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THESIS

REMOTELY EFFECTIVE: UNMANNED AERIAL VEHICLES, THE INFORMATION REVOLUTION IN MILITARY AFFAIRS, AND THE RISE OF THE DRONE IN SOUTHEAST ASIA

by

Grant J. Cassingham

September 2016

Thesis Advisor: Erik J. Dahl
Co-Advisor: Michael S. Malley

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The information revolution in military affairs (IRMA) has changed the way that wars are fought and won. Exploiting the revolution's core principles enables a net-centric, informationalized force to outmaneuver and defeat its adversaries. Unmanned aerial vehicles (UAV) represent a critical advancement in intelligence collection capability, but are they as revolutionary a technology as one might expect? Is UAV acquisition without IRMA exploitation the equivalent of purchasing surface-to-air missiles without their radars?

This thesis argues that IRMA exploitation is a necessary precondition for effective UAV employment, especially in the maritime domain. By examining the maritime UAV use of several countries across the IRMA exploitation spectrum, one can see that UAV deployment without an underlying information architecture undermines the utility of an unmanned asset.

Southeast Asia is the world's fastest growing UAV market. While analysts have predicted that UAVs will disrupt the regional balance of power, this analysis finds that due to a lack of IRMA exploitation, the chances of disruption are extremely remote. This thesis identifies the IRMA-related deficiencies of future UAV users, and provides recommendations for increasing the chance of effective UAV use and ultimately, combat efficiency.

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REMOTELY EFFECTIVE: UNMANNED AERIAL VEHICLES, THE INFORMATION REVOLUTION IN MILITARY AFFAIRS, AND THE RISE OF THE DRONE IN SOUTHEAST ASIA

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

ADIZ	air defense identification zone
AEW	airborne early warning
AIS	automated identification system
BAMS-D	Broad Area Maritime Surveillance – Demonstrator
C2	command and control
C4I	command, control, communications, computers, and intelligence
CARAT	Cooperation Afloat Readiness and Training
CMC	Central Military Commission
CNA	computer network attack
COMINT	communications intelligence
COTS	commercial-off-the-shelf
CWS	Coast Watch System
DARPA	Defense Advanced Research Projects Agency
DART	DCGS Analysis and Reporting Team
DCGS	Distributed Common Ground System
DGS-1	Distributed Ground Station One
EIS	Eyes-in-the-Sky
ELINT	electronic intelligence
FMV	full motion video
FYDP	Future Years Defense Program
HADR	humanitarian assistance and disaster relief
HALE	high altitude, long endurance
HUMINT	human intelligence
IAI	Israel Aerospace Industries
IKC2	Integrated Knowledge-Based Command and Control
IMINT	imagery intelligence
IADS	integrated air defense system
ICJ	International Court of Justice
ICP	Integrated Command Platform

IFC	Information Fusion Centre
IRGCN	Islamic Revolutionary Guard Corps Navy
IRMA	information revolution in military affairs
ISAR	inverse synthetic aperture radar
ISR	intelligence, surveillance, and reconnaissance
IT	information technology
JASDF	Japan Air Self-Defense Force
JDAM	Joint Direct Attack Munition
JMSDF	Japan Maritime Self-Defense Force
MAF	Malaysia Armed Forces
MALE	medium altitude, long endurance
MALSINDO	Malaysia, Singapore, Indonesia
MASINT	measurement and signature intelligence
MCP	MALSINDO Coordinated Patrol
MILF	Moro Islamic Liberation Front
MINDEF	Singapore Ministry of Defense
MMEA	Malaysian Maritime Enforcement Agency
MOEC	Multinational Operations and Exercises Centre
MPA	maritime patrol aircraft
MSI	Maritime Security Initiative
MSS	Ministry of State Security
NCW	network centric warfare
OASIS	Open and Analysed Shipping Information System
PGM	precision guided munition
RMA	revolution in military affairs
SAF	Singapore Air Force
SAR	synthetic aperture radar
SIGINT	signals intelligence
SMART	Sense-Making Analysis and Research Tool
SMSC	Singapore Maritime Security Centre
STUAS	small tactical unmanned aerial vehicle
TERN	Tactically Exploited Reconnaissance Node

UAV	unmanned aerial vehicle
UCAV	unmanned combat aerial vehicle
UNCLOS	United Nations Convention on the Law of the Sea
VTOL	vertical takeoff and landing

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I. INTRODUCTION

Much ink has been spilled in the security world over the drone's rise to prominence. Many experts believe that the drone, or unmanned aerial vehicle (UAV), represents one of the most significant technological developments in recent military history. Although sophisticated, remotely-piloted UAVs are significantly less costly to acquire and operate than traditional manned airborne reconnaissance programs. For this reason, among others, many countries are turning to unmanned platforms for everything from intelligence collection to kinetic strikes. Simply operating an unmanned platform, however, is not a guarantee of its effectiveness for military or political use. Effectiveness is "the degree to which something is successful in producing a desired result."[1] Little attention has been paid to what makes UAV platforms effective assets beyond the tactical level of war.

If gaining an asymmetric advantage over an adversary were as simple as the mere acquisition and deployment of unmanned platforms, many countries would be on the verge of upending the status quo of regional hegemony. Southeast Asia, for example, stands at the precipice of widespread UAV adoption. Will the plethora of new platforms set to fly over Southeast Asia be worth their considerable investment, especially if the unmanned systems are limited by a country's information technology, doctrine, organization, or authority? It is distinctly possible that acquiring UAV systems without exploiting the information revolution in military affairs (IRMA) is the equivalent of purchasing surface-to-air missiles without their radar systems. The missiles may fire, but the chances of hitting their intended targets would be marginal.

Many countries are acquiring or developing drones for a variety of uses. UAVs could help countries gain vital intelligence critical to policy-making. In one

[1] *Oxford Dictionary*, s.v. "Effectiveness," Accessed August 22, 2016, http://www.oxforddictionaries.com/us/definition/american_english/effectiveness.

example, maritime disputes in the South China Sea increase the possibility of conflict between states. China's exploitation of IRMA gives it a significant advantage over other countries in maritime domain awareness, enabling it to exert its considerable force when and where it needs to be applied. UAVs can possibly provide a cheap solution to an intelligence, surveillance, and reconnaissance (ISR) overmatch through the provision of full motion video (FMV) evidence of incidents at sea in disputed areas, deterring hostile maneuvers by belligerents in maritime disputes, and enabling smaller powers to maneuver tactical assets more rapidly. The advantages of unmanned systems are enabled, or constrained, by the IRMA and a country's ability to exploit it.

A. MAJOR RESEARCH QUESTION

Unmanned aerial vehicles represent a critical advancement in intelligence collection capability, particularly for countries lacking an airborne reconnaissance program. The capability does not, however, exist in a vacuum. UAVs are part of a larger information environment within the country's national security apparatus. Advances in information collection and processing contributed to what has been called an information revolution in military affairs.[2] Although UAVs are capable assets in the information domain, deploying UAVs does not constitute exploitation of the IRMA. What this thesis seeks to determine is whether effective UAV use and IRMA exploitation are symbiotic rather than simply complementary. This thesis asks two key questions. First, is IRMA exploitation necessary for effective UAV employment? Once one can ascertain whether IRMA is essential for effective UAV use, one can assess whether a country is likely to field its unmanned capabilities in an effectual way. Second, with Asia's unique security challenges and status as an emerging UAV market, which Southeast Asian countries are likely to be able to use their UAVs effectively to conduct ISR missions in the maritime domain?

[2] Richard A. Bitzinger, "Come the Revolution: Transforming the Asia-Pacific's Militaries," *Naval War College Review* 48, no. 4 (Autumn, 2005): 40–41.

B. SIGNIFICANCE OF THE RESEARCH QUESTION

Until recently, establishment of an advanced ISR program for developing countries was prohibitively expensive. Airborne reconnaissance, in particular, requires considerable investment in personnel, matériel, and training to receive actionable intelligence. As technology improves, specifically for unmanned platforms and sensors, barriers to entry for countries seeking airborne reconnaissance capabilities are reduced. Reconnaissance in the maritime domain is a notoriously difficult problem set. It is also the environment that can benefit the most from UAV use. Unmanned systems enable countries lacking maritime domain awareness to receive and process near real-time intelligence on targets that otherwise could not be surveilled. UAVs provide information that does not require extensive analysis to inform policymakers. Obtaining FMV or static imagery intelligence (IMINT) requires little ancillary information to be understood by people unfamiliar with the intelligence trade. By comparison, signals intelligence (SIGINT), measures and signatures intelligence (MASINT), and human intelligence (HUMINT) require extensive training by analysts to vet information that may still prove to be fragmentary at best. UAVs offer immediate, digestible information that is difficult to refute for policy use. What was once a significant advantage for military powers like the United States and China is now available to developing countries for a fraction of the price.

As described by Benbow in this thesis' literature review, a country is considered to have exploited the IRMA if it has networked sensors, informationalized command and control (C2), and a precision strike capability. Additionally, a country that has exploited IRMA will have near-complete situational awareness and will predict the implications of its command decisions with relative accuracy. How countries use their UAV platforms within an IRMA-enabled information architecture may help explain the relationship between UAVs and information advantage. Lack of access to timely information due to poor IRMA exploitation may be a key factor in explaining why developing countries that purchase UAVs do not see substantive improvements in their

forces' capabilities. This research seeks to better understand the value of establishing a UAV program, how it could be effectively used to develop actionable intelligence, and how such intelligence could be used to advantage in the pursuit of a political end.

The dramatic pace at which information can now be obtained, analyzed, and delivered to policymakers elevates the potential importance of IRMA exploitation for countries that are undergoing military modernization. Most case studies in IRMA are limited to countries with strong technical intelligence capabilities and vast command, control, communication, computer, and intelligence (C4I) infrastructure. Advanced use of unmanned systems within a larger C4I infrastructure requires exploitation of the IRMA. These advanced cases can be used as models for comparison against UAV-using countries that have not exploited the IRMA. Deployment of unmanned resources without exploiting IRMA limits the effectiveness of the platforms and negates the potential asymmetric value of the asset. Limited research exists regarding the current or potential exploitation of IRMA in Southeast Asia, despite the region's considerable growth as a UAV market.

C. LITERATURE REVIEW

Though the concept of an information revolution in military affairs and the proliferation of UAVs in Southeast Asia are relatively new topics, there is a growing amount of literature that addresses relevant aspects of each. There are emerging bodies of work that focus separately on the proliferation of drones and on the exploitation of IRMA. There has been, however, only limited study of the relationship between UAVs and IRMA exploitation. Even in emerging drone markets like Southeast Asia, little attention has been paid to the larger architecture that supports and enables UAV systems. Many experts recognize the increased rate of UAV acquisition in Southeast Asia but focus on UAVs as a

subset of larger trends in military modernization.[3] The most extensive bodies of work relevant to this thesis pertain to the study of revolutions in military affairs and the relationship between information and military effectiveness. Defining the concepts themselves and understanding how they interact with one another is critical to analysis of UAV effectiveness. Reviewing additional literature related to trends in Southeast Asian security and the limited scholarship on proliferation of unmanned aerial vehicles in Asia will inform discussion related to UAV effectiveness in the region.

1. Revolutions in Military Affairs

There is a substantial body of literature concerned with defining revolutions in military affairs (RMA). Richard Hundley's research on RMA for the Defense Advanced Research Projects Agency (DARPA) succinctly describes RMA as "a paradigm shift in the nature and conduct of military operations which either renders obsolete or irrelevant one or more core competencies of a dominant player, creates one or more new core competencies, in some new dimension of warfare, or both."[4] Hundley's research on RMA is particularly helpful in laying out what he views as the definitive and alternative characteristics of RMA.[5] Among the numerous characteristics identified, principal among them is the sudden obsolescence of an enemy's core competencies and/or the creation of new dimensions of warfare.[6]

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[3] Desmond Ball, Richard Bitzinger, Amitav Acharya and others briefly discuss UAVs in their larger debate on the existence of an arms race in Southeast Asia. For the most comprehensive resource, see: Desmond Ball and Australian National University, *Security Trends in the Asia-Pacific Region: An Emerging Complex Arms Race* (Canberra: Australian National University Strategic and Defence Studies Centre, 2003).

