Kisar. All the islands, apart from Ilha de Arauro, belongs to Indonesia.

In the west, two mountainous islands are called Pulau Pantar and Pulau Alor and they are covered with forest. The inhabitants live by trade and fishing along the coast, and by agriculture and breeding cattle in the uplands. Pulau Atauro, which belongs to Timor L'Est, rises steeply from the coast on all sides, and the few inhabitants survive by fishing and cultivation of maize. Pulau Wetar is a large island with hills up to 1,359 metres high. The island supports only a small population that lives along the coast, which is rather unhealthy. Pulau Kisar is 240 metres high and the interior is sparsely covered with vegetation.

It is probable that Timor L'Est will argue that Indonesia's archipelagic baselines are improper, because it is clear that the rectangular area of territorial waters off Ocussi is surrounded by Indonesia's archipelagic waters. Article 47 (5) of the Law of the Sea deals with this question.

"5. The system of such baselines shall not be applied by an archipelagic State in such a manner as to cut off from the high seas or the exclusive economic zone the territorial sea of another State."

Figure 6 shows the lines of equidistance between the territory of Timor L'Est and the major Indonesian islands called Pulau Alor and Wetar. The problem faced by Timor L'Est is that there is no evidence that Indonesia has interfered with the lawful commerce of vessels registered by Timor L'Est in the vicinity of Ocussi. Vessels registered in Timor L'Est or vessels registered in any other part of the world may sail through Indonesia's archipelagic waters to trade legally with Ocussi. Such vessels can approach Ocussi from any direction.

The second string to Timor L'Est's bow is that a strict line of equidistance should separate the territorial seas of Indonesia and Timor L'Est . A strict line of equidistance, drawn from the Indonesian low-water lines of Pulau Alor and Pulau Liran and the low water line of Timor L'Est's Pulau Atauro, would produce a triangular penetration northwards, between Pulau Alor and Pulau Wetar.

Unfortunately for Timor L'Est, Indonesian authorities deposited the coordinates of points on its archipelagic baseline with the United Nations, in accordance with Article 47.9 of the Law of the Sea on 25 March 2009.

Figure 6: Lines of equidistance between the territory of Timor L'Est and the major Indonesian islands called Pulau Alor and Wetar.

Figure 7: Coordinates of points deposited by the Indonesian authorities on its archipelagic baseline with the United Nations on 25 March 2009.

These points, shown in Figure 7 are TD 113B, TD 113A, TD 113 and TD 112A. Indonesia revised its older regulation which was Number 38/2002 and substituted new baselines with Government Regulation Number 37/2008, which was deposited with the United Nations. The latest baseline can be found on the UN DOALOS website. Timot L'Est might feel aggrieved that Indonesia's archipelagic baseline passes so close to the north coast of Pulau Atauro, but it should recognise that the arrangement provides no impediments to the passage of vessels registered in Timor L'Est.

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MARITIME HUMAN TRAFFICKING IN MALAYSIA: SCOPE OF THE PROBLEM AND ROLE OF ENFORCEMENT AGENCIES

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ABSTRACT

The rise in illegal seaborne transborder migration, especially involving trade in human flesh, is a worrying phenomenon for coastal states like Malaysia with its long and porous national coastline. Human trafficking is a multidimensional issue. It violates national laws as well as the rights of the victims. There is increasing concern that terrorists could use trafficking syndicates to transport extremists through the permeable maritime borders posing threats to national security. This article looks at the scope of human trafficking in Malaysia, and examines the effectiveness of maritime law enforcement agencies in interdicting criminal syndicates operating in Malaysia's Maritime Zone, in order to secure the nation's maritime borders and boost national security. This paper argues that strengthening border security through greater maritime surveillance, security operations and improving security apparatus is vital. However, this alone is inadequate to eliminate the transnational crime which is showing dangerous upward trend especially since the global economic crisis erupted. Strategies aimed at ending human trafficking must focus on eliminating the demand for cheap labour, ensuring political and economic stability in neighbouring countries to deter the influx of illegals, and introducing an effective and transparent migration framework that ensures that only bonafide foreign labour force is engaged. This will ensure that national security is not compromised while addressing human security concerns that underlie the illegal movement of labour.

INTRODUCTION

A 4,675 km-long coastline (2,068 km covering Peninsular Malaysia and 2,607 km covering Sabah and Sarawak) [1] means that Malaysia has to deal with many complex maritime challenges, and not least the illegal uses of its waters to traffic humans or worse, inflict maritime terror. In fact, two events in recent years have mortified the Malaysian government. The first is the placement of the country in Tier 3 by the US State Department in its 2001, 2007 and 2009 Annual Trafficking in Persons (TIP) Report, along with 16 other mainly African countries, for not fully complying with the Trafficking Victims Protection minimum standards [2] for the elimination of trafficking (though in June 2010 Malaysia was upgraded to Tier 2 Watch List) and not making significant efforts to do so; the U.S. government allots foreign non-humanitarian and non-trade aid partially based on the grade a country receives in the Trafficking in Person's Report.

The second embarrassing incident occurred when the US Senate Committee on Foreign Relations following the TIP Report, launched its own investigations into

trafficking allegations and extortion of Myanmar migrants/refugees in Malaysia along the Thai-Malaysia border.

The report, entitled "Trafficking and Extortion of Burmese Migrants in Malaysia and Southern Thailand" [3], confirmed the trafficking and human rights abuses and worse, implicated Malaysian immigration officials, police and *Ikatan Relawan Rakyat Malaysia* (Volunteer Corps or more commonly known as RELA) personnel in the transboundary crime [4]. The TIP Report, since it was first introduced in 2001, has labelled Malaysia as a source, transit and destination country.

The TIP Report indicates human trafficking has become a major concern and a pressing issue for Malaysia. There are many reasons why Malaysia is attractive to human traffickers and this paper will briefly examine both the pull and push factors related to this illegal trade. It will focus on cross border trafficking of humans in Malaysia's Maritime Zone [5] within the context of national security interests. Firstly, this paper provides a definition of human trafficking distinguishing it with human smuggling. It analyses briefly the structural or root factors of trafficking highlighting the nexus between international migration and human trafficking. It will reveal that the former remains a major challenge to national stability and having a better managed migration framework can minimise illegal migration and help counter public corruption of government officials who facilitate trafficking.

Secondly, this paper will also study the effectiveness and challenges faced by maritime law enforcement agencies in interdicting human trafficking syndicates with the ultimate aim of bolstering Malaysia's maritime security and ensuring integrity of the borders. Recommendations for policy interventions to mitigate this alarming threat through domestic, regional and international measures are provided. This includes a proposal for an establishment of a more structured and liberal legal migration regime which does not compromise national security demands to counter influx of illegals that have contributed to their exploitation.

DEFINITION OF HUMAN TRAFFICKING AND USE OF ANTI TRAFFICKING IN PERSONS (ATIP) ACT AS LEGISLATIVE TOOL

The term human trafficking was first used by US President Dwight Eisenhower in 1959 and became an official term in the 1990s referring to illegal trade in humans or human slavery. Literature review reveals organised crime syndicates are at the centre of this illegal human trade, but often family members or friends are involved by introducing the victim to the perpetrator. The flourishing and profitable crime, which is estimated to generate USD32billion annually is aided and abetted by corrupt and indifferent state officials.

The most authoritative reference for the definition of human trafficking is the 2006 *United Nations Protocol to Prevent, Suppress and Punish Trafficking in Persons Especially Women and Children*.

The UN Trafficking Protocol is a supplement to the 2003 UN Convention against Transnational Crime known as the Palermo Convention. The Protocol, which Malaysia ratified in February 2009, defines human trafficking as [6]:

> *the recruitment, transportation, transfer, harbouring or receipt of persons by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labour or service, slavery or practices similar to slavery, servitude or the removal of organs.*

Malaysia's Anti Trafficking in Persons (ATIP) Act was enacted in 2007 and enforced in 2008, a product of US accusation that it is not providing enough evidence of increasing efforts from the previous years to tackle trafficking problem. ATIP Act defines trafficked persons as [7]:

> *the recruitment, transportation, transfer, harbouring or receipt of persons by means of the threat or use of force or other forms of coercion, of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purpose of exploitation. Exploitation shall include, at a minimum, the exploitation of the prostitution of others or other forms of sexual exploitation, forced labour or service, slavery or practices similar to slavery, servitude or the removal of organs.*

Three elements define what really constitutes trafficking in persons: the act, the method, and the purpose involving three stages namely, recruitment, transportation and exploitation. The UNODC protocol draws a key distinction between "trafficking" and "smuggling," defining the latter as the "procurement, in order to obtain, directly or indirectly, a financial or other material benefit, of the illegal entry of a person into a State Party of which the person is not a national or a permanent resident" [8]. Smuggling takes place across the borders, whereas human trafficking can happen within national borders and if it involves crossing national boundaries, it can be both through legal and illegal procedures while smuggling is strictly illegal and a violation of state security and its borders. Smuggling is considered voluntary whereas trafficking involves significant deception, coercion and exploitation. However, in reality, the boundaries between smuggling and trafficking are hazy as smugglers are often involved in trafficking and use the same network and routes and in addition, individuals who pay to acquire services of a smuggler may end up in exploitative conditions [9].

Malaysia's recent amendment to the ATIP Act in October 2010 [10], lumping trafficking of people with smuggling of people, is likely to result in confusion among front line law enforcement agencies as trafficked victims could be detained as illegal immigrants. NGOs such as Human Rights Watch have expressed reservation as trafficking is a breach of human rights while smuggling is a violation of immigration laws [11]. Trafficked victims could now be detained as illegal or undocumented immigrants

throwing a spanner in the works of tackling trafficking as law enforcement officials may treat trafficking victims as undocumented migrants leading to immediate deportation destroying prosecutorial evidence via victims' testimony against traffickers. Undeniably, this will weaken government efforts to combat trafficking, exposing trafficked victims and exploited migrants to further rights violations.

The definition of trafficking contained in the now-amended ATIP Act is narrower and ceases to comply with international law. The new definition of human trafficking refers to a person who is exploited by means of "coercion". Coercion here refers to "use or threats of serious harm; any plan or scheme intended to cause the person to believe failure to perform an act would result in serious harm and; the abuse or threatened abuse of the legal process". The ATIP Act's use of the word coercion contradicts the UN Trafficking Protocol that defines trafficking as involving not only coercion, but also "of abduction, of fraud, of deception, of the abuse of power or of a position of vulnerability or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person" (article 3 of the Trafficking Protocol). The Trafficking Protocol's broad definition covers child trafficking (which ATIP does not) where adults abuse their power to force children into exploitative work and severely control their movements. The ATIP Act also fails to take into consideration abuse of adult victims using fear tactics, and psychological manipulation that deters victims from seeking assistance. Unfortunately, ATIP Act exclusion of these situations by default, exclude many trafficked persons from protection.

Further, the revised ATIP Act contains provisions on smuggling inconsistent with Malaysia's obligations under the Trafficking Protocol. Human Rights Watch stressed that "if Malaysia wants to end human trafficking, it needs to start treating trafficking victims as victims … and Prime Minister Najib should return the amended anti-trafficking law to Parliament to stop trafficking victims from being re-victimized and to ensure that Malaysian law reflects international best practice" [12].

The insertion of "smuggling of migrants" into new Part IIIA of the ATIP Act criminalises irregular migration into or out of Malaysia and conflating trafficking of people with smuggling of people. International law and best practices recognise that smuggling and trafficking are distinct crimes necessitating different strategies and law enforcement measures. Hence, the Palermo Convention has a separate protocol, called the Protocol against the Smuggling of Migrants by Land, Sea and Air, which Malaysia has not ratified. Both protocols have separate international framework to address two dissimilar problems supporting a different and unique policy response.

Underlying the recent ATIP Act amendment is the flawed assumption that the crimes of smuggling and trafficking are linked, that is, tackling smuggling will prevent trafficking. However, anti-trafficking efforts worldwide demonstrate just the opposite. A narrow focus on fighting migrant smuggling will hurt anti-trafficking initiatives as the emphasis on exploitation, which defines trafficking, is shifted to controlling immigration. This severely undermines identification of human trafficking victims and in Malaysia, this (victim identification) has been singled out as a weak link in its anti-trafficking measures by NGOs working on human rights issues. However, there are valid concerns raised by law enforcement officials that extremist elements could disguise themselves as victims to inflict terror and put national security at risk. Thus, it is important to acknowledge that alongside human security human trafficking victims are vital

Eliminating human trafficking and minimising irregular migration require different skills and strategies. It is vital that to effectively combat trafficking that the legal framework must recognize that victim's identification and evidence are crucial to prosecuting the human trafficking crime. Traffickers are known to severely control the victims' movements as well as withhold their personal documents and identifications. Thus, gaining the trust of victims for effective testimony is critical for prosecution. However, there are inadequacies in terms of implementation. For example, RELA is employed in immigration enforcement but are neither well trained nor sufficiently concerned to identify trafficked victims. Experience in many countries has also shown that cracking down on irregular migrants can increase traffickers' ability to control and intimidate their victims who, fearful that seeking help will lead only to arrest and deportation, remain silent.

The ATIP Act had been recently amended and approved by the *Dewan Rakyat* with a new section on human smuggling. Human traffickers now could be fined between RM500,000 and RM1mil, a 10-fold increase from the former provision in the Act and/or jailed up to 20 years [13].It was hoped that harsher penalties will be a good deterrent against trafficking. In addition, the amendment will include the labour department, police, immigration and maritime authorities as enforcement agencies. In 2006, no traffickers were prosecuted in Malaysia but 35 people were prosecuted for using minors for prostitution [14]. The government also arrested 22 individuals for procuring brothels, and 16 for pimping. In fact the MOU signed with Indonesia, allows Malaysian employers to confiscate passports from migrant workers leading to involuntary servitude but there have been no prosecutions of these employers for trafficking.

Since, the ATIP Act came into force, the government has successfully exposed several trafficking in persons syndicates involving sexual exploitation and human smuggling, transiting Malaysia to a third country, especially Australia. The first case charged under ATIP Act 2007 was on July 9, 2010 involving a Thai national, for accepting money to exploit a Myanmar refugee. A Malaysian immigration official was also charged in court on July 2009 for providing protection to syndicates engaged in trafficking of Myanmar refugees by selling them as debt bondage to Thai Fisherman [15]. In 2009, 22 people were charged under the 2007 ATIP Act. Malaysia has tried 168 human trafficking cases and convicted 16 people since 2008 until June 2010 under the ATIP Act. [16] . In January 2010, the first labour trafficking case was unearthered in the fisheries industry when the Malaysian Maritime Enforcement Agency intercepted Thai fishing boats in Sarawak coast. Five Thai traffickers were arrested but the case was eventually thrown out for lack of evidence [17].

The government has rescued 1,200 victims of human trafficking since 2008 and prosecuted 155. Nine people have been convicted thus far for people smuggling [18]. Victims are usually deported within six months after their stay at a designated shelter and Tekong charged for crime. The Ministry of Home Affairs has promised to speed up the process of prosecuting those charged with trafficking and to provide training to ensure that prosecutors are able to handle cases related to ATIP. However, law enforcement officials admit to the difficulty they face in distinguishing bona fide victims from imposters as they are trained first and foremost to treat those captured as suspects who intend to destabilise national security.

Table 1: Nationality of trafficking victims (28 August 2008 – 20 June 2010) (Source: Ministry of Home Affairs)

Countries	Total				Overall Total
	Female		Male		
	Adults	Underage	Adults	Underage	
Indonesia	109	11	1	0	121
Sri Lanka	10	6	93	4	113
Philippines	83	0	2	0	85
Thailand	33	4	0	0	37
China	10	2	13	4	29
Myanmar	5	9	9	0	23
Vietnam	13	6	0	0	19
Malaysia	0	8	0	6	14
India	6	0	0	0	6
Cambodia	2	0	0	1	1
Australia	271	46	118	25	450

Those convicted will have to pay the government all the profits they have made as well as to cover the cost of housing and deporting the migrants. The amendments sought to tackle human trafficking in a more comprehensive manner as the crimes included smuggling of drugs and firearms.[19] It criminalises the exploitation of migrants and generating illegal income from the smuggling or harbouring of migrants. It was hoped that with the new amendments, and strengthening of investigation methods, evidence gathering and victim protection in Malaysia can be placed in Tier 2 proper of the *US State Department TIP Report.* Table 1 shows the nationality of trafficked victims into Malaysia.

Prior to the coming into force of the Anti-Trafficking in Persons (ATIP) Act, there was an absence of a single comprehensive law or specific legislation to penalise offences perpetrated under trafficking, though Article 6 of the Malaysian Federal Constitution bars all forms of coerced labour. Before the ATIP Act was enforced, both perpetrators and victims were classified as illegal immigrants and viewed as criminals. The Immigrant Act, Sections 8, 15 and 32 were used to charge them. However, this did not deter clandestine entry of migrants into Malaysia. There were other legislative mechanisms employed to punish traffickers but were not comprehensive, such as Section 371 of the Penal Code and the Child Act 2001 (which prohibits child trafficking) incorporating provisions of the UN Convention on the Rights of the Child [20].

STRUCTURAL FACTORS AND THE NEXUS BETWEEN MIGRATION AND HUMAN TRAFFICKING

Globally, human trafficking remains the third most profitable form of organised crime – after the illicit trade in drugs and arms. Every year, about 2.5 million people are trafficked across the borders for mainly sexual and labour exploitation, and 1.2 million of these are under the age of 18. Of this number, 225,000 victims come from Southeast

Asia and 15,000 from South Asia [21]. This is admittedly a conservative figure. Malaysia is considered one of the leading countries whereby global black market inequalities the trafficking of human beings for prostitution and slavery is estimated to generate anywhere between USD 13-32 billion a year.

In modern times, persecution, armed and economic conflicts, and subsequent displacement have triggered human insecurities. The new globalised economic order has in addition contributed to poverty, underdevelopment, unemployment, inequalities and environmental destruction leading to human vulnerability and exploitation. There has been intense and escalating migration flow from countries affected by these push factors. Traffickers take advantage of these socio-economic and political factors, targeting vulnerable people who are already seeking to migrate to Malaysia to meet labour demand in lowly paid sectors. Thus supply and demand are the main driving factors of trafficking. Malaysia is perceived as economically more prosperous, politically more stable and has less cultural and religious barriers – a pull factor for most deprived victims. The global financial meltdown further aggravated this problem as certain economic sectors such as agricultural, manufacturing, construction and services continue to experience high demand for cheap labour. The victims may be deceived into believing they are being recruited for legitimate and high paying employment. In addition, though the migrant may have given consent to illegal migration via human smugglers, coercion or deception is enough to nullify a victim's consent to be smuggled. Debt bondage is another popular method to control these trafficked persons and to ensure their continued profitability [19].

Most of the victims are from the poorer parts of Asia such as Indonesia, Philippines, Cambodia, Vietnam, Myanmar and Laos Thailand. Malaysia has also increasingly become a magnet for people from war-torn countries such Iraq, Sri Lanka and Afghanistan to seek work illegally or seeking a transit to richer nations like Australia and Canada, and often, they fall prey to trafficking networks for forced labour and sexual exploitation [22]. There have been reported cases of Cambodian teenagers being forced to work aboard fishing vessels in the South China Sea to the illegal harvesting of human organs to high-class prostitutes from the former USSR plying their trade in the heart of KL. On 28 April 2009, an overcrowded boat capsized off the coast of Johor causing the deaths of seven family members. Investigations revealed that the passengers were smuggled Afghans and Pakistanis (or trafficked, it was not ascertained) [23]. They were believed to be heading to Indonesia en route to Australia. A survey in 2008 indicated 2,000 barter trade boats entered and left Malaysia and ferry boats transporting 4.8 million passengers in 1,500 ferry boats in the first six months of 2008 [24]. Table 2 displays the latest figure obtained from the Ministry of Home Affairs on the breakdown of victims based on gender, nationality, shelter and the type of protection order.

Protection Order refers to protection extended to "genuine" human trafficking victims while Interim Protection Order refers to protection for those whose claims of trafficking are still being investigated and verified.

