เอกสารวิจัยส่วนบุคคล

เรื่อง

การปฏิวัติอุตสาหกรรมครั้งที่ ๔ ในกองทัพอากาศไทย

The 4th Industrial Revolution in the Royal Thai Air Force

โดย

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หนังสือรับรอง

คณะกรรมการเอกสารวิจัยโรงเรียนเสนาธิการทหารอากาศได้ตรวจและรับรองว่าเอกสารวิจัยส่วนบุคคล เรื่อง การปฏิวัติอุตสาหกรรมครั้งที่ ๔ ในกองทัพอากาศไทย The 4th Industrial Revolution in the Royal Thai Air Force ของ นาวาอากาศโท คิธ เชียง นายทหารนักเรียนโรงเรียนเสนาธิการทหารอากาศ รุ่นที่ ๖๗ เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรเสนาธิการทหารอากาศ โรงเรียนเสนาธิการทหารอากาศ กรมยุทธศึกษาทหารอากาศ ประจำปีการศึกษา ๒๕๖๖

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บทคัดย่อ

เอกสารวิจัยเรื่อง การปฏิวัติอุตสาหกรรมครั้งที่ ๔ ในกองทัพอากาศไทย

ชื่อนักศึกษา นาวาอากาศโท คิธ เชียง

ที่ปรึกษา นาวาอากาศโท นิโคลา โกฮ์

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การปฏิวัติอุตสาหกรรมครั้งที่ ๔ (4IR) หมายถึง การเปลี่ยนแปลง ทางเทคโนโลยีอย่างก้าวกระโดดที่ส่งผลกระทบอย่างมากต่อกองทัพ การวิจัยสารคดีนี้วิเคราะห์ผลกระทบของ 4IR ต่อกองทัพขนาดเล็กที่มีเทคโนโลยีทางทหารที่เกิดขึ้นใหม่ และแนวทางของกองทัพขนาดเล็ก ต่อการนำเทคโนโลยีใหม่มาใช้ เอกสารฉบับนี้เสนอกรอบแนวทางสำหรับกองทัพอากาศไทยในการนำเทคโนโลยีใหม่มาใช้ พร้อมกับประเด็นสำคัญด้านเทคโนโลยีหลายประการตามเอกสารยุทธศาสตร์กองทัพอากาศ ๒๐ ปี (ฉบับปรับปรุง พ.ศ.๒๕๖๓)

ผลการวิจัยพบว่ากองทัพอากาศไทยยังไม่ได้กล่าวถึงข้อควรพิจารณา ที่สำคัญบางประการ ในการนำเทคโนโลยีใหม่ ๆ มาใช้ รวมถึงเทคโนโลยีหลัก ๆ หลายด้านที่ไม่ได้ระบุไว้ในยุทธศาสตร์กองทัพอากาศ ๒๐ ปี (ฉบับปรับปรุง พ.ศ.๒๕๖๓) เพื่อให้ทันกับความก้าวหน้าทางเทคโนโลยี 4IR บทความนี้แนะนำกรอบกลยุทธ์หกส่วนสำหรับกองทัพอากาศไทยรวมถึงการจัดลำดับความสำคัญของการลงทุนเชิงกลยุทธ์ มุ่งเน้นไปที่ความปลอดภัยทางไซเบอร์ การลงทุนในทรัพยากรบุคคลโดยมุ่งเน้นที่สาขาเทคโนโลยีดิจิทัล การร่วมมือกับสถาบันขั้นสูงทางเทคโนโลยี การจัดการผลกระทบทางจริยธรรม และการเพิ่มความคล่องตัวขององค์กร การเพิ่มความรู้ด้านดิจิทัลหลักสูตรระดับอุดมศึกษาฟรี ในเทคโนโลยีดิจิทัลการสรรหาผู้มีความสามารถด้านวิทยาศาสตร์ เทคโนโลยี วิศวกรรม และคณิตศาสตร์ (STEM) และกระบวนการจัดซื้อจัดจ้างที่คล่องตัวเป็นส่วนสำคัญของแนวทางนี้ นอกจากนี้ กองทัพอากาศไทยควรสำรวจพื้นที่ทางเทคโนโลยีที่ไม่ได้กล่าวถึงในเอกสารยุทธศาสตร์กองทัพอากาศ ๒๐ ปี (ฉบับปรับปรุง พ.ศ.๒๕๖๓) เช่น คลาวด์คอมพิวติ้ง เทคโนโลยีอากาศยานไร้คนขับขั้นสูง และการพิมพ์ ๓ มิติ การนำกรอบแนวทางนี้มาใช้และการสำรวจเทคโนโลยีเหล่านี้จะสนับสนุนความพยายามในการปรับปรุงให้ทันสมัยของกองทัพอากาศไทยโดยรักษาความได้เปรียบทางยุทธศาสตร์และตำแหน่งในฐานะหนึ่งในกองทัพอากาศที่ดีที่สุดในอาเซียน

ABSTRACT

Research Title The 4th Industrial Revolution in the Royal Thai Air Force

Name Lieutenant Colonel Keith Chiang

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Research Advisor Wing Commander Suttichai Chaiyajit

The 4th Industrial Revolution (4IR) signifies a transformative phase characterised by disruptive technologies with profound implications for the military. This documentary research analyses the impact of the 4th Industrial Revolution (4IR) on the smaller militaries, some of the emerging military technologies today, and the approach of smaller militaries toward the adoption of new technologies. The paper then proposes an approach framework for the RTAF toward adopting new technologies, together with several key technology focus areas based on the RTAF White Paper 2020.

The results found that the RTAF has yet to address some key considerations towards adopting new technologies, as well as several key technology areas not featured in the RTAF White Paper 2020. To keep up with the 4IR technological advancements, this paper suggests a strategic six-part framework for the RTAF, including prioritising strategic investments, focusing on cybersecurity, investing in human capital with a focus on digital technology fields, collaborating with technologically advanced institutions, addressing ethical implications, and enhancing organisational agility. Increased digital literacy, free tertiary courses in digital technology, recruitment of Science, Technology, Engineering, and Mathematics (STEM)

talents, and an agile procurement process are integral to this approach. The RTAF should also explore technological areas not addressed in the RTAF White Paper 2020, such as Cloud Computing, advanced UAS technologies, and 3D printing. Adopting this approach framework and exploring these technologies would support the RTAF's modernisation efforts, maintaining its strategic edge and position as one of the best air forces in the ASEAN.

FOREWORD

In an era of rapid technological advancement, we stand on the precipice of the 4th Industrial Revolution (4IR), representing a time of significant and transformative change. The dawn of the 4IR signals a new age where disruptive technologies such as the Internet of Things (IoT), robotics, cloud computing, and Artificial Intelligence (AI) fundamentally alter how we live and work. This revolution, unique for its speed, complexity, and transformative power, poses both unprecedented opportunities and complex challenges to the military.

While it is evident that larger militaries are more well positioned given the heavy investments in 4IR technologies, the approach of smaller militaries toward technology adoption needs to be more strategic due to their limited resources. This research endeavours to propose a suitable approach framework for the RTAF and highlight several technology areas not addressed in the RTAF White Paper 2020, to ensure that the RTAF is well-positioned to harness the potential of these emerging 4IR technologies.

Lieutenant Colonel 

(Keith Chiang)

Student of RTAF Air Command and Staff College Class 67

July 2023

ACKNOWLEDGEMENT

I would like to begin by expressing gratitude to my research consultant, Lieutenant Colonel Nichola Goh, for her invaluable support and guidance throughout the course of this study. Her expertise and constructive critiques have helped shape this paper. I also wish to sincerely thank my research advisor, Wing Commander Suttichai Chaiyajit, whose insights and encouragement helped me overcome various research challenges.

I am grateful for the support from the RTAF Air Command and Staff College, without which this research would not have been possible. Their commitment to the research efforts and development of the students here at the RTAF Air Command and Staff College is truly commendable.

Finally, I express my heartfelt gratitude to my beloved wife, Victoria, and my 4-month-old daughter, Olivia, for their endless love, patience, and understanding throughout my research journey. Their love and support have been my stronghold, giving me the strength to pursue my passion for learning and discovery.

In closing, while this paper is the culmination of many hours of work and dedication, I am mindful that any success is a result of collaboration and the kindness of my other classmates here at the RTAF Air Command and Staff College. Thank you to all those who contributed to this effort.