[4] Richard O. Hundley, *Past Revolutions, Future Transformations: What Can the History of Military Revolutions in Military Affairs Tell Us About Transforming the U.S. Military?* (Santa Monica, CA: Rand, 1999), xiii.

[5] Richard Hundley cites the extensive body of work dedicated to defining RMA and notes that it does not help one describe what constitutes an RMA. See: Hundley, *Past Revolutions, Future Transformations*, 8.

[6] Hundley, *Past Revolutions, Future Transformations*, xiii–xiv.

a. History of RMA

Revolution in military affairs, formerly referred to as military revolution, was first used in academic circles in 1955 as a way to describe landmark changes in the conduct of warfare.[7] RMA began to be used heavily in military circles at the peak of the Cold War, especially as the Soviet Union started to devote considerable attention to the study of RMA.[8] Despite diverging scholarly opinions on nearly every RMA, there are a few commonly accepted historical RMA that exemplify the concept. Napoleon's military reforms and the simultaneous development of nuclear weapons with ballistic missile delivery systems demonstrate the transformative nature of RMA both in military conflict and in statecraft.

(1) The Napoleonic RMA

Napoleon Bonaparte's concept and implementation of *grande guerre* from 1792–1815 is almost universally considered to exemplify RMA.[9] There are certainly antecedents to Napoleon's way of war, but scholars widely credit Napoleon himself with the changes that resulted in the RMA.[10] Napoleon's RMA was less about embracing technological innovation and more about realizing the benefits of political and societal nationalism, proof that RMA does not have to result explicitly from technological development. France's *levée en masse* mobilization following the French Revolution provided Napoleon substantial resources for war.[11] According to Tim Benbow's analysis of the Napoleonic RMA, "the introduction of promotion by merit as the norm brought a new stream of

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[7] Williamson Murray, "Thinking About Revolutions in Military Affairs," *Joint Forces Quarterly*, no. 16 (Summer, 1997), https://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA354177.

[8] Tim Benbow, *Magic Bullet: Understanding the Revolution in Military Affairs* (London, Brassey's, 2004): 13.

[9] Colin S. Gray, *Strategy for Chaos: Revolutions in Military Affairs and The Evidence of History* (London, Frank Cass Publishers, 2002), 140–141.

[10] Ibid.

[11] Benbow, *Magic Bullet*, 25.

talent into the officer corps. The result was new organisation and doctrine, which permitted tactical and operational approaches that were considerably more offensive."[12] Napoleon's skill in executing military strategy manifested into the *Grande Armée* that reached its peak efficiency between 1805–1806.[13] Colin Gray notes that "Napoleon enjoyed untrammelled, centralised, political and military command over a unified national army."[14] The reintroduction of total war to Europe via Napoleon's novel tactics fundamentally and irrevocably changed Europe's way of war. The eminent military philosopher Carl von Clausewitz noted in *On War* that "not until statesmen had at least perceived the nature of the forces that had emerged in France, and had grasped that new political conditions now obtained in Europe, could they foresee the broad effect all this would have on war."[15] The Napoleonic RMA highlights the importance of the relationship between socio-political and military dimensions of national power. Furthermore, it elucidates that the innovative use of new technology, rather than the technology itself, can be revolutionary.

(2) The Nuclear RMA

The nuclear RMA differs from many others in that with the exception of the detonations at Hiroshima and Nagasaki during World War II, this revolution has not been tested in combat. The nuclear RMA's history began in Japan, but its realization took place between 1948 and 1955 when the United States exploited the nuclear RMA in the creation of nuclear-armed long-range strike forces.[16] The strategic nature of the RMA, however, does not require mushroom clouds to irrevocably alter the conduct of warfare and statecraft. Despite its genesis having been through technological means, nuclear RMA is fundamentally about

[12] Benbow, *Magic Bullet*, 26.

[13] Gray, *Strategy for Chaos*, 152.

[14] Ibid.

[15] Carl von Clausewitz, *On War*, trans. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), 209.

[16] Gray, *Strategy for Chaos*, 230.

the strategic implications of using force. The nuclear RMA did not come about simply through the invention of the atomic bomb. Rather, it resulted from a combination of technologies, including ICBMs.[17] The deterrent effect of a credible nuclear weapons delivery solution elevates the importance of diplomacy and other forms of statecraft. By assuring that a nuclear war would be a total one, even great powers were forced to give pause to war planning and consider the potential costs of miscalculation and over-aggression.

The nuclear RMA also aptly demonstrates, similar to the information RMA, that transnational technological advancements can be exploited by a host of international actors. Several countries, ranging from great powers like the Soviet Union to small countries like North Korea, exploited the nuclear RMA. Disputes between India and Pakistan or Israel and Iran exemplify how even technologically sophisticated RMA can be exploited by countries of all sizes.

b. The Role of Technology

Scholars agree that technology alone is an inadequate determinant of RMA. Steven Metz and James Kievit discuss RMA as "arising from simultaneous or mutually supportive change in technology, systems, operational methods, and military organizations."[18] Though most often RMA are initiated by advancements in technology, revolution only occurs when organizations choose to evolve with them.[19] Countries seeking to exploit revolutions in military affairs must, according to the consulted literature, make fundamental changes in the way they use innovative technology. Richard Bitzinger substantiates this concept, stating that RMA "is more than simply overlaying new technologies and new hardware on existing force structures; it requires fundamental changes in military doctrine,

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[17] Benbow, *Magic Bullet*, 48.

[18] Steven Metz and James Kievit*, Strategy and the Revolution in Military Affairs: From Theory to Policy* (Carlisle Barracks, PA: U.S. Army War College Strategic Studies Institute, 1995), http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=236, 9–11.

[19] Benbow, *Magic Bullet*, 22.

operations, and organization."[20] In order to truly exploit an RMA, the relevant literature holds that countries cannot rely solely on the adoption of innovative technology like UAVs.

Usually, a revolution in military affairs occurs at the nexus of technology and doctrine. Innovative technologies rarely change the nature of conflict and war by themselves, though they often serve as a catalyst. Technology-driven RMA often reflect the confluence of a series of technological advances and are frequently fully exploited by actors that were not involved in the technology's development.[21] To use the UAV example, translating information to intelligence requires the combination of a number of technologies including reconnaissance sensors, long-dwell airframes, remote control, data relay, and image or signal analysis software. Beyond the technology, the revolutionary effects of being able to remotely sense information and deliver intelligence in real time to policymakers are made possible through extensive training, well-conceived doctrine, and efficient organization. Hundley's research yields that, "all successful technology-driven RMAs appear to have three components: technology, doctrine, and organization."[22] Analysis of a country's progress in synthesizing the three components can aid in the prediction of its success or failure of IRMA exploitation.

2. The Information Revolution in Military Affairs

The information revolution in military affairs is the latest RMA being considered and debated in military research. Literature pertaining to the IRMA focuses on whether the IRMA is truly revolutionary, with strong proponents and opponents on each side.

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[20] Bitzinger, "Come the Revolution," 39.

[21] Hundley, *Past Revolutions*, 13–14.

[22] Ibid., 15.

a. What is the IRMA?

According to Benbow, there are three elements that make up the IRMA: sensors, command and control, and precision strike.[23] The IRMA allows a commander to have "near-complete situational awareness; and, at the limit, to allow accurate predictions of the implications of decision."[24]

The processing, analysis, and conversion of information to actionable intelligence is key to understanding the IRMA concept. Proponents of the concept argue that IRMA is truly revolutionary because it shifts the focus of warfare from the means of force used to the results of the force itself. John Arquilla and David Ronfeldt suggest that IRMA embodies a Sun Tzu-style philosophy: that a country could defeat a belligerent adversary not by destroying its forces, but by disrupting its ability to understand the dynamics of the battlefield and communicate.[25]

Opponents of the IRMA theory contend that despite advances in technology, the use of information and intelligence is not a new concept. Using historical case studies, eight prominent scholars writing in *Information and Revolutions in Military Affairs* demonstrate that information was used to advantage in major battles predating the development of modern IRMA theory.[26] While there is some truth to the argument that the data being shared today does not differ substantially from that of World War II, proponents of IRMA would argue that the speed and manner in which the information is used, and the organizational changes that it necessitated are indicative of a RMA.

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[23] Benbow, *Magic Bullet*, 80.

[24] Norman C. Davis, "An Information-Based Revolution in Military Affairs," *Strategic Review 24* no. 1 (Winter, 1996): 83.

[25] John Arquilla and David Ronfeldt, "Cyberwar is Coming!" *Comparative Strategy* 12, no. 2 (Spring, 1993): 45.

[26] Emily O. Goldman, ed*., Information and Revolutions in Military Affairs* (New York: Routledge, 2005).

The information revolution in military affairs came about through increases in technological capability pertaining to data processing, communications, and information technology (IT). Countries that exploit the IRMA are more efficient and can make decisions that are not completely shrouded in the fog of war.

It is important to differentiate between popular understandings of information, information technology, and information resources. Emily O. Goldman's research into the IRMA clearly defines each term for better understanding. The terms in Table 1 are broken up into an inexhaustive list of examples for each concept.

Table 1. IRMA Terms.[27]

Information	Information Resource	Information Technology
Data	Analyst	Satellite
Words	Body of Knowledge	Computer
Numbers	Intelligence Agencies	Cloud Services
Images	Models / Doctrine	Cell Phones

Goldman notes that information technologies and information resources are often confounded.[28] The IRMA is certainly enabled by technological advances in data processing, by access to intelligence, and by improvements in C2 capability; but the IRMA also encompasses the conceptual aspects of information resources like models and doctrine.[29] Only when a country's information resources and information technology move in concert, can it claim exploitation of the IRMA.

[27] Adapted from Goldman, *Information and Revolutions in Military Affairs*, 2.

[28] Emily O. Goldman, "Introduction: Information Resources and Military Performance," in *Information and Revolutions in Military Affairs*, ed. Emily O. Goldman (New York: Routledge, 2005), 2.

[29] Ibid.

b. IRMA Exploitation

The IRMA exists conceptually regardless of whether a country chooses to incorporate the IRMA's advantages into its armed forces. IRMA exploitation refers to the realization of key components of the information revolution in military affairs. A country can exploit the revolution by demonstrating proficiency in networked sensors, informationalized C2, precision strike, near-complete situational awareness, and accurately predictive decision-making. The components of IRMA are inter-related, requiring proficiency in one or more to exploit the rest. A country cannot have near-complete situational awareness without a network of sensors. Accurate predictive decisions cannot be made without an informationalized command structure or precisely employed weapons. Proficiency in one aspect of IRMA will not necessarily lead to a simultaneous exploitation of the other components.

c. IRMA Diffusion

The existence of IRMA, and its recognition as a revolutionary military concept, was not immediately apparent to global forces. Real-world demonstration of IRMA's value by countries like the United States led to the gradual adoption of IRMA-related technologies and doctrine. How the IRMA diffuses from the original exploiting country to the rest of the world is contingent on a number of factors. Emily Goldman's analysis of IRMA diffusion in Asia offers discrete categories that she believes have the biggest impact on future IRMA exploitation. Goldman finds that a country is most affected by their relationship to the United States, motivations to adopt innovation, and factors that affect their capacity to integrate RMA-related innovation.[30]

[30] Emily O. Goldman, "Introduction: Military Diffusion and Transformation," in *The Information Revolution in Military Affairs in Asia*, ed. Emily O. Goldman and Thomas G. Mahnken (New York: Palgrave MacMillan, 2004): 4.

Goldman uses a methodology she calls diffusion diagnostics to analyze key components of the RMA exploitation process.[31] This model looks at a country's motives for seeking RMA exploitation and settles on "four types of explanations: security; political economy; technology; and institutional."[32] Next, and most relevant to analysis of Southeast Asian IRMA exploitation, Goldman's model examines four factors that enable or constrain adoption of new innovations.