Historically, trans-Asian migration had been a key component of British colonial labour policy which had led to unregulated migration of ethnic Indians and Chinese through the indentured system to work mainly in the rubber plantation and tin mining respectively. Post colonial Malaysia imports more migrant workers than any other ASEAN country to overcome shortages of low and medium skilled labour force in the agricultural,

construction, maintenance and services sectors and other sectors not considered lucrative by locals. According to the International Labour Organisation (ILO), Malaysia currently has 35% of 13.5 million migrants in the region. The 1959 Immigration Act however has restricted the quantity of migrants and the Employment Restriction Act 1968 made access to labour market for foreigners dependent on possession of work permits. Human trafficking and human smuggling syndicates have taken advantage of Malaysia's vulnerability in this regard. It is estimated that there are 1.9 million undocumented migrants [25] in the country and no reliable statistics exist as to the proportion of trafficked victims. Officially there are 1.8 million [26] documented foreign workers in Malaysia. According to the 2010 US State Department Annual Trafficking in Persons Report, human trafficking cases in Malaysia involve the transportation and exploitation of domestic workers, sex workers and bonded labourers.

Table 2: The number of human trafficking victims in Malaysia (2008-2010). (Source: Majlis Anti Permerdagangan Orang (MAPO, Anti-Human Trafficking Council))

Number	SHELTER	BUKIT LEDANG (FEMALE) 24/03/2008 - 06/10/2010		LIKAS (FEMALE) JUNE 2009 - 06/10/2010		KLIA (MALE)		TANJUNG KLING (MALE) 15/08/2010 - 10/10/2010		BEKENU (MALE)		BUKIT LEDANG (CHILDREN) 24/03/2008 - 06/10/2010		TOTAL
	NATIONALITY	IPO	PO	IPO	PO	IPO	PO	IPO	PO	IPO	PO	IPO	PO	
1	MALAYSIAN	3	0	0	0	0	0	0	0	0	0	0	0	3
2	THAI	75	33	0	0	0	0	0	0	0	0	0	0	108
3	INDIAN	12	10	0	0	0	0	0	26	0	0	0	0	48
4	VIETNAMESE	80	19	3	3	0	0	0	8	0	0	0	0	113
5	FILIPINO	95	62	90	60	0	0	0	0	0	0	0	0	307
6	INDONESIAN	187	0	100	67	0	0	0	0	0	0	0	0	521
7	CAMBODIANS	11	2	1	1	0	0	0	0	0	0	0	0	15
8	CHINESE	151	6	0	0	0	0	0	0	0	0	0	0	157
9	MYANMAR	12	5	0	0	0	0	0	0	0	1	0	0	18
10	SRI LANKAN	10	11	0	0	0	0	0	25	0	0	0	0	46
11	BANGLADESHI	0	0	0	0	0	0	0	33	0	0	0	0	33
12	AFGHANISTANI	0	0	0	0	0	0	0	7	0	0	0	0	7
13	NEPALESE	1	0	0	0	0	0	0	0	0	0	0	0	1
		637	148	194	131	0	0	0	99	0	1	54	43	1474

Unsecured or ungoverned seas are potential havens for human trafficking syndicates. Parts of the Malaysian coastline are permeable, ungazetted and often difficult to regulate providing relatively cheap and inconspicuous movement for syndicates. Geographical factors compound the difficulty of monitoring smuggling and trafficking especially when taking into account the geographical features of Peninsular Malaysia and archipelagic nature of the areas surrounding Malaysia. Basic methods of entry are through boats,

ferries and ship. Table 2 shows the number of illegals detained in the Malaysian Maritime Zone. However, the statistics do not depict the proportion of trafficked victims. There is lack of reliable data on human trafficking in Malaysia due to its illicit nature and reluctance of victims to make reports for fear of retaliation by the syndicates, and also fear of arrest by immigration officials as they entered the country illegally. According to the Ministry of Home Affairs, 78 cases and 126 arrests were made between January and June 2010 while interim protection orders were issued for 618 victims. The figures are just the tip of the iceberg [27]. Tenaganita, a local NGO, reported that 65% of trafficked persons in Malaysia end up as forced labour [28].

Table 3: Illegals detained in the Malaysian Maritime Zone.
(Source: Malaysian Maritime Enforcement Agency (MMEA))

Year	Number of Illegals Detained in the Malaysian Maritime Zone							
	Indonesian	Philippines	Thai	Myanmar	Bangladesh	India	China	Total
2006	59	6	-	-	-	-	-	65
2007	97	52	10	31	1	-	6	197
2008	303	88	1	17	5	2	-	416
2009	382	212	6	25	-	2	-	627
2010	48	113	18	121	-	-	-	300
TOTAL	889	471	35	194	6	4	6	1605

Despite numerous strategies to remedy unlawful migration through regulations, none of the strategies have effectively stemmed the flow of illegal migrants or protect them against exploitation [29]. The main factors are corruption and outsourcing for labour. In addition, since Malaysia has not ratified the 1951 UN Convention on Refugees, refugees who have fled here are considered illegal immigrants and thus vulnerable to trafficking. The asylum seekers mostly from Myanmar engage smugglers to bring them into Malaysia, who are later exploited. Since 2005, in Malaysia the immigration policy has changed from the direct recruitment system to a labour outsourcing scheme and the establishment of labour-hire firms. This corresponds with the government's push for a greater economic role of small and medium enterprises. This new scheme has led to "bonded-labour" arrangements and directly encouraged trafficking [30].

The best way to attack human trafficking syndicates is to deprive them of their profits. Severe policies on border control increases cost of migration and can be counterproductive in terms of reducing the number of smuggled humans ending up as exploited and forced into slavery to pay back the debt owed to the intermediaries. In fact, regularisation policies are even cheaper than border controls as they have been proven to be ineffective in preventing trafficking and smuggling. Studies conducted in America on border enforcement in preventing trafficking of humans indicate that enforcing traditional security methods alone are inadequate and that to tackle transborder crime, one has to look at the wider human security issue. However, the tension between the economic case for free movement and political pressures to tighten the border has led to selective immigration policies. This selective policy has attracted only the highly skilled labour while restricting labour migration of the poor and less skilled creating a burgeoning demand for smuggling and trafficking syndicates. Restricting asylum has

also largely contributed to trafficking, In fact, the more sophisticated instruments used to curb trafficking will not reduce the flows but force victims to pay higher fees and risk risky routes. The government may find itself having to control migration flows to retain political legitimacy and electoral support as well as allay concern of the public to limit the socio-economic setbacks of unwanted immigration. Malaysia also finds itself as a favourite transit point as first preference western destination countries become more difficult to reach.

Liberalising migration policies entails easing restrictions on labour mobility for both skilled and unskilled workers which will expand the legal routes and reduce illegal migration. The government needs to embark on intensive campaign and to gain public support for at least partial expansion of labour schemes. This may not completely eliminate trafficking but some provision of legal channels can contain the problem. From an economic perspective, free labour movement would generate substantial economic gains for Malaysia by increasing labour market efficiently, expand production and reduce negative effects of surplus labour in source countries. Research indicates the gains to global GDP from free labour movement could be between 15–67 % with full liberalisation and 3–10 % if only skilled migration is liberalised [31].

Other options that the Malaysian government could explore to reduce migration pressures in source is through targeted use of development aid, foreign direct investment, trade liberalisation, humanitarian assistance, human rights policy and conflict prevention. In addition, the Malaysian government can embark on expanding public information and have more transparent debate to disseminate information on migration processes. Migrants from source countries are often not supplied with accurate information and the receiving communities such as Malaysia are not aware of the causes of migration. Such campaigns can help prevent exploitation by traffickers and potential migrants are aware of dangerous travel routes used in trafficking. Malaysian public must be given accurate and balanced information including the advantages of labour migration. This could facilitate expanding legal migration schemes. These are all important components of a better managed international migration system.

ROLE OF MARITIME ENFORCEMENT AGENCIES

With a more globally interdependent economy and Malaysia's heavy reliance on the maritime environment for trade and commerce (it is estimated that 90% of Malaysia's trade is seaborne), ensuring a safe and secure maritime environment has become critical to national security and economic well-being. In addition, since security measures at ports, airports and land border crossings are becoming more robust and sophisticated, syndicates are increasingly considering the lengthy coastlines for unauthorised entry into Malaysia. Therefore, patrolling, monitoring and exerting unambiguous control over the maritime borders and sound maritime surveillance approaches are vital. Two federal law enforcement agencies help to patrol the Malaysian Maritime Zone with the assistance of local law enforcement organisations. They are the Royal Malaysian Police through the Marine Operations Force (MOF) and the Malaysian Maritime Enforcement Agency (MMEA- equivalent to a national coast guard but considered a paramilitary outfit). The Immigration Department helps to screen potential trafficking syndicates and conducts raids from time to time with the help of RELA to clamp down on trafficking.

Marine Operations Force (MOF)

MOF is the Marine Police division of the Royal Malaysian Police responsible for maintaining internal security of Malaysia as well as its internal waters from any undesirable threats and, before the formation of MMEA, was solely tasked with coordinating search and rescue operations in the Malaysian Maritime Zone and on the high seas. With the formation of MMEA in 2005 as the national coast guard, the MOF is now in charge of security of coastal shore line up to only 12 nautical miles that includes national and territorial waters, lakes, ponds, river mouths and estuaries. There appears to be an overlap in duties and jurisdiction between MOF and MMEA but the Police Internal Security and Public Order Director Commissioner Datuk Hussin Ismail had maintained that MOF's main tasks are policing duties while MMEA's role is to enforce the country's maritime laws [32].

The MOF admits to the difficulty in ascertaining if victims are indeed trafficked [33]. The problem lies in distinguishing smuggled victims from trafficked one as smuggled victims can be considered trafficked if they are deceived or unable to pay the smugglers and have to serve as bonded labour to pay off the syndicates. Most are charged under the Immigration Act which carries 6-month imprisonment followed by deportation. Federal Marine Police Commander Senoir Assistant Commisioner II (SACII) Datuk Isa Munir said the force was closely monitoring human trafficking activities and had detained two syndicate heads under the Emergency (Public Order and Prevention of Crime) Ordinance 1969 this year [34]. In May 2010, the marine police detained 863 foreigners, mostly Indonesians, who came into the country illegally via the Straits of Malacca. In comparison, the authorities made 2,435 arrests from January to May 2009.

The illegal immigrants from Indonesia are mainly from Surabaya, Samarinda and Sulawesi who head to transit points in Nunukan. Tarakan, Sg Nyamuk used as transit point before arriving at Tawau. Sabah also faces huge problems with illegal immigrants from Philippines especially refugees fleeing the troubled Mindanao region. In fact the state had launched a massive operation to deter the illegals encroaching into Sabah [35]. The police have received radar and camera equipment from United States to help monitor the movement of ships. The operations may be extended to Sarawak.

MOF also stations boats in "hotspots" such as Port Klang, Port Dickson, Lumut, Pontian, Tanjung Piandang (Penang), Kuala Kedah, Pulau Sebatik, Kudat and Tawau. The boats are fitted with radars provided by Australian Coast Guard and have four to six personnel with night vision goggles. It is in the midst of deploying advanced radar systems to help detect infiltration in territorial waters to monitor maritime human trafficking operations. MOF also receives "hot intelligence" from the Departments of Customs, Immigration and Fisheries on suspicious vessels ferrying trafficked victims, in addition to assistance from local police and the Special Branch. The latter agencies provide early warning signals and information. In addition, top enforcement agencies around the world are sharing intelligence and collaborating to cripple the syndicates [36]. MOF also receives assistance from the Singapore Marine Police, Indonesian navy and Thai coast guards. MOF data thus far indicates that most human trafficking syndicates use Malaysia as a transit point. Figure 1 indicates the source of illegal immigrants in Sabah and the transit points they use. In fact, recently, SACII Datuk Isa Munir asserted

that "syndicates had changed their modus operandi following stern action taken by authorities to clamp down on human trafficking" [37]. Previously syndicates smuggled asylum seekers via the Kuala Lumpur International Airport (KLIA) or Changi airport before they are transported via boat from Pengerang in Johor into Indonesian waters. Now, however, the migrants or asylum seekers travel from Indonesian waters to Thai waters where the refugees are brought to Australia by boat. The most recent news report reveals that "heightened enforcement against human trafficking has forced syndicates to shift their base outside Malaysia" and that Malaysia was no longer considered a safe place for the syndicates to move people".[38]

MOF has indicated that its manpower must be increased to 4,000 from the current 2,450 to assist coastal police stations and in policing major rivers and maritime entry points within their jurisdiction. While this can help in terms of tightening security around these routes, it must be noted that human trafficking syndicates are getting smarter to bypass such security measures. Sound maritime approaches are vital for effective interdiction such as intelligence sharing among agencies (both land and air) and maximising domain awareness to integrate intelligence and law enforcement information.

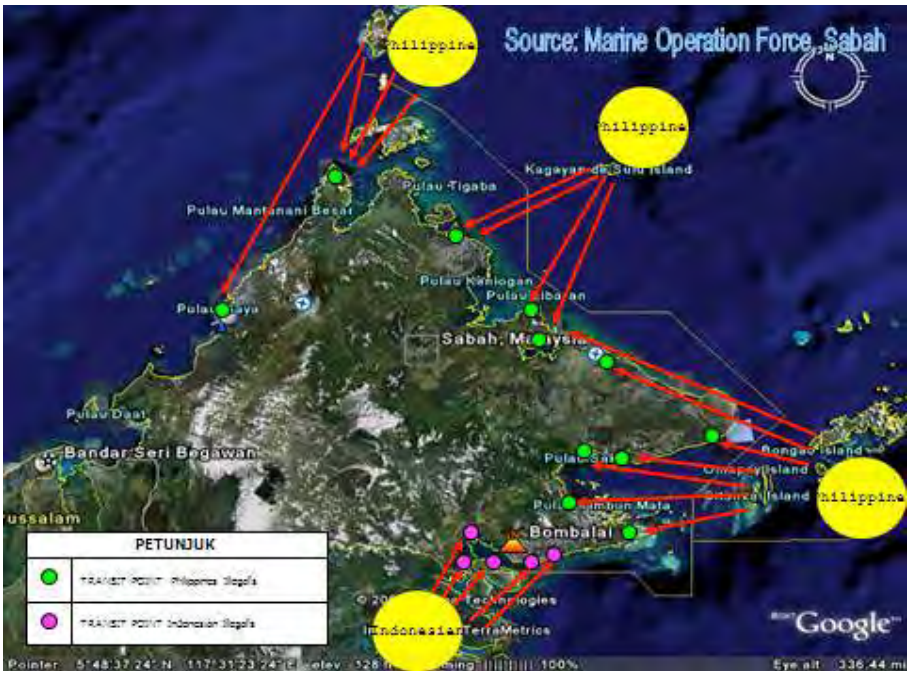

Figure 1: Source of illegal immigrants and transit points in Sabah. (Source: Marine Operation Force (MOF)

Malaysian Maritime Enforcement Agency (MMEA)

MMEA was formed in 2005 as Malaysia's statutory response to the threats of maritime terrorism [39] and to effectively function as a paramilitary law enforcement agency. It is designed to be the sole maritime law enforcement agency to respond to the security of the waters around the ports and navigation routes and its major functions

are to carry our air and coastal surveillance [40]. In addition, the issue of overlapping functions among the 11 maritime enforcement agencies was to be dealt with through the formation of MMEA by streamlining the operations [41] and enforce maritime law. MMEA is responsible for anything within and beyond the 12 nautical miles. There is clearly an overlap in terms of duties and jurisdiction with MOF. In addition, MMEA is "to receive and consider any report of the commission of an offence" [42] and to "to stop, enter, board, inspect and search any place, structure, vessel or aircraft and to detain any vessel or aircraft" [43]. These powers are similar to the powers vested in the MOF to fight maritime crime and it is possible that overlapping of jurisdiction can infringe on law enforcement duties.

MMEA conducts surveillance on areas which are prone to human trafficking activities such as Pengerang at Johor's east coast as its proximity to Indonesian islands makes it a favourite haunt for human trafficking syndicates. Most of the boats leaving Pengerang head for Batam, Karimun or Bintan. According to the MEMA southern regional chief, there are 15 secret routes used by syndicates to smuggle illegal immigrants along the Pengerang coast [44]. In Sarawak, the MMEA jointly conducts operation with the Marine Fisheries Department, Immigration Department, Fisheries Development Authority and Sarawak Rivers Board, to combat human trafficking believed to occur off Tanjung Manis [45]. The MMEA also utilises Radar Sea Surveillance Systems along the coast facing Straits of Malacca. Top officials from MMEA reveal that trends indicate human trafficking syndicates relocating to Thailand due to aggressive surveillance and interdiction by MMEA. However, since the agency plans increase its staff strength from the current 3,000 personnel to 9,000 by 2011 apart from commissioning new bases in Labuan, Kudat and Lahad Datu fully equipped with airplanes, helicopters, ships and boats, it is expected that the MMEA would eventually emerge as the sole maritime enforcement agency within the next two years. Currently, MMEA owns 126 vessels, three helicopters and two Bombardier aircraft.

MMEA does indeed has the powers to function as a paramilitary coastguard and combat maritime crime. However, the legislative framework it is operating under is less than satisfactory as the Malaysian Maritime Enforcement Agency Act 2004 (MMEA Act 2004), Section 16 states that the agency and relevant existing maritime agencies "shall closely coordinate, consult and liaise with each other and render to each other assistance for carrying out the provisions of the 2004 Act". The act makes references to other domestic legislation that concerns Malaysian maritime zone and thus MMEA must have a solid legal foundation to carry out its functions and a legislative reform is in order to iron out the overlaps and conflicts in terms of jurisdictions with other enforcement agencies.

Statistics indicate an elevated figure of foreign barter trade vessels, fishermen and passenger ships entering Malaysian waters using non-SOLAS ships (Convention on Safety of Life at Sea for ships beyond 500 gross tonnage) These ships can violate security as they do not have a tracking device aboard and are not covered by International Ship and Port Facility Security (ISPS) enforcement regime (The ISPS International Ship and Port Facility Security Code was designed to tighten security of ports and ships to counter global maritime terrorism threat and enforced on July 2004 [20]). MMEA must consider measures to identify the position of non- SOLAS ships. The low cost AIS (automated identification system) that costs between RM 1,000 - 2,000 should be made a requirement to be fitted on board every non-SOLAS ships.

Department of Immigration

The Department of Immigration has three major functions: issuance of Malaysian passports, travel documents, visas, passes and permits to foreigners; control of entry and exit of Malaysian citizens and foreigners through various gazetted check points; and enforcement of the Immigration Act, Passport Act and Immigration Regulations. According to the former Director of Enforcement Unit, Department of Immigration, Dato' Ishak Haji Mohamad, despite the number of irregular migrants remaining on the high side, clandestine entry has markedly declined. Clandestine entrants namely human trafficking victims number around 30% of illegal immigrants [46]. Entry into and exit from port of entry is under the purview of the Department. The Immigration Department acknowledges that it is getting more common to see traffickers using legal means to dupe victims. It was also getting increasingly difficult for the Department officials to differentiate trafficked victims from smuggled (voluntary) ones. Almost 10% of Malaysian population are foreigners and out of that figure, it was not clear how many are trafficked, though the Department regularly conducts raids and arrests foreigners without documents.

There is ongoing tension between immigration and migration. Domestic immigration laws here regulate the entry of non citizens to protect the borders and sovereign integrity of Malaysia. International migration laws recognise free movement of people between borders if their lives are in mortal danger which are at odds with Malaysia's immigration laws to keep these people at bay. A consequence of this is trafficking especially in view of the fact that it has not signed the United Nations Convention Relating to the Status of Refugees and syndicates take advantage of asylum seekers planning to enter Malaysia. Desperate people usually resort to desperate measures contributing to this transborder illegal recruitment and exploitation of vulnerable people especially when abetted by corrupt law enforcement officials. On August 1, 2010, 20 Immigration officials were suspended for alleged abetting in the release of 12 trafficked Afghans at the KLIA detention centre. This was a second such incident. On March 27, 2010, 13 Afghans and four Myanmar nationals had escaped the same depot using similar method of escape, after cutting through grilles to open two gates. The Minister of Home Affairs commented that it "would be meaningless to come up with a good system to manage foreigners if officers failed to carry out their duties with a high level of integrity and commitment" [47]. It is evident here the battle against trafficking would be lost if law enforcement officials are easily corruptible.

RECOMMENDATIONS

The challenges facing Malaysia's maritime surveillance force have changed dramatically over the past decade and transformed the security environment into something more complex and uncertain. This new scenario highlighted by the growing cases of human trafficking, shows that syndicates will inflict socio-political and economic damages through their criminal enterprise. Thus, good management of border security is vital through advancing surveillance, biometrics, detection and information sharing technologies. Credible deterrence and increasing interdiction capabilities

and capacity by maritime law enforcement agencies such as MMEA, MOF and the Immigration Department are essential. Since security measures at ports, airports and land border crossings are becoming more robust and sophisticated, syndicates are increasingly considering lengthy coastlines and uninhabited areas for unauthorised entry into Malaysia. Therefore, patrolling, monitoring and exerting unambiguous control over the maritime borders and sound maritime approaches are vital. Parts of the coastline which are relatively permeable (*jalan tikus*), such as those along the borders of Thailand-Malaysia, Sabah-Philippines and Sarawak-Indonesia, must see increased security and surveillance.