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CHAPTER 1

INTRODUCTION

1. Importance and Origin of Research

Industrial revolutions create profound and sudden technological changes that affect businesses and militaries alike. The 4th Industrial Revolution (4IR) is the current and developing environment in which disruptive technologies and trends, such as the Internet of Things (IoT), robotics, cloud computing, and Artificial Intelligence (AI), are changing the way people live and work. These emerging technologies of the 4IR provide tremendous opportunities and complex challenges to the military.

The 4IR is distinct from the previous three industrial revolutions due to its unprecedented speed, complexity, and transformative power. Characterised by a fusion of technologies "blurring the lines between the physical, digital, and biological spheres," the 4IR is set to grow exponentially (Schwab, 2016). The pace of change is staggering, with the global expenditure on drones and robotics surging from $128.7 billion in 2020 to $241.4 billion in 2023, underlining the accelerated adoption of new technologies (*Spending Forecast - Robotics and Drones Globally 2023*, n.d.). Similarly, the number of IoT-connected devices globally reached 11.7 billion in 2020, and there are expected to be more than 30.9 billion IoT-connected devices by 2025 (*49 Stunning Internet of Things Statistics to Know in 2023*, n.d.).

While the larger militaries have the wherewithal to invest in 4IR technologies, the approach of smaller militaries, due to their limited resources and sizes, is less straightforward. The study will examine the approach and key considerations of smaller militaries, and propose an approach to technology adoption and a few key technology focus areas for the Royal Thai Air Force (RTAF) to take advantage of and safeguard against the emerging 4IR technologies.

2. Research Objectives

2.1 To learn about 4IR and the transformative technologies in the military.

2.2 To learn about the approaches of smaller militaries towards 4IR technology adoption.

2.3 To propose an approach to technology adoption and key technology focus areas for the RTAF to maximise the benefits and minimise the risks of 4IR technologies.

3. Research Question

3.1 The key research question is: How should the RTAF approach 4IR technologies? The sub-questions within are:

3.1.1 Why do Industrial Revolutions matter to the military?

3.1.2 What is the 4IR, and how is it relevant to the military?

3.1.3 What are some examples of transformative 4IR military technologies?

3.1.4 How do smaller militaries approach the adoption of new technologies?

3.1.5 How should the RTAF approach 4IR technologies, and what are the focus areas for the RTAF to benefit from emerging 4IR technologies?

4. Scope of Research

4.1 The paper will examine the 4IR, including past Industrial Revolutions, and the 4IR's relevance to the military.

4.2 The paper will explore the 4IR technologies that are transformative in the military and examine the opportunities and risks.

4.3 The paper will study the approaches of smaller militaries, which are less well-funded and smaller-sized, towards technology adoption. A case study will be used to further examine the approach taken by smaller militaries.

4.4 In the context of the RTAF, the paper will propose an approach framework and key technology focus areas to take advantage of emerging 4IR technologies, by applying established frameworks (e.g. SWOT) to perform the analysis and synthesis.

5. Research Methodology

5.1 Historical research on industrial revolutions and their impact on the military.

5.2 Documentary research on transformative 4IR technologies in the military, and the approaches of smaller militaries towards technology adoption.

5.3 Data analysis and synthesis to support further analysis and recommendations for the RTAF's approach towards 4IR technologies.

6. Expected Benefits from Research

The benefits of the research are twofold. First, the research will gain insights into the transformative capabilities of emerging 4IR technologies in the military, and the key considerations of smaller militaries towards adopting 4IR technologies. Besides the opportunities, it is equally important to examine the threats of 4IR technologies. Second, the research will apply the research findings in the context of the RTAF, and formulate an approach and technology focus areas to take advantage of the opportunities afforded by 4IR technologies.

7. Terminology Definition

7.1 "4th Industrial Revolution" refers to the present trend of automation and data exchange in industrial technologies, including developments in AI, IoT, autonomous robots, and cloud computing. It is characterised by the integration of advanced technologies, such as AI, machine learning, blockchain, and advanced robotics, into manufacturing processes, as well as the use of cloud computing, big data, and data analytics to drive decision-making and optimise performance (Schwab, 2016).

7.2 "Smaller Militaries" refers to the militaries of countries that have smaller military budgets. In this research, this refers to all the other countries outside the top 10 based on annual military expenditures. In 2021, only 10 countries have military expenditures greater than US$50B (USA, China, India, United Kingdom, Russia, France, Germany, Saudi Arabia, Japan, S. Korea) (*SIPRI Milex*, n.d.).

8. Conceptual Framework

8.1 The first step is to conduct basic research and literature reviews regarding (1) 4IR, (2) transformative 4IR technologies in the military, and (3) approaches of smaller militaries towards 4IR technologies.

8.2 The second step is to examine and sieve out the relevant findings on 4IR from the research, both qualitative and quantitative, based on the RTAF's long-term 20-year strategy and plans.

8.3 The third step is to apply the research results to perform further analysis to formulate an approach framework for the RTAF towards 4IR technologies and use established frameworks (e.g. SWOT analysis) to determine the technology focus areas for the RTAF to take advantage of emerging 4IR technologies.

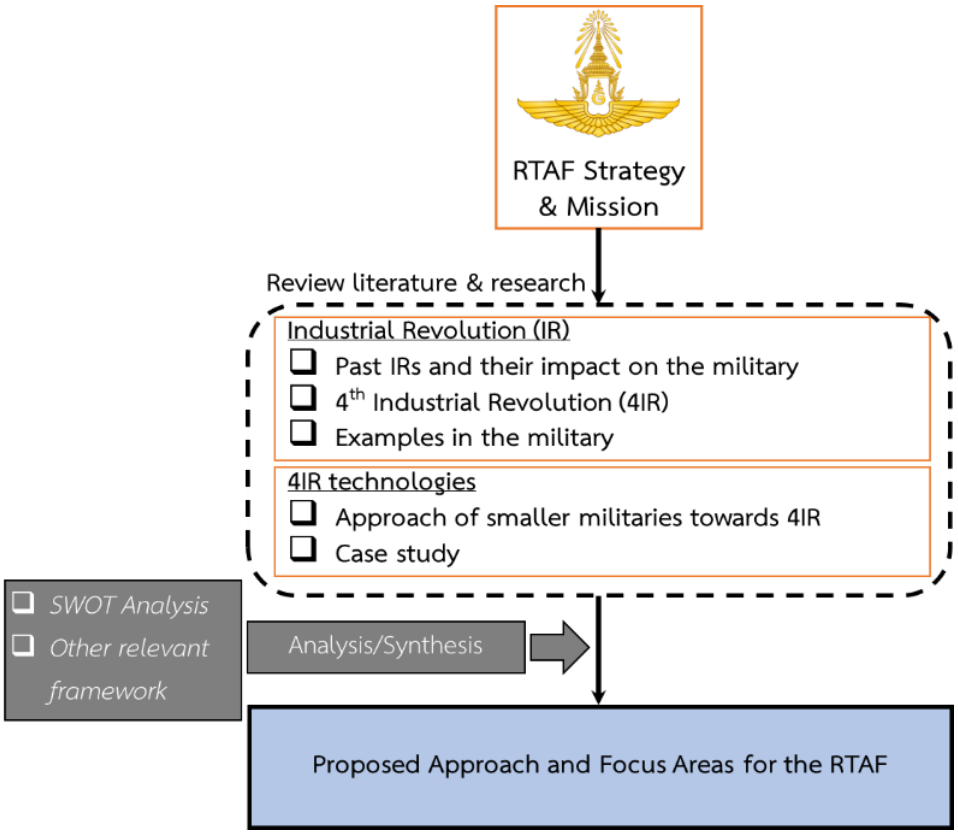

Figure 1 – 1 Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

1. History of Industrial Revolutions and Their Impact on the Military

The *1st Industrial Revolution* was a phase of profound economic, social, and technological transformation that started in Britain in the late 18th century. The invention of the steam engine and spinning jenny (mass production of weapons and supplies), steam-powered boats and trains (movement of troops and supplies), and rifling (improved weapon accuracy and range) had a significant impact on the military.

Between 1870 and 1914, the *2nd Industrial Revolution*, also known as the technological revolution, saw the introduction of new technologies such as the telegraph, telephone, and electricity. Telegraph and telephone technologies enabled more effective military planning and communications, while the use of aircraft and submarines in World War I also changed battlefield strategies, as novel types of combat such as airstrikes and submarine attacks were introduced.