(1) Polity

Polity refers to the political environment in a country and the range of variables that may encourage or discourage IRMA exploitation. Enabling and constraining characteristics of different political factors are given in Table 2.

Table 2. Political Factors Affecting Diffusion and Innovation.[33]

Factor	Enabler	Constraint
State Structure Political Diversity	Centralized, strong Diverse interests in dominant coalition; controversy in military organization	Diffuse, weak Consensus in dominant coalition; consensus in military organization
Legal and regulatory framework	Protection of intellectual property rights	Constitutional and legal prohibitions on military activity
Security focus of armed forces	External security focus drives quest for competitiveness and superiority	Internal security focus diverts best troops and resources to prop up regime
Civil-Military Relations	Professional autonomous military	Politicized military with civilian intervention

[31] Ibid.

[32] Goldman, "Military Diffusion and Transformation."

[33] Source: Adapted from Goldman," Military Diffusion and Transformation," 9.

(2) Economy

In order to obtain or develop new technologies to incorporate into a novel doctrine, a country has to demonstrate that it has the physical and human capital to make such an investment. Goldman asserts that there are three kinds of economic variables that either enable or constrain IRMA exploitation: "economic growth; industrial and technological capabilities; and defense spending."[34] See Table 3 for a list of economic factors and their effects on a country's potential IRMA exploitation.

Table 3. Economic Factors Affecting Diffusion and Innovation.[35]

Factor	Enabler	Constraint
Economic growth Defense spending Industrial and technology base	Strong High Integration with global economy; indigenous R&D; strong information industry	Weak Low Norm of self-reliance; dependence upon imports and reverse engineering; weak information industry
Sectoral interconnectedness	Horizontal integration of defense and commercial sectors; free flow of information	Segregated defense sector; high secrecy
Production incentives Organizational slack Technology Transfers	Spin-on focus Market economy Low export controls on receiving state	Commercial focus Planned economy High export controls on receiving state

(3) Society and Culture

Exploiting an existing RMA is not as simple as reverse engineering the technology and imitating the doctrine. Especially in the fast-changing state of IRMA, a country must learn to innovate in ways that make sense for its own security needs. Southeast Asia in particular is rich in socio-cultural values and

[34] Goldman, "Military Diffusion and Transformation," 9.

[35] Source: Adapted from Goldman, "Military Diffusion and Transformation," 11.

norms that may not be easy to change, should full exploitation of the IRMA require it. Education levels and social familiarity with technology can certainly affect the diffusion of the IRMA in a country.[36] Goldman presented a range of factors that can affect adoption in an IRMA seeking country (see Table 4).

Table 4. Social and Cultural Factors Affecting Diffusion and Innovation.[37]

Factor	Enabler	Constraint
Social structure	Unified social structure or unifying ideology	High levels of internal social conflict
Human capital	High level of technical education and literacy; societal familiarity with, and use of, computers	Low level of technical education and literacy; low societal familiarity with, and use of computers
Organizational Set	Strong	Weak
Cultural resonance	Strong resonance eases transmission and enhances desire for adoption	Weak resonance inhibits transmission and diminishes desire for adoption
Cultural tolerance	Tolerance of diversity and internal debate facilitates innovation and diffusion	Official orthodoxy hinders innovation and diffusion
National culture	Participatory Short power distance Lower uncertainty avoidance Low individualism Low masculinity	Control Long power distance High uncertainty avoidance High individualism High masculinity

(4) Military Organizations

Goldman asserts in her research that military organizations are categorized in three ways: “natural systems, rational systems, and open systems.”[38] Natural systems, according to Goldman tend to be risk averse and

[36] Goldman, “Military Diffusion and Transformation,” 13.

[37] Source: Adapted from Goldman, “Military Diffusion and Transformation,” 14.

[38] Goldman, “Military Diffusion and Transformation,” 15.

seek their own survival or advantage.[39] Rational systems are consistently striving to improve their own efficiency and learn from past experience.[40] Open systems tend to be driven by institutional beliefs or doctrine. Military systems that assert that things have always been done a certain way are much more likely to be characterized as open systems. Military factors for RMA exploitation are summarized in Table 5.

Table 5. Military and Organizational Factors Affecting Diffusion and Innovation.[41]

Factor	Enabler	Constraint
Existing organizational preferences	Parity in power among service's branches	Asymmetry in power among service's branches skewed toward legacy systems
Domestic pressure	High and multiple sources	Low
Experiential base	Strong	Weak
International vulnerability	High	Low
Organizational type	Cybernetic; rational, learning system	Socio-political; military highly politicized
Organization's beliefs	Meshes with innovation	Conflicts with innovation (e.g. ANZAC spirit)
Interconnectedness	High promotes jointness	Low feeds inter-service rivalry

These categorical factors will be used to predict Southeast Asia's potential for IRMA exploitation. By examining the political, economic, socio-cultural, and military aspects of Southeast Asian countries, one may assess whether they are likely to exploit IRMA, potentially yielding predictions of future UAV effectiveness.

[39] Ibid.

[40] Ibid.

[41] Source: Adapted from Goldman, "Military Diffusion and Transformation," 16.

3. Information and Military Performance

Statecraft is fundamentally about the use of power. As defined by Adda Bozeman in her book, *Strategic Intelligence and Statecraft*, statecraft is "the sum total of human dispositions, doctrines, policies, institutions, processes, and operations that are designed to assure the governance, security, and survival of a politically unified human group."[42] If the old adage about knowledge and power is true, the relationship between information and military performance is of the utmost importance. Unsurprisingly, there is a large amount of scholarly research concerning the dependence of foreign policy on timely and accurate intelligence.[43] There is little divergence in the literature from the acknowledgement of strategic intelligence's value in policy-making. In the multitude of scholarly works on intelligence and policy, empirical evidence is presented time and again demonstrating that knowledge gained from intelligence is critical for prudent decision-making. Founding OSS member and namesake of the Central Intelligence Agency's analytic tradecraft school Sherman Kent once noted that:

> Our policy leaders find themselves in need of a great deal of knowledge of foreign countries. They need knowledge which is complete, which is accurate, which is delivered on time, and which is capable of giving us the truth, or a closer approximation to the truth, than we now enjoy.[44]

Intelligence analysis is not conducted for its own sake. Rather, its *raison d' êtr*e is the timely and relevant delivery of knowledge to a policymaker before a decision has to be made. Timeliness is contingent on an information architecture that enables the flow of information. One of the most comprehensive works consulted in this paper's preliminary research that discusses the interrelationship

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[42] Adda Bozeman and N. McCrae, *Strategic Intelligence & Statecraft: Selected Essays* (Washington: Brassey's, 1992): 1.

[43] Sherman Kent, Angelo Codevilla, Adda Bozeman, David Tucker and others have informative works specifically focused on the interrelationship between intelligence and statecraft.

[44] Sherman Kent, *Strategic Intelligence for American World Policy* (Princeton: University Press, 2000), 5.

between information and power came in a 1996 article in Foreign Affairs. The authors' central prediction is that the country that can best use the tools of the information revolution will ultimately yield the greatest power geopolitically.[45] Though the article is 20 years old, the arguments made are as pertinent today as when they were written.

The relevant literature on the relationship between intelligence and military effectiveness is notably one-sided. No scholarly work consulted for this thesis argues or implies that less intelligence in military operations is better. Even those that write extensively about intelligence failure do not argue that a professional intelligence bureaucracy should not exist, simply that it should be reformed.[46] Interestingly, there is a proclivity in the growing amount of literature for criticizing failures of policy rather than judging events as intelligence failures.[47] David Bossie and others including the current Secretary of Defense, Ashton Carter, argue that degrading, downplaying, or ignoring intelligence collection and analysis is in itself a failure of policy.[48] The trend in the literature is fairly straightforward: increasing intelligence collection and analysis capabilities, to include UAV use, will directly benefit the execution of statecraft.

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[45] Joseph Nye and William A. Owens, "America's Information Edge," *Foreign Affairs*, April 1996, https://www.foreignaffairs.com/articles/united-states/1996-03-01/americas-information-edge.

[46] Many words have been penned over intelligence failure. This thesis does not focus directly on intelligence failure, therefore extensive discussion falls outside of the scope of this study. For extensive reading on the topic, see: Richard Betts, Robert Jervis, Melvin Goodman, and Dave Bossie.

[47] There are numerous scholarly articles and a sizable amount of press editorials that directly blame policy-makers for using intelligence failure as a scapegoat for policy failures. See: Stephen Marrin, "The 9/11 Terrorist Attacks: A Failure of Policy Not Strategic Intelligence Analysis," *Intelligence and National Security* 26, no. 2–3 (December, 2011): doi:10.1080/02684527.2011.559140.182.

[48] Ashton B. Carter, "A Failure of Policy, Not Spying," *Washington Post*, April 3, 2005, http://www.washingtonpost.com/wp-dyn/articles/A20057-2005APR1.html; Dave N. Bossie, *Intelligence Failure: How Clinton's National Security Policy Set the Stage for 9/11* (Nashville, TN: WorldNetDaily Books, 2004)

Emily Goldman's research specifically addresses the relationship between information and military performance. Goldman's work concludes that:

> Improvements in military performance can be assessed along six different dimensions, corresponding to six basic objectives that have characterized modern military operations: lethality, reach, resupply, accuracy, legitimacy, and timeliness/speed. Information resources directly facilitated each of these objectives.[49]

4. IRMA Exploitation and UAV Effectiveness

There is very limited body of work on the relationship between IRMA exploitation and UAV effectiveness. Both topics are in nascent stages of scholarly research and very few have connected the effectiveness of the UAV system to the greater information environment.

The most relevant work on the topic is a 2015 paper written by Andrea and Mauro Gilli. The authors addressed concerns over the potential instability caused by the proliferation of unmanned technologies and found that there were adoption challenges that limited the effectiveness of the UAVs. Gilli and Gilli argue that the number of people and systems required to effectively analyze UAV data from advanced systems like the MQ-9 Reaper are the main reason UAV proliferation will have a limited effect on international relations in the near future.[50] The authors note that employing UAVs "requires complex infrastructural and organizational support—often beyond the reach of wealthy and developed countries."[51] According to the research,

> Many countries have the resources to acquire expensive weapon platforms. However, when introducing intensive data gathering systems like drones, they '"often lack the expertise to integrate and support such systems, and at times even use the hardware [while

[49] Goldman, "Information Resources and Military Performance," 9.

[50] Andrea Gilli and Mauro Gilli, "The Diffusion of Drone Warfare? Industrial, Organizational, and Infrastructural Constraints: Military Innovations and the Ecosystem Challenge" (master's thesis, Stanford University, 2015), 36, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2425750.

[51] Ibid., 24.

> their] organizations struggle with managing the new flood of data, drawing relevant conclusions, and initiating the appropriate response."[52]

Furthermore, the paper notes how difficult it is for even advanced military forces to incorporate net-centric warfare assets into their organizations. The authors argue that adoption of UAVs "calls for difficult and lengthy doctrinal adaptation and organizational change as armed forces must become proficient in the language of net-centric warfare (i.e., the rapid acquisition, exploitation, and dissemination of information across different sensors, nodes, platforms, and sensors)."[53] Gilli and Gilli's research directly addresses the difficulties global UAV proliferation and stands in stark contrast to those that assert the UAVs are, by themselves, strategically relevant.

5. Unmanned Aerial Vehicles in Southeast Asia

Two of the main themes in contemporary work on Southeast Asian security are maritime territorial disputes in the South China Sea and regional military modernization. Both concepts are associated with regional growth in, and the increased procurement of, UAVs. This section discusses the current state of UAV scholarship in Southeast Asia and regional UAV market growth.