In fact, the Ministry of Home Affairs recently had asserted that the government is looking at the pattern of migration and monitoring the influx of migrants to Malaysia particularly the long sea borders of Sabah and Sarawak with Indonesia and Philippines, which are exposed and difficult to control. The government is also in the midst of scrutinising proposals to use radar technology to detect the movement of migrants in Malaysia in efforts to efficiently monitor the border. This is definitely a move in the right direction.

Two strategic actions to achieve the above are urgent: maximise Maritime Domain Awareness (MDA) and enhance regional cooperation. Domain awareness can provide early identification of potential threats and appropriate response. The MDA is the integration of Global Maritime Intelligence and Global Maritime Situational Awareness. Global Maritime Intelligence is the product of changing intelligence capabilities, policies and operational relationships used to integrate all available data, information, and intelligence in order to identify, locate, and track potential maritime threats. Global Maritime Situational Awareness on the hand results from the persistent monitoring of maritime activities for identifiable trends and anomalies [48]. It is nevertheless challenging. Malaysia's great length of shorelines, and vastness of the seas helps conceal and provide access points to the land. Thus, integrating intelligence, law enforcement information and public intelligence are vital.

Various maritime agencies such as the Fisheries Department, Marine Department and Customs Department in Malaysia must cooperate with each other through channelling relevant information to a single body such as MMEA to collect, fuse, integrate and disseminate timely intelligence and information. A robust maritime command and control system can be achieved through establishing this intelligence enterprise.

Securing Malaysia's maritime domain must also enlist the support of regional and international bodies as the issue of human trafficking could damage both regional and international relations. In addition, increased economic interdependency and globalisation made possible by maritime shipping emphasises the need for coordinated approach through patrols and intelligence/information sharing. Coastal security must be enhanced and a coordinated arrangement that involves vessel identification, identity for fishermen and installation of a chain of coastal radars. Restrictive human trafficking measures implemented by other countries in the region will reduce the amount of trafficking in Malaysia. Improved transparency in the registration of vessels and identification of ownership, cargoes and crew of the multi-flag vessels are essential. Syndicates are exploiting these weak regulations and enforcement by re-registering vehicles under fictitious corporate names, renaming and repainting vessels. New initiatives with

International Maritime Organisation and the World Customs Organisation will ensure reduced threat from syndicates as information and intelligence gathering from them would help regional nations in interdiction efforts. Reinforcing information exchange among agencies of neighbouring countries is essential to evaluate risk for vessels. Monitoring of illegal movements of boats and ferries can help the law enforcement officials to intercept trafficking syndicates. In addition, it should be made compulsory for small vessels to obtain Port Clearance (document for entry and exiting a port), making monitoring illegal vessels easier.

Shared understanding of threat priorities will help unify actions and plans. Malaysia, Indonesia and Australia are the main targets of human trafficking syndicates. Malaysia is a source, transit and destination country, while Indonesia is a source and transit country; Malaysia and Indonesia are used as transit countries by syndicates for victims destined to Australia. Malaysia had conducted talks with Indonesia to develop a framework of cooperation and monitor the sea by deploying high speed mobilization boats and patrol boats. By regulating and monitoring movement of boats and ferries and also checking immigration status of passengers at ports, influx of smuggling and trafficking can be contained [20].

As the nature of the crime spans national boundaries and jurisdiction, transnational efforts are vital, both in terms of security cooperation as well as economic collaboration. Though Malaysia is working closely with source and transit countries such as Thailand, Indonesia, Cambodia and Vietnam to promote development of cooperative mechanism to counter this threat, it has to boost the existing cooperation through greater economic investment and security collaboration to boost maritime security. In addition, that collaboration must extend to post conflict societies, such as Afghanistan, Sri Lanka and Iraq, which are experiencing political and economic instability and its citizens increasingly seeing Malaysia as a lucrative economic destination.

However, eradicating human trafficking phenomena does not rest solely on tighter border control and surveillance. The latter is slowly giving way to the expansion of fake document industry and the entry of irregular migrants via legal means who are later exploited and forced into servitude and debt bondage. Corruption among low level officials at the state bureaucracy in facilitating acquiring of fake identity cards in Sabah has been uncovered [49]. In addition, many migrants are duped into buying fake employment documents. The author agrees with the perspective of the International Organisation for Migration (IOM) that human trafficking and human smuggling cannot be effectively contained by tightening border security and enacting tougher anti-trafficking laws only [50]. Syndicates are gaining in sophistication and volume, and are capable of finding alternative routes to ply their trade. Thus, root causes of trafficking must be addressed. Poverty is the driving force here which leaves people vulnerable. It is likely to take decades if efforts are limited to fighting trafficking at the border level only. Better bilateral and multilateral economic ties and enhancing trade relations between Malaysia and source countries in the region would go some way in addressing conditions in the latter countries. Malaysian companies must be encouraged to invest in Cambodia, Vietnam, Myanmar and other poorer ASEAN countries to build up the economy and create more employment opportunities. This would prevent the poor from remote regions from being deceived into promises of jobs in relatively rich destination countries like Malaysia.

Addressing the systematic structural factors that give rise to exploitative labour practices is crucial. Anti trafficking laws must provide opportunities for victims to become regular migrants with decent wages and working conditions. In fact, the International Labour Organization (ILO) believes that "legal labour migration channels contribute to both reducing trafficking in children and women and the smuggling of migrants" [51]. IOM also agrees that orderly migration management is important to protect the state against unauthorised migration which violates state security.

However, it is crucial that existing mechanisms to identify trafficking victims must be fool-proof and effective i.e. its ability to distinguish genuine trafficking victims from impostors. Law enforcement officials have expressed concern that extremists may disguise themselves as victims to penetrate Malaysian intelligence and inflict terror in the home ground. The concerns are valid and should not be brushed aside especially in the post 9/11 security scenario. Thus, it is vital there is constant interaction between enforcement officials with NGOs working in the field via training mechanisms to assist only genuine victims. This ensures national security is not compromised.

CONCLUSION

Malaysia's fundamental concern is to protect its national security interests against enemies. Human trafficking poses a severe challenge to this. This transnational crime is facilitated by economic globalisation with poor and desperate migrants becoming victims of syndicates who deceive them into promises of lucrative jobs abroad. It is aided by significant political and economic instability in source countries which have inadequate law enforcement capabilities. The syndicates are well organised and well equipped and use the oceans for illegal trading of humans as the relatively undefended coastlines are less risky alternative for unlawful entry into Malaysia. The illicit maritime trade generates vast amounts of cash and a huge source of virtually untraceable funds. Some of these monetary assets are used to bribe law enforcement officials and fund additional illicit activities.

A significant commitment related to investment in sophisticated technology and assets are needed to tighten border security and surveillance especially since some of the equipment is considered old and not cost effective to maintain. The possibility of terrorists taking advantage of smuggling and trafficking networks to bypass border security measures cannot be ruled out. Security of the maritime domain entails cooperation with regional nations to protect common interests as human trafficking does not recognise political or geographical boundaries Specific interventions are necessary such as structural reforms to address underlying conditions leading to forced labour migration and enslavement through developing legal migration regimes which will prevent illegal migration and counter public corruption of government officials, distortion of wage and prevent traffickers from amassing huge fortunes that drive the underground economy

Thus, good border management demands that security should not be pitted against economic well being. Malaysian government must facilitate and defend trade for smooth flow of shipping as it is a major trading nation and our economy is inextricably linked with the oceans for commerce and resources. The government must facilitate the movement of goods and people across the nation's borders while screening out illegals. Malaysia's prosperity and security depend on effective handling of the human trafficking challenge.

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the profits they have made as well as cover the cost of housing and deporting the migrants. The amendments sought to tackle human trafficking in a more comprehensive manner as the crimes included smuggling of drugs and firearms. It criminalises the exploitation of migrants and generating illegal income from the smuggling or harbouring of migrants. It was hoped that with the new amendments, and strengthening of investigation methods, evidence gathering and victim protection Malaysia can be placed in Tier 2 proper of the US State Department TIP Report.

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REVIEW OF ARMOUR PROTECTION TECHNOLOGY FOR THE FUTURE LIGHT ARMOURED VEHICLES

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ABSTRACT

The development of the DEFTECH AV4 (4 × 4) light armoured vehicle(LAV) which commenced in early 2005 by DRB-HICOM Defense Sdn. Bhd.(DEFTECH), is the first armoured fighting vehicle to be designed and built in Malaysia. Though the vehicle has not made any breakthrough into the local or international market, it has created confidence for the government to provide comprehensive support to DEFTECH to venture into the design and manufacturing of an armoured wheeled vehicle (AWV). In the current warfare scenario, where significant number of battles are fought in the urban areas by unconventional forces, using small and medium caliber weapon besides extensive use of rocket propelled grenades and improvised explosive devices, the development of a light armoured vehicle must consider an all round protection against these threats. With the better understanding of material technologies and warhead attack mechanisms, armour developers have successfully developed protection systems that can withstand attack by bigger threats such as the medium cannon, besides designing mechanism to defeat shaped charge warheads. This paper discusses the current and the ongoing researches in armour protection technologies for consideration in the development of a light armoured vehicle.

INTRODUCTION

The defence industry sector the world over has played vital roles towards building indigenous industrial capability, technological development, providing economic spin offs including export activities and employment creation, as well as human capacity building. It has been instrumental towards various technological breakthrough as well as creating downstream industrial activities into the civil sectors [1]. With these incentives in mind, the introduction of the Defense & Security Technology Park (DSTP) in Sungkai, Perak by the Malaysian government, shows her seriousness to propel the country into an innovation-led economy, by hosting the most advanced and fully integrated centre for research and development towards producing innovative defense industry related products. The DSTP is envisioned to be a premier defence technology park with advanced infrastructure and services that will facilitate knowledge-based economy to grow and compete in the global market [2].

The development of defence related system is not new to the country. The research and development of the DEFTECH AV4 (4 × 4) light armoured vehicle which commenced in early 2005 by DRB-HICOM Defence Sdn. Bhd. was the first armoured fighting vehicle to be designed and built in Malaysia [3]. Though the DEFTECH AV4 has not made any breakthrough into the local or international market, it has created confidence for the government to provide comprehensive support to venture into the design and manufacturing of an armoured wheeled vehicle (AWV). The entire process of the 8x8 AWV program involves the local design, development, testing, qualification, manufacture, supply and provision of technical support and maintenance throughout its life cycle [4].

The design of the 8x8 AWV will take into consideration the protection system to suit the current trend of threats from conventional small and medium caliber weapon and the protection against mine blasts, the rocket propelled grenades (RPGs) and the improvised explosive devices (IEDs). Besides the basic armour, appliqué armour technology will be utilized to provide a higher level of protection [5].

CHALLENGES TO THE DEVELOPMENT OF LIGHT ARMOURED VEHICLES

Change in Threat Environments.

Most of today's military equipment and organization were originally designed to fight in conventional warfare environment. A common scenario was that the opposing force would attempt to occupy land. Defense against such an assault was perceived to require heavy weapons such as tanks, fighters and bombers and possibly aircraft carriers. However, with the downfall of the Russian bloc, a similar threat has not emerged. It is now difficult to predict with a high degree of confidence the identity of the countries or the actors that may threaten the country's interests and security [6].

Current studies see a "broad arc of instability" from the Middle East to Northeast Asia, where non-state entities whose activities are damaging (drug trafficking, terrorism, etc.) are growing in strength and finding safe-haven in weak and failing states. In addition, new technologies (especially information technology and those related to chemical, biological, radiological, nuclear, or enhanced high-explosive weapons) are increasingly emerging within the reach of potential adversaries, and warfare may extend to space and cyber space.

To sum, up many analysts believe that the state nations are now faced with "asymmetric warfare," in which means such as drug-trafficking, terrorism, and biological warfare would be used to attack nation's interests. The event of September 11 appears to confirm the judgment that the threats of the future are unlikely to look like the threats of the past. Another term used in military theory which also expresses the idea of transformation is "revolution in military affairs" [7].

As the main thrust of warfare is moving from the well defined formative maneuver of a conventional battle formations, of which the use of tanks and heavy artillery, besides the attack by bomber aircraft and fighter jets are significant in winning a battle, the change of threat environment, of which the definition of 'enemies' are always difficult to be specific, and the direction of threats are always not clearly defined, the advantages of the battlefields has moved on the 'enemies' side. In this situation, the use of LAV has increasingly become more significant as seen in the deployment of peace enforcement forces in conflict areas such as in Iraq, Afghanistan, Lebanon and other affected nations.

Roles of Light Armoured Vehicles

Infantry Fighting Roles. An infantry fighting vehicle (IFV) is an armored personnel carrier which can provide significant fire support. Modern IFVs are well-armed infantry carriers, differing from earlier APCs by their heavier armament allowing them to give direct-fire support during an assault. Many also have firing ports allowing the infantry to fire personal weapons while mounted. They are typically armed with a 20mm or larger cannons such as 35mm or 40mm caliber, and possibly with Anti Tank Guided Missiles (ATGMs). Specially-equipped IFVs have taken on some of the roles of light tanks; they are used by reconnaissance organizations. Some light IFVs are used by airborne units which must be able to fight without the heavy firepower of tanks on deployment [8].

The Reconnaissance Roles. Some LAV are organized, equipped, and trained to conduct reconnaissance and limited security tasks for its parent battalion. The platoon's primary mission is to provide battlefield information. The reconnaissance platoon also assists in the tactical control, movement, and positioning of the battalion's companies and platoons. The reconnaissance platoon is employed under battalion control, but it may be detached for a specific operation. The reconnaissance platoon can also be tasked to conduct zone reconnaissance [9]. Such tasks given to reconnaissance platoon are:

i. To conduct area reconnaissance.
ii. To conduct route reconnaissance.
iii. To screen within the platoon's capability.
iv. To conduct surveillance of critical areas of concern.
v. To guide maneuver forces.
vi. To conduct chemical detection and radiological survey and monitoring.

Personal Carrier Roles. An Armored Personnel Carrier, or APC, is used primarily to transport soldiers into battle. With a tough armored body, APCs are able to safely carry infantry personnel into combat zones – protecting them from enemy fire, explosions, and shrapnel. Many models of APCs are armed only with a machine gun. As such, the vehicles are not designed to remain in combat or take part in fire fights [10].

Protection Capability of Modern Light Armoured Vehicles

With the advanced knowledge in material science, armor protection scientists have worked extensively to develop mechanisms to defeat the main threats from advanced warheads. Some of the armor protection inventions have enabled a LAV to withstand impacts from medium cannons of up to 30mm calibers. The following paragraphs highlight some of the armour protection capabilities developed for the latest modern LAV.

The Pandur II 8x8 vehicle, developed as a private venture by the Austrian company Steyr-Daimler-Puch Spezialfahrzeuge and is currently in production for the Portuguese Armed Forces, has the protection capability against 7.62mm armour piercing rounds. It also incorporates add-on armour which increases the protection level against 14.5mm armour piercing shells at 100m. Spall liners and additional armour protection against landmines can also be fitted as options [11].

The Swedish Defence Materiel Administration (the FMV) and the BAE Systems Hägglunds have been working on the Splitterskyddad EnhetsPlattform (SEP) or Modular Armoured Tactical System to meet the future operational requirements of the Swedish Army. The requirements included vehicles that were not only more capable but also modular, flexible and that are upgradeable. To meet these requirements, SEP is claimed to have an innovative and advanced design, to be used for a wide range of functions and roles on a uniform basic platform. The active protection system of the SEP Armoured Fighting Vehicles offers high level of protection which can be fitted with add-on armor against heavy machine gun fire, artillery shell splinters and landmines. It can withstand attack from RPG-7 rounds resulting in no serious damage from explosives [12]

The SUPERAV by IVECO S.pA design exploits the lessons learnt from operations in Iraq and Afghanistan, with the innovative chassis and hull design providing high levels of protection against both mine and IED attack without compromising the vehicle's amphibious performance. By designing in survivability from the outset, Iveco's engineers have ensured that, even at the lower gross vehicle weight available, the SUPERAV will have the highest protection in its class. Survivability is enhanced by a series of design innovations, including high performance on-board fire fighting and anti-explosion systems [13].

The 8 x 8 Freccia Medium Armoured Vehicle developed by the Consortium of Iveco and Oto Melara for the Italian Army is protected against 20mm attack over the frontal arc and with all round protection against 12.7mm attack and can be fitted with up to three tons of additional passive or reactive armour[14].

The MOWAG Piranha IV armored personnel carrier, designed by General Dynamics European Land Systems - Mowag GmbH Corporation is another vehicle having a high level of protection. Besides, it was designed with increased internal volume and greater carrying capacity. The Piranha IV is fitted with a high hardness armor steel hull,

with provision for add-on armor kits. The vehicle can be fitted with level B modular armor package which provides an all-round protection from 14.5-mm armor-piercing projectiles. Over the frontal arc protection is provided against 30-mm armor-piercing rounds. The hull floor of the Piranha IV is protected against 8 kg anti-tank mines [15].

The Infantry Armoured Vehicle (IAV) Stryker, produced by General Dynamics Land Systems hull is constructed from high-hardness steel which offers a basic level of protection against 14.5mm rounds on the frontal arc, and all-around protection against 7.62mm ball ammunition. In addition to this, Strykers are also equipped with bolt-on ceramic armor which offers all-around protection against 14.5mm, armor-piercing ammunition, and artillery fragments from 152mm rounds. In addition to the integral ceramic armor, Stryker reactive armor tiles (SRAT) protects the vehicles from improvised explosive devices [16].

The Singapore's AV-82 Terrex 8x8, jointly developed by the Singapore Technologies Kinetics and Turkish firm Otokar, is constructed of all welded steel, with modular armour. Its all-round armor protects occupants from small arms fire, while the frontal armor withstands 12.7-mm armor piercing bullets. Add on armor plates can be added for a higher level of protection. The vehicle has a V-shaped hull, which deflects mine blasts. It can withstand up to 12 kg TNT explosion under the hull and the vehicle can still keep on moving [17].

The Nexter Systems VBCI 8 x 8 was designed to meet the French Army requirement for the infantry combat vehicles and armoured personnel carriers. It operates in high intensity operations alongside the Leclerc main battle tanks. The crew and troops are protected from a range of threats, including 155mm shell shrapnel and small and medium caliber shells. The welded steel and aluminium alloy hull is fitted with spall liners and add-on titanium armour plate to protect against anti-tank weapons. This is claimed to provide protection over the frontal arc against medium-caliber attack and RPG-7s and similar threats. Other appliqué armour systems are being considered, for example explosive reactive armour. The vehicle is claimed to have a high level of protection against mines [18].

BTR-90 (GAZ-5923) is an 8×8 wheeled infantry fighting vehicle developed for the Russian Army. The armour of the BTR-90 comprises welded steel armour plates. The armour can withstand hits from 14.5 mm rounds over the frontal arc. The side armour can provide protection against large caliber machine gun fire and shrapnel. Additional armoured plates can be installed on the vehicle to increase protection. Active protection methods such as explosive the reactive armour can also be used,. These can be added over the existing armour of the vehicle [19].

The race to provide higher protection for the crews of the LAV has seen a great number of innovations among the armour system researchers. The armour technologies of the past such as the rolled homogenous armour (RHA) has given ways to modern armour materials such as the titanium alloy, high strength aluminum alloy, very high hardness

materials, ceramic and composite materials. Besides, the utilization of electromagnetic and electrical means in active armour provide increase in protection levels in the LAV. The new findings and innovations provide solutions to improve the protection to the LAV, resulting in new challenges to warhead designers to find ways to improve lethality to their inventions.

CONVENTIONAL THREAT ON LIGHT ARMOURED VEHICLES.

Protection Level of a Light Armoured Vehicles.

Protection Levels Against Kinetic Energy Threat. The guideline for the protection of an LAV describes the system qualification and acceptance procedure for determining the Protection Level of Logistic and LAV for kinetic energy (KE) and artillery threats. The threats to be considered are small and medium caliber KE ballistic rounds and fragment simulating penetrators (FSP) representing artillery shell fragments, as defined in STANAG 4569(See Table 1). This process includes standard techniques and reproducible test procedures for evaluating the ballistic resistance of vehicle armour components (integral, add-on, opaque and transparent).