Beginning in the late 20th century, the proliferation of computer technologies and the Internet defined the *3rd Industrial Revolution*, also known as the digital revolution. Weaponised drones and precision-guided weaponry brought new concepts to Intelligence, Surveillance, and Reconnaissance (ISR) and targeting missions, computers enabled military commanders to make more informed decisions by analysing large amounts of data, and satellite communications led to dependable communication even in remote locations (*Industrial Revolution - The First Industrial Revolution | Britannica*, 2023).

2. The 4th Industrial Revolution (4IR) and Why It Matters

According to Schwab (2016), the 4th Industrial Revolution (4IR) that we are currently undergoing is the "convergence of physical, digital, and biological systems", which is a result of the swift developments in big data, robotics, IoT, AI, 3D printing, and other modern technologies. The 4IR is causing enormous changes in the way we work, live, and interact, and it has the potential to cause both positive and negative impacts on people, businesses, and society at large (*The Fourth Industrial Revolution*, 2016).

The 4IR is shifting the way militaries operate by bringing new technologies that alter the characteristics of conflict and warfare. Tesar & Work (2018) argue that advanced 4IR technologies will *fundamentally change concepts of military operations*, *enhance operational tempo and decision-making on the battlefield*, and *create new avenues of collecting and analysing intelligence* (Tesar & Work, 2018). One example is the extensive use of drones, including weaponised ones, in the Russian-Ukraine war ('How Are "kamikaze" Drones Being Used by Russia and Ukraine?', 2022). Also, robotics and AI are increasingly used to automate hazardous jobs, thus reducing the risk to soldiers. Integration of IoT and big data analytics enhance command and control systems, allowing military commanders to make better decisions more quickly.

To truly embrace 4IR technologies in the military, Schwab (2016) highlighted the need for organisations to adapt or possibly even transform themselves to become more "agile". Similar to how private companies adopt agile responses to product development, militaries need to maintain "agile" in the face of continuous and fast-changing environments, which could necessitate collaboration with private companies to integrate and regulate these new technologies (Schwab & Davis, 2018).

Concomitantly, militaries need to be equally mindful of the threats of 4IR technologies. Some of the key risks of 4IR technology in the military are *job displacement*, *cyberattacks*, and *ethical concerns* (Schwab, 2016).

First, given automation and AI's potential to *displace jobs*, military leadership needs to appreciate the impact of these new technologies and ensure the upskilling of soldiers to fit the new jobs. Failure to do so would lead to operational inefficiencies and morale issues. On upskilling, many established militaries have already recognised the need to raise baseline qualifications to effectively harness the potential of

emerging technologies. For example, the U.S. Air Force and Space Force established the 'Digital University' in 2020, offering airmen and space soldiers free courses on digital skills and emerging technologies such as AI and data science (*Digital University*, n.d.). These developments underscore the shift in militaries towards fostering a more technologically adept workforce to exploit the benefits of the 4IR.

Second, military and critical infrastructure are more susceptible to *cyberattacks* as a result of the rising use of digital technology and networked systems (Schwab & Davis, 2018). According to a report from the U.S. Government Accountability Office, the Department of Defence has been identified as having significant vulnerabilities in nearly all the mission-critical cyber defence systems that were tested (*Weapon Systems Cybersecurity*, 2018). Furthermore, a study by the Ponemon Institute found that 66% of surveyed companies reported experiencing a cyberattack in 2019 (*Ponemon Library*, n.d.).

Third, the increased data collection and use of AI in autonomous systems create ethical concerns, such as privacy risks and lack of accountability. (Wallach & Allen, 2008). The increased connectivity and data collection, while enhancing productivity and efficiency, poses significant risks to individual privacy. Also, the employment of AI in autonomous weapon systems to make life-and-death decisions is another ethical concern as questions continue to mount regarding the issue of accountability and the potential for their misuse (Kwik, 2023).

3. Transformative 4IR Technologies in the Military

The latest wave of technological innovations has the potential to transform the characteristics of war. These transformative technologies offer unprecedented levels of precision, speed, and efficiency in military operations, and are essential for maintaining a competitive advantage in the modern security landscape. In this regard, it is important to understand the potential of 4IR technologies in the military and their implications for future warfare. It should be noted that these technologies are mainly led by the major military powers, ranked by defence spending. In 2021, the United States led this index by a significant margin at approximately US$800 billion, while China and Russia are at US$293 billion and US$66 billion respectively. On the other

hand, smaller militaries such as Thailand and Singapore have defence expenditures of US$6.6 billion and US$11 billion respectively (*SIPRI Milex*, n.d.). Therefore, access to these cutting-edge technologies remains dominated by the larger militaries, and smaller militaries have limited access to them.

The following technologies are broadly categorised into two groups. The first group refers to the function-based technologies which refers to emerging technologies that contribute directly to the various functions of warfare (e.g. offensive, defensive). This group consists of hypersonic technology, space-based capabilities, Directed Energy Weapons (DEWs), AI-powered autonomous systems, and cyber capabilities. The second group refers to the enabling technologies, or potential force multipliers, which have broad applications that can enhance military operations across multiple domains or functions. This group consists of cloud computing, Artificial Intelligence (AI), and 3D printing.

3.1 Hypersonic Technology. A strategic weapon culminated by 4IR technologies is the hypersonic missile, which is capable of high-speed, long-range strikes and enhances survivability against enemy air defences, providing a significant strategic advantage. Given the high developmental cost, hypersonic missiles are known to be developed by only a few countries with higher defence spending, including Russia, China, and the United States (Gale, 2022). Recent employment of hypersonic "Kinzhal" missiles by the Russian military has been observed during the Russian-Ukraine war in 2023, although its success in the conflict has been debatable (Neuman, 2023).

3.2 Space-based Capabilities. Space-based capabilities have become increasingly crucial in modern warfare as a strategic enabler of communication, intelligence, surveillance, and reconnaissance capabilities, making it a force multiplier across multiple military operations. The US, Russia, and China are the major militaries leading the development of advanced space-based systems, demonstrating their importance in maintaining a competitive edge. Besides the US Global Positioning System (GPS) and Russian GLONASS, China's BeiDou Navigation Satellite System (BDS) and ongoing development of anti-satellite (ASAT) weapons show the importance of space capabilities in modern warfare (Desk, 2021). With the growing investments, the militarisation of space will play a significant role in shaping the future of global security.

3.3 Directed Energy Weapons. Directed Energy Weapons (DEWs) involves the emission of highly focused energy, including lasers, microwaves, and particle beams, to disable or destroy targets. This novel and emerging technology deliver precise, rapid, and scalable effects with minimal collateral damage, making it ideal in both defensive and offensive applications. Currently, the US, Russia, and China are leading the development of DEWs. Some examples include the US' Tactical High Power Microwave Operational Responder (THOR), and also Russia's "Peresvet" combat laser system that was recently deployed in the Russia-Ukraine war in 2022 (*'Peresvet' and 'Zadira'*, 2022). As DEWs continue to evolve, it continues to demonstrate the potential to revolutionise modern warfare by providing militaries with effective means to counter emerging threats such as drones and satellites.

3.4 AI-powered Autonomous Weapons Systems. This refers to weapons that use AI algorithms to make decisions during operations and are capable of engaging targets without human intervention. One example is the USAF XQ-58A Valkyrie *"loyal wingmen"* drone which can operate with minimal guidance from the pilot, including generating maps, jamming enemy signals, and launching munitions. This novel concept of *Manned Unmanned Teaming (MUT)* is a force multiplier to manned fighter jets (Losey, 2022). Another example is the employment of *loitering munitions*, also known as "kamikaze drones", which entails these weaponised Unmanned Aerial Systems (UAS) flying above an area for a long time before attacking a target of opportunity. Its increasing popularity can be attributed to its success in military conflicts, such as the "Lancet" loitering munitions used by the Russian military in the Russian-Ukraine war in 2022 (*Loitering Munitions in Ukraine and Beyond*, 2022). The third example is *swarm technology*, which is the coordination and control of multiple autonomous systems toward a common goal. China has positioned itself as one of the leaders, with the Chinese company Ehang demonstrating the world's largest quadcopter UAV swarm consisting of 1,374 UAVs in 2018 (*Swarm Drones - New Frontier of Warfare*, 2021). Given its wide range of applications, major countries such as the US, China, and even India, have already demonstrated ambitions to add *swarm technology*, and *counter-swarm technologies*, to their military capabilities (Gagaridis, 2022).