Scholarly work on UAV adoption in Southeast Asia is lacking in breadth and depth. The literature focuses more on UAV acquisition and less on UAV use or the benefits of UAV employment. Most research focuses on defense analysts' projections for massive growth in the UAV market with little analysis as to what this could mean in regional politics. Analysis by regional scholars focuses on the implications of armed unmanned systems more than the far more prevalent types used for reconnaissance.

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[52] Ibid.

[53] Gilli, "The Diffusion of Drone Warfare," 30.

Desmond Ball offers the most pertinent analysis of the likely effects of unmanned ISR platform expansion in Southeast Asia, though it is over a decade old. Ball argues rather forcefully that increases in EEZ surveillance will "generate tensions and more frequent crises; they will produce escalatory dynamics; and on balance they will lead to less stability in the most affected regions, including especially Asia."[54] Ball's analysis focuses on the escalatory nature of increased collection activity as the basis for concluding that more ISR equates to more conflict. Notably absent from Ball's analysis is consideration for the intelligence obtained through UAV employment. Though difficult to incorporate in his analysis, policy decisions made because of UAV-derived intelligence could arguably decrease instances of crisis through reduced misperception. The lack of writing on the implications of drone proliferation in Southeast Asia could be explained by a lack of familiarity on the part of scholars with UAV-derived intelligence and what that can provide to military commanders and politicians alike.

Unmanned aerial vehicles are not necessarily new to the Southeast Asian region, with discussions of their adoption appearing in scholarly works nearly a decade old. The pace at which Southeast Asian countries are procuring or producing new unmanned aerial vehicles has, however, accelerated in the last five years. Southeast Asian countries are improving indigenous UAV development capabilities with Singapore leading the charge for a Southeast Asian export market.[55]

The majority of unmanned platforms procured by Southeast Asian militaries are imported from market leaders like the United States, Israel, and increasingly, China.[56] Analysis of the Asia-Pacific region in 2005 yielded

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[54] Desmond Ball, "Intelligence Collection Operations and EEZs: The Implications of New Technology," *Marine Policy* 28 (July, 2004): 67–74.

[55] Michael Blades, *Global UAS Indigenous Programs*, (San Antonio, TX: Frost and Sullivan, 2015), http://www.marketresearch.com/product/sample-9199075.pdf, 11.

[56] Ibid., 12.

predictions of a potential $7 billion USD market through 2025 for unmanned aerial vehicles.[57] More recent analysis predicts that the figure could grow to $1.7 billion USD per year by 2017, more than doubling original estimates.[58] Asia remains the second largest buyer of drones outside of the United States. Southeast Asia makes up a small, but growing segment of the Asian drone market with massive increases in defense spending over the past 15 years. From 2001–2016, Indonesia, Malaysia, Singapore, Vietnam, and the Philippines experienced an average defense budget increase of 288%.[59] Singapore's defense budget grew from $5.4 billion USD in 2001 to $14.78 billion USD with $2.6 billion programmed for procurement in 2016 alone. On November 17, 2015, the United States pledged $119 million in military assistance to Southeast Asia in FY2015 and $140 million in FY16 dedicated to developing Southeast Asian maritime capabilities.[60] In the Philippines, Vietnam, Indonesia, and Malaysia specifically, the funds are dedicated to increasing ISR, patrol capabilities, and aircraft procurement for maritime domain awareness.[61] Increases in military assistance also coincide with the lifting of a ban on exporting armed UAVs to security partners worldwide.[62] Southeast Asian defense procurement budgets are growing concurrent with the surging number of international firms seeking to sell unmanned systems.

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57 Kelvin Wong, "Armed Drones in Asia," *RSIS Commentaries* 97 (Singapore: S. Rajaratnam School of International Studies, August, 2010), 2.

58 Guy Martin, "Asian Region UAV Capability on the Rise," *Defence Review Asia*, December 19, 2012, http://www.defencereviewasia.com/articles/195/Asian-region-UAV-capability-on-the-rise.

59 "Defence Budgets," *IHS Jane's*, accessed December 14, 2015, https://janes.ihs.com/CustomPages/Janes/Jdb/JdbHome.aspx.

60 "FACT SHEET: U.S. Building Maritime Capacity in Southeast Asia," *White House*, November 17, 2015, https://www.whitehouse.gov/the-press-office/2015/11/17/fact-sheet-us-building-maritime-capacity-southeast-asia.

61 Ibid.

62 "South-East Asia: Drone Sales May Raise Terror Risks," *Oxford Analytica*, March 13, 2015, https://www.oxan.com/display.aspx?ItemID=DB198258.

Southeast Asian acquisition and production of UAVs is continuing at a rapid pace. Although exact numbers within respective orders of battle are difficult to come by and change frequently, there is information available about the types of platforms already obtained and which systems are potential acquisitions in the future.

a. Singapore

Singapore has the most advanced UAV capability of all Southeast Asian militaries. It has had an operational UAV capability since 1994.[63] Singapore operates numerous indigenous platforms and has strong relationships with Israeli producers. It is known to operate the Israeli Aerospace Industries' Hermes and Heron platforms.[64] Singapore also demonstrated is shipborne tactical UAV capability by deploying the Insitu ScanEagle during the CARAT 2015 exercises with the United States.[65] Singapore is focusing on expanding its medium altitude long endurance (MALE) capability in the near future.

b. Indonesia

Indonesia has limited operational UAV capability but is expanding. President Joko Widodo intends to modernize the Indonesian military and stated his intention to acquire unmanned aerial vehicles to combat illegal fishing and piracy within Indonesia's vast EEZ.[66] Development using commercial-off-the-shelf platforms (COTS) enables the Indonesian Navy to rapidly assemble and operate UAVs with limited acquisition lead time. Indonesia was to acquire "eight indigenously-developed Wulung tactical UAV systems and a number of remote

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[63] IHS Jane's "Singapore Procurement,"*Jane's Sentinel Security Assessment–Southeast Asia*, accessed December 14, 2015, https://janes.ihs.com/SouthEastAsia/Display/1305144.

[64] IHS Jane's, "Singapore Procurement."

[65] "US, Singaporean Navies Debut UAV Operations in 'CARAT' Exercise," *IHS Jane's*, July 14, 2015, accessed December 14, 2015, http://www.janes.com/article/52977/us-singaporean-navies-debut-uav-operations-in-carat-exercise.

[66] Haeril Halim, "Jokowi Wins On Prabowo's Turf," *The Jakarta Post*, June 23, 2014, http://www.thejakartapost.com/news/2014/06/23/jokowi-wins-prabowo-s-turf.html.

ground stations by the end of 2015."[67] The program has developed steadily since 2004 and is now approaching deployment.[68]

c. Malaysia

Malaysia utilizes a number of indigenously-produced platforms and leases numerous platforms from foreign companies like Insitu.[69] MALE platforms like the Aludra Mk 1, Aludra Mk 2, and Yabhon Aludra as well as tactical platforms like Insitu's ScanEagle patrol near Semporna and are operated primarily out of Kudat.[70] Malaysia's capabilities are growing and increasingly being observed operating in the maritime domain.

d. Vietnam

Vietnam's primary UAV system is the indigenously-produced Patrol VT tactical UAV.[71] It is expanding domestic production of UAV systems to improve its ISR capabilities. Interest in acquisition from foreign defense companies is increasing. According to press reports, "Industry sources told Reuters that Vietnam was in discussions with Swedish defence contractor Saab, the European multinational Eurofighter, the defence wing of Airbus and U.S. firms Lockheed Martin and Boeing."[72] Vietnam is also considering purchase of systems from Belarus and Israel.[73]

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[67] IHS Jane's, "Indonesia Procurement," *Jane's Sentinel Security Assessment – Southeast Asia*, accessed December 14, 2015, https://janes.ihs.com/SouthEastAsia/Display/1305012.

[68] Ibid.

[69] IHS Jane's, "Malaysia Procurement," *Jane's Sentinel Security Assessment – Southeast Asia*, accessed December 14, 2015, https://janes.ihs.com/SouthEastAsia/Display/1305050.

[70] IHS Jane's, "Malaysia Procurement."

[71] IHS Jane's, "Vietnam Procurement," *Jane's Sentinel Security Assessment – Southeast Asia*, 2015, accessed December 14, 2015, https://janes.ihs.com/SouthEastAsia/Display/1305177.

[72] Oliver Holmes, "Vietnam Sends Message to China With Bid to Buy Fighter Jets and Drones," *The Guardian*, October 27, 2015, http://www.theguardian.com/world/2015/jun/05/vietnam-message-china-fighter-jets-drones-south-china-sea.

[73] IHS Jane's, "Vietnam Procurement."

e. Philippines

The Philippines has two General Atomics Predator UAVs registered with the national security advisor and a plan, as of 2013, to purchase more tactical UAVs to support expeditionary and marine forces.[74]

6. IRMA Exploitation in Southeast Asia

In general, Asia has seen a vast expansion and improvement in its war-fighting capability in the previous two decades.[75] While there has certainly been tangible progress in military acquisitions and upgrades, upgrades in C4ISR capabilities are more relevant to discussions of IRMA exploitation. Some Southeast Asian countries have made significant improvements to their underlying information infrastructure, but it is far from uniform. Singapore is perhaps the most advanced, with a secure network that utilizes multiple communications paths to connect its air and maritime surveillance information.[76] Doctrinally, Singapore's "Integrated Knowledge-Based Command and Control" (IKC2) is focused on the "acquisition, development, and integration of technologies for command and control with intelligence, surveillance, and reconnaissance systems and with precision-guided weapons."[77] Sam Bateman's analysis of the Asian maritime security environment asserts that regional C4ISR capabilities are expected to increase.[78] Bateman argues that the wider use of drones will enhance information-sharing and maritime domain awareness, especially in concert with the aforementioned C4ISR improvements.[79]

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[74] IHS Jane's, "Philippines Procurement," *Jane's Sentinel Security Assessment – Southeast Asia*, accessed December 14, 2015, https://janes.ihs.com/SouthEastAsia/Display/1305084.

[75] Bitzinger, "Come the Revolution," 42.

[76] Ibid., 43.

[77] Bitzinger, "Come the Revolution," 48.

[78] Sam Bateman, "The Future Security Environment in Asia: A Risk Assessment Approach," *Contemporary Southeast Asia* 37 no.1 (April, 2015): https://muse.jhu.edu/article/580565/pdf.

[79] Ibid.

Most countries today, however, fall short of the progress that Singapore has demonstrated. Richard Bitzinger argues that there are several socio-political impediments and traditions that are getting in the way of Southeast Asian IRMA exploitation.[80] He argues that while it is probably too early to talk about IRMA for most Southeast Asian countries, it will remain a contentious and legitimate subject of discussion for years to come due to its current relevance in a number of regional security issues.[81]

D. POTENTIAL EXPLANATIONS AND HYPOTHESES

Fundamentally, this analysis is about whether UAVs require IRMA exploitation to be effectively employed. The impressive qualities that UAVs bring to a country' military capabilities appear to rely on a sophisticated informational architecture representative of the IRMA.

Hypothesis One: UAVs require extensive IRMA exploitation to be effective. This hypothesis asserts that UAVs are completely reliant on an overarching C4ISR infrastructure and doctrinal acceptance within the military to be effective. Extensive IRMA-exploitation provides policymakers near real-time access to information, networked C2, near-complete situational awareness, and the ability to make predictive policy decisions. Extensive exploitation of the IRMA increases the speed at which policy instruments like precision strikes can be employed in response to UAV-derived intelligence.

Hypothesis Two: UAVs require partial IRMA exploitation to be effective. This hypothesis elevates the importance of the drone itself. In this model, the unique capabilities of the platform and the advantage that it provides to countries that were previously unable to field any reliable airborne reconnaissance capability are enough to affect the status quo on the ground or in the water. UAV use from tactical units can drive immediate decisions provided the country's

[80] Bitzinger, "Come the Revolution," 51–52.

[81] Ibid., 55–57

military chain of command provides such authorities. This hypothesis also acknowledges that there has been at least a partial change in doctrine, organization, or IT capability that drives a commander in the field to seek UAV-derived intelligence.