Table 1: NATO AEP-55 STANAG 4569 - Protection Levels for occupants of logistic and light armoured vehicles

Level	KE Threat	Bullet	Distance	Velocity*
I	Rifle	7.62 x 51 NATO Ball (Ball M80) 5.56 x 45 NATO SS109 5.56 x 45 M193	30 Meters	833m/sec (M80) 900m/sec (SS109) 937m/sec (M193)
II	Infantry Rifle	7.62 x 39 API BZ	30 Meters	695m/sec
III	Sniper Rifle	7.62 x 51 AP (WC core) 7.62 x 54R B32 API (Dragunov)	30 Meters	930m/sec (51 AP) 854m/sec (54R)
IV	Heavy Machine Gun	14.5x114AP / B32	200 Meters	911m/sec
V	Automatic Cannon	25mm APDS-TM-791 or TLB 073	500 Meters	1258m/sec

Protection Levels Against Mine Blasts and IEDs. Anti vehicle mines rely on the blast effect from the main explosive charge (normally 5-7 kilograms) to incapacitate vehicles. The charge is usually initiated by a pressure mechanism that activates the mine. While the blast effect is devastating to light, soft-skinned vehicles, damage to medium-size armoured vehicles is usually contained to the wheel stations or tracks. The shock effect transferred to the hull can cause injury to occupants, especially if the hull is penetrated. Most of modern LAV is designed to withstand blast against anti tank mines of at least Level 3 (Protection Level Specification as in Table 2 below). Additional design feature such as ‘V’ shaped underbelly design may improve the protection further.

Table 2: Protection Levels of LAV as Per Stanag 4569 specifications against blast mine threats.

LEVEL		Grenade and Blast Mine Threat	
4	4b	Mine Explosion under center	10 Kg (explosive mass) Blast AT Mine
	4a	Mine explosion pressure activated under any wheel or track location	
3	3b	Mine explosion under center	8 Kg (explosive mass) Blast AT Mine
	3a	Mine explosion pressure activated under any wheel or track location	
2	2b	Mine explosion under center	6 Kg (explosive mass) Blast AT Mine
	2a	Mine explosion pressure activated under any wheel or track location	
1	Hand grenades, unexploded artillery fragmenting sub munitions, and other small anti-personnel explosive devices detonated anywhere under the vehicle		

Conventional Threats to Light Armoured Vehicles.

The threat faced by the LAV can be classified into two categories;

i. **Kinetic Energy (KE) Rounds.** The KE rounds are the war heads made of high density metals such as the tungsten or depleted uranium with the density exceeding 18,000kg/m3 (compared to the density of the armour steel of around 9000kg/m3) The kinetic energy rounds produce a high kinetic energy on impact. The net penetration is influenced by the difference between the penetrator and the target density. Examples of the KE rounds are the Armour Piercing (AP) rounds and the Armour Piercing Fin Stabilised Discarding Sabot (APFSDS) rounds.

ii. **Chemical Energy (CE) Warheads.** Chemical energy warheads utilizes the energy created from the detonation of its main explosive, commonly the TNT, RDX, HMX or Comb B, to destroy a target. A CE warhead creates high pressure blast waves which can destroy defensive infrastructures such as protective bunkers or military vehicles.

Examples of CE warheads are the RPGs, the explosively formed projectiles (EFP) popularly used in making the IEDs and High Explosive Squashed Head (HESH).

a. **Armour-Piercing (AP) Rounds.** An AP round is a type of ammunition designed to penetrate armor by attaining a high velocity, and collide with their target, converting their kinetic energy into destructive shock waves and heat. At a lower velocity of around 1000m/s, the KE rounds punches the target armour causing either penetration through the armour or creating spalling effects due to its tensile stresses on the rear side of the armour. AP rounds are still commonly used in small or medium caliber weapon systems [20].

b. **Armour-Piercing Fin Stabilised Discarding Sabot (APFSDS)**. A type of kinetic energy projectile fired from a cannon or a gun to attack armoured targets. Traditionally, shells are given stability in flight from the rifling of the gun barrel, which imparts a spin to the round. Up to a certain limit this is effective, but once the projectile's length is more than six or seven times its diameter, rifling becomes less effective. Adding fins to the base of the round gives the round stability, hence Armour-Piercing Fin-Stabilized Discarding Sabot (APFSDS) (Figure 1). APFSDS rounds generally operate in the range of 1,400 to 1,900 km/s. The sabots also travel at such a high velocity that upon separation, they may continue for many hundreds of meters at speeds that can be lethal to troops and damage light vehicles [21]

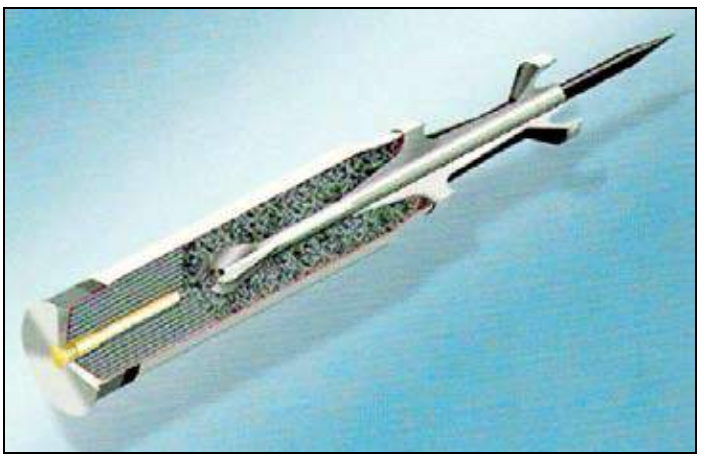

Figure 1: A cutout diagram of a Fin Stabilized Discarding Sabot [22]

c. **Rocket-Propelled Grenade** (RPG). An RPG is a shoulder-fired, anti-materiel weapons system which fires rockets equipped with an explosive warhead. These warheads are affixed to a rocket motor and stabilized in flight with fins. Some types of RPG are reloadable while others are single-use. RPGs, with the exception of self-contained versions, are loaded from the muzzle. RPGs are

very effective against armored vehicles such as armored personnel carriers [23]. Typical RPG utilizes the High Explosive warhead to inflict damage on the target. The HE warhead detonates upon impact. The warhead case and charge generate a moderate amount of fragmentation, which can pass through many obstacles [24]. Another commonly utilized warhead is the Monroe-effect shaped charge. A shaped charge warhead is made of a concave metal hemisphere or cone (known as a liner) backed by a high explosive, all in a steel or aluminum casing. When the high explosive is detonated, the metal liner is compressed and squeezed forward, forming a jet whose tip may travel as fast as 10 kilometers per second. The jet properties depend on the charge shape, the energy released, and the liner mass and composition. A shaped-charge warhead can be expected to penetrate armor equal to 150-250% of the warhead diameter [25]. The shaped charge jet causes fire inside the hull of the LAV.

d. **Explosively Formed Penetrator** (EFP) also known as a self-forging warhead, or a self-forging fragment, is a special type of shaped charge designed to penetrate armour effectively at standoff distances. The force of the blast molds the liner into any of a number of configurations, depending on how the plate is formed and how the explosive is detonated. Sophisticated EFP warheads have multiple detonators that can be fired in different arrangements causing different types of waveform in the explosive, resulting in a long-rod penetrator, an aerodynamic slug projectile or multiple high-velocity fragments. A less sophisticated approach for changing the formation of an EFP is the use of wire-mesh in front of the liner: with the mesh in place the liner will fragment into multiple penetrators. As a rule of thumb, an EFP will perforate a thickness of armour steel equal to half the diameter of its charge for a copper or iron liner, and armour steel equal to the diameter of its charge for a tantalum liner, whereas a typical shaped charge will go through six or more diameters. EFPs have been used extensively in improvised explosive devices against armoured cars with introduction in IEDs by insurgents in Iraq and Afghanistan. [26]

e. **High Explosive Squash Head** (HESH). HESH is a type of chemical energy ammunition which is not velocity dependent. In this round the explosive is contained in a thin-walled projectile which collapses on striking the target, allowing the plastic explosive to spread. A base fuse then detonates the explosive which sends strong shock waves through the armour. Reflection from the internal armour surface causes an overmatch of the armour which then fails, causing a large 'scab' or 'spall' to form and fragments to fly off inside the vehicle as shown in Figure 3 [28]

f. **Anti Tank Mine Blasts**. Traditionally, guerilla forces use standard mines to hit enemy patrols and military vehicles. Such mines included small (anti-personnel) or larger anti-tank mines, as well as armor penetrating and self-forged fragmentation (SFF) mines. Mines originally developed as a defensive weapon, were originally used to delay and disrupt enemy movements into a defense organized area [29].

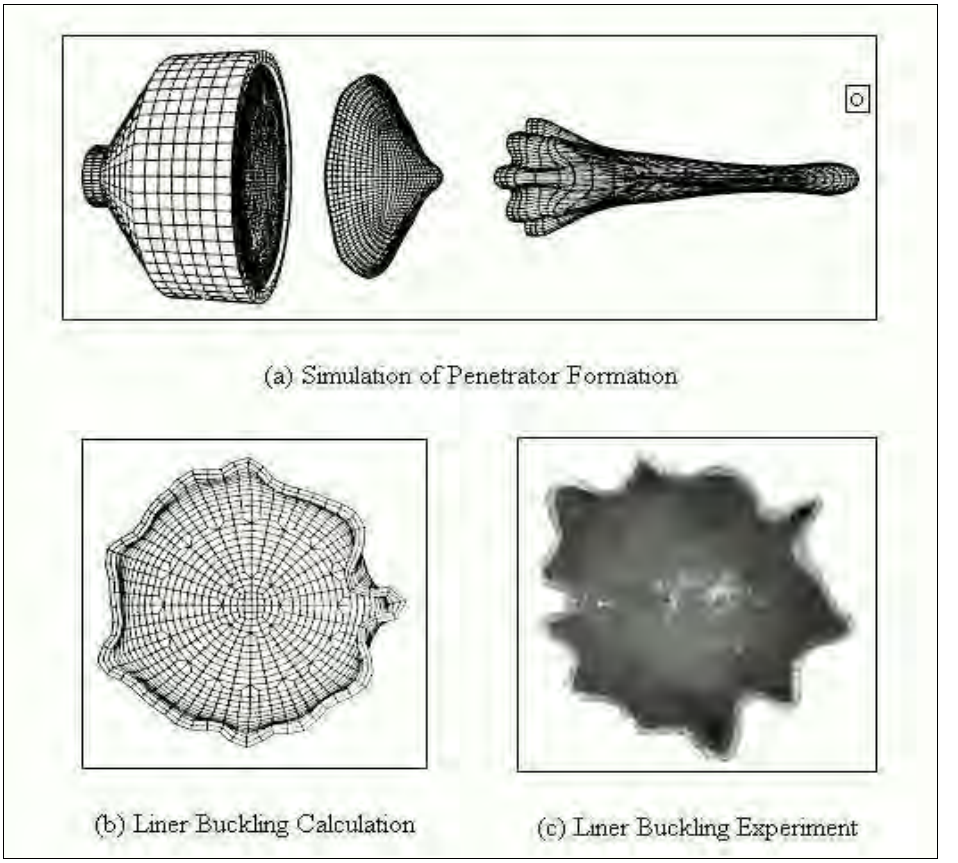

Figure 2: Simulation of Explosive Penetrator Formation with dynamic buckling of the liner [27]

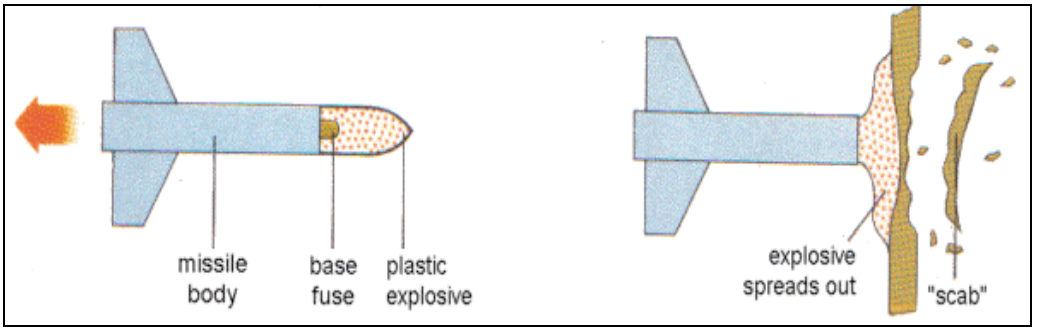

Figure 3: Operation of High Explosive Squashed Head Round [28]

The destruction due to mine blast is from its extensive release of blast wave from an explosion. An explosion of a mine is defined as a large-scale, rapid, and sudden release of energy. The detonation of a condensed high explosive generates hot gases under pressure of up to 300 kbar and a temperature of about 3000 to 4000°C. The hot gas expands, forcing out the volume it occupies. This is followed by the formation of a blast wave. The blast wave instantaneously increases to a value of pressure above the ambient atmospheric pressure which is referred to as the side-on overpressure and decays as the shock wave expands outward from the explosion source. After a short time, the pressure behind the front drops below the ambient pressure. Finally, in the explosion event, the shock wave will become negative, creating vacuum and high intensity pressure that, accompanied by high suction winds, carry the debris for long distances away from the explosion source [30].

PROTECTION TECHNOLOGY FOR LIGHT ARMOURED VEHICLES

Operations in former Yugoslavia, Somalia, Israel, Afghanistan and Iraq have shown the need for all-round protection particularly when operating in urban environments. Armoured vehicles must offer protection against a range of threats, including medium and large-caliber kinetic energy rounds, shaped-charge warheads, explosively formed projectiles, high explosive squash head, shell fragments and small arms. All of these weapons are becoming more lethal. To counter the ever improving improvement in warhead designs, armoured vehicle developers have increased their effort to develop a better protection for their armoured vehicles. The armour protection of a combat vehicles has always been constrained by its weight. With this, countering the threat level has become an increasingly serious problem. Much effort has been devoted to the development of armour that would provide greater ballistic protection with small increase in vehicle weight.

High Hardness Armour Steel.

Steel for armour plate must be strong, hard, and tough (does not shatter when struck with a fast, hard blow). Rolling and forging (hammering the steel when it is red hot) homogenizes the grain structure in the steel, removing imperfection which would reduce the strength of the steel. Rolling also elongates the grain structure, which enable the stress under which the steel is placed when loaded to flow throughout the metal, and not be concentrated in one area. RHA, an earlier type of armour, is called homogeneous armour because its structure and composition is uniform throughout its section. The face of the steel, which starts as an RHA plate, is hardened by a heat-treatment process [31] Steels for armouring are generally characterised in having a predominantly tempered martensitic structure. Such martensitic armour steels have high strength and good ballistic performance properties, which enables the steel to resist the impact of a high velocity projectile. Armour steel alloys can have a variety of chemical compositions. Through the years military and security specifications have been developed which mostly focused on improving the hardness and impact resistance properties, and also the yield and tensile

strength of these various alloys. One of the main thrusts of these developments has been to lower the thickness of the armour plate in order to reduce the mass of armoured vehicles and body armour [32]

Armour steel manufactures have increased the availability of quenched and tempered armor steels by updating current steel military specifications. The most important has been the updated specification for high-hardness armor (HHA). One of the high-performing steel alloys for AP bullet protection are the HHA with a hardness range of 477–534 Brinell hardness number (BHN), This HHA specification allows modern continuous processing technologies to be used efficiently and offers a new class of auto-tempered high-hard steels. Reports have been documented that the ballistic performance of the auto-tempered HHA steel has resulted in a tough high hardness steel for both blast and ballistic applications. The development and availability of air-quenched, auto-tempered HHA steel increases the availability of high hardness plate, as traditional water or oil quench and temper facilities are not required. This new class of tough HHA steel plates will increase the metallic armor solutions for armor designers [33]

Another high performance steel alloy is the dual hardness armor (DHA), which is produced by roll bonding a 601–712 BHN front plate to a 461–534 BHN back plate. The composites of the two steels are used where one is chosen for its hardness and the other for its toughness. The concept of dual hardness composite armor involves the use of a hard front side that breaks up the projectile such as the penetrator of an armor-piercing projectile. The front side is not intended to shatter or spall even though it may be cracked by the ballistic impact because the front side is metallurgically bonded to a tougher crack-arresting rear side. Generally, such armor plate is produced by selecting two steel compositions, producing each of them in a plate product form, and then roll bonding them to form the composite dual hardness armor steel plate [34].

Experimental results show that the targets of dual hardness exhibit very good resistance against the impact of AP projectile. This ballistic performance increases with the increase of the thickness of the steel with higher hardness. This is valid up to some value of this thickness [35]. While both these metal specifications serve their intended applications, considerable efforts to develop monolithic ultra-high hardness (UHH) steels with a hardness of 600 BHN or greater have been accomplished [36]

Aluminum Armour.

Owing to their strength-to-weight ratio, plasticity, fracture toughness and corrosion resistance, aluminum alloys are widely applied in military industry. New technologies and intensive activity in this field enabled replacement of steel parts by aluminum alloys in development and production of modern fighting vehicles, missiles and ammunition, fighter aircrafts, floating bridges, etc [37]. Aluminum is much lighter than steel and relatively strong. Aluminum 5083 H115, constructed from the aluminum - 4.5% magnesium alloy, are being used in the US Combat Systems M113 series of armoured vehicles. It is able to take advantage of up to 20 per cent weight savings over steel

without reducing protection levels. Although the resistance of this alloy to 7.62mm armor-piercing (AP) attack is slightly less than that of steel, it is slightly better than steel for 14.5mm diameter AP, and the vehicle is lighter than an equally protected steel version. Additional weight savings are gained from the use of aluminum because of the greater rigidity of the thicker, but lighter plate, nine times stiffer than steel, with the consequent saving on stiffening structure. [38]

A demand in the early 1960s for lighter and therefore ballistically stronger aluminum armor led to the introduction of a heat treatable, weldable aluminum - 4.5% zinc - 2.5% magnesium alloy designated 7039. The aluminum 7039 was later further upgraded into the slightly stronger and more corrosion-resistant alloy 7017. A comparison of this alloy with steel for 7.62mm AP and 14.5 mm AP is a weight saving of about 20% is shown for 7017 when using the 14.5 mm round (See Table 3).

Selection of the alloy by the vehicle designer not only requires consideration of the type of threat in each particular area of the vehicle but also must take into consideration other characteristics such as stress corrosion resistance. Like many other structural materials, the aluminum alloys have, to varying degrees, some susceptibility to stress corrosion [39].

Table 3: The comparison of Al 5000 grades compared to Al 7000 grades.

Alloy	0.2% P.S. (MPa)	U.T.S. (MPa)	Elongation % on 5D	Density g/cm^3
5083-H115	290	360	9	2.66
7017-T651	425	485	12	2.78
7018-T7651	300	360	13	2.79
7020-T651	360	400	12	2.78
7039-T651	400	460	12	2.78

When aluminum corrodes the surface of the plate is covered by the product of the corrosion. The product of this corrosion is Aluminum Oxide; a ceramic and is the 3rd hardest substance known. In its crystalline form, called corundum, its hardness makes it suitable for use as an abrasive and as a component in cutting tools. Corundum is the second hardest material after a diamond. Aluminum oxide adds great mechanical strength, has excellent resistance to corrosion and wear, and is a nontoxic material [40].

The thin coating protects the aluminum under the surface and stops further corrosion. Steel on the other hand, when it corrodes, the Iron Ferrite peels straight off and exposes the underlying material, which is why steel rusts so fast. The only real difference between aluminum and steel is that aluminum losses its strength at a much lower temperature, meaning that an aluminum vehicle that has burnt will generally collapse.

Titanium Armour.

During the past several years, there is a continuing urgent need to reduce the weight of all ground vehicles. Titanium is an "excellent alternative to steel" because it is 30% lighter. A study to compare the efficiency of Titanium shows that, with the same strength as steel armour, it has a density about 40% less [41]. The consideration of replacing Titanium to the current steel armour is also due to its cost advantage. The current steel turret, hull, and suspension represent 70% of the weight of an armoured vehicle, but only at 23% of its cost. Thus, a lighter-weight, higher-cost armor materials would have a small impact on the cost of the finished product. Because of their unique combination of properties, titanium alloys offer the most cost-competitive way of substantially reducing weight while maintaining survivability. The U.S. Marines will likely adopt titanium alloys for their future combat vehicles. These vehicles are expected to weigh between 10 and 20 tons, and capable of surviving attacks from ballistic and blast threats [42].