3.5 Cloud Computing. Amidst an industrial revolution that is driven by data to enable new technologies, the ability to ensure safe and efficient means to collect, store, and share data across the organisation cannot be overstated. Besides the developed nations such as the US and UK, countries with smaller militaries such as Norway, Finland, and Singapore have already invested in Cloud Computing to modernise their Information Technology (IT) infrastructure (*Fact Sheet*, 2021). In terms of direct operational impact, it is useful to note that cloud technology is also used by the most advanced aircraft on the battlefield, such as the USAF's B-21 "Raider" sixth-generation aircraft, and it is expected to result in a "more maintainable and sustainable aircraft with lower-cost infrastructure" (*10 Facts About Northrop Grumman's B-21 Raider*, n.d.).

3.6 Artificial Intelligence. Artificial intelligence (AI) is increasingly used by militaries today to enhance decision-making capabilities through the analysis of large amounts of data, thus enabling rapid and more accurate intelligence gathering and threat identification. A good example is the US Department of Defence's Project Maven, which created AI algorithms to process video footage from drones and automatically detect potential targets (Strout, 2022). AI also plays an important role in enhancing cyber capabilities, in terms of detecting and defending against cyber threats in real-time. The adoption of AI is enabling the military to operate more effectively and adapt to the rapidly changing nature of modern warfare.

3.7 3D Printing. Today, 3D printing is being used by a growing number of militaries to improve efficiency and resilience, reduce cost, and enhance capabilities. For example, the US military uses 3D printing for rapid prototyping that allows for rapid testing and development (Owen, 2022), while the UK adopts 3D printing to manufacture spare parts for military equipment, which minimises stockpiles and enables quicker repairs during operations (*3D Printing of Spare Parts and Equipment for the UK's Armed Forces May Soon Be a Reality*, 2022).

4. Smaller Militaries and their Approaches Towards 4IR Technologies

Smaller militaries refer to the armed forces of countries that have relatively fewer military personnel and smaller defence budgets compared to larger militaries of other countries. This categorisation can be based on the number of personnel, the defence budget, and the number of weapons systems and equipment (*SIPRI Milex*, n.d.).

In his article, Nah (2018) analyses the potential benefits and challenges the 4IR technologies pose for smaller militaries. The article highlights that while these technologies offer several advantages such as increased situational awareness, improved decision-making, and operational efficiency, smaller militaries face significant challenges in adopting them. These challenges include high costs of acquisition, maintenance, and training, technology asymmetry, and the risk of cyber threats. To fully leverage the benefits of 4IR technologies, the author suggests that smaller militaries must carefully weigh the potential benefits and challenges and adopt a proactive and strategic approach. Additionally, international cooperation and partnerships may also be crucial for smaller militaries to successfully integrate these technologies into their operations. Therefore, the article provides valuable insights for understanding the key considerations regarding 4IR technologies of smaller militaries and highlights the need for a strategic approach to their adoption.

Mulqueen (2014) argues that smaller militaries, despite their limited resources, can still contribute effectively to national defence and international security through strategic planning and efficient use of resources to leverage the advantages of 4IR technologies. Of note, the authors propose the following strategies and policies to maximise the military's effectiveness. First, smaller militaries should *prioritise* the adoption of 4IR technologies based on their specific security needs, budgetary constraints, and strategic objectives. Second, smaller militaries should seek to establish *collaboration* or cooperation with technologically advanced countries or private companies that can provide access to cutting-edge technologies, technical expertise, and training. This collaboration between the military and commercial sectors is increasingly vital in the era of the 4IR, as joint efforts are needed to expedite the development of advanced technologies and preserve a military's strategic edge. Third, smaller militaries should invest in their *indigenous defence industry* to develop,

maintain, and upgrade new 4IR technologies. This can foster innovation, reduce reliance on foreign suppliers, and contribute to economic growth. Fourth, smaller militaries should invest in *human capital* by developing a skilled workforce capable of handling new 4IR technologies. Fifth, smaller militaries should focus on reinforcing *cybersecurity and resilience*. As 4IR technologies often rely on interconnected digital systems, smaller militaries should prioritise robust cybersecurity measures to protect critical infrastructure and maintain operational readiness.

By adopting a strategic approach, smaller militaries can leverage 4IR technologies more effectively to enhance defence capabilities, maintain regional security, and address evolving challenges in the modern battlefield (Mulqueen, 2014).

5. Royal Thai Air Force and Technology Adoption

Thailand has a "smaller military" (ranked 24th globally) (2023 Thailand Military Strength, n.d.) due to the number of personnel (approx. 456,000 active duty in 2023), defence budget (approx. 1.3% or $6.6 billion in 2021), and the amount of equipment.

Based on the RTAF White Paper 2020, the RTAF demonstrates a systematic approach toward prioritising new capabilities and technologies. The RTAF White Paper 2020 starts by describing the emerging threat situations across the Air, Cyber, and Space domains and highlights future key challenges. This is followed by iterating the RTAF's key mission, roles, and responsibilities, before highlighting the RTAF's forecasted key capabilities and budget requirements in the future.

Using this approach, the RTAF has made good progress in adopting new technologies and capabilities over the past decade. With air combat operations being the key capability of the RTAF, investing in modern fighter aircraft technologies remain a top priority. To this end, the RTAF replaced its ageing F-5 fleet with the modern 4.5th Generation JAS-39 Gripen fighter jets, before refreshing a portion of its F-16 fighter fleet with a Mid-Life Upgrade (MLU) with upgraded avionics and weapon systems. Another key priority of the RTAF is in the Intelligence, Surveillance, and Reconnaissance (ISR) capabilities, which has led to the acquisition of the Saab 340 AEW&C, Aerostar tactical UAV, before the development of the indigenous U-1 UAV. With over 40 years of experience in the Space domain, the RTAF has also continued development in its

space-based capabilities which provide critical information and situational awareness to support effective air operations and safeguard national security.

However, several key challenges are highlighted in the RTAF White Paper 2020. First, the issue of operating both modern and legacy systems concurrently. Besides the high maintenance costs of legacy systems due to the scarcity of spare parts, the RTAF experiences operational limitations when employing both modern and legacy systems concurrently due to the technological gap (for example, JAS-39 Gripen and F-16A/B). Second, there are RTAF manpower issues that have yet to be addressed. Besides the issue of having inadequate mid-level personnel in both staff and operations, the RTAF is cognisant of the demographic differences, or generation gap, with the new generation personnel who will be the main workforce in the future. Third, the RTAF faces the issue of technology monopoly in the form of strict technology export policies imposed by foreign companies and governments. This limits the RTAF's ability to modernise on its own and poses issues of technology sovereignty due to over-reliance on the foreign manufacturer or country. In addition, the training and maintenance requirements for these new advanced technologies will require increasingly complex training and qualifications that may pose a challenge to the existing manpower in the RTAF.

Overall, the RTAF has demonstrated a willingness to modernise its systems to keep up with the technological landscape and fulfil its key missions and roles. While keeping an eye on the challenges such as manpower and technological sovereignty, the RTAF's efforts have ensured that it is well-positioned to respond to a wide range of threat scenarios in the future.

6. Case Study of the Republic of Singapore Air Force (RSAF)

Singapore has a "smaller military" (ranked 29th globally) (*2023 Singapore Military Strength*, n.d.) due to the number of personnel (approx. 310,000 active duty in 2023), defence budget (approx. 2.9% or $15 billion in 2019), and the number of systems and equipment. The RSAF has been proactive in adopting 4IR technologies as part of modernisation efforts, addressing key challenges of manpower and data exploitation.

6.1 Investment in Unmanned Systems. The RSAF has been investing in UAS to improve operational effectiveness and mitigate manpower challenges. First, the RSAF

has been investing in *modern UAVs for ISR missions*, such as the Heron 1 and Orbiter 4 UAVs, with the latter operating well in urban areas and being runway independent (*RSAF Acquires Orbiter 4 UAV, Formidable-Class Frigates to Be Upgraded*, 2022). Second, under its Smart Airbase concept, the RSAF plans to use AI-enabled smaller drones to *patrol the airbase perimeter* and *perform runway damage assessment*. For perimeter patrol, the drones will identify and track the target so that security troopers will be able to track down the intruder more efficiently, thereby enhancing operational effectiveness while optimising manpower. For runway damage assessment, a group of small drones will detect and classify the runway damage and share the data in real-time with the command centre, thereby saving manpower and time (*'Smart' RSAF Airbases to Use Drones to Detect Intruders, More Efficient Munitions Loader Will Be Deployed - CNA*, 2021).