Hypothesis Three: UAVs are effective or ineffective regardless of IRMA exploitation. This hypothesis asserts that IRMA exploitation has no impact on UAV measures of effectiveness. This eventuality has the least support based on the review of relevant literature. Since the UAV's purpose is either defined or enabled by humans in the information environment, this hypothesis is most likely to be true only in cases of fully-autonomous UAV platforms: a technology that has not yet seen maturity.

Once confirmed, one of these hypotheses may help predict the effects of UAV proliferation in Southeast Asia. Examining the UAV capabilities of the individual countries and their proclivity for IRMA exploitation may elucidate which countries are poised for information advantage, particularly in the maritime domain.

E. RESEARCH DESIGN

This thesis will provide a comparative analysis of UAV use in countries whose ability to exploit IRMA ranges from extremely low to very high. First, the thesis will examine IRMA-exploiting countries that use UAVs like the United States and China. Next, it will explore non- or partial IRMA-exploiting countries like Iran, Italy, and Brazil. A comparison among these countries will help assess the relationship between IRMA exploitation and UAV effectiveness. Then, this thesis will assess the potential effectiveness of countries in Southeast Asia that have recently acquired UAV capabilities. With UAV technology spreading from global powers to developing countries throughout the world, there is no single case study or regional issue that universally explains the relationship between UAV effectiveness and the IRMA. Southeast Asia's recent and growing adoption

of unmanned technology, relative lack of C4I infrastructure, and maritime security challenges, make it an ideal region to analyze within the context of this study.

This research consults a wide range of sources to include scholarly books, journals, articles, official publications, university research, and reports from influential think tanks and NGOs. There is extensive press coverage of UAV proliferation in Asia and Southeast Asia that can provide valuable information about regional trends and use. Data from unclassified sources on foreign military acquisitions, defense budgets, and military capacity help build a picture of the current UAV capabilities and IRMA exploitation.

F. THESIS OVERVIEW AND CHAPTER OUTLINE

The forthcoming chapters will provide a detailed analysis of UAV proliferation and use in multiple countries. This introductory chapter established the research questions, defined key terms and concepts, and introduced previous research in the field.

Chapter II is a detailed analysis of countries that operate UAVs and have exploited the IRMA. Using the U.S. and the China as case studies, the chapter will highlight how UAVs feed into their larger information and decision-making architecture.

Chapter III is similarly structured in its analysis of UAV-operating countries that do not appear to have exploited the IRMA. Iran is a good case study because of its long history of UAV employment and relative aversion to innovative concepts like the IRMA. Several other countries like Italy and Brazil will also be examined.

Chapter IV takes the lessons learned from the United States, China, Iran and others and compares them to the emerging UAV users in Southeast Asia. Focusing on Singapore, Malaysia, Indonesia, Vietnam, and the Philippines, the analysis will examine current and projected UAV platforms, current IRMA exploitation, and/or receptiveness to the diffusion of RMA. The diffusion

diagnostic model is applicable in these cases because many of them have not, by many analysts' standards, exploited the IRMA.

Finally, Chapter V will address the hypotheses and address the research questions. It will also provide an assessment of the potential asymmetric value of UAV-derived intelligence and recommended actions for Southeast Asian countries seeking to increase UAV effectiveness.

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II. MARITIME UAV EMPLOYMENT BY INFORMATION RMA-EXPLOITING STATES

To better understand the relationship between UAV effectiveness and IRMA exploitation, this study selected case studies from countries that demonstrate both concepts. The two countries, the United States and China, are from different geographic areas with distinct cultural and political characteristics. Both countries utilize a range of unmanned platforms, especially in the maritime domain. The U.S. and China have advanced C4ISR infrastructures and have optimized their respective military structures to operate in an informationalized environment. This chapter will compare and contrast the U.S. and China as examples of state actors that utilize UAVs and have exploited the IRMA. A comprehensive overview of every unmanned platform in the U.S. and Chinese arsenal is unnecessary within the scope of this study.

A. UNITED STATES OF AMERICA

The U.S. is involved in maritime disputes around the world. From promoting freedom of navigation in the South China Sea to patrolling strategic maritime chokepoints like the Strait of Hormuz, the U.S. has a particular need for intelligence, surveillance, and reconnaissance (ISR) at sea. It is therefore unsurprising that the United States is the global leader in unmanned systems research and employment.[82] While the MQ-1 Predator and MQ-9 Reaper platforms remain the most ubiquitous symbols of America's contribution to unmanned warfare, there are nearly 200 different maritime-related unmanned

[82] Glennon J. Harrison, "Unmanned Aircraft Systems (UAS): Manufacturing Trends," *Congressional Research Service*, January 30, 2013, http://www.fas.org/sgp/crs/natsec/R42938.pdf.

platforms in service or in a developmental status with the United States government.[83]

1. Maritime Challenges

For the United States, disputes at sea or in littoral waters usually arise when other countries' claims infringe on the freedom of navigation. Maritime UAV employment for the United States does not focus on enforcing its own territorial claims, rather on gaining intelligence regarding the status of disputes to which the United States is not a belligerent. The United States also utilizes unmanned aircraft to assist in maintaining maritime domain awareness of foreign military ships, submarines, and port facilities.

Though not directly involved in maritime disputes in the South China Sea, the U.S. utilizes reconnaissance assets including UAVs to maintain situational awareness on tactical and operational developments between claimants. China's claims in the South China Sea conflict with those of several Southeast Asian states, particularly in the Spratly Islands. U.S. foreign policy goals in the South China Sea include deterring China from militarizing land formations in the Spratlys and ensuring freedom of the seas for civil and naval vessels alike.[84] Despite not being a signatory to the UN Convention on the Law of the Sea (UNCLOS), the U.S. has an interest in recognizing the legitimately claimed territorial waters and exclusive economic zones of all states.

Another significant maritime dispute that the U.S. monitors is Iran's excessive territorial water and airspace claims in the Arabian Gulf. In 1973, Iran asserted its baseline claim to extend in a straight line from the outermost portions of its territorial waters. By extending its baseline claims, Iran has, in the United

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[83] IHS Jane's, "United States of America," *IHS Jane's*, Accessed July 14, 2016, https://janes.ihs.com/UnmannedAerial/search?f=COUNTRYREGIONTAXONOMY(United%20States).

[84] Michael S. Schmidt, "In South China Sea Visit, U.S. Defense Chief Flexes Military Muscle," *The New York Times*, April 15, 2016, http://www.nytimes.com/2016/04/16/world/asia/south-china-sea-us-ash-carter.html?_r=0.

States' view, illegitimately expanded its territorial waters and airspace, all while increasing the size of its Air Defense Identification Zone (ADIZ).[85] The increased baseline claim, coupled with a history of hostile encounters at sea between U.S. and Iranian vessels, a strategic choke point in the Strait of Hormuz, and larger geopolitical issues at play have contributed to an increased U.S. presence in the Arabian Gulf and the related need for maritime ISR assets.

2. Unmanned Aerial Vehicle Capability

The U.S. has the most sophisticated unmanned aerial program in the world. U.S. drones range from tactical airframes capable of delivering lethal effects to long-dwell persistent ISR platforms. The U.S. uses unmanned platforms for missions ranging from high-value target elimination to maritime reconnaissance.

a. Current Platforms

There are well over 500 distinct unmanned platforms publicly known to be part of the U.S. unmanned arsenal or in development with defense contractors.[86] Platforms like the MQ-1 Predator, MQ-9 Reaper, RQ-4 Global Hawk, and the RQ-170 Sentinel dominate the headlines because of their persistence in Afghanistan, Syria, the Horn of Africa, and other battlefields in the Global War on Terrorism. Despite the public focus on counter-terror and counter-insurgency missions, maritime platforms including the MQ-4C Triton, RQ-21 Blackjack, and MQ-8C Fire Scout exist at the cutting edge of UAV technology and are receiving significant funding in defense procurement efforts.[87]

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[85] Office of Ocean Affairs, "Limits in the Seas: No. 114 Iran's Maritime Claims," *United States Department of State*, March 16, 1994, http://www.state.gov/documents/organization/58228.pdf.

[86] IHS Jane's, "United States of America."

[87] Derrick Maple, "US DOD FY17 Budget: In Depth Analysis - Unmanned Aerial Vehicles (UAV) Market," *IHS Jane's Defence Budgets*, March 8, 2016, https://janes.ihs.com/DefenceBudgetsReports/Display/file.axd?f=/ExternalItems/Janes/images/binder/jdb/jdb2012/data/jdb_a149_a.pdf.

The U.S. military uses a variety of platforms in the maritime domain, even ones that were not specifically designed for maritime use. The majority of the U.S. Navy's maritime UAV platforms are considered small tactical unmanned aerial systems (STUAS). The ScanEagle and RQ-21A Blackjack STUAS platforms can be launched from ships at sea. They are limited in their range and on-station time but provide the Navy a unique capability that does not require vertical takeoff and landing. The U.S. Air Force maintains the only credible unmanned aerial strike capability at sea with the MQ-1 Predator and MQ-9 Reaper platforms; however, both aircraft are not optimized for the maritime environment. Although some platforms certainly work better over the sea, almost all unmanned platforms can be used in a maritime reconnaissance capacity.

(1) Capital Investment

Of the $4.14 trillion FY17 defense budget submitted to Congress in February 2016, $1.35 billion were dedicated to UAV procurement.[88] Although the Air Force received the majority of the funding to purchase 24 additional MQ-9 Reapers, $464.7 million of the remaining funds went into acquiring two of the Navy's MQ-4C Triton high-altitude long endurance (HALE) systems.[89] Despite an overall DOD UAV budget reduction of 25%, Congress expects to maintain stable funding levels for the Navy's RQ-21A Blackjack and MQ-8B/C Fire Scout for the five-year Future Years Defense Plan (FYDP).[90]

b. UAV Employment

The Navy relies most heavily on two airframes to handle the majority of its operations at sea. The RQ-4A, also known as the Broad Area Maritime Surveillance—Demonstrator (BAMS-D), is the immediate precursor to the MQ-4C Triton. The RQ-4A utilizes the same airframe as the USAF Global Hawk with

[88] Maple, "US DOD FY17 Budget."

[89] Ibid.

[90] Ibid.

modifications made to the sensor packages onboard the aircraft in support of its maritime mission.[91] The aircraft primarily conducts open water and littoral surveillance with its signals intelligence (SIGINT) and imagery intelligence (IMINT) sensors. It collects Automatic Identification System (AIS) signals and has an electro-optical, infrared, synthetic aperture radar (SAR), and inverse synthetic aperture radar (ISAR) capability with a dwell time of up to thirty hours.[92] The United States primarily deploys the BAMS-D for HALE maritime missions in the Middle East.[93] The two BAMS-D airframes in the U.S. inventory have operated consistently since 2009 and are expected to sustain operations until the full integration of the MQ-4C Triton upgrade.[94] Figure 1 displays the U.S. Navy's RQ-4A BAMS-D platform. When considering A2AD environments, unmanned HALE platforms offer a unique advantage. The MQ-4C Triton is expected to be one means of intelligence collection in denied areas where the employment of traditional maritime patrol aircraft like the EP-3 Aries and P-8 Poseidon would put crew members at risk.

[91] Navy Air Systems Command, "BAMS-D," Navy Air Systems Command, accessed July 16, 2016 http://www.navair.navy.mil/index.cfm?fuseaction=home.displayPlatform&key=624BC6D7-45CE-446C-BA1E-5818E57F9914.

[92] Navy Air Systems Command, "BAMS-D."

[93] Ibid.

[94] IHS Jane's, "Procurement: United States," *Jane's Sentinel Security Assessment – North America*, April 9, 2016, https://janes.ihs.com/Janes/Display/1303949.