Titanium alloys offer many advantages (comparison between steel, aluminum and titanium performance in Table 4). The alloys have a high mass efficiency compared with RHA and aluminum alloys across the spectrum of ballistic threats as well as good multi-hit ballistic capability. No additional appliqué armor is necessary. They have a high strength-to-density ratio and excellent corrosion resistance, which results in lower maintenance costs. Titanium alloys are readily fabricated in existing production facilities and are easily recycled; scrap and mill revert is currently remelted on a large-scale commercial basis [43]

One disadvantage with Titanium is adiabatic shear band formation, which may result in spalling. Resistance of materials to ballistic impact can be substantially enhanced if we can avoid formation of adiabatic shear bands. Another disadvantage of titanium is its high cost. Although titanium alloys have been used successfully in aircrafts for many years, the high cost of titanium which has become even higher recently making it 10 times costlier that steel, coupled with the sparse information on its ballistic properties have prevented widespread use of titanium in ground vehicles [44].

Table 4: Properties of steel, aluminum and titanium armor

	Steel	Aluminum	Titanium
Tensile Strength (MPa)	1,170	350	970
Density (g/cm^3)	7.86	2.70	4.50
Specific Strength* (MPa-cm^3/g)	150	130	220
Mass Efficiency (E_m)**	1	1.0-1.2	1.5
Tensile Strength (MPa)	1,170	350	970
* Specific strength—tensile strength divided by density. ** Mass Efficiency (E_m)—the weight per unit area of RHA required to defeat a given ballistic threat divided by the weight per unit area of the subject material.			

Ceramic Armour.

Ceramic materials have been applied in armour systems for several decades due to its low density and high compressive strength. Early work on failure mechanism of ceramic/metal was done in the late 1960s, proving that the impact produces a conoid spalling on the ceramic back surface at the beginning of penetration that the mechanism of a major damage is in the following sequence: formation of tensile radial cracks on the rear surface, propagation of a shear dominated cone crack and fragmentation and crushing of the cone crack envelope under compressive stresses [45]. The distribution of energy among the fragments of ceramic is illustrated in a numerical analysis shown in Figure 4.

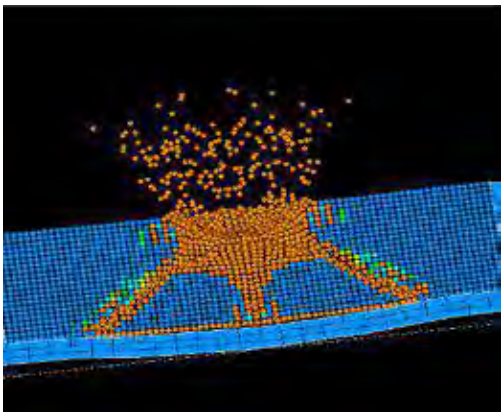

Figure 4: Numerical analysis of the formation of conoid spalling, distributing the energy of penetrators among the fragments [46]

Ceramics have the attractive properties of higher hardness, lower density, higher modulus coupled with some flexural strength and fracture toughness. Metals on the other hand provide the higher strength and toughness combinations with lower hardness levels. Table 5 shows the typical properties of ceramic armour materials with these important parameters for the commonly used ceramics. Also included in the table is the ballistic efficiency parameter (EH/ρ) and a relative cost estimate compared to alumina, which is the most widely used ceramic armour material [47].

While obvious system design improvements have been achieved over the last decade, extensive work on improving the properties of the ceramic materials continues. One of the most desired variables to eliminate is porosity, so that full theoretical densities are achieved. Hot pressing creates fully dense ceramics, so the focus on ceramics processed using this technique is on the other property improvements.

The best way to increase ceramic efficiency is to extend the time that the ceramic works on a bullet to cause shattering; increase the dwell duration or dwell-penetration transition velocity (the velocity above which penetration occurs, and below which the bullet is defeated on the ceramic surface); and/or achieve a greater pressure on the penetrator during penetration to increase the erosion efficiency of the highly damaged, communited ceramic. Additionally, and of particular interest in armor protection, is a requirement to predictably defeat multiple impacts within a single plate or array. Finally, cost, manufacturability and integration with the backing materials of the armor system must also be taken into consideration [48].

Table 5: Properties of ceramic armour materials

Property	B_4C	TiB_2	SiC	AlN	Al_2O_3
Density, gm/cc	2.5	4.5	3.15	3.25	3.8
Flexural Strength, MPa	410	400	400	310	379
Elastic Modulus, GPa	400	565	370	330	340
Hardness, Kg/mm^2	3000	3300	2700	1300	1600
Fracture Toughness, MPa√m	2.5	6.2	4.3	3.7	3.5
Ballistic Efficiency Parameter (EH/!)	480	418	311	130	143
Cost Relative to Alumina	x 10	x 10	x 5		x 1

Nano Metallic Armour.

Researchers on nano-structures had found that inorganic compounds such as WS2, MoS2, TiS2and NbS2 that normally occur as large flat platelets can be synthesized into much smaller nano-spheres and nano-tubes which they named inorganic fullerene-like nano-structures or IF for short. The new IF material produced by the Weizmann Group was made of Tungsten Disulfide (WS2). In contrast to organic Fullerenes, IF is easier and much less expensive to produce, it is chemically stable and is less reactive and consequently less flammable. Organic Fullerenes are also considered to be highly toxic while IF materials have been tested extensively and deemed safe. Tungsten Disulfide is relatively heavy. Works on Titanium Disulfide, which is at least four times lighter and is expected to perform even better than Tungsten Disulfide against shock waves, is currently being conducted. One of the most interesting new IF properties discovered is its extremely high degree of shock absorbing ability. Shock absorbing materials are commonly used in impact resistant applications such as ballistic protection personal body armor, bullet proof vests, vehicle armor, shields, helmets, and protective enclosures [49].

The Israelis have developed some new armors that is supposed to be five times stronger than steel. Although test specifics are not described very well, they did a test where this material supposedly took the equivalent of about 280 tons of pressure on a sabot-style projectile hit (quote was a steel projectile at 1.5 kilometers per second) without breaking [50].

ADVANCED ARMOUR SYSTEMS

Passive armour forms the main protective envelope of all fighting vehicles and it will continue to be the main method of protection of vehicles. For kinetic energy shots, passive armour is the best conceivable way of offering assured protection. Protection against blast and fragments also needs passive armour. Against slow flying high caliber HEAT missiles, active armour is likely to emerge as the main mechanism of protection. This may also be extended for protection against fast moving KE shots which is currently under various stages of R&D world over. Attempts are being made to integrate these armour inventions on light LAVs. Other new armour concepts like the non-explosive reactive armour(NxRA), hybrid explosive reactive armour, intelligent dynamic armour and electromagnetic armours are some of the promising candidate armour systems for the future armoured platform.

Explosive Reactive Armour

The Explosive Reactive Armor (ERA), was originally designed to defeat High Explosive Anti Tank (HEAT) warheads, the sort found on antitank rockets and missiles. The HEAT warhead usually moves at a lower speed, but the explosion of the warhead creates a narrow jet of super-heated metal moving forward at extremely high velocity, and this jet of metal is what penetrates the armor. The high-velocity metal jet penetrates armor exactly the same way a conventional penetrator does, and its performance can be calculated using the same fluid dynamics equations. In a HEAT round, the penetrator is itself a fluid, although a fluid with a lot of momentum. But because it is a fluid, it is easier to distort and to break apart into smaller chunks [51].

An element of ERA consists of a sheet or slab of high explosive sandwiched between two plates, typically metal, called the reactive or dynamic elements. On attack by a penetrating weapon, the explosive detonates, forcibly driving the metal plates apart to damage the penetrator. Against a shaped charge, the projected plates disrupt the metallic jet penetrator, effectively providing a greater path-length of material to be penetrated. Against a long rod penetrator, the projected plates serve to deflect and break up the rod. This disruption is attributed to two mechanisms. First, the moving plates change the effective velocity and angle of impact of the shaped charge jet, reducing the angle of incidence and increasing the effective jet velocity versus the plate element. Second, since the plates are angled compared to the usual impact direction of the shaped charge warheads, and as the plates move outwards, the impact point on the plate moves over time, requiring the jet to cut through fresh plate material. This second effect significantly increases the effective plate thickness during the impact [52].

ERA can only withstand one hit from a shape charge as the armor literally explodes upon impact. ERA is not safe to install in vehicles that will be deployed with infantry units. The amount of shrapnel discharged from an impact with explosive reactive armor is enough to kill any infantry nearby [53]. For many years now, explosive reactive armour (ERA) has been well proven in reducing the penetration of shaped-charge jets into MBT hulls. This kind of appliqué protection, however, is more suited to heavy vehicles than LAVs [54]. However a new configuration of panels is being developed. These days, researchers are working intensively on an ERA development project for lightweight LAVs. Another promising area is the dual purpose ERA or Hybrid ERA that works against KE as well as HEAT and also adaptable to light armoured vehicles. The task would need optimization of explosive composition, sensitivity, detonation velocity etc so that the armour can respond only when required.

Electric Armour

When armaments like RPG hit a tank, a "shaped-charge" warhead blasts a jet of hot copper into a target at around 1,000mph - capable of slicing through a foot of conventional solid steel armour [55]. The electric armour is made up of two or more conductive plates separated by some space or by an insulating material, creating a high-power capacitor. In operation, a high-voltage power source charges the armour. When an incoming body penetrates the plates, it closes the circuit to discharge the capacitor, dumping a great deal of energy into the penetrator, which may vaporize it or even turn it into a plasma, significantly diffusing the attack. This technology has not yet been introduced on any known operational platform.

Protection against Mines and IEDs

A majority of vehicles are highly vulnerable to such attacks using mines and IEDs. There is a strong need for the light vehicles as well as the tanks to provide protection against mine blasts. Many vehicles are now being designed to provide protection against mines. Mines are used mainly buried in unpaved remote countryside routes. However, the much lighter mines and buried charges that are generally used can be countered in a number of ways. The effect on the crew can be reduced considerably by lifting crew seats off the floor to which they are traditionally fixed and attaching them to the sides of the hull or, better still, to its roof. Lifting crew seats off the floor also removes the risk of them being struck by floor plates which can bow inwards under dynamic pressure, even though they may spring back afterwards. To avoid the risk of injury to their feet and legs, the crews' feet must also be kept off the floor plates by means of side-mounted foot rests or by an inner floor well-separated from the bottom plate [56].

The effect or damages on the structure due to blast loading can be overcome by several methods. One of the methods is to provide a sufficient stand-off distance to the target. Another method is by developing a material which is very ductile and has large energy absorption capabilities when subjected to blast loading.

IED charges have low penetration efficiency, one of the most important add-on protections for target vehicles are ballistic plate, made of steel or composite materials and blast mitigation material which absorbs the blast effect. Flexible composite fabric liners applied inside the fighting compartment of armored vehicles can also absorb much of the melted metal spall generated when a shaped charge penetrates through the main armor, therefore limiting the internal damage and casualties. For further protection, heavier ceramic protection is used. Stepped up IED attacks on vehicles and convoys, coupled with the acute threat from mines, made better force protection a vital requirement [57].

CONSIDERATIONS FOR THE MALAYSIAN DEVELOPED LAV

Technology Development

The joint venture between the Turkish Manufacturer of NURUL Tracked Armoured Personnel Carrier and PARS 8x8 LAV, FNSS and the DRB-HICOM Defense Sdn. Bhd, to design and manufacture a LAV is a timely initiative to jump start the development of defence industry in Malaysia. The government's commitment in providing the support to DRH-HICOM to embark into the long term contract of the design, manufacture and supplying the LAV to the Malaysian Army will see the transfer of technology which will provide the confidence and experience needed by local engineers and scientists to venture into more complicated technologies.

With this initiative, it is not impossible that Malaysia will become a leading manufacturer of the armoured vehicles in the near future, as what has been achieved in other industries such as electronics, oil and gas and automotives. The nation, having a diversified industry based economy, besides being a developed education hub of this region, will have the opportunity to garner the expertise among engineers in the industry and scientists within the various institutes of higher learning to embark into intensive research and development works to support the industry. With the commitment from various government agencies, the users, the industry, research agencies such as Science and Technology Research Institute for Defence (STRIDE) and local universities, the success probability is bright.

Operational Doctrine

The focus of the development and manufacturing of the armoured vehicle to be supplied to the Malaysian Army is a right start in order to develop the confidence of both the industry partner and also on the product. In order for the project to be a success. Firstly, the vehicle must be designed, to meet the Malaysian Army's doctrinal requirements. A LAV in the Malaysian Army doctrinal context will be deployed for the following purposes; in the reconnaissance role, secondly, as the armoured personnel carrier and, thirdly, as the infantry fighting vehicle.

These roles will fit well into the current trend of the armoured troop deployments, mainly in the peace keeping role as exhibited in the United Nation Integrated Mission in Timor-Leste (UNMIT) and UN Interim Force in Lebanon (UNIFIL) and in a rare occasion, peace enforcement roles such as the one committed under the United Nation Protection Force (UNPROFOR) in Bosnia. Both the roles see the deployment of the troops taking active parts in the reconnaissance and observation duties besides transporting of troops. The utilisation of the armoured force in support of active fighting seemed slim in majority of United Nation missions. Back home, the current relationship among ASEAN Nations for the past decades has been nonetheless cordial, reducing the probability of confrontation between countries.

With the scenario of operational requirements mentioned earlier, the Malaysian Army LAV should be designed based on the following scenario; firstly to meet training requirements which will mostly be conducted in Malaysian terrain and secondly, to meet the requirement of peace keeping missions under the United Nation operations. Malaysian developed LAV designer faces a tough decision in determining the specification for the vehicle's mobility criteria. In one aspect, they have to consider the mobility requirement when the vehicles are operating in country, where in general, in an off-road deployment, Malaysian terrain is relatively soft. This is clearly exhibited when the deployment of the vehicle takes place in the palm oil plantations, paddy fields and rubber estates during rainy seasons. On the other hand, most of the deployments under the United Nation operations take place in dry, semi desert countries such as in Somalia, Lebanon and Afghanistan. Mobility factor is also being determined by the type of road network in the affected nation. In countries like Bosnia and Lebanon, where majority of the roads connecting places are narrow, big and bulky armoured vehicles will find it difficult to negotiate the roads network.

In the abovementioned operational scenarios, the possibility of the Malaysian LAV to be attacked cannot be ruled out. Hence the design of the LAV protection must take into consideration the threats from medium caliber weapons such as the 12.7mm heavy machine gun and 25mm cannon with armour piercing (AP) capabilities. Other threats include the shaped charge warhead from the RPGs and IEDs besides anti tank mines of lower capability. In cases of attack from higher lethal weapons such as direct fire from a tank gun, direct impact of big caliber gun ammunition and bigger capability tank mines, not much can be done to protect the LAV.

POSSIBLE ARMOUR PROTECTION SYSTEMS FOR THE MALAYSIAN ARMY LIGHT ARMOURED VEHICLES

The Basic Armour

The basic armour is meant to protect the LAV from the KE and the HESH rounds. The development of high performance, high hardness armour (HHA) steel alloys for AP

rounds with a hardness range of 477–534 Brinell hardness number (BHN), increases the availability of high hardness plates of choice for armor designers.

The latest development of steel alloy armour plates is the dual hardness armor (DHA), which is produced by roll bonding a 601–712 BHN front plate to a 461–534 BHN back plate. The concept of dual hardness composite armor involves the use of a hard front side that breaks up the projectile and the high strength back plates that reduces spalling. Experimental results show the targets of dual hardness exhibits high resistance against the impact of AP projectile. The DHA seems favorable due to its ability to break up the penetrator by the hard front plates and ability to reduce spalling by the tough back plate.

Compared to steel, aluminum is much lighter and relatively strong. It is able to take advantage of up to 20 per cent weight savings over steel without reducing protection levels. Additional weight savings are gained from the use of aluminum because of the greater rigidity of the thicker, but lighter plate, nine times stiffer than steel. A comparison of this alloy with steel against 7.62mm AP and 14.5 mm AP is a weight saving of about 20% is shown for Aluminum 7017 against the 14.5 mm round impact. The only real difference between aluminum and steel is that aluminum losses its strength at a much lower temperature, meaning that a burnt aluminum vehicle that has burnt will generally collapse.

Titanium is an "excellent alternative to steel" because it is 30% lighter. Titanium, with the same strength as steel armour has a density about 40% less than steel. The current steel turret, hull, and suspension represent 70% of the weight of an armoured vehicle, but only 23% of its cost. Thus, a lighter-weight, higher-cost armor material would have a small impact on the cost of the finished product. Titanium alloys are readily fabricated in existing production facilities and are easily recycled; scrap and mill revert is currently re-melted on a large-scale basis.

High hardness ceramic on the other hand is an efficient candidate for defeating KE penetrators due to its ability to break up into large number of fragments, hence absorbing the energy of the aggressor. Despite its efficiency in defeating KE penetrators, ceramic armour is not popularly used in LAV due to the volume it occupies. Finally, cost, manufacturability and integration with the backing materials of the armor system must also be taken into consideration. Adding ceramic slabs on top of selected subsystems of the LAV is a popular solution to increasing the protection of an LAV.

Among the many candidates for the basic armour, nano material is becoming increasingly popular among researchers, having super high hardness and high strength characteristic. The technology is currently being aggressively developed by scientists for the next generation LAVs.

The considerations for the basic armour provide two possible choices; of either the DHA which will give an improved protection, but with additional weight penalty, or the

titanium alloy which is 30% lighter with the same strength. The relatively higher cost of the titanium alloy needs to be considered before making the choice. Geometry of the armour systems as demonstrated in the sloped armour and spaced armour configurations increase the absorption performance of the system, hence increasing the protection probability. Armour system also must be able to reduce the risks of fire inside the hull.

The Modern Armour

The utilization of modern armour is to neutralize the incoming shaped charge jet. The ERA utilises a flying plate forced by exploding sandwiched explosive to repel the incoming KE penetrator or shaped charge jet. Whereas, in the case of the electric armour, when an incoming body penetrates the plates, it closes the circuit to discharge the capacitor, dumping a great deal of energy into the penetrator, which may vaporize or even turn it into a plasma, significantly diffusing the attack. The use of ERA is limited when the operation involves dismounted infantry. At the moment the choice is still with ERA until the electric armour concept is proven.

Protection against Mine Blasts and IEDs

The effect on the crew from mine blasts can be reduced considerably by lifting crew seats off the floor to which they are traditionally fixed and attaching them to the sides of the hull or, better still, to its roof. Lifting crew seats off the floor also removes the risk of them being stuck by floor plates which can bow inwards under dynamic pressure, even though they may spring back afterwards. To avoid the risk of injury to their feet and legs, the crews' feet must also be kept off the floor plates by means of side-mounted foot rests or by an inner floor well-separated from the bottom plate. The design of the hull also plays important roles to provide a higher protection against mine blasts and IEDs. A 'V' shape underbelly hull has been proven effective in deflecting away the blast waves of the mines.

CONCLUSION

To be an effective and competitive armoured fighting vehicle, the Malaysian made LAV must be able to withstand the common threats faced by peace keeping and peace enforcement forces. The attack from the front will most likely come from another armoured vehicle. The LAV must be equipped with enough armour to withstand a frontal attack from medium cannons of at least 25mm caliber. One of the popular options taken by most armoured vehicle designer is to design the front part of the vehicle with a level V protection. Such a protection level can be achieved by adding modular add on armour such as the ERA or ceramic armour. This will provide appropriate protection from KE and also shaped charge threats.

The threats to the sides and rear of the LAV will most probably come from dismounted infantry equipped with either small arms, heavy machine guns of the caliber 14.5mm or

by the RPGs. As such the hull on the sides and rear of the vehicle shall be designed to provide protection of at least to the level IV. Similar to the front part of the vehicle, the ERA is best suited to provide the appropriate protection to the sides of the vehicle. A 'V' shaped underbelly hull is a current practice to reduce the effect of limited blasts from anti tank mines. The 'V' shaped underbelly hull will deflect the blast waves away from the vehicle crew.

Deploying spaced armour concept to increase the protection level may be the solution to the LAV protection design. The spaced armour configuration is known to increase the protection level in certain LAVs without increasing the total weight of the vehicle. Regardless of the choices, consideration must be focused to provide a higher level of protection, sufficient fire power with reduction in weight penalty to ensure maneuverability to meet its operational requirement. .