6.2 Embracing digitalisation. The RSAF has been embracing digitalisation to enhance organisational efficiency and operational capabilities. First, as part of the wider government efforts, the RSAF has adopted *commercial cloud platforms* to host less sensitive services and data which enhances efficiency and saves manpower. Cloud computing will improve collaboration across the government sector and secure sensitive military information (Koh, 2021). Besides hardware, the RSAF has also prepared the "software" by *developing the people and processes* through education to raise the digital literacy of every worker and relooking at internal processes to promote "organisation agility". To address the threat of cyberattacks, the SAF has also introduced a fourth Service – *Digital and Intelligence Service (DIS)* – to focus on "the digital domain to detect, mitigate and repel any potential aggressors" (*SAF's New 4th Service Will Serve as Front-Line Force in the Digital Domain: Ng Eng Hen | The Straits Times*, 2022).

6.3 Integration of AI and Big Data. The RSAF has been exploring the use of AI and big data to improve decision-making and operational efficiency. First, the RSAF is using *predictive maintenance* techniques to enhance the operational readiness of its aircraft fleet. AI algorithms are used to analyse real-time data from sensors and perform predictive maintenance, reducing the time required for unscheduled maintenance and increasing aircraft availability. Second, to minimise aircraft turnaround time and

workload of the engineers, the RSAF employs *automated inspection* involving the use of sensors in the aircraft hangars equipped with improved AI algorithms that enable the detection and classification of defects, as well as the use of Unmanned Ground Vehicles (UGV) for aircraft inspection (*Singapore Air Force and Navy Leveraging Data Analytics, AI and Robotics for Smarter Operations and Capabilities - OpenGov Asia*, 2018).

6.4 3D Printing. The RSAF, and the wider SAF, have started to explore 3D printing, also known as additive manufacturing, to transform capability development and logistics processes. It provides the RSAF with flexible spares support, addresses obsolescence issues, and supports rapid prototyping (*Fact Sheet - Rapid Prototyping through 3D Printing Capability*, 2018).

6.5 Partnership with Industry. Through the Defence Technology Community (DTC), the RSAF gets to work with other companies and educational institutions to co-develop and implement 4IR technologies, leveraging their expertise and resources. For example, the SAF works with local industries such as ST Engineering companies, local research institutes such as Temasek Labs, and foreign partners including foreign governments, international research institutes, and international defence companies (*MINDEF Singapore*, n.d.).

CHAPTER 3

RESEARCH METHODOLOGY

1. Research Methods

The research methods used in the paper are historical research, documentary research, as well as data analysis and synthesis.

Historical research is used to provide context and insights on past industrial revolutions and their impact on the military, including specific technological disruptions and how they shaped the battlefield and altered the characteristics of war.

Documentary research is used to gain insights into how 4IR technologies impact the militaries. Besides analysing reports and journals to examine the current and future 4IR technologies, the paper highlights the risks of adopting disruptive technologies indiscriminately. Documentary research is also used to study the key considerations regarding 4IR technologies of the smaller militaries with lesser resource capabilities. The paper identifies several approaches used by smaller militaries to address technological disruptions and how to optimise their technological adoption. In addition, a case study on the RSAF's approach towards 4IR technologies demonstrates how a smaller military is adapting amidst the 4IR technological landscape. The identification of best practices of other Air Forces will support the further analysis and formulation of potential strategies for the RTAF to adopt new technologies more effectively.

Data analysis and synthesis are used to fuse the information from different research papers and literature reviews to support further analysis of the approach of the RTAF towards 4IR technologies. The process involves the analysis of mainly qualitative data collected through various methods to identify the significant technologies, trends, opportunities, and challenges for the RTAF. By integrating the data analysis, the study provides a comprehensive and holistic understanding of the

focus areas that the RTAF should prioritise in the 4IR. In addition, the data synthesis identifies the potential obstacles that the RTAF may face in pursuing these focus areas. By identifying these challenges, the study will also provide recommendations on how to address them, thus ensuring that the focus areas are both realistic and achievable.

2. Sources

The sources of information consist of journal articles, books, thesis papers, and research papers.

3. Method of Analysis

3.1 Content Analysis. The paper presents the collected data on the history of industrial revolutions and highlights some of the emerging 4IR technologies in the military today. The paper also examines the approaches and key considerations of smaller militaries toward technology adoption, given the size and resource limitations. The content analysis is based mainly on qualitative methods, and a case study of the RSAF's approach towards 4IR technologies is also used.

3.2 Interpretation. The paper interprets the findings of the analysis and formulates a possible approach toward technology adoption, including key technology focus areas, for the RTAF. This step involves applying analytical tools such as SWOT analysis to identify the internal strengths and weaknesses of the RTAF as well as the conditions of the external environment, before proposing several key areas of technology that the RTAF can focus on.

4. Summary of Research Model

Using historical research, documentary research, data analysis, and synthesis, as well as a case study of the RSAF, the paper has used a research model which is based mainly on the qualitative analysis of the research data to recommend the focus areas of 4IR technologies for the RTAF.

CHAPTER 4

DATA ANALYSIS

After examining the key 4IR technological trends and approaches of smaller militaries, the paper seeks to propose a broad approach framework and a few technological focus areas for the RTAF to leverage the benefits of emerging 4IR technologies while minimising the risks. This chapter aims to apply the findings from the literature review and identify key opportunities and gaps, especially in the RTAF White Paper 2020.

1. Approach of the RTAF towards 4IR Technologies

The RTAF may wish to consider the following framework which provides a holistic and strategic approach towards 4IR technology adoption.

1.1 Prioritise Investments in the Most Impactful Areas. This involves identifying the most urgent or strategic needs of the RTAF, followed by determining the 4IR technologies that can address those needs. This assessment should consider factors such as the *current technological infrastructure*, the *abilities of the personnel*, and the *strategic objectives* of the RTAF. The need for prioritisation is also mentioned in *"Chapter 4: RTAF Structure and Key Capability Requirements"* of the RTAF White Paper 2020.

1.2 Prepare for Cybersecurity Risks. Essential 4IR technologies such as cloud computing and AI rely heavily on data. The RTAF should ensure that both the system and personnel are prepared to handle cyber threats. Besides the systems, it is equally important to educate the personnel on basic data literacy to instil positive security habits in cyberspace. A brief overview of the threats in the cyber domain is also highlighted in *"Chapter 2: Situation and Challenges"* of the RTAF White Paper 2020.

1.3 Invest in Human Capital. Given the higher baseline qualification of operating new technologies, the RTAF should invest more in human capital, such as specialised

training and education, to ensure that the RTAF personnel are equipped to handle the new technologies. Besides advocating basic digital literacy skills for all personnel, the RTAF can also learn from the U.S. Air Force's 'Digital University' and collaborate with educational institutions to offer free courses on digital skills and emerging technologies such as AI and data science. In addition, the RTAF may wish to consider the recruitment of more Science, Technology, Engineering, and Mathematics (STEM) talents to exploit the benefits of new technologies.

1.4 Collaborate with Other Organisations. The RTAF can *collaborate with other organisations*, including the commercial sector and larger militaries, to benefit from their technology expertise and resources. If the cost of technology is a critical factor, the RTAF could consider more affordable *Commercial-Off-The-Shelf (COTS)* technological solutions instead of bespoke military solutions, while keeping in mind the *global supply chain vulnerabilities* seen during the Covid19 pandemic. Collaborations will also benefit the local defence industry, such as economic growth, expertise, and technology sovereignty.

1.5 Ethical Implications. Given the growing ethical implications of emerging 4IR technologies, the RTAF should take a more proactive approach to mitigating potential leaks, privacy breaches, and lack of accountability, by ensuring the development of suitable policies and strategic communications to address those concerns. While not featured in the RTAF White Paper 2020, this will be increasingly relevant as the RTAF heads towards becoming a more digital air force.

1.6 Organisational Agility. *Organisational agility* is key to exploiting 4IR technologies due to the continuous and fast-changing operating and technological environment. Besides acquiring new hardware, the RTAF could reinforce its organisational 'agility' through promoting innovation and willingness to try new ideas. This could involve education, relooking at internal processes, creating suitable "sandboxes" for experimentation, and forums for personnel to bring up new ideas. For example, given the rapidly evolving COTS technologies, an *'agile procurement process'* is needed to keep up with the pace of technology changes, instead of the conventional procurement process which may take up to a few months.

2. SWOT Analysis of the RTAF

2.1 The following *Figure 4-1 SWOT analysis of the RTAF* is extracted from the "20-year Strategy of the RTAF (2018-2037)" (ยุทธศาสตร์กองทัพอากาศ 20 ปี, 2563).