Figure 1. U.S. Navy RQ-4A Broad Area Maritime Surveillance—Demonstrator (BAMS-D).[95]

The Insitu ScanEagle, recently acquired by Boeing, is the primary aircraft utilized by the United States for surveillance at sea. Figure 2 depicts a ScanEagle UAV at sea. With 206 in the inventory, the United States Navy sends many of is Arleigh Burke-class missile destroyers and amphibious warships to sea with ScanEagle detachments aboard.[96] The ScanEagle is deployed with a pneumatic launcher from the deck of a vessel or a shore site, eliminating the need for a runway.[97] ScanEagle recovers by hooking onto a proprietary vertical cable Insitu developed.[98] The ScanEagle has electro-optical, infrared, and SIGINT sensor packages that can be utilized to collect intelligence.[99]

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[95] Source: Naval Air Systems Command, "BAMS-D at Point Mugu before 2008 Deployment," *Naval Air Systems Command*, Accessed August 23, 2016, http://www.navair.navy.mil/index.cfm?fuseaction=home.PhotoGalleryDetail&key=6F290DD6-BA64-4FE5-9261-672D034E6B08.

[96] Guy Anderson and Paul Burton, "Navigating the International Markets: United States," *IHS Jane's*, May 2016, https://janes.ihs.com/Janes/Display/1731900.

[97] Insitu, "ScanEagle," *Insitu*, Accessed July 17, 2016, https://insitu.com/information-delivery/unmanned-systems/scaneagle.

[98] Ibid.

[99] Ibid.

The United States Navy and DARPA are developing a vertical take-off and landing (VTOL) ISR and strike UAV called the Tactically Exploited Reconnaissance Node (TERN).[100] The TERN program is designed to add an unmanned platform to nearly every ship in the fleet, vastly improving maritime domain awareness capability and ad hoc military strike. The program is expected to demonstrate the capability in 2018 with full scale production undertaken by Northrop Grumman.[101]

Figure 2. U.S. Navy ScanEagle.[102]

3. Exploitation of the Information Revolution in Military Affairs

The U.S. fully exploits the IRMA. Using a network of sensors tied to command and control nodes, decision-makers receive a near-complete picture of the battlespace, use predictive analysis to calculate the implications of their

[100] Daniel Patt, "Tactically Exploited Reconnaissance Node," *DARPA*, Accessed July 17, 2016, http://www.darpa.mil/program/tactically-exploited-reconnaissance-node.

[101] Daniel Wasserbly, "DARPA Eyes 2018 for TERN UAV's First Flight," *IHS Jane's*, May 11, 2016, http://www.janes.com/article/60245/darpa-eyes-2018-for-tern-uav-s-first-flight.

[102] Source: Gary Yarrish, "US Navy Scan Eagle UAV," *Model Airplane News*, April 1, 2010, http://www.modelairplanenews.com/blog/2010/04/01/us-navy-scan-eagle-uav/.

decisions, and strike with precise lethality. This net-centric approach to warfare benefits greatly from a range of unmanned vehicles capable of collecting data and providing timely strike options with no risk to U.S. personnel. Simultaneously, the benefits of all-source fusion analysis improve the mission effectiveness of the unmanned platform.

a. Sensors

The United States has an extensive sensor capability in a range of intelligence disciplines. Satellite, air, ground, surface, subsurface, and cyber sensor capabilities are available to the U.S. intelligence community.[103] UAVs are a large part of the U.S. sensor network. Data from unmanned platforms filter back to networked analysis centers like Distributed Ground Station One (DGS-1) at Langley Air Force Base, Virginia. The 6000 airmen that work at DGS-1 analyze 20 terabytes of data each day. These airmen process approximately 460,000 hours of full-motion video and disseminate 2.6 million images to the intelligence community, Defense Department, and civilian decision-makers every year.[104]

While many sensors can be seen as passive data collection nodes, exploitation of the IRMA allows for higher quality sensing, especially from flexible platforms like UAVs. The U.S. Air Force Distributed Common Ground System (DCGS) Analysis and Reporting Teams (DART) fuse multiple sources of intelligence and cue unmanned assets to investigate potential threats.[105] The UAV is made a much more effective asset by maneuvering in concert with real-time intelligence reporting.

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[103] Jeffrey T. Richelson, "The Technical Collection of Intelligence," in *Handbook of Intelligence Studies*, ed. Loch K. Johnson (New York: Routledge, 2006), 108–114.

[104] Marcus Weisgerber, "A Look Inside a Secret U.S. Air Force Intelligence Center," *Defense One*, November 18, 2014, http://www.defenseone.com/technology/2014/11/look-inside-secret-us-air-force-intelligence-center/99347/.

[105] David A. Deptula and James R. Marrs, "Global Distributed ISR Operations: The Changing Face of Warfare," *Joint Forces Quarterly* 54 (July, 2009): 113–114.

b. Command and Control

The U.S. DOD has extensive command and control capabilities at the strategic, operational, and tactical levels of war. With civilian oversight, command decisions are enabled by an advanced network-centric information technology infrastructure. U.S. C2 doctrine is codified in DOD Joint Publications and facilitated by a secure supporting communications system.[106] Critically, networks used for C2 also enable the sharing of intelligence. "Control and appropriate sharing of information is a prerequisite to maintaining effective C2."[107]

c. Precision Strike

The U.S. military has an advanced precision strike capability. Precision-guided munitions (PGM) are core to the application of military force. The U.S. maintains precision strike capability with nuclear and conventional ballistic missiles, cruise missiles, and bombs in all warfare domains. UAVs add to the precision strike capability by employing or guiding PGMs. Unmanned combat systems shorten the kill chain and enable the striking of ad hoc targets without prior planning.

d. Situational Awareness

American forces and policymakers are enabled by information technology, intelligence capabilities, and a network-centric organizational design to maintain global situational awareness on a range of political, economic, and security related issues. The White House Situation Room, National Military Command Center, and other joint operations centers are physical manifestations of and hubs for situational awareness within the U.S. national security apparatus. The U.S. military maintains all-source intelligence fusion capabilities ranging from the unit to the combatant command level. Civilian and military intelligence

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[106] United States Department of Defense, *Joint Publication 1: Doctrine for the Armed Forces of the United States*, *United States Department of Defense* (Washington, DC: DOD, 2013), xxiii.

[107] United States Department of Defense, *Joint Publication 1*, V-15

organizations communicate with one another at the tactical, operational, and strategic levels to provide the clearest and most accurate pictures of the battlespace.

U.S. doctrine indicates that situational awareness is a fundamental component of C2.[108] Situational awareness is "a prerequisite for commanders anticipating opportunities and challenges. True situational understanding should be the basis for all decision makers."[109] UAVs provide real-time input to a commander's understanding of the battlespace.

e. Predictive Decision-Making

Intelligence drives operations for the United States military. The U.S. uses information from various sensors and fuses them into intelligence assessments. Commanders make predictive decisions based on potential courses of action and the expected outcomes of their decisions. U.S. doctrine indicates that a clear operational picture helps make effective decisions in anticipation of an adversary's movement. "The commander who can gather information and make better decisions faster will generate a rapid tempo of operation sand gain a decided advantage."[110] An information advantage allows commanders to make decisions with confidence that the outcome will reflect their intentions.

4. Conclusion

The U.S. is engaged in military conflicts and geopolitical disputes in worldwide. The country's maritime disputes and ISR requirements usually occur far from U.S. territorial waters. The United States' principal foreign policy goals in getting involved in maritime disputes are either to address a direct security concern or in support of common international agreements like the UNCLOS.

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[108] United States Department of Defense, *Joint Publication 1*, xxiiii.

[109] Ibid., V-17.

[110] United States Department of Defense, *Joint Publication 1*, V-16.

To support its foreign policy goals at sea, the United States military employs unmanned aerial vehicles to receive tactical information on belligerents or changes in the battlespace. Legacy platforms modified for maritime use like the BAMS-D as well as new and innovative maritime surveillance platforms like the ScanEagle give the United States an information advantage at a far lower risk and cost than traditional manned reconnaissance programs. The United States invests heavily in unmanned technologies and has plans for substantial increases in UAVs at sea in the future and over its FYDP.

Exploiting the IRMA enables the U.S. government to more quickly utilize the information gained from UAV platforms for maritime domain awareness, tactically shift military assets, and present evidence of UNCLOS violations on an international stage. The United States' networked sensors and C2 capabilities enable near-complete situational awareness which assists in making predictive decisions and in the employment of its considerable precision strike capability.

The adoption and advancement of maritime UAV technologies for use by the United States military helps it more readily accomplish its maritime-specific policy goals. Fully exploiting the IRMA is a critical factor for the successful use of UAVs and amplifies the effectiveness and importance of their employment. Even at the tactical level, IRMA exploitation is required to translate information collected from unmanned assets into actionable intelligence. The UAV and the intelligence it collects cannot operate in a useful manner without being tied into a larger information architecture that advantages predictive decision making. The effectiveness of the unmanned system is directly tied the IRMA exploitation.

B. PEOPLE'S REPUBLIC OF CHINA

The PRC has quickly developed one of the most advanced UAV capabilities in the world. As it begins to expand its sphere of influence to distant seas, the PRC's need for high fidelity intelligence grows. With the Chinese military not significantly engaged in any major ground conflicts external to its borders, China's principal disputes are territorial conflicts in the South and East

China Sea. China has a robust C4ISR capability, a well-developed IT infrastructure, and considerable governmental support.[111] It has partially exploited the IRMA.

1. Maritime Challenges

China is engaged in several maritime disputes. China's claims in the South China Sea underlie many of its conflicts with neighboring countries. China also has a notable and ongoing dispute with Japan over the Senkaku Islands, maritime disputes with Vietnam, and fishing disputes with multiple countries in the region. In both the South and East China Seas, China has begun using unmanned platforms in support of its operations.[112]

Although China's claim over many of the features in the South China Sea was invalidated by the Permanent Court of Arbitration at The Hague in July of 2016, it is unlikely to relinquish de facto control of its outposts in the Spratly Islands. Reclamation efforts at Fiery Cross Reef and Subi Reef are similar to previous Chinese efforts at Woody Island.[113] In 2015 and 2016, China stationed BZK-005 UAVs on Woody Island in the South China Sea, extending the platform's maritime surveillance range into the South China Sea.[114]

China and Japan both claim the Senkaku Islands, located approximately 205 miles due east of the Chinese mainland. Tokyo's purchase of three of the islands in 2012 from their private Japanese owner intensified the dispute

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[111] Michael S. Chase et al., *Emerging Trends in China's Development of Unmanned Systems* (Santa Monica, CA: RAND Corporation, 2015): http://www.rand.org/pubs/research_reports/RR990.html.

[112] Ankit Panda, "Meet China's East China Sea Drones," *The Diplomat*, June 30, 2016, http://thediplomat.com/2015/06/meet-chinas-east-china-sea-drones/.

[113] Michael Green, Bonnie Glaser, and Zack Cooper, "Seeing the Forest through the SAMs on Woody Island," *CSIS Asia Maritime Transparency Initiative*, February 18, 2016, https://amti.csis.org/seeing-the-forest-through-the-sams-on-woody-island/.

[114] Ankit Panda, "South China Sea: China's Surveillance Drones Make it to Woody Island," *The Diplomat*, June 1, 2016, http://thediplomat.com/2016/06/south-china-sea-chinas-surveillance-drones-make-it-to-woody-island/.

between the two countries.[115] Since the Chinese declared an Air Defense Identification Zone (ADIZ) in 2013 that included the Senkaku Islands, Chinese and Japanese fighters have repeatedly responded to one another, coming as close as 100 feet of separation in 2014.[116] China began deploying at least three BZK-005 UAVs from Daishan Island for operations over the Senkaku Islands in 2013.[117]

2. Unmanned Aerial Vehicle Capability

China began investing heavily in unmanned technology beginning in the early 2000s.[118] It currently deploys or exports tactical and medium-altitude, long endurance (MALE) UAVs for surveillance and precision strike. China's drone inventory is constantly growing and evolving, making any inventory a mere snapshot in time. Identifying the platforms by name is no less challenging, as the aircraft and their upgrades almost all go by different names in both Chinese and translated English. Although industry watchdogs like IHS Jane's keep close tabs on military and commercial development, there are close to 100 UAV-related companies that are either state-owned or privately operated.[119] China's export market primarily consists of MALE platforms like the Yilong which it makes attractive due to China's lack of export restrictions and comparatively low price to similar U.S. models.

a. Current Platforms

China currently deploys several tactical and MALE platforms with its military. The most commonly observed platforms are the BZK-005, the Yilong,

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[115] Center for Strategic and International Studies, "East China Sea Tensions: Approaching a Slow Boil," *CSIS Asia Maritime Transparency Initiative*, Accessed July 26, 2016, https://amti.csis.org/east-china-sea-tensions/.