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NUMERICAL SIMULATION STUDY IN EARLY SCABBING OCCURRENCE ON A CONCRETE TARGET SUBJECTED TO LOCAL IMPACT LOADING

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ABSTRACT

Concrete is a common material for protective structures to resist impact and explosive loads. In addition to nuclear industry requirements, the design of the containment buildings and internal concrete barrier walls of nuclear facilities need to be considered to produce more efficient protection against impact by kinetic projectile, generated both accidentally or deliberately, in various impact and blast scenarios (e.g. failure of a pressurized vessel, failure of a turbine blade or other high speed rotating machines, aircraft crashes, fragments generated by accidental explosions, etc.). Hard projectile impact can affects both local damage to the structure around the contact zone and overall dynamic response of the structure. Scabbing effect is one of the local damage phenomena that have been investigated in this project. The influences of the relative effective target thickness as the ratio of projectile diameter (H/d) on the critical impact energy at which scabbing occur are explored. The scabbing phenomenon has been observed through existing experimental results to provide more understanding on early stage of scabbing occur. The numerical simulation model is developed using Finite Element (FE) with 2-Dimensional and elastic assumptions. Encouraging predictions show when numerical simulation predictions were compared with existing experimental data.

INTRODUCTION

The investigation of scabbing phenomenon was first introduced by Hopkinson [1]. He conducted an experiment for measuring transient wave pressure in different thickness of steel plates by the detonation of high explosive and observed that at a sufficient thickness, the back face of plate's sample experienced fractured and scabs. This phenomenon later is described as a scabbing phenomenon. Rinehart [2] further investigated the phenomenon

using the metal materials in contact with explosives to induce a high intensity wave in the metal. He concluded that the phenomenon is caused by the spatial distribution of the pressure within the wave and by a critical normal fracture stress that is characteristic of the material. Kumar and Davis [3] discussed the phenomenological of scabbing and suggested that the experiment based on an inverse approach derived from pulse shape determination and some of the dynamic properties of the material. Kumar and Davis [4] analysed the scabbing phenomenon in term of wave propagation effects using one-dimensional analysis approached. Hwang and Davis [5] extended the approached and interpreted it into contour plotting method for further studies on scabbing phenomenon of non-linear materials due to tensile reflection. Most of the earlier studies on scabbing were conducted on metal slabs. However, scabbing in metal slabs is normally associated with high strain rates and has brittle features because the ductility of the metal decreases with the increase of strain rate. Thus, similar scabbing mechanism observed in metallic targets applies to brittle targets, such a concrete slab.

Scabbing phenomena in concrete structures have attracted increased attentions due to the growing applications of concrete structures under impact and blast loads in both civil and military engineering. In general, studies on scabbing in a concrete slab normally fall into three categories, i.e. experiment and empirical formulation, analytical model and numerical simulation.

Experimental observation is useful to provide the basic understanding of the scabbing mechanism and failure mode of concrete target. The local impact damage modes observed in concrete structures have been discussed in many publications, which include penetration, spalling, scabbing, plugging, cracking and perforation, as summarised in Li et al. [6]. These local impact damage modes are produced by different mechanisms. Spalling and scabbing are caused by the tensile stress reflected from the impact-induced compressive stress wave on the top and distal free surfaces of the concrete slab, respectively. Penetration is related to the opening of a cavity in the concrete target by projectile. Plugging failure is determined by the competition between the driven force on a plug and the shear strength around the plug. Previous studies were ambiguous about the relationship between scabbing and plugging. For example, Hughes [7] attributed the scabbing in a reinforced concrete to two different mechanisms, i.e. the reflected tensile stress wave and the shear cone. Dinic and Perry [8] mentioned that scabbing may occur before shear plug formation or as a result of shear plug movement. Kojima [9] and Sugano et al. [10] observed that the formation of cone shear is closely associated with the occurrence of scabbing in concrete target.

It has been found by Stephenson et al. [11] that there exists a minimal thickness of the concrete target for preventing scabbing (i.e. scabbing limit) against the impact by a hard projectile. Empirical formulae on scabbing limit were developed due to the complexity of scabbing phenomenon and lack of valid analytical models. The latest review of empirical formulae were presented by Li et al. [6] where a wide range of empirical formulae on the local impact effects on concrete target are summarised. These empirical formulae were developed based on the data-fitting of experimental results. Although, these empirical

formulae provide the straightforward approach to design concrete structures against scabbing, their application is limited by their valid experimental conditions.

Analytical model is an alternative approach for studying scabbing phenomenon and provides the response and failure mechanisms during a scabbing process. Moreover, analytical model is simple and efficient, which can be used directly to recommend formulae for the design of target. However, most of the theoretical scabbing models were developed for metals and for one-dimensional rods [e.g. Kumar and Davis [4], Hwang and Davis [5], Johnson [12]. Limited investigations were done for scabbing in concrete or other brittle targets. Riera [13] presented a critical impact velocity formula for the occurrence of scabbing based on a plane stress wave assumption, which depends on some empirical data-fittings. Gao et al. [14] have considered the scabbing in their multi-stage perforation model where the occurrence of scabbing is caused by the combination of the reflected tensile stress wave and the second compressive wave. However, the model only can be solved numerically due to the complication involving with the non-linear differential equation.

Numerical simulation is another possible approach to study scabbing phenomenon and provide detailed information for the scabbing process, which may be useful to improve the design of concrete target. Kusano et al. [15] and Magnier and Donze [16] employed discrete element method (DEM) to model scabbing phenomenon and reasonably good agreements with the selected empirical formula were reached. Leppanen [17] simulated scabbing phenomenon using smooth particle hydrodynamic (SPH) technique in AUTODYN and successfully showed the formation of scabbing. However, despite excessive computational resources for the numerical simulation of a dynamic fragmentation problem, uncertainty increases due to the needs of more material parameters. It is necessary to develop reliable analytical scabbing models, which can link relevant failure mechanisms and experimental evidences.

In general, the efforts in scabbing phenomenon study is still limited, especially in analytical model development and numerical simulation due to the limitation of theories that can be related with the experimental evidence. In the present study, a scabbing phenomenon is explored in detail. Investigation on stress wave propagation and free-surface reflection has been carried in a concrete slab using FE method. Critical impact energy for the occurrence of scabbing is obtained and compared with available experimental data.

DIMENSIONAL ANALYSIS

Non-dimensional numbers are used to analyse the scabbing effect for the concrete structure. The scabbing limit, i.e. the minimum target thickness to prevent scabbing, is generally defined by

$$h_s = fn(M, V_0, d, \rho, \#_f, f_c, f_t, E, a, r) \qquad (1)$$

where ρ, E, $!_f$, f_c and f_t are the density, young' s modulus, shear strength, unconfined compressive and tensile strengths (stresses) of the concrete target, respectively. a is the characteristic size of aggregate and r is the average percentage amount of reinforcement each-way-each-face. M and V_0 are the mass and the initial impact velocity of a projectile and is the (cylindrical) projectile shank diameter.

It has been observed that the reinforcement has little influence on the scabbing damage, but may reduce scabbing effects and prevent perforation [9]. Furthermore, amount and size distribution of aggregate in concrete have no significant effects on scabbing [18]. When both the aggregate size and the amount of reinforcement are neglected, a dimensional analysis based on Equation (1) leads to

$$\frac{h_s}{d} = f\left(\frac{E_k}{d^3 f_c}, \frac{M}{\rho d^3}, \frac{f_t}{f_c}, \frac{\#_f}{f_c}, \frac{E}{f_c}\right) \qquad (2)$$

where $E_k = \frac{1}{2} M V_0^2$ is the kinetic energy of the projectile.

Although the scabbing limit is normally selected as a design parameter, the critical impact velocity (Vc) causing scabbing for a given target thickness is another important parameter associated with scabbing. When hs=H in Equation (2), the critical impact energy can be expressed by

$$\frac{E_c}{d^3 f_c} = f\left(\frac{M}{\rho d^3}, \frac{H}{d}, \frac{f_t}{f_c}, \frac{\tau_f}{f_c}, \frac{E}{f_c}\right) \qquad (3)$$

where H is the thickness of the concrete target and $E_c = \frac{1}{2} M V_c^2$ .Non-dimensional numbers in Equation (3) will be used in following numerical simulation predictions and experimental data presentations.

STRESS WAVE PROPAGATION IN TARGET SUBJECTED TO LOCAL IMPACT

Kennedy [19] has described scabbing phenomenon as the ejection or peeling of fragments from the distal free surface of the concrete target after it is subjected to projectile impact on its front face. Generally, scabbing mode can be classified into two types [9], [10], i.e.;

i. Scabbing: massive ejection of plug or fragments on the distal side of the target shown in Figures 1(a) and 2(a).
ii. Just (incipient) scabbing: formation of plug or fragments on the distal side of the target with minor ejections shown in Figures 1(b) and 2(b).

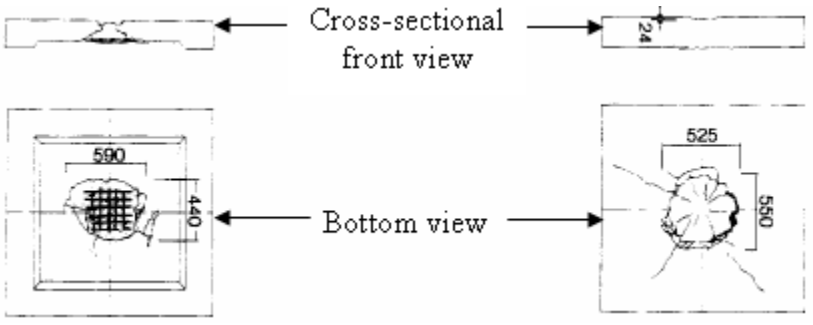


Figure 1: Experimental illustration of (a) scabbing, (b) just scabbing [10]

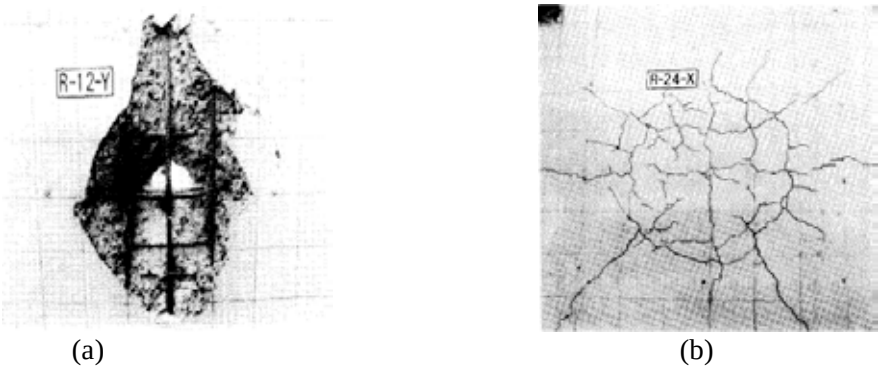


Figure 2: Post-experimental of (a) scabbing, (b) just scabbing [9]

Scabbing is mainly due to the excessive resultant tensile stress. In a one-dimensional brittle rod, scabbing may occur when the resultant tensile stress is equal or greater than the maximum tensile strength of the material. For a panel target, the formation of a massive plug may also need to overcome shear resistance, which is clearly shown by experimental evidences in Kojima [9] and Sugano [10].

It should be noted that the effect of reinforcement and aggregate are neglected in the following analyses. Light or moderate reinforcement (i.e., 0.3–1.5% each way) and different size of aggregate have minor effect on penetration and scabbing. However, heavy reinforcement (i.e., 1.5–3% each way) would markedly increase the perforation resistance by preventing scabbing and cone shearing [20], which need further studies.

NUMERICAL SIMULATION MODEL

In this section the stress wave propagation in target following a local impact by a hard projectile is investigated. Attentions is paid on the early stage of the compressive stress wave propagation and the reflections of the compressive stress wave on the free distal surface of the target, and thus, elastic section of the stress-strain curve in Figure 3 is employed for the target material.

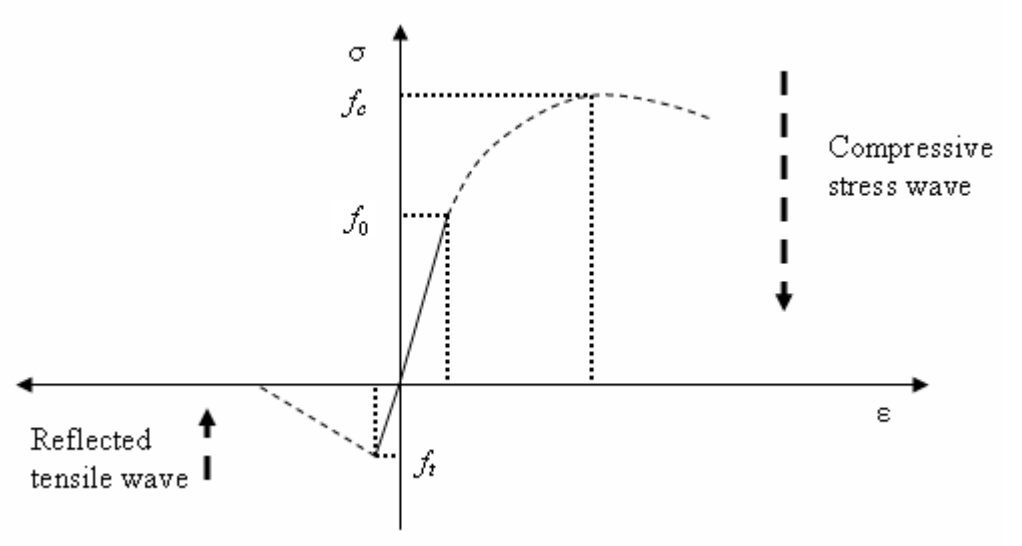


Figure 3: Uniaxial behaviour of concrete material

Model Development

The numerical model is developed using ABAQUS finite element software package. The front surface of a fully clamped target is impacted by a rigid projectile with a flat nose at a given impact velocity. Both projectile and target are modelled as axisymmetric 2-Dimensional problems shown in Figure 4. The projectile is treated as a rigid body with total 20 linear line elements (Type RAX2). The target is modelled as an elastic body with 1680 linear quadrilateral elements (Type CAX4R) by structured meshing technique and 501 linear triangular elements (Type CAX3) by free meshing technique. A distortion control is applied to avoid disproportional distortion of elements in the target mesh. The simulation model is based on explicit dynamics analysis procedure, which uses central difference time integration rule to calculate the incremental deformation of the target [21].

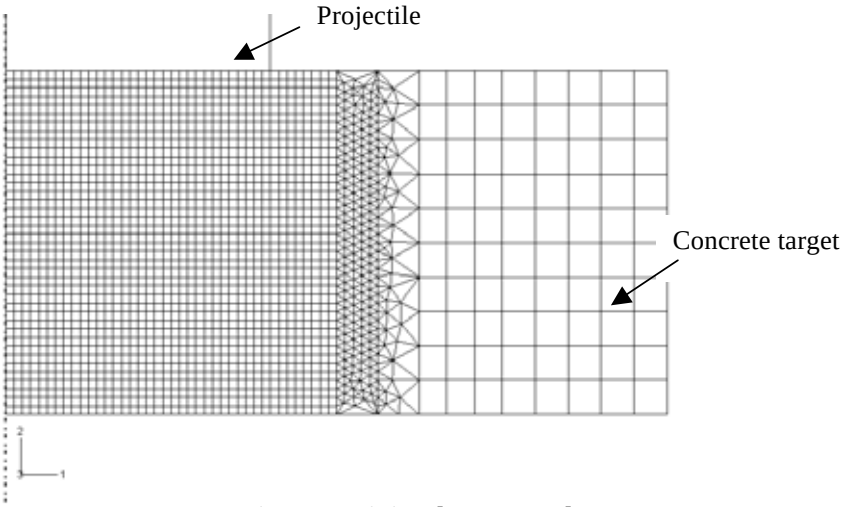


Figure 4: Finite element mesh

The interested simulation time is calculated based on the reflecting time of the impact-induced compressive stress wave from the distal free surface of the target, i.e. $\frac{H}{c} < t < \frac{2H}{c}$, where *H* is the length of the target thickness and $c = \sqrt{E/\rho}$ is the elastic stress wave speed in the target, E and ! are Young's modulus and density of the target. Figure 5(a-e) shows the propagation of impact-induced compressive stress wave and its superposition with the reflected tensile stress wave from the free distal surface. The impact velocity of the projectile is V = 8m/s and the ratio of the target thickness to the projectile diameter is H/d = 1.3. The scabbing region is noted when the net maximum tensile stress is equal to or greater than the tensile strength of the concrete panel. It is shown that the impact introduces a compressive stress wave, which propagates toward the distal surface. The wave front is approximately a plane (a line in this axisymmetric 2-dimensional problem). The compressive stress wave is reflected into a tensile stress wave from the distal free surface. The reflected tensile stress is superposed to the incoming compressive stress to produce a region of net tensile stress. When the net tensile stress is equal to or greater than the tensile strength of the concrete, tensile failure should occur at those locations, which may subsequently lead to the occurrence of scabbing. The similar method also has been applied to simulate the experimental data from Bainbridge [22].

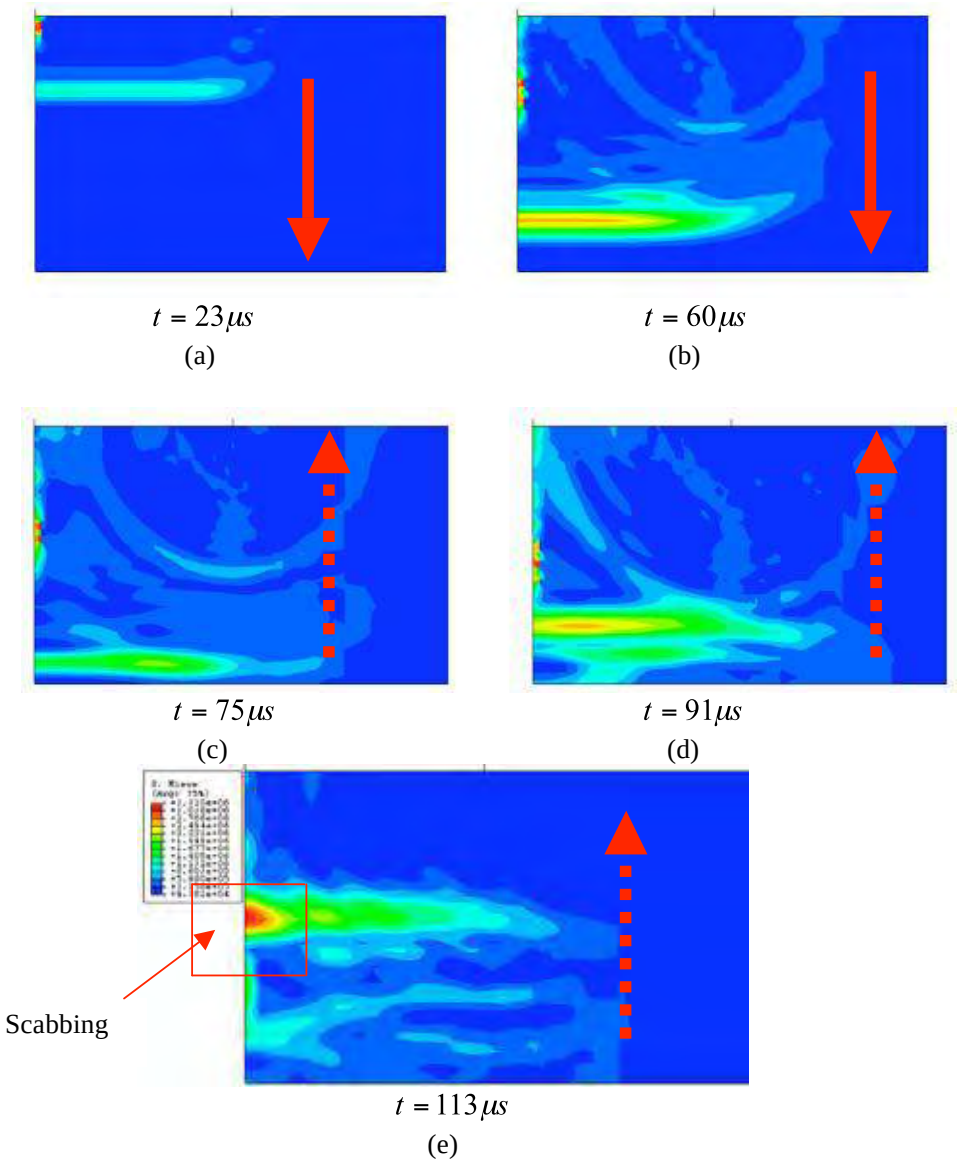
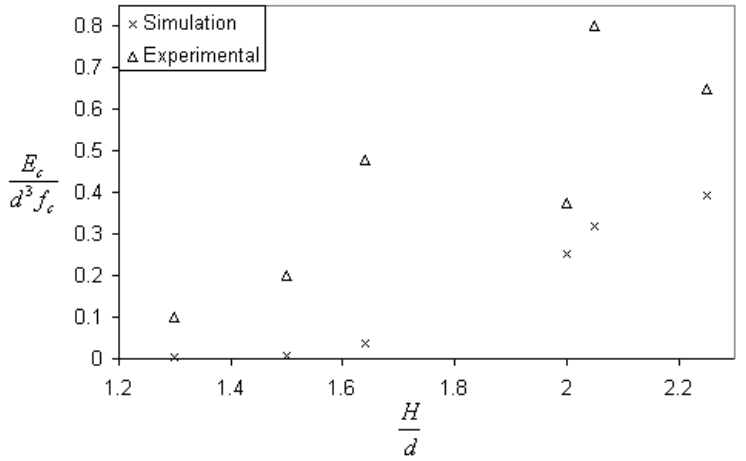


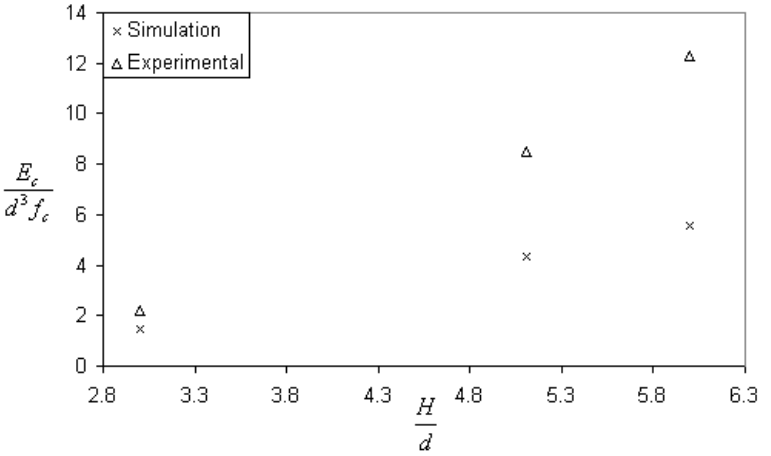
Figure 5(a-e): Wave propagation with reference to time of occurring scabbing

RESULTS AND DISCUSSION

For validation purpose, comparisons between experimental data obtained from Bainbridge [22] and corresponding predictions based on numerical simulation are shown in Figures 6 (a-b). Because of the lack of just-scabbing data in Bainbridge [22], the lowest scabbing data are also used in Figure 6 (a-b).