	Strengths		Weaknesses
S1	Commitment and focus in pursuing according to the RTAF strategy.	W1	Ageing assets and equipment are costly to maintain.
S2	Operate armaments and operating systems that use modern technology.	W2	New forms of logistics that are not well understood.
S3	Combat personnel have experience in NCO operations at tactical and operational levels.	W3	Lack of medium-level manpower and expertise in logistics.
S4	Knowledge and experience in UAS production with modern technology.	W4	Insufficient computer engineers, such as aircraft software engineering.
S5	A strong network infrastructure that covers training and operational missions.	W5	Lack of clarity in the concepts of new missions, thus affecting the understanding of the operators.
S6	Modern surveillance and detection systems that support key national interests.	W6	The structure does not address the new workload arising from technological or external factors.
S7	Space capabilities.	W7	Regulations do not facilitate cooperation with the Defence Industry agencies of Thailand.
S8	Military aviation standards according to international standards.		
S9	Poised to develop national defence industry such as the F-5TH, and U1 UAV projects.		
	Opportunities		Threats
O1	Modern technology is highly advanced and can be more accessible.	T1	Procurement of weapon systems is increasingly complex, such as strict export control policies.
O2	Trends of increased cooperation and improved air force relations in ASEAN.	T2	Air Force armaments rely on foreign technology with limited access to technological know-how.
O3	The growing use of similar armaments creates opportunities for collaboration (User Groups).	T3	Weapon systems of air power are very expensive, limiting the ability to procure in desired quantities.
O4	Develop the country towards Thailand 4.0 via a Special Eastern Economic Corridor.	T4	Finding sources to maintain obsolete technologies, which are costly and difficult.
O5	Promotion and cooperation with all sectors in the country and abroad.	T5	Operational systems including IT and communications are vulnerable to attacks.
O6	Greater cooperation in HADR and clearer policies and procedures in ASEAN.	T6	The roles and missions of the air force are increasing in every dimension due to rising threats.

Table 4 – 1 SWOT Analysis of the RTAF

3. Focus Areas of 4IR Technologies using the TOWS Strategies

3.1 Digital Technologies to Enhance Efficiency and Security. The RTAF can overcome the lack of digital expertise (**W4**) to take advantage of new digital Information Technology (IT) capabilities that have the potential to address efficiency and security issues (**T5**). Given the maturity of *Cloud Computing* today, it can be a force multiplier that enables the RTAF to modernise its IT infrastructure, as well as improve inter-agency collaboration and data security. Beyond that, the RTAF can also consider digital technologies such as *Big Data* and *Data Analytics* to extract insights and patterns from large amounts of data, as well as *Artificial Intelligence (AI)* to enhance situational awareness and decision-making. At the strategic level, investments in these digital technologies have the potential to "right-size" the RTAF's manpower in the future to overcome resource constraints.

3.2 Emerging UAS Technologies with Increasing Roles on the Battlefield. Leveraging on current UAS capabilities (**S4**), it may be opportune for the RTAF to further invest in other emerging UAS-related technologies, such as *Swarm Technology*, *Weaponised 'Kamikaze' Drones,* and *Manned Unmanned Teaming*. These disruptive technologies will enable the RTAF to learn new ways of warfighting, and also maintain awareness of asymmetric threats by adopting these technologies (**O1**). Also, the RTAF may wish to consider collaborations with advanced countries on other disruptive technologies such as *Directed Energy Weapons (DEW)* due to its potential in counter-swarm drone capabilities, which is relevant to the RTAF's role against non-traditional threats of small-sized UAVs.

3.3 3D Printing to Address Logistical Challenges. Given its growing technological maturity, the RTAF can consider investing in *3D printing*, or additive manufacturing. It is a technology that is readily available, leverages the capability of the RTAF personnel in operating modern technology (**S2**), and has the potential to address one of the RTAF's key challenges – the high costs of maintaining ageing machinery that is facing obsolescence (**T4**). This technology is already being adopted by both larger and smaller militaries, including the US, UK, and Singapore. Beyond addressing the current logistical needs, 3D printing will also be able to support rapid prototyping that may

prove useful for the RTAF's innovation efforts, as well as the experimentation of new capabilities and indigenous capability developments.

CHAPTER 5

SUMMARY OF RESULTS, DISCUSSION, AND RECOMMENDATIONS

1. SUMMARY OF RESULTS

The paper examined the history of industrial revolutions, the 4IR and its relevance to the military, transformative 4IR technologies in the military, the approaches of smaller militaries towards 4IR technologies, and proposed an approach framework and several technology focus areas for the RTAF. Based on the analysis, the following key results were identified:

1.1 Similar to past Industrial Revolutions, the 4IR brings profound changes to military operations and creates new opportunities and risks, including enhanced efficiency and effectiveness, lower risks to soldiers, expeditious decision-making, job displacement, cybersecurity, and ethical concerns.

1.2 Some of the 4IR technological innovations offer capabilities that provide a competitive advantage in the modern security landscape. Led by the major military powers, these technologies include but are not limited to, hypersonic technology, space-based capabilities, directed energy weapons, AI-powered autonomous weapon systems, cloud computing, AI, and 3D printing.

1.3 Due to resource and size constraints, smaller militaries should adopt a strategic approach towards new technologies to fully leverage the benefits of 4IR technologies. Some key considerations include prioritising investments, collaborating with the commercial sector, developing local defence industry, investing in human capital, and focusing on cybersecurity capabilities.

1.4 Based on the RTAF White Paper 2020, the RTAF adopts a systematic approach to adopting new technologies. Aligned with its missions and roles, the RTAF has demonstrated a willingness to modernise its military capabilities while keeping an eye

on the challenges to ensure that the RTAF maintains its strategic edge and operational effectiveness.

1.5 A case study of the RSAF offers insights into a smaller military that employs a proactive stance towards new 4IR technologies, such as UAS technologies, Cloud Computing, AI and Big Data, and 3D printing, to improve operational efficiency and address manpower challenges.

1.6 Similar to other smaller militaries, a holistic and strategic approach toward technology adoption is necessary for the RTAF. This comprises a few key areas – prioritising investments, focusing on cybersecurity risks, investing in human capital, collaborating with industry and militaries, addressing ethical concerns, and strengthening organisational agility. Based on a SWOT analysis of the RTAF, the paper has identified several TOWS strategies which consist of key technological areas not featured in the RTAF White Paper 2020 that the RTAF can look further into.

2. DISCUSSION

The results highlight the significance of the 4IR and its transformative impact on the military. The past industrial revolutions have demonstrated the profound changes brought about by technological advancements, and the 4IR is no exception. The rapid development and convergence of technologies in the 4IR have created new opportunities and challenges for militaries worldwide. Smaller militaries, such as the RTAF, should adopt a strategic approach towards new technologies to fully leverage the benefits of new technologies while minimising the risks. The proposed recommendations aim to complement, rather than replace, the existing efforts in the RTAF White Paper 2020 to strengthen and future-proof the RTAF's position in an increasingly complex security landscape.

3. RECOMMENDATIONS

As a smaller military striving to keep pace with the fast-changing 4IR technology environment, the RTAF should adopt a holistic and strategic approach towards adopting new technologies to fully leverage the benefits and minimise the risks. This paper recommends an approach framework that consists of six parts, in no particular order. First, the RTAF should *prioritise* investments based on strategic needs, readiness,

and organisational goals. Second, as the RTAF becomes a more *digital air force*, greater focus should be placed on *cybersecurity* risks, such as investing in cyber capabilities and raising digital literacy in the organisation. Third, it is increasingly important for the RTAF to invest in *human capital*, such as offering free tertiary courses in digital technology fields, as well as the recruitment of more STEM talents. Fourth, given the growing pace of technology development, *collaboration* with other more technologically advanced institutions, including the commercial sector and developed militaries, may be key to providing access to advanced technologies and resources. Fifth, *ethical implications*, such as privacy risks and accountability, must also be proactively addressed through national policies and strategic communications. Lastly, *organisational agility* is crucial to effectively respond to a fast-changing technology and security environment. Besides fostering innovation, the RTAF should develop an *agile procurement process* to keep pace with COTS technologies and seize opportunities.