[116] Ibid.

[117] Panda, "Meet China's East China Sea Drones."

[118] Panda, "Meet China's East China Sea Drones."

[119] Ibid.

and the CH-4. China's Yilong, also known as the Pterodactyl, closely resembles the General Atomics MQ-1 Predator. China's CH-4, displayed in Figure 4, appears to be a copy of the MQ-9 Reaper.[120] China has exported CH-3 and CH-4 platforms to Iraq, the UAE, Nigeria, and Myanmar.[121] China flew its BZK-005, a MALE surveillance aircraft depicted in Figure 3, over the Senkaku Islands in September 2013. The platform was indigenously produced and is intended to fly a similar profile to the RQ-4 Global Hawk but flies a much lower flight profile. Overall, more than 300 UAVs are in service within the Chinese military.[122]

Figure 3. Chinese Harbin BZK-005 UAV.[123]

[120] Benjamin David Baker, "Drone Wars: China and U.S. Compete on the Global UAV Market," *The Diplomat*, October 25, 2015, http://thediplomat.com/2015/10/drone-wars-china-and-us-compete-on-the-global-uav-market/.

[121] Adam Rawnsley, "Meet China's Killer Drones," *Foreign Policy*, January 14, 2016, http://foreignpolicy.com/2016/01/14/meet-chinas-killer-drones/.

[122] IHS Jane's, "Procurement: China," *Jane's Sentinel Security Assessment – China and Northeast Asia*, February 10, 2016, https://janes.ihs.com/Janes/Display/1303148.

[123] Source: China Defence Today, "Unmanned Aerial Vehicles," *China Defence Today* Accessed August 20, 2016, https://chinadefencetoday.com/weapons/aircraft/unmanned-aerial-vehicles/.

(1) Capital Investment

China's FY17 defense budget is approximately $200 billion with $27.8 billion set aside for procurement.[124] China's procurement budget has grown by approximately $10 billion in the last five years despite an economic slowdown in recent years. China does not break its budget out for each branch of service in the People's Liberation Army. China's notorious secrecy over its budget makes it difficult to determine how much of the Chinese budget is invested in unmanned platforms. Its unmanned systems programs fall under the PLA's General Armament Department and General Staff Department.[125]

b. UAV Employment

China's UAV operations are difficult to assess due to high levels of state secrecy and the relatively few times that China's UAVs have been observed in operation. China's PLA employs its unmanned platforms primarily in the maritime domain. Chinese press reports of UAV training indicate that UAVs are deployed to identify unknown radar contacts at sea. A March 2016 Chinese press article described a military exercise over the East China Sea during which an unidentified UAV system is directed to reconnoiter a radar target at sea.[126] According to the article, "The mission controller switched to reconnaissance mode and adjusted the reconnaissance view angle. An intelligence analyst interpreted images accurately and in detail, and sent up an intelligence report…Very quickly a number of missiles roared away from ships and warplanes, headed for a target sea area."[127] It is difficult to determine if the description of Chinese training is accurate, notional, or merely theater to project

[124] Craig Caffrey, "China Defence Budget," *Jane's Defence Budgets*, March 14, 2016, https://janes.ihs.com/Janes/Display/1327472.

[125] Chase et al., "Emerging Trends in China's Development of Unmanned Systems."

[126] Liu Changpeng, Liu Linqing, and Zhao Haitao, "A Regiment Explores How to Boost Its Combat Power, Adds 'Will to Win' to Its Unmanned Aerial Vehicles," *Renmin Haijun*, March 15, 2016, p. 3.

[127] Ibid.

competency in unmanned systems deployment. The article also cites an incident in 2013 where UAVs were deployed to track foreign vessels near Chinese territorial waters. There is no further information about the interaction that could confirm the deployment but the timing is consistent with Chinese BZK-005 operations near the Senkaku Islands.

Although employment of Chinese UAVs including the CH-3, Yilong, and CH-4 platforms have principally been carried out by export recipients, their reputation for effectiveness as a cheaper alternative to the Predator is growing. On average, the Yilong costs one third of the MQ-1 Predator.[128] In December, 2015 Iraqi forces utilized a CH-4 to launch airborne strikes.[129]

Figure 4. Chinese-Exported CH-4B UAV in Iraq.[130]

[128] Rawnsley, “Meet China’s Killer Drones.”

[129] Ibid.

[130] Source: Qualitative Military Edge, “CH-4B RAINBOW,” *Qualitative Military Edge*, Accessed August 20, 2016, http://militaryedge.org/armaments/ch-4b-rainbow/.

3. Exploitation of the Information Revolution in Military Affairs

a. Sensors

China has rapidly expanded its remote sensing capabilities with the introduction of sub-meter satellite imaging in 2014 and a maturing over-the-horizon detection and targeting capability.[131] According to a DOD analysis, "Long-range air surveillance radars and airborne early warning aircraft…are said to extend China's detection range well beyond its borders."[132] The few times that Chinese UAVs have been observed operating at sea suggest that they were not the primary detection sensor of foreign naval capabilities. As with the Chinese press article, China does not appear to use UAVs for preliminary detection of targets. In June 2011, a Japanese P-3 observed a PLAN UAV operating near a Jiangwei II frigate. The P-3 was operating well within the radar detection range of the frigate and it is suspected that the PLAN wanted the vessel to be photographed operating at sea for propaganda purposes.[133] There is no evidence beyond the Chinese article to suggest that Chinese UAVs serve as cuing assets for PLAN vessels or aircraft.

b. Command and Control

China places a high priority on C2. Technological and organizational changes in the PLA's structure combine with its broad goal of an informationalized battlefield to make joint operations in multiple locations efficient.[134] China is modernizing its command systems to make them more secure, reliable, and useful to commanders in the field.[135] According to U.S.

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[131] United States Department of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2015*, April 7, 2015 (Washington, DC: GPO, 2015), 13.

[132] U.S. Department of Defense, *Military and Security Developments*, 37.

[133] James C. Bussert, "Chinese Navy Employs UAV Assets," *Signal Magazine*, April 2012, http://www.afcea.org/content/?q=node/2918.

[134] U.S. Department of Defense, *Military and Security Developments*, 37.

[135] Ibid., 38.

DOD assessments, “The PLA views technological improvements to C4I systems as essential to its broader goals of informationalization, which seeks to improve the speed and effectiveness of decision-making while providing secure and reliable communications to fixed and mobile command posts.”[136] There is no evidence to suggest that China leverages its C2 capabilities in the use of its UAVs.

c. Precision Strike

The PRC has a world-class precision strike capability. In addition to its highly accurate short, medium, intermediate-range ballistic missiles, China utilizes advanced LACM and PGMs.[137] China’s activities in cyberspace demonstrate a capability to accurately reach targets in the logical and persona layers of the domain. This level of accuracy could be used to precisely conduct computer network attack (CNA). UAVs are a new addition to the precision-strike capabilities of the PLA. China has demonstrated through its export sales that its UAVs have the capacity to strike targets with PGMs.[138]

d. Situational Awareness

China considers information dominance to be the key to winning modern conflict.[139] According to Dean Cheng’s review of foreign military analyst research, China considers information dominance to be “the ability to gather, transmit, manage, analyze, and exploit information, and preventing an opponent from doing the same.”[140] New C4I technologies like the Integrated Command Platform (ICP) vastly help the PLA in achieving its goals of an informationalized

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[136] Ibid., 37–38.

[137] U.S. Department of Defense, *Military and Security Developments*, 46.

[138] Patrick Boehler and Gerry Doyle, “Use By Iraqi Military May Be a Boon for China-Made Drones,” *The New York Times*, December 17, 2015, http://www.nytimes.com/2015/12/18/business/international/china-drone-export-iraq.html?_r=0.

[139] Dean Cheng, “The PLA’s Interest in Space Dominance,” *Heritage Foundation*, February 18, 2015, http://www.heritage.org/research/testimony/2015/the-plas-interest-in-space-dominance.

[140] U.S. Department of Defense, *Military and Security Developments*, 46.

military. According to DOD analysis, the ICP provides "intelligence, battlefield information, logistical information, and weather reports, which give commander improved situational awareness."[141] UAVs in theory should help provide greater fidelity on maritime contacts. In practice, there is very little evidence to support this theory.

The U.S. Office of Naval intelligence noted that Chinese expansion of naval missions beyond its littorals has precipitated an improvement in maritime situational awareness.[142] Despite this innovation, China's best source of information on maritime contacts remains direct reporting from naval and law enforcement vessels. China's sensor network is still maturing. Little is known about how the different data sources are actually processed, analyzed, and disseminated to commanders in mainland China or at sea.

e. Predictive Decision-Making

Chinese decision-making, particularly in crisis situations, falls to senior leadership within the Chinese Communist Party. China's leadership receives stovepiped intelligence streams from the CCP, PLA, and Ministry of State Security (MSS).[143] The Central Military Commission (CMC) usually holds a meeting to discuss the intelligence once it is received. Despite multiple streams of intelligence, China still is subject unplanned or uncontrolled behavior. According to scholars, this is due to local PLA leaders who are not closely controlled by civilian party members.[144] The disconnect between policymakers and military officials can at times lead to uncoordinated and confusing signaling, complicating the prediction of policy decisions.

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[141] Ibid., 38.

[142] Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities – Background and Issues for Congress* (CRS Report no. RL33153) (Washington, DC: Congressional Research Service 2016), 88–89, https://www.fas.org/sgp/crs/row/RL33153.pdf.

[143] Michael D. Swaine, "China's Assertive Behavior Part Four: The Role of the Military in Foreign Crises," *Hoover Institute*, April 30, 2012, http://www.hoover.org/sites/default/files/uploads/documents/CLM37MS.pdf.

[144] Ibid.

Chinese efforts to improve its decisive processes focus on the speed of information acquisition, processing, and decision-making.[145] Timely and accurate information helps facilitate prediction. “In particular the transmission of ISR data in near-real-time to commanders in the field can facilitate the commander’s decision-making process, shortening command timelines, and making operations more efficient.”[146]

4. Conclusion

China’s principal external security challenges exist in the maritime domain. With disputes between China and Japan over the Senkaku Islands and multiple countries in the South China Sea, the PRC has a growing list of intelligence requirements.

China rapidly developed a number of tactical and MALE unmanned aerial vehicles that purportedly feed into a larger C4I architecture. There is no evidence to prove that UAV-derived intelligence is making it in any form to Chinese policymakers. The indigenously produced BZK-005 UAV has been observed operating near the Senkaku Islands and on the tarmac at Chinese bases in the Paracel Islands. China’s goals for dominating an informationalized battlefield push continued investment and research into more advanced UAVs with precision strike capabilities and longer dwell times.

China exploits the IRMA with a network of sensors, a hierarchical and integrated command and control structure, an advanced precision strike capability, a maturing situational awareness of the maritime domain, and a tendency toward predictive decision-making. This analysis cannot, however, conclude that the PRC uses UAVs effectively. Although it has sufficiently

[145] Ibid., 37.

[146] U.S. Department of Defense, *Military and Security Developments*, 46.

exploited the IRMA, China does not appear to have incorporated their unmanned technologies into its information architecture. UAVs are not serving as forward detection nodes and there is no information to suggest that UAVs are impacting the deployment of maritime assets.