(a)



(b)

Figure 6(a-b): Comparison between numerical simulation predictions and experimental data of the critical impact energy of projectile for scabbing, (a) $\frac{H}{d} < 2.4$ **; (b)** $2.8 \leq \frac{H}{d} \leq 6.3$

In this experiments, the smallest value of H/d is 1.3 and the largest value of H/d is 6.0. It is shown that the present numerical simulation model is consistently given the lower bound of experimental results and produced a similar general trend of experimental results in the whole range of experiments presented in Figure 6(a-b). This is suggesting that the proposed numerical simulation model is a conservative.

Lastly, the present model is neglected by the effect of reinforcement and aggregate, which in actual fact, light or moderate reinforcement (i.e., 0.3–1.5% each way) and different size of aggregate added little effect to penetration and scabbing. Furthermore, heavy reinforcement (i.e., 1.5–3% each way) would obviously increase the perforation resistance that will avoid scabbing to be form Li and Chen [20].

CONCLUSIONS

Scabbing phenomenon has been investigated thorough, through experimental observation. The numerical simulation model was developed with elastic assumption and was used to predict the early stage of the scabbing occurrence caused by the reflected tensile wave.

The influence of the relative target thickness, $\frac{H}{d}$ over the critical impact energies, $\frac{E_c}{d^3 f_c}$ of occurrence scabbing has been explored by comparing numerical simulation predictions with experimental data. Generally, the numerical simulation provides encouraging prediction which is consistent and follows a general trend of experimental results.

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A REVIEW OF THE EFFECTS OF ENVIRONMENTAL PARAMETERS ON POLYMER COMPOSITE MATERIALS

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ABSTRACT

Advanced composite materials based mainly on epoxy resins are being used in increasing amounts in aerospace components due to their high strength / weight ratio. Such components have to survive in a wide range of temperatures and humid environments in different parts of the world. The current generation of epoxy resins used in high performance fibre reinforced laminates absorb moisture from the atmosphere, which leads to a reduction in glass transition temperature and to a softening of the resin with a loss of resin stiffness and strength. Moisture absorption at room temperature is in general a reversible process and for most advanced composites, there is no degradation in room temperature mechanical properties. As moist resins soften at elevated temperatures, resin dominated strengths and stiffnesses are significantly less at these temperatures, than those for dry composites. In addition, certain combinations of temperature and moisture, particularly when a component is stressed, can produce microcracking in the resin or at the fibre / matrix interface, which will degrade the mechanical properties even at room temperature. On the whole, this review establishes that moisture and temperature are two important environmental parameters that need to be considered by composite material designers when setting design limits for components or structures, in particular for operation in high temperature and humid environments.

INTRODUCTION

Composites, in the strictest sense, consist of any type of multiphase material. Generally speaking, a composite material is a material with several distinct phases present. Normally, the composite consists of a reinforcing material (e.g. fibre, whisker) supported by a binder or matrix material. The reinforcing material is normally the load carrying medium in the material, and the matrix serves as a carrier, protector and load transfer medium around the reinforcement.

It is instructive to consider plastic matrices from the point of view of fibre utilisation since incorporation of fibres in plastic matrices can be regarded as the most powerful way of utilising the high strengths available. In contrast, fibre reinforcement of metals can be regarded as merely an extension of the currently available range of strengthening mechanisms. However, in terms of their application in general engineering, plastics tend

to exhibit low modulus and, quite often, low strength as compared with metals. The incorporation of fibres is generally easy and fibre loadings of up to about 70 % are realisable. The resulting products are extremely stiff and strong with low density.

In the early days of development of fibre reinforced plastic composites for use in aerospace vehicles, there were considerably fewer choices available to the designer in materials, fabrication techniques and design concepts than there are today. Advanced fibre reinforced plastic composites have several properties which make them suitable for aircraft structural applications. They have high specific stiffness and strength, good corrosion resistance and fatigue properties (at least in tension), and are highly formable [1]. According to Dorey [2], weight savings of between 10 - 30 % can be achieved for direct material replacement and up to 50 % for complete structural designs.

The beginnings of these materials can be traced back to the late 1930s when flax thread was impregnated with phenolic resin to produce what was probably the first example of *high performance* composites. In the following years, a number of fibres were investigated but none were found to have the specific stiffness and strength properties required for structural aircraft applications [3]. In the mid-1960s, a process was developed at the Royal Aircraft Establishment to process high modulus and strength carbon fibres from polyacrylonitrile (PAN) [4]. When combined with thermosetting resins which had already been developed for glass fibre reinforced composites, a material was produced which had excellent specific stiffness and strength values [5]. These properties make composite materials viable for use in aircraft structural applications. Many of these advanced fibres and resins are being combined together in unidirectional preimpregnated form, such as yarn, tape and sheet material. The availability of such unidirectional *prepreg* material permits precise orientation of each ply in a composite which gives maximum structural efficiency for a given application.

In a fibre reinforced polymeric composite material, the strength of the bond between the fibre and the matrix determines the failure mode and the detailed failure mechanisms, and is the key to reinforcement efficiency, tensile, compressive, shear and fatigue strengths, toughness, and environmental resistance. In order for the matrix to transfer the load, it must have sufficiently high cohesive shear strength and it must provide sufficiently high interfacial shear strength, either through chemical or mechanical adhesion, or a combination of both. There are two principal theories on how load transfer between fibres is achieved in fibre reinforced polymeric matrix composites [6]. The first theory is the mechanical bonding, friction, or *shrink-fit* theory, whereby during polymerisation or curing of the resin, the resin shrinks around the fibre with sufficient force to provide frictional resistance to movement of the fibre through the cured resin. The second theory is the chemical coupling theory, whereby certain functional groups in the polymer chemically react with the reinforcement surface to form a chemical bond, or a separate chemical coupling agent is used, one part of which react with, or is compatible with, the polymeric matrix.

The introduction of composite materials into aircrafts has been hindered to some extent by the complexities of designing with anisotropic, inhomogeneous materials. Currently, a methodology exists for designs based on a stiffness requirement, however problems are encountered when a strength criteria is to be satisfied. Design data for strength is difficult to measure since the test results are often sensitive to test geometry. Furthermore, composites are prone to a fairly wide range of defects and damage arising during both manufacture and service. This damage can seriously affect the residual strength of the material and hence, needs to be accounted for at the design stage.

The compressive strength of plastic composites fall as the matrix offers decreasing resistance to fibre buckling. This indicates that compressive strength increases with increasing matrix modulus and yield strength. Interlaminar shear strength is also directly related to compressive strength, since ultimate failure tends to occur as delamination takes place. Other factors such as tensile properties and elongation are related to compressive strength, but it is considered that these are merely indirect effects.

Delaminations were identified as possibly the most important type of defect because they can cause large reductions in residual compressive strength and can be difficult to detect [1]. Delaminations can develop during service due to:

i. Thickness stresses developed at free edges, holes, ply drops or ply terminations, bonded or co-cured joints, and bolted joints.
ii. Effects of moisture and temperature, for example residual thermal stresses from processing and moisture gradients through the thickness of the laminates.
iii. Low energy impact damage caused by runway stones or hail stones, and dropped tools.

Of these factors, low energy impact has been identified as the most insidious [1] because the probability of occurrence is high. The internal damage, in the form of delaminations, is likely to remain undetected. Since routine non-destructive testing (NDT) is almost always confined to potential hot-spots as full scale NDT is both costly and time consuming). Furthermore, it may cause large reductions in residual compression strength.

One of the principle goals of materials suppliers has been to develop more damage resistant and tolerant materials. Much of the effort has been directed towards increasing the toughness of matrix materials and producing fibres with higher strains to failure [7]. An essential tool for such materials development is the availability of test methods that can provide data appropriate to the properties in question. Compression after impact (CAI) tests are widely used in industries to assess the relative performance of different composite formulations with various fibre and matrix combinations [8, 9]. The test is widely regarded as a damage tolerance test, but in reality measures two different aspects of materials' performance, namely the resistance of the laminate to damage (in the impact test) and subsequently, the resistance of the laminate to the propagation of the damage (during compression).

ENVIRONMENTAL EFFECTS ON POLYMER COMPOSITE MATERIALS

The real test for fibre reinforced composite materials is during in-service use, where they are subjected to all the natural hazards of service life. The increasing use of these materials in various industries, particularly the aircraft industry, has resulted in extensive research to determine their behaviour under different environmental conditions.

Thus, there are thus conflicting requirements for manufacturing and performance for fibre reinforced composites. Aircraft structures have to be designed to last at least 20 years in service and because of the possible susceptibility of the resin matrices to absorb moisture, designs usually aim to take maximum advantage of the fibre controlled properties. However, some critical properties, such as compression strength under hot / wet conditions, where microbuckling of the fibres dominates the failure, are determined by environmental effects and can restrict the design limit of the material (to about 0.4 % strain for hot / wet compression for carbon fibre reinforced plastics (CFRP)) [10]. Therefore, it is important to allow for the effects of absorbed water in deciding allowable design properties.

The mechanisms of moisture absorption, the plasticising effect of absorbed moisture and the lowering of the glass transition temperature are well known processes which have been widely studied in polymeric materials [11-14]. To a lesser extent, moisture absorption has also been studied in composite materials and it has been shown that, in general, the mechanism of moisture penetration is much more complex than in the case of unreinforced matrices [15, 16].

Current carbon fibre-epoxy resin composites such as the XAS/914 system tested by Port [17] and the T800/924C examined by Soutis [18] (Figure 1), fail by microbuckling throughout the temperature range used by Ewin and Ham [19]. It was also found that the compressive strengths of these systems were only 60 % of the tensile strength. The difference between the tensile and compressive strengths of unidirectional carbon-epoxy composites has arisen largely by virtue of continued improvement in the tensile strength of the fibres, which can be attributed to smaller fibre diameters, and better fibre processing and surface treatment techniques; the tensile strength of the composite is a fibre-dominated property. In comparison, resin stiffness significantly influences compression strength and currently used materials tend to employ resins having lower stiffness than those used earlier. One of the main reasons for the resin stiffness not being improved is that any significant increase tends to produce a more brittle material.

The current generation of epoxy resins used in high performance fibre reinforced composites absorb moisture from the atmosphere with the surface layer reaching equilibrium with the surrounding environment very quickly, followed by diffusion of water into all of the materials. Epoxy resins can absorb a maximum of between 1 to 10 % weight of water (depending on chemical composition), so in composites with 60 % fibre volume, the water uptake is between 0.3 to 3% weight. Moisture absorption by the epoxy

resins leads to a reduction in the glass transition temperature and to a softening of the resin with a loss of resin stiffness and strength, particularly at elevated temperature [21]. These degraded resin properties manifest themselves in the fibre reinforced composites as loss of performance in the resin dominated properties, such as reductions in strength and stiffness under shear and compressive loadings, and loading perpendicular to the fibres [21, 22]. In many cases, moisture absorption obeys Fick's law and diffusion is driven by the water concentration gradient between the environment and the material producing continuous absorption until saturation is reached [23].

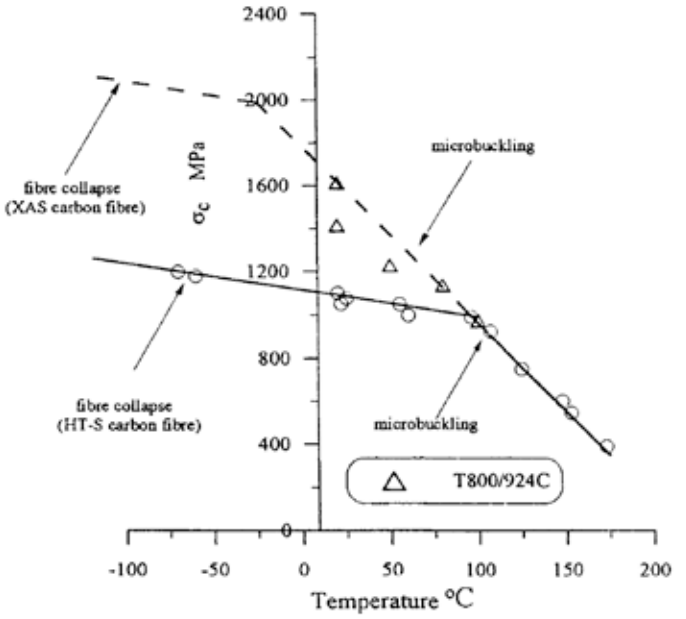

Figure 1: Effect of temperature on the compressive strength of CFRP composite. (Reproduced from Soutis [20])

THE EFFECT OF THERMOHUMID CONDITIONS ON COMPOSITE PROPERTIES

Moisture and temperature may affect the performance of composite materials, such as tensile and shear strength, elastic moduli, fatigue behaviour, creep, swelling (dimensional changes), and electrical resistance. The absorption of moisture in humid environments at room temperature is in general a reversible process and for most advanced composites, there is no degradation in room temperature mechanical properties [24]. As moist resins soften at elevated temperatures, resin dominated strength and stiffnesses are significantly less at these temperature, than those for dry composites.

Certain combinations of temperature and moisture, particularly when a component is stressed, can produce microcracking in the resin or at the fibre / matrix interface,

which will degrade the mechanical properties even at room temperature. For instance, 15 to 60 % loss of interlaminar shear strength can be expected at room temperature and high moisture contents [10]. In compression, the fibres rely on the matrix to provide the support necessary to prevent fibre buckling; under hot / wet conditions, the resin softens and the compression strength is reduced. In flexure, since the compressive strength is reduced under hot / wet conditions, the flexure strength shows a similar trend [21] and exhibits compression face failures.

It has been suggested that the effect of moisture and temperature on resin properties and resin dominated composites properties can be generalised [25] into a simple algebraic expression for incorporation into available composite micromechanics equations:

Where T_s is the glass transition temperature of the wet resin, T is the test temperature, and T_o is 273°K . This kind of relationship is suggested for unidirectional flexural, in-plane shear and matrix tensile strengths, in-plane shear modulus, and transverse modulus.

$$\frac{\text{Wet resin mechanical property at test temperature}}{\text{Dry resin mechanical property at room temperature}} = \left[\frac{T_s - T}{T_s - T_o}\right]^{1/2}$$

The test kit is simple to be used even by unskilled staff as it only requires two chemicals to perform the test. The test kit is also easy to be handled and transported as all chemicals used are in solid form.

THE INFLUENCE OF THERMOHUMID CONDITIONS ON COMPRESSIVE PROPERTIES

Potter and Purslow [26, 27] carried out compression strength tests on notched carbon fibre-epoxy resin specimens under various environmental conditions. Their investigation revealed the occurrence of two failure modes in the room temperature dry specimens; the stronger specimens failed by in-plane buckling of the 0° fibres, while the weaker specimens by both in-plane and out-of-plane buckling of the 0° fibres. The failure to laminate under hot / wet conditions occurred by out-of-plane microbuckling of the 0° plies. This was said to be because the elevated temperature and increased moisture content reduced the fibre-matrix bond strength. Any weakening in the fibre-matrix interface resulted in less lateral support for the fibres and premature failure tov laminate due to out-of-plane fibre buckling.

CONCLUSION

This review has established that moisture and temperature affect the performance parameters of fibre reinforced composite materials [23, 28, 29,], i.e. tensile, compressive

and shear strength, elastic moduli, swelling (dimensional changes), etc. Hence, moisture absorption and heat resistance of composite materials are thus of considerable importance, in particular to designers when setting design limits for components or structures operating in high temperature and humid environments.

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THE RELATIONSHIP BETWEEN TRAINING ASSIGNMENTS, FEEL IMPORTANCE AND TRAINING MOTIVATION: A STUDY IN A MILITARY TRAINING ACADEMY

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ABSTRACT

This study was conducted to examine the influence of feel importance in the relationship between training assignment and training motivation using 145 usable questionnaires collected from cadet officers in a military training academy, Malaysia. The results of the exploratory factor analysis confirmed that the measurement scales used in this study satisfactorily met the standards of validity and reliability analyses. Further, the outcomes of stepwise regression analysis showed two important findings: first, the relationship between mandatory and feel importance significantly correlated with training motivation. Second, relationship between voluntary and feel importance significantly correlated with training motivation. This result demonstrates that the ability of management to properly implement mandatory and voluntary assignments have invoked cadet officers' feel importance about the training programs. As a result, it may lead to an increased training motivation. Statistically, this result confirms that feel importance does act as a mediating variable in the training assignment model of the studied organization. In addition, discussion, implications and conclusion are elaborated.

INTRODUCTION

Training is an important segment of human capital development [1,2] where it is primarily implemented to enhance trainees' new knowledge, up to date skills and abilities, as well as positive attitudes [3-6].This training objective can be achieved if the management properly implements training assignments in organizations. Training assignment refers to the management that makes two types of training decisions: mandatory assignment and voluntary assignment [7-9]. Mandatory assignment is often viewed as a compulsory training assignment where employees have no choice or excuse; they must attend training programs that are assigned to them. This assignment is usually decided by the managers because they feel that employees must attend a very important training program that can meet their organizational strategy and goals [9-11]. On the other hand, voluntary assignment is often seen as an alternative training assignments where employees have choices whether they want to attend or not to attend training

programs that are assigned to them. This assignment is usually made by managers because they feel that employees know better which training programs are really useful and may help them to fulfill their organizational strategy and goals [9,12,13]. Hence, if the management can properly implement such training assignments this may help to increase employees' understanding about the benefits of attending on-the-job and off-the-job training programs [9, 14].

Further studies in training and development program highlight that the ability of the management to properly implement such training assignments may positively affect training motivation [8,15,16]. Many scholars like Mathieu et al. [8], Quinones [14], and Hicks and Klimoski [15] view training motivation as individuals who have high motivation, internal needs and/or desire to attend, learn and involved in training programs. In a training program model, many scholars state that the ability of the managers to implement planned mandatory and voluntary assignments may encourage employees to attend, learn and involved in training programs [3,17,18].