Through the SWOT analysis, it is recommended for the RTAF to consider a few technological areas which are not captured in the RTAF White Paper 2020. First, the RTAF should consider digital technologies such as *Cloud Computing* to enhance collaboration and security, *advanced UAS technologies* such as *swarm* and *kamikaze drones* to enhance operational effectiveness, as well as *3D printing* to address obsolescence and support prototyping. Investments in digital technologies will also have the potential to be a force multiplier, enabling the RTAF to "right-size" its manpower in the future to overcome resource constraints. Together with the broad strategic approach framework, these recommendations will reinforce the RTAF's modernisation efforts and maintain its strategic edge to be one of the best air forces in ASEAN.

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APPENDICES

APPENDIX A Exponential Growth of IoT Technology

The Internet of Things (IoT) has been quite the buzzword in business and, more recently, in consumer electronics. To help understand what the hoopla is all about, TechJury has put together this latest set of IoT statistics.

These data points cover a wide range of topics including the most up-to-date trends and numbers related to IoT, the impact it is having and is expected to have in the future in different segments, the growth drivers, and the key concerns that may act as barriers, and the forecasts of the market size of IoT in various industries.

Key Internet of Things (IoT) Statistics

- There are expected to be more than 64B IoT devices worldwide by 2025.
- By the end-2022, 29 billion devices will be on the IoT network.
- By 2022, 100% of the global population is expected to have LPWAN coverage.
- IoT has the potential to generate $4T to $11T in economic value by 2025.
- The main revenue driver for 54% of enterprise IoT projects is cost savings.
- The wearable devices market will be worth $1.1 billion by 2022.
- 97% of organizations feel there are challenges to creating value from IoT-related data.
- The IoT in banking and financial services market size is expected to grow to $2.03B by 2023.

As you would note, one salient feature of predictions on IoT is that there can be wildly varying figures on the number of devices, market size, or investment across different studies.

Even a search for the answer to the seemingly simple question “How many IoT devices are there in 2022” returned remarkably different figures from reputed companies and research bodies. This makes building a coherent story difficult.

Still, even though all forecast figures might not always appear to be in perfect sync, there is a general trend that emerged after consulting enough different pieces of research. They all say we can expect much faster growth in IoT adoption rates across all sectors. In the next four to five years we will see better progress than during the whole of the last decade.

Source : 49 Stunning Internet of Things Statistics to Know in 2023. Techjury. (https://techjury.net/blog/internet-of-things-statistics/)

APPENDIX B Technology Adoption in the RSAF

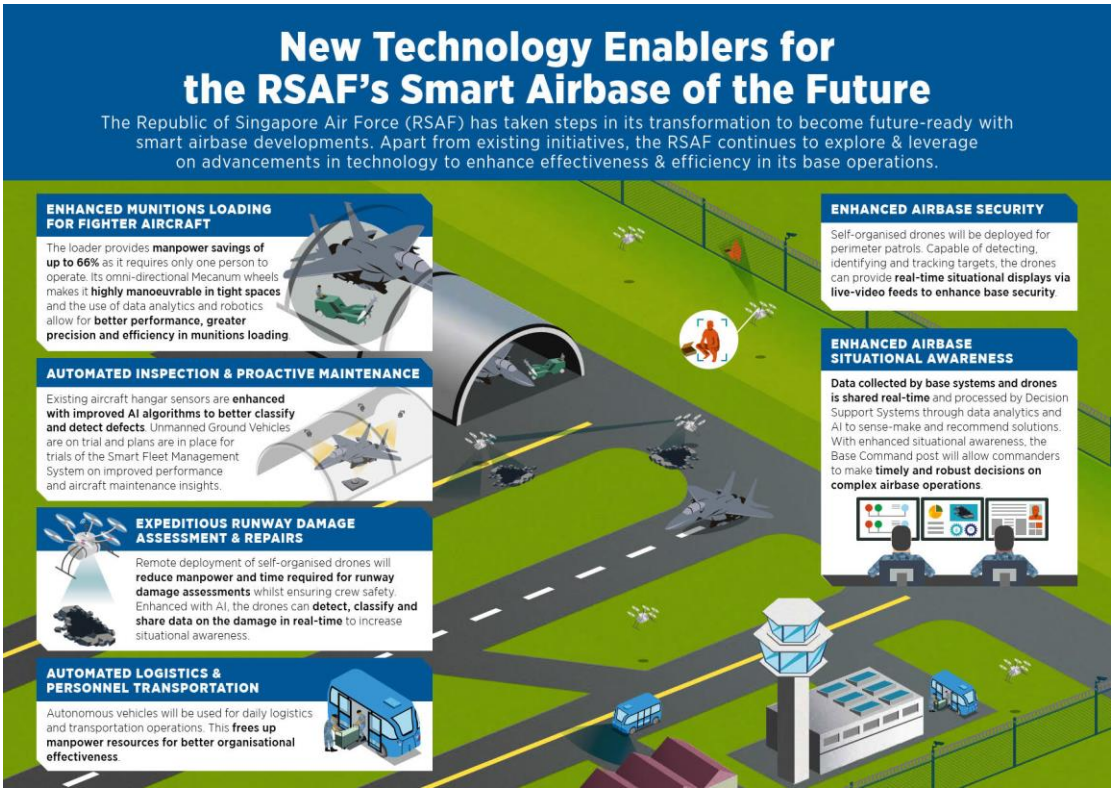

Figure B – 1 New Technology Enablers of the RSAF's Smart Airbase of the Future

Source : DSTA website (https://www.dsta.gov.sg/whats-on/spotlight/taking-flight-with-smarter-airbases)

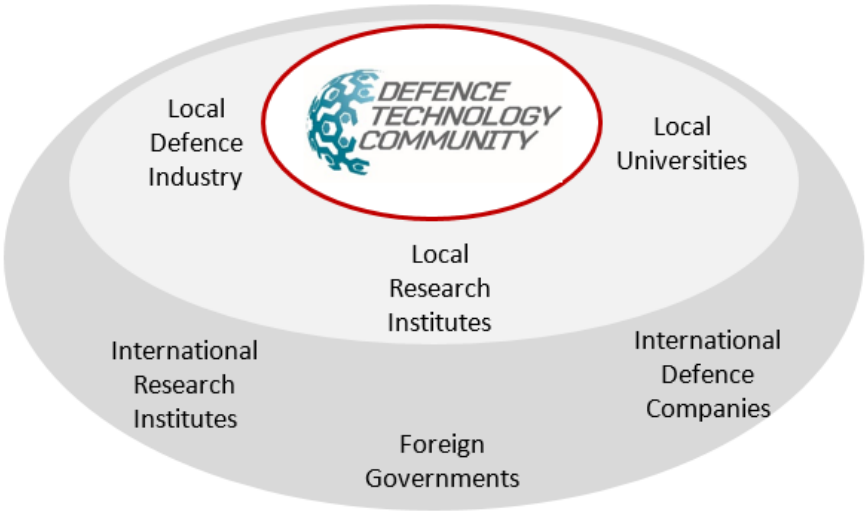

Figure B – 2 Defence Technology Ecosystem of Singapore

Source : MINDEF Singapore website

(https://www.mindef.gov.sg/web/portal/mindef/defence-matters/defence-topic/defence-topic-detail/defence-science-and-technology)

APPENDIX C SWOT Analysis of the RTAF

๒.๓ การวิเคราะห์ SWOT ของกองทัพอากาศ

๒.๓.๑ จุดแข็ง

✦ มุ่งมั่นและให้ความสำคัญการขับเคลื่อนตามยุทธศาสตร์กองทัพอากาศอย่างต่อเนื่อง

✦ อาวุธยุทโธปกรณ์และระบบปฏิบัติการใช้เทคโนโลยีที่ทันสมัย

✦ กำลังพลส่วนกำลังรบมีความเข้าใจและประสบการณ์ในการปฏิบัติการที่ใช้เครือข่ายเป็นศูนย์กลาง (Network Centric Operations : NCO) ในระดับยุทธการและยุทธวิธี

✦ กำลังพลบางส่วนมีความรู้และประสบการณ์ในการปรับปรุงอากาศยานและการผลิต อากาศยานไร้คนขับ ซึ่งใช้เทคโนโลยีที่ทันสมัยและมีมาตรฐานรองรับอย่างเป็นระบบ

✦ โครงสร้างพื้นฐานของระบบเครือข่าย ครอบคลุมพื้นที่ในการปฏิบัติภารกิจทางยุทธการ และสามารถรองรับการปฏิบัติภารกิจในปัจจุบัน

✦ มีระบบตรวจจับที่ทันสมัยสามารถสนับสนุนการแก้ไขปัญหาสำคัญของชาติได้ทั้งในส่วนของ Airborne Sensor, Ground Sensor และ Space Surveillance