Interestingly, a thorough review of such relationships reveals that the effect of mandatory and voluntary assignments on training motivation is not direct, but its effect on training motivation is indirectly affected by employees' feel importance about the training programs [9, 16]. According to many scholars, such as Noe [13], Mathieu and Martineau [16], and Cohen [19], feel importance is often related to as individuals perceive the assigned training programs as benefits, appropriateness and usefulness. Within a training program framework, many scholars think that mandatory assignment, voluntary assignment, feel importance and training motivation are distinct constructs, but highly interrelated. For example, the ability of managers to properly implement mandatory and voluntary assignments will increase employees' feel importance about the training programs, which in turn, leads to an enhanced training motivation in organizations [8, 10, 16]. Even though this relationship is important, little is known about the mediating role of feel importance in training management research literature [9, 16]. Hence, it motivates the researchers to further explore the nature of this relationship.

OBJECTIVE OF THE STUDY

This study has two major objectives: firstly, is to measure the relationship between training assignment and training motivation. Secondly, is to quantify the mediating effect of feel importance in the relationship between training assignment and training motivation.

LITERATURE REVIEW

This section provides theoretical and empirical evidences supporting two major relationships: (1) between training assignment and training motivation, and (2) between training assignment, feel importance and training motivation.

Relationship between Training Assignment and Training Motivation

Many previous studies used a direct effect model to investigate training assignments based on different samples, like trainees in a navy SCUBA training program [7], managers in a state college [8], 184 banking employees in Taiwan [9], and 100 employees in a city based authority in Sarawak [20]. Findings from these studies showed that the ability of managers to properly implement mandatory and voluntary assignments regarding training program had been a major predictor of training motivation in the organizations [7,9,20].

Relationship between Training Assignment, Feel Importance and Training Motivation

Several recent studies used an indirect effect model to examine training assignments using different samples, such as employees in a nuclear plant [16], employees in several banks in Taiwan [9], and 100 employees in a city based local authority in Sarawak [20]. Findings from these studies reported that the ability of managers to appropriately implement mandatory and voluntary assignments had strongly increased employees' feel importance about the training programs. Consequently, it could lead to an enhanced training motivation in the respective organizations [9,16,20].

These studies support the nation of motivation theory, namely Maslow's [21, 22] needs hierarchy, Adams' [23, 24] equity theory and Vrooms' [25] expectancy theory. Firstly, Maslow's hierarchical of needs clearly explains that human needs have five hierarchies: physiology, safety, sense of belonging, esteem and self-actualization as important motivating factors. Secondly, Adams' [23, 24] equity theory posits that fair treatments or unfair treatments in distribution of outcomes may positively or negatively affect individuals' attitudes and behaviors in organizations [23, 24]. Thirdly, Vrooms' [25] expectancy theory reveals that individuals will perform their actions if they understand the value of outcomes [25]. Application of these theories in a training management show that the ability of managers to properly implement mandatory and voluntary assignments will strongly increase employees 'understanding about the need, value and significance of training programs, which in turn, leads to higher training motivation in organizations [9, 16, 20].

Conceptual Framework and Research Hypothesis

The literature has been used as a basis to develop a conceptual framework for this study as shown in Figure 1.

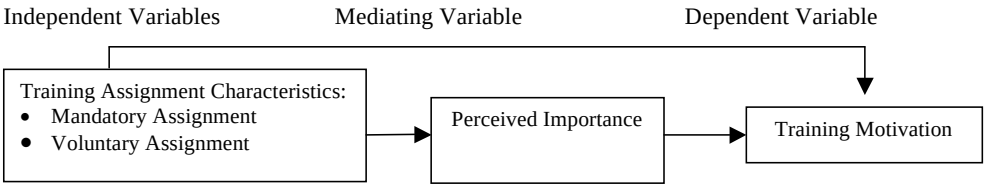

Figure 1: Conceptual Framework

Based on the framework, it was hypothesized that:

H1: There is a positive relationship between mandatory assignment and training motivation.
H2: There is a positive relationship between voluntary assignment and training motivation.
H3: Feel importance positively mediates the relationship between mandatory assignment and training motivation.
H4: Feel importance positively mediates the relationship between voluntary assignment and training motivation.

METHODOLOGY

Research Design

This study used a cross-sectional research design that allowed the researchers to integrate training program literature, the in-depth interviews, the pilot study and the actual survey as a main procedure to gather data. Using such methods may gather accurate data, decrease bias and increase quality of data being collected [26, 27]. The location of this study is a military training organization in Malaysia. At the initial stage of data collection, the in-depth interviews were conducted involving one military officer, one first year cadet officer, one second year cadet officer and one third year cadet officer. They were selected based on purposive sampling where they have good knowledge and experiences in training programs. The information gathered from this interview method helped the researchers to understand the training assignment characteristics, feel importance features, training motivation elements, and relationship between such variables in the studied organization. This information was transcribed, categorized and compared with the relevant training program literature. Next, the triangulated outcomes were used as a guideline to develop the content of the survey questionnaire for a pilot study. Thus, a pilot study was done by discussing the importance, relevance, clarity and suitability of questionnaires with the interviewed participants. Their opinions were sought to verify the content and format of survey questionnaires for an actual study. Back translation techniques were used to translate the survey questionnaires into English and Malay languages in order to increase the validity and reliability of research findings [26, 27].

Measures

The survey questionnaire used in this study had three sections. Firstly, mandatory assignment had 7 items and voluntary assignment had 5 items that were adapted from training assignment literature [6-9, 16]. Secondly, feel importance was measured using 4 items that were modified from training benefits literature [9,10,16].Finally, training motivation was measured using 6 items that were modified from training motivation literature [6-9,28,29].All items used in the questionnaires were measured using a 7-item

scale ranging from "strongly disagree/dissatisfied" (1) to "strongly agree/satisfied" (7). Demographic variables were used as controlling variables because this study focused on employee's attitudes.

Unit of Analysis and Sampling

The population of this study was 200 cadet officers. The researchers had obtained an official approval to conduct the study from the head of the organization and also received advice from him about the procedures of conducting the survey in his organization. Next, 150 survey questionnaires were distributed using a convenient sampling technique to 150 cadet officers in the organization. Of the number, 145 usable questionnaires were returned to the researchers, yielding 96.7 percent of the response rate. The survey questionnaires were answered by participants based on their consents and on a voluntarily basis. The number of this sample exceeds the minimum sample of 30 participants as required by the probability sampling technique, showing that it may be analyzed using inferential statistics [27].

Data Analysis

A Statistical Package for Social Science (SPSS) version 17.0 was used to analyze the data. Firstly, exploratory factor analysis was used to assess the validity and reliability of measurement scales [30]. Secondly, Pearson correlation analysis and descriptive statistics were conducted to determine the co linearity problem, to further confirm the validity and reliability of constructs [31-32]. Finally, stepwise regression analysis was recommended to assess the magnitude and direction of each independent variable, and vary the mediating variable in the relationship between many independent variables and one dependent variable [33]. Baron and Kenny [34] suggest that a mediating variable can be considered when it meets three conditions: first, the predictor variables should be significantly correlated with the hypothesized mediator. Second, all the predictor and mediator variables should also be significantly correlated with the dependent variable. Third, a previously significant effect of predictor variables should be reduced to non-significance or reduced in terms of effect size after the inclusion of mediator variables into the analysis [35]. In this regression analysis, standardized coefficients (standardized beta) were used for all analysis [36].

FINDINGS

Respondent Characteristics

Table 1 shows that majority respondents were males (77.2%), ages between 20 to 21 years old (66.2%), first year students (33.8%) and second year students (33.1%), Malay (93.8%), group who attended theoretical and practical training (67.6%), and students from Faculty A (86.9%)

Table 1: Respondent Characteristics (N=145)

Respondent Profile	Sub-profile	Percentage (%)
Gender	Male	77.2
	Female	22.8
Age	Below than 19 years old	2.8
	20 to 21 years old	66.2
	22 to 23 years old	24.1
	24 to 25 years old	6.9
Year of Study	1st Year	33.8
	2nd Year	33.1
	3nd Year	33.1
Race	Malay	93.8
	Chinese	0
	Indian	2.1
	Others	4.1
Type of Training	Theory	32.4
	Practical	0
	Theory and Practical	67.6
Faculty	A	86.9
	B	6.9
	C	6.2

5.1.2 Exploratory Factor Analysis

Table 2 shows that the variables used in this study had Kurtosis value of less than ±2 or Skewness value of less than ±2 [30], therefore it could be generalized that the variables satisfactory met the requirements of univariate normality assumption.

Table 2: The Results of Normality Test

Variable	N	Minimum	Maximum	Mean	Standard Deviation	Skewness	Kurtosis
Mandatory Assignment	145	4.00	7.00	5.5596	.68667	-.187	.201
Voluntary Assignment	145	1.20	6.60	4.6262	1.21112	-.956	.201
Feel Importance	145	3.00	7.00	5.3655	.83646	-.309	.201
Training Motivation	145	3.67	7.00	5.3437	.91839	-.101	.201

Tables 3 and 4 show the results of validity and reliability for the measurement scales. A factor analysis with direct rotation was done for four variables with 22 items. Next, the Kaiser-Mayer-Olkin Test (KMO) which is a measure of sampling adequacy was conducted for each variable and the results indicated that it was acceptable. Relying on Hair et al. [30],and Nunally& Bernstein's [37] guideline, these statistical analyses showed that (1) all research variables exceeded the acceptable standard of Kaiser-Meyer-Olkin's

value of 0.6; (2) all research variables were significant in Bartlett's test of sphericity; (3) all research variables had eigenvalues larger than 1 and had variance explained more than 0.45; (4) the items for each research variable exceeded factor loadings of 0.40 [30]; and (5) all research variables exceeded the acceptable standard of reliability analysis of 0.70 [37]. These statistical results showed that the measurement scales used in this study met the acceptable standard of validity and reliability analyses as shown in Tables 3 and 4.

Table 3: The Results of Validity and Reliability Analysis for the Measurement Scale

Variable	No. of Item	Factor Loading	KMO	Bartlett's Test of Sphericity	Eigenvalue	Variance Explained	Cronbach Alpha
Mandatory Assignment	7	.61 to .86	.90	695.74, p=.000	4.7	66.73	.92
Voluntary Assignment	5	.64 to .83	.71	419.67, p=.000	3.3	65.25	.87
Feel Importance	4	.53 to .86	.81	457.21, p=.000	3.2	80.75	.92
Training Motivation	6	.74 to .93	.79	709.43, p=.000	4.0	66.64	.94

Table 4 shows the results of Pearson correlation analysis and descriptive statistics. The means for all variables are from 4.63 to 5.56, signifying that the levels of mandatory assignment, voluntary assignment, feel importance, and training motivation are ranging from high (4.0) to highest level (7). The correlation coefficients for the relationship between the independent variable (i.e., mandatory and voluntary assignments) and the mediating variable (i.e., feel importance), and the relationship between the mediating variable (i.e., feel importance) and the dependent variable (i.e., training motivation) were less than 0.90, indicating the data were not affected by serious co linearity problem [30]. Thus, these statistical results provide further evidence of validity and reliability for measurement scales used in this research [30, 37].

Table 4: Pearson Correlation Analysis and Descriptive Statistics

Variable	Mean	Standard Deviation	Pearson Correlation Coefficients			
			1	2	3	4
1. Mandatory Assignment	5.56	0.68	(1)			
2. Voluntary Assignment	4.63	1.21	.26**	(1)		
3. Feel Importance	5.38	0.84	.62**	.41**	(1)	
4. Training Motivation	5.34	0.91	.37**	.53**	.46**	(1)

Note: Significant at *p<0.05;**p< 0.01

Reliability Estimation is shown in a parenthesis

Outcome of Testing Hypotheses 1 and 2

As described in Table 4, the results of Pearson correlation analysis showed two important findings: first, mandatory assignment significantly correlated with training motivation (r=.37, p<0.01), therefore H1 was supported. Second, voluntary assignment significantly correlated with training motivation (r=.53, p<0.01), therefore H2 was supported. Statistically, these results demonstrate that mandatory and voluntary assignments are important predictors of training motivation in the studied organization.

Outcome of Testing Hypothesis 3

Table 5 shows the results of testing hypotheses using a stepwise regression analysis. It shows that demographic variables were entered in Step 1 and then followed by entering independent variable (i.e., mandatory assignment) in Step 2, and mediating variable (i.e., feel importance) in Step 3. Training motivation was used as the dependent variable. An examination of multi colinearity in the coefficients table shows that the tolerance value for the relationship between the independent variable (i.e., mandatory assignment) and the dependent variable (i.e., training motivation) were 0.89. While, the tolerance value for the relationship between the independent variable (i.e., mandatory assignment), the mediating variable (i.e., feel importance) and the dependent variable (i.e., training motivation) was 0.54. These tolerance values were more than the established tolerance value of .20 (as a rule of thumb), indicating the variables were not affected by multi colinearity problems [31].

Table 5: The Results of Stepwise Regression Analysis

Variable	**Dependent Variable (Training Motivation)**		
	Step 1	**Step 2**	**Step 3**
Controlling Variable			
Gender	.01	.02	.06
Year of Study	-.15	-.13	-.10
Age	.21	.12	.08
Race	-.07	-.05	-.01
Type of Training	-.03	-.06	-.08
Faculty	.05	.06	-.01
Dependent Variable			
Mandatory Assignment		.34***	.09
Mediating Variable			
Feel Importance			**.41*** **
R Square	.07	.17	.26
Adjusted R Square	.03	.13	.22
R Square Change	.07	.10	.09
F	1.70	4.01***	5.96***
F Change R Square	1.70	16.71***	16.41***

Note: Significant at *p<0.05; **p<0.01; ***p<0.001

Table 5 shows the results of testing hypotheses in Step 3. The inclusion of feel importance in Step 3 of the process reveals that relationship between feel importance and training assignment (i.e., mandatory assignment) positively and significantly correlated with training motivation (ß=.41, p<0.001), therefore H3 was fully supported. This relationship explains that before the inclusion of feel importance in Step 2, mandatory assignment was found to be a significant predictor of training motivation (Step 2: ß=.34, p<0.001). In terms of explanatory power, the inclusion of this variable in Step 2 had explained 17 percent of the variance in dependent variable. As shown in Step 3 (after the inclusion of feel importance into the analysis), the previous significant relationship between mandatory assignment and training motivation changed to non significant (Step 3: ß=.09, p>0.05). In terms of explanatory power, the inclusion of feel importance in Step 3 had explained 26 percent of the variance in dependent variable. This result confirms that feel importance does act as a full mediating variable in the relationship between mandatory assignment and training motivation in the studied organization.

Outcome of Testing Hypothesis 4

Table 6 shows the results of testing hypotheses using a stepwise regression analysis. It shows that demographic variables were entered in Step 1 and then followed by entering independent variable (i.e., voluntary assignment) in Step 2, and mediating variable (i.e., feel importance) in Step 3. Training motivation was used as the dependent variable. An examination of multi colinearity in the coefficients table shows that the tolerance value for the relationship between the independent variable (i.e., voluntary assignment) and the dependent variable (i.e., training motivation) were 0.71. While, the tolerance value for the relationship between the independent variable (i.e., voluntary assignment), the mediating variable (i.e., feel importance) and the dependent variable (i.e., training motivation) was 0.72. These tolerance values were more than the established tolerance value of .20 (as a rule of thumb), indicating the variables were not affected by multi colinearity problems [31].

Table 6 shows the results of testing hypotheses in Step 3. The inclusion of feel importance in Step 3 of the process reveals that relationship between feel importance and training assignment (i.e., voluntary assignment) positively and significantly correlated with training motivation (ß=.54, p<0.001), therefore H4 was fully supported. This relationship explains that before the inclusion of feel importance in Step 2, voluntary assignment was found to be a significant predictor of training motivation (Step 2: ß=.66, p<0.001). In terms of explanatory power, the inclusion of this variable in Step 2 had explained 38 percent of the variance in dependent variable. As shown in Step 3 (after the inclusion of feel importance into the analysis), the previous significant relationship between voluntary assignment and training motivation did not change to non significant (Step 3: ß=.54, p<0.001), but the strength of the relationship between such variables was decreased. In terms of explanatory power, the inclusion of feel importance in Step 3 had explained 43 percent of the variance in dependent variable. This result confirms that feel importance does act as a partial mediating variable in the relationship between voluntary assignment and training motivation in the studied organization.

Table 6: The Results of Stepwise Regression Analysis

Variable	Dependent Variable (Training Motivation)		
	Step 1	Step 2	Step 3
Controlling Variable			
Gender	.01	.00	.04
Year of Study	-.15	-.19**	-.15*
Age	.21*	.11	.06
Race	-.07	.25**	.23***
Type of Training	-.03	-.01	-.04
Faculty	.05	-.03	-.06
Dependent Variable			
Voluntary Assignment		.66***	.54***
Mediating Variable			
Feel Importance			**.27*** **
R Square	.07	.38	.43
Adjusted R Square	.03	.35	.40
R Square Change	.07	.31	.05
F	1.70	11.97***	12.84***
F Change R Square	1.70	68.61***	12.12***

Note: Significant at *p<0.05; **p<0.01; ***p<0.001

DISCUSSION AND IMPLICATIONS

The findings of this study confirms that feel importance does act as a mediating variable in the relationship between training assignment characteristics (i.e., mandatory and voluntary assignments) and training motivation in the studied organization. In the organizational context, the majority of the interviewed participants perceive that managers have used more mandatory assignments than voluntary assignments in order to motivate cadet officers to attend and learn new knowledge, to update skills and abilities, as well as to possess positive attitudes in training programs. Besides that, the level of employees' feel importance about the training programs is high in training programs. In terms of correlation, the ability of managers to properly practice mandatory and voluntary assignment have increased cadet officers' feel importance about the training programs. As a result, it may lead to higher training motivation in the studied organization.

The implications of this study can be divided into three categories: theoretical contribution, robustness of research methodology, and practical contribution. In terms of theoretical contribution, the findings of this study highlights two major issues: firstly, feel importance has mediated the effect of mandatory assignment on training motivation. Secondly, feel importance has mediated the effect of voluntary assignment on training motivation. This result is consistent with studies by Tsai and Tai[9], Mathieu and Martineau [16], and Azman, Suriani, Ali &Osman [20]. In sum, this study has provided a great potential to understand that high level of feel importance about the training programs will strongly encourage cadet officers to implement mandatory and voluntary assignments in order to learn new knowledge, update skills and abilities, as well as provide positive attitudes in the training programs.

With respect to the robustness of research methodology, the survey questionnaires used in this study have exceeded a minimum standard of validity and reliability analyses; this can lead to the production of accurate findings. In terms of practical contributions, the findings of this study may be used to improve the design and administration of training and development program for cadet officers. In order to achieve this objective, managers may focus to improve the following aspects: firstly, update training content and methods. For example, current training contents need to give more attention on developing trainee competencies in cognitive, emotions and good moral values than solving technical and daily management problems.

Application of such competencies can be enhanced if cadet officers are properly trained by using practical training methods, such as team building, role play and cross-cultural case studies. This training method may increase the capability of cadet officers to perform challenging jobs in military organizations. Secondly, strengthen recruitment policy. For example,managers need to give more priority in recruiting cadet officers based on emotion and cognitive compentencies besides academic achievement. This recruitment policy may help to hire intelligent candidates who may be trained to fulfill future important positions in millitary organizations. Thirdly, adjust performance appraisal system. For example, current performance appraisal needs to give more focus on evaluating the capability of cadet officers in attending and learning new knowledge, update skills and abilities, as well as provide positive attitudes than physical skills. This appraisal system will motivate cadet officers to use multi skillings in performing their duties and responsibilities, such as planning military exercise, conducting training, joint military exercise, planning and negotiation for security, managing disasters, and peace keeping missions. If these suggestions are heavily considered this may upgrade the ability of cadet officers in performing millitary strategic missions.

CONCLUSION

This study used a conceptual framework that was developed based on the training assignment research literature. The measurement scales used in this study satisfactorily met the standards of validity and reliability analysis. The outcomes of stepwise regression analysis confirmed that feel importance had mediated the effect of training assignment characteristics (i.e., mandatory and voluntary assignments) on training motivation in the studied organizations. This result has also supported training assignment literature mostly published in Western countries. Therefore, current research and practice within the training assignment model needs to consider feel importance as a critical aspect of the training system. This study further suggests that the ability of management to properly implement mandatory and voluntary assignments will strongly motivate cadet officers to attend, learn and be involved in training programs, as well as to transfer what they have learnt in training programs when they join the workplace. Thus, these positive outcomes may lead to an increased organizational competitiveness in an era of global competition.

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