✦ มีพื้นที่/ห้วงอากาศ รองรับการบินทดสอบ และการทดลอง รวมทั้งบุคลากรที่มีความเชี่ยวชาญ

✦ มาตรฐานการบินทางทหารตามมาตรฐานสากล และมีการจัดการมาตรฐานอาวุธยุทโธปกรณ์ซึ่งเทียบเคียงได้ตามมาตรฐานสากล (International Standard)

✦ มีความพร้อมในการส่งเสริมและพัฒนาอุตสาหกรรมป้องกันประเทศซึ่งเป็นอุตสาหกรรมเป้าหมายลำดับที่ ๑๑ (New S-Curve 11) ของรัฐบาล ดังเห็นได้จาก

Figure C – 1 SWOT Analysis of the RTAF (1 of 3)

Source : กองทัพอากาศ (2563) ยุทธศาสตร์กองทัพอากาศ 20 ปี (พ.ศ.๒๕๖๐ - ๒๕๘๐)

ความสำเร็จของความร่วมมือกับอุตสาหกรรมป้องกันประเทศของไทยในการปรับปรุงเครื่องบินแบบ F-5TH และการผลิตอากาศยานไร้นักบิน แบบ U1 ของกองทัพอากาศ

๒.๓.๒ จุดอ่อน

✦ อาวุธยุทโธปกรณ์บางส่วนมีอายุการใช้งานนาน มีสภาพเก่า (Aging Asset) และใช้เทคโนโลยีดั้งเดิม ซึ่งต้องดำรงขีดความสามารถให้สามารถปฏิบัติการได้อย่างมีประสิทธิภาพ จึงมีค่าใช้จ่ายสูงมากกว่าปกติ

✦ การส่งกำลังบำรุงรูปแบบใหม่ ๆ มีความซับซ้อนมากขึ้น กำลังพลที่มีความเข้าใจมีจำนวนไม่เพียงพอ

✦ ขาดแคลนกำลังพลระดับปานกลาง (น.ต. - น.ท.) โดยภาระงานมีจำนวนและความซับซ้อนมากขึ้น เช่น การดำเนินการตาม พ.ร.บ.ใหม่ ๆ และการขับเคลื่อนยุทธศาสตร์ชาติและแผนการปฏิรูปประเทศ เป็นต้น

✦ กำลังพลที่มีความเชี่ยวชาญเฉพาะของสายวิทยาการหลัก (ช่าง/สื่อสาร/สรรพาวุธ) เช่น วิศวกรอากาศยาน วิศวกรซอฟต์แวร์ วิศวกรคอมพิวเตอร์ มีจำนวนไม่เพียงพอและขาดความรู้เชิงลึกสำหรับเทคโนโลยีที่ทันสมัย

✦ ความไม่ชัดเจนของแนวความคิดในการปฏิบัติภารกิจของงานใหม่ส่งผลต่อความเข้าใจของผู้กำกับดูแล ผู้ปฏิบัติงาน และสายวิทยาการ

✦ โครงสร้างไม่ครอบคลุมภาระงานใหม่ ซึ่งเกิดจากการเปลี่ยนแปลงเทคโนโลยีหรือเกิดจากปัจจัยภายนอก โดยการปรับปรุงโครงสร้างให้สอดคล้องใช้เวลาในการดำเนินการนาน

✦ กฎระเบียบไม่เอื้อให้เกิดการพัฒนาหรือการสร้างความร่วมมือกับหน่วยงานอุตสาหกรรมป้องกันประเทศของไทย

๒.๓.๓ โอกาส

✦ เทคโนโลยีสมัยใหม่มีความก้าวหน้าสูงและเข้าถึงได้ง่ายขึ้น สามารถประยุกต์ใช้ในการปฏิบัติภารกิจมากยิ่งขึ้น เช่น Big Data, Artificial Intelligence, Nano Technology หรือ Robots เป็นต้น

✦ แนวโน้มความร่วมมือและความสัมพันธ์ทางการทหารระหว่างกองทัพอากาศอาเซียนมีมากขึ้น ทั้งการแลกเปลี่ยน การเยือน และการเรียนรู้ ซึ่งลดโอกาสการเกิดความขัดแย้ง

✦ กองทัพอากาศในภูมิภาคใช้อาวุธยุทโธปกรณ์แบบเดียวกันมีมากขึ้นเป็นโอกาสในการสร้างความร่วมมือของกลุ่มผู้ใช้งาน (User Groups) เพื่อเรียนรู้และแบ่งปันประสบการณ์ในด้านต่าง ๆ เช่น การฝึก การซ่อมบำรุง และการส่งกำลังบำรุง เป็นต้น

Figure C – 1 SWOT Analysis of the RTAF (2 of 3)

Source : กองทัพอากาศ (2563) ยุทธศาสตร์กองทัพอากาศ 20 ปี (พ.ศ.๒๕๖๐ - ๒๕๘๐)

✦ การพัฒนาประเทศไปสู่ยุค “ไทยแลนด์ ๔.๐” โดยการพัฒนาระเบียงเศรษฐกิจพิเศษภาคตะวันออก (Eastern Economic Corridor) ซึ่งกำหนดให้อุตสาหกรรมการบินเป็นอุตสาหกรรมที่ได้รับการส่งเสริม

✦ การส่งเสริมและสร้างความร่วมมือกับทุกภาคส่วนทั้งในประเทศและต่างประเทศ เพื่อเสริมสร้างศักยภาพด้านอุตสาหกรรมการบิน อุตสาหกรรมป้องกันประเทศ (New S-Curve 11) และอุตสาหกรรมการพัฒนาคนและการศึกษา (New S-Curve 12) ตามนโยบายรัฐบาล

✦ ความต้องการและความร่วมมือในการช่วยเหลือด้านมนุษยธรรมและบรรเทาภัยพิบัติ (HADR) เพิ่มมากขึ้น ตลอดจนนโยบายและวิธีปฏิบัติที่ชัดเจนมากขึ้นของประชาคมอาเซียน เช่น HADR SOP เป็นต้น

๒.๓.๔ อุปสรรค

✦ การจัดหาอาวุธยุทโธปกรณ์มีความซับซ้อน เช่น มีการกำกับการส่งออก มีการกำกับการใช้งานกับ Third Party และบริษัท/ประเทศผู้ผลิตมีสิทธิ์ที่จะปฏิเสธการสนับสนุน/ขายอาวุธได้ ซึ่งเป็นผลจากการครอบงำทางเทคโนโลยีของบริษัท/ประเทศผู้ผลิต

✦ อาวุธยุทโธปกรณ์ของกองทัพอากาศพึ่งพาเทคโนโลยีจากต่างประเทศ มีลิขสิทธิ์ที่จำกัดระยะเวลาใช้งาน ส่งผลให้มีข้อจำกัดในการใช้งานและการพัฒนา

✦ อาวุธยุทโธปกรณ์ของกำลังทางอากาศมีราคาสูงมากทั้งเครื่องบินรบ เครื่องบินลำเลียง อากาศยานแบบอื่น ๆ และระบบอาวุธต่าง ๆ ส่งผลให้ไม่สามารถจัดหาในสัญญาเดียว เนื่องจากจะเป็นภาระของงบประมาณแผ่นดิน

✦ บทบาทของเครื่องมือ/สื่อสังคมออนไลน์ ส่งผลให้การสื่อสารหรือการรับรู้สู่สาธารณะ (Communication and Perception) มีความรวดเร็วและความอ่อนไหวสูง ซึ่งจะเกิดผลกระทบเชิงลบได้ง่าย

✦ การหาแหล่งในการดูแลหรือซ่อมบำรุงอาวุธยุทโธปกรณ์ซึ่งใช้เทคโนโลยีดั้งเดิมหรือเทคโนโลยีที่ล้าสมัยแล้ว (Obsolete Technology) กระทำได้ยากและมีราคาสูง

✦ ระบบเทคโนโลยีสารสนเทศและการสื่อสารซึ่งถูกนำมาใช้ในการปฏิบัติงานและการปฏิบัติการร บ มีความอ่อนไหวต่อการถูกโจมตี

✦ บทบาทและภารกิจของกองทัพอากาศรองรับภัยคุกคามและการปฏิบัติภารกิจในทุกมิติเพิ่มสูงขึ้น

Figure C – 1 SWOT Analysis of the RTAF (3 of 3)

Source : กองทัพอากาศ (2563) ยุทธศาสตร์กองทัพอากาศ 20 ปี (พ.ศ.๒๕๖๐ - ๒๕๘๐)

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