C. SUMMARY AND ASSESSMENT

This chapter explored the use of UAVs by IRMA-exploiting countries in order to highlight the impact IRMA exploitation has on effectiveness. UAVs are useful platforms for ISR in the maritime domain because they can collect multiple categories of information simultaneously over wide areas that offer limited alternative means of collection.

Both the United States and China operate a large number of technically capable unmanned platforms. Each state is faced with a number of maritime-related security challenges but each utilizes its UAV systems differently. China and the United States have both exploited the IRMA but it is not apparent that both states integrate data from unmanned sensors in the development of situational awareness or in predictive decision-making. The effectiveness of the UAV platform is contingent on a state's exploitation of IRMA, but exploitation of IRMA does not automatically lead to effective UAV deployment.

The United States and China appear to understand the value of IRMA exploitation and unmanned aircraft, respectively. Accordingly, each has invested heavily developing technically capable platforms and the key elements of IRMA. The United States' exploitation of the IRMA and its ability to remotely sense in the maritime domain through an array of unmanned assets provides a model of UAV effectiveness. It is doubtful that the United States would be effective in its use of maritime-specific UAVs if it did not have its impressive intelligence processing capability. Conversely, China's UAV use is in its nascent stages, despite exploitation of the IRMA. China does not demonstrate an effective UAV deployment capability or any improved maritime domain awareness capabilities. While IRMA exploitation is an absolute necessity at the tactical, operational, and

strategic levels for UAVs to be effective assets, how UAVs are incorporated into the network of sensors and subsequently used affects their value to commanders and policymakers alike.

III. MARITIME UAV EMPLOYMENT BY NON-INFORMATION RMA-EXPLOITING STATES

There are many countries that operate UAVs despite not having fully exploited the IRMA. According to the Center for a New American Security, "over 90 countries and non-state groups operate drones today, and even more are certain to do so in coming years."[147] While there are a range of factors that drive countries to obtain UAVs, their subsequent use and value is contingent on the information environment they operate in.

Iran has a long history with UAV experimentation, demonstrated limited exploitation of the IRMA, and expanded its UAV use in the maritime domain over the past 20 years.[148] More recently, countries including Greece, Brazil, and Italy, have begun operating advanced UAVs without having exploited the IRMA. This chapter will look at Iran's program in detail and subsequently make comparisons to the programs of several other non-IRMA exploiting countries.

A. ISLAMIC REPUBLIC OF IRAN

Iran is engaged in maritime disputes with larger military powers immediately adjacent to its territorial waters. Unlike the U.S., China, and Australia, three wealthy countries that have the financial and developmental means to acquire and field a proficient maritime patrol force, Iran was left after its 1979 revolution with little more than a few decaying American patrol aircraft. Although Iran's history with developing unmanned aerial vehicles extends back to

[147] Kelly Sayler, et al., "Global Perspectives: A Drone Saturated Future," *Center for a New American Security*, Accessed August 6, 2016, http://drones.cnas.org/reports/global-perspectives/.

[148] Adam Rawnsey and Chris Biggers, "We Found Iran's Secretive Drone Base," *The Daily Beast*, April 2, 2015, http://www.thedailybeast.com/articles/2015/04/02/we-found-iran-s-secretive-drone-base.html.

the early 1980s, Iran's progress toward developing a proficient UAV capacity accelerated in the last 10 years.[149]

Iran's maritime disputes can be categorized as conflicting territorial claims, often brought about by the geographic constraints of the region. An overview of Iranian forces shows that primary basing of military and paramilitary forces exists in the southern regions of the country, primarily defending approaches from the sea. Consequently, this is where the majority of Iranian UAVs are based.

1. Maritime Threats

Iran is particularly defensive of its territorial seas and airspace. In addition to its controversial 1973 straight baseline claim, Iran has disputes over areas in the Shatt al-Arab region near its border with Iraq and a long history of conflict in the Strait of Hormuz. In 2016, Iran was at the center of an international incident in which two U.S. Navy riverine command boats strayed into Iran's territorial waters near Farsi Island and were captured by Iranian Revolutionary Guard Corps Navy (IRGCN) forces.[150]

The constrained waters of the Strait of Hormuz and southern Arabian Gulf coupled with Iranian territorial waters around Abu Musa, Greater Tunb, Lesser Tunb, and Siri Island force transiting ships to exercise the right of innocent passage through Iranian territorial waters and to comply with the internationally recognized Transit Separation Scheme.[151] Iran frequently monitors naval traffic through the Strait of Hormuz and near its claimed baselines. UAVs are one way that Iran has attempted to monitor vessels transiting near or through its waters.

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[149] Arthur Holland Michel, "Iran's Many Drones," *Center for the Study of the Drone at Bard College*, November 25, 2013, http://dronecenter.bard.edu/irans-drones/.

[150] United States Navy, "Navy Releases Results of Riverine Command Boat, Farsi Island Investigation," *United States Navy*, June 30, 2016, http://www.navy.mil/submit/display.asp?story_id=95458.

[151] Robert S. Strauss Center for International Security and Law, "About the Strait," *University of Texas*, August 2008, https://www.strausscenter.org/hormuz/about-the-strait.html.

2. Unmanned Aerial Vehicle Capability

Iran's UAV capabilities have improved significantly since their initial fielding. Although the country has operated unmanned aircraft since the early 1980s, development and employment of new UAV airframes as part of routine surveillance operations is relatively new for the Iranian military.

Iranian drones range from STUAS platforms to MALE airframes. Iranian UAVs have been witnessed operating over Syria in support of engaged Iranian forces.[152] Its maritime UAVs have been observed overflying U.S. Navy warships in the Arabian Gulf.[153] Iran also exports indigenously produced UAVs to countries like Sudan.[154]

a. Current Platforms

Iran is publicly known to have approximately fifteen different variants of UAVs based on eleven distinct airframes.[155] Most Iranian unmanned platforms are designed for ISR but newer platforms like the Shahed 129 show an Iranian proclivity to arm unmanned aircraft.[156] The oldest platform in the Iranian inventory is the Ababil class of UAV. Developed indigenously by HESA in the early 1980s, the Ababil comes in short-range, medium-range, and attack variants in the Ababil-S, Ababil II, and Ababil-T, respectively.[157] The latest version of the airframe, called the Ababil III, was released in 2014.[158] The newest platform in

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[152] Patrick Hilsman, "Iran's Drone War Against Syria," *The Daily Beast*, May 14, 2016, http://www.thedailybeast.com/articles/2014/05/14/iran-s-drone-war-in-syria.html.

[153] Sam LaGrone, "U.S. Navy Confirms 'Abnormal and Unprofessional' Iranian UAV Recon Flight Over Carriers Truman, Charles de Gaulle," January 29, 2016, https://news.usni.org/2016/01/29/u-s-navy-confirms-abnormal-and-unprofessional-iranian-uav-recon-flight-over-carriers-truman-charles-de-gaulle.

[154] IHS Jane's, "Rise of the Pahphad: Iran's Unmanned Aerial Vehicles," *IHS Jane's*, November 16, 2012, https://janes.ihs.com/Janes/Display/1530140.

[155] IHS Jane's, "Air Force: Iran," *IHS Jane's,* June 16, 2016, https://janes.ihs.com/Janes/Display/1319050.

[156] Michel, "Iran's Many Drones."

[157] IHS Jane's, "Air Force - Iran."

[158] Ibid.

the Iranian inventory is the Fotros, claimed by Iran to have a 30-hour endurance at 25,000 feet.[159] The Fotros is displayed in Figure 5. Iran recently announced the Hamaseh unmanned combat aerial vehicle (UCAV), which made its unarmed debut in 2016 during Iran's Great Prophet exercises.[160]

Figure 5. Iranian Fotros.[161]

Two of Iran's most frequently employed UAVs in the maritime domain are the Mohajer class and the Shahed 129 UCAV. The Mohajer class of UAV, like the Ababil, saw use in the Iran-Iraq war. The platform's latest upgrade is the Mohajer-4, depicted in Figure 6, commonly used to surveil U.S. Navy vessels transiting at sea.[162] The Mohajer-4 is a medium-sized, rail launched aircraft

[159] Ibid.

[160] Ibid.

[161] Source: Brendan McGarry, "Iran Unveils its Biggest Drone Yet," *Defense Tech*, November 18, 2013, http://www.defensetech.org/2013/11/18/iran-unveils-its-biggest-drone-yet/.

[162] Michel, "Iran's Many Drones."

that reportedly entered production in late 1997.[163] The aircraft has a range of approximately 81 nm with an infrared sensor package and possible daytime TV camera.[164]

Figure 6. Iranian Mohajer-4.[165]

The Shahed 129 is most likely a reverse-engineered version of the Israeli Hermes 450.[166] The Shahed 129 is claimed to have a 1000 nm range with 24-hour endurance, although this is probably unlikely given the size of comparable airframes.[167] The Shahed 129 was reported to have flown over the USS Harry S. Truman Strike Group on January 12, 2016.[168] The aircraft

[163] Martin Streetly, *IHS Jane's All The World's Aircraft: Unmanned 2016–2017 (Surry, UK:* IHS, 2016*): 85.*

[164] Ibid., 86.

[165] Source: Qualitative Military Edge, "Mohajer-4," *Qualitative Military Edge*, Accessed July 18, 2016, http://militaryedge.org/armaments/mohajer-4/.

[166] IHS Jane's, "Rise of the Pahphad."

[167] Ibid.

[168] Dan Gettinger, "Drone Activity in Iran," *Center for the Study of the Drone at Bard College*, March 3, 2016, http://dronecenter.bard.edu/drone-activity-in-iran/.

reportedly also conducted air-to-ground strikes in Syria in October, 2015.[169] In February 2016, the Iranian military redesigned the Shahed 129.[170] The new version looks similar to the American MQ-9 Reaper with a new dome on the front of the airframe that could be housing for a beyond line-of-sight SATCOM capability. Both versions are shown in Figure 7.

Figure 7. Left: Original Iranian Shahed 129; Right: Updated Variant.[171]

b. Capital Investment

Iran's FY17 defense budget in total amounted to approximately $8.136 billion.[172] This figure covers both the Iranian regular forces as well as the Iranian Revolutionary Guard Corps paramilitary force. Iran set aside $1.314 billion for procurement in FY17.[173] UAVs fall under Iran's air forces, both IRIAF and IRGCAF. The Iranian Air Force allocated $441 million for procurement, although much of that funding is being used for the acquisition of strike and

[169] Gareth Jennings and Neil Gibbons, "Iranian UAV Shown Striking Targets in Syria and Iraq," *IHS Jane's 360*, February 5, 2016, http://www.janes.com/article/57777/iranian-uav-shown-striking-targets-in-syria-and-iraq.

[170] Gareth Jennings, "Iran reveals redesigned Shahed-129 UAV," *IHS Jane's*, February 19, 2016, http://www.janes.com/article/58167/iran-reveals-redesigned-shahed-129-uav.

[171] Source: Adapted from Tamir Eshel, "Iran's Shahed-129 Combat Drone to Enter Serial Production," *Defense Update* September 28, 2013, http://defense-update.com/20130928_irans-shahed-129-combat-drone-to-enter-serial-production.html; Jennings, "Iran reveals redesigned Shahed-129 UAV."

[172] IHS Jane's, "Iran Defence Budget," *Jane's Defense Budgets*, March 17, 2016, https://janes.ihs.com/Janes/Display/1327486.

[173] Ibid.

air-to-air capabilities.[174] It is unknown how much of the budget is allocated to UAV purchases.

c. UAV Employment

Iran operates six dedicated drone bases near its southern border.[175] As many of these aircraft are capable of being launched from pneumatic launchers or traditional airstrips, the six identified bases are not the only locations capable of deploying UAVs. Commercial imagery analyzed by Bard College's Center for the Study of the Drone, included as Figure 8, identified Mohajer, Ababil, and Shahed 129 airframes on the tarmac at Qeshm Island, Bandar Abbas, Jask,. Minab, Jakigur, and Konarak.[176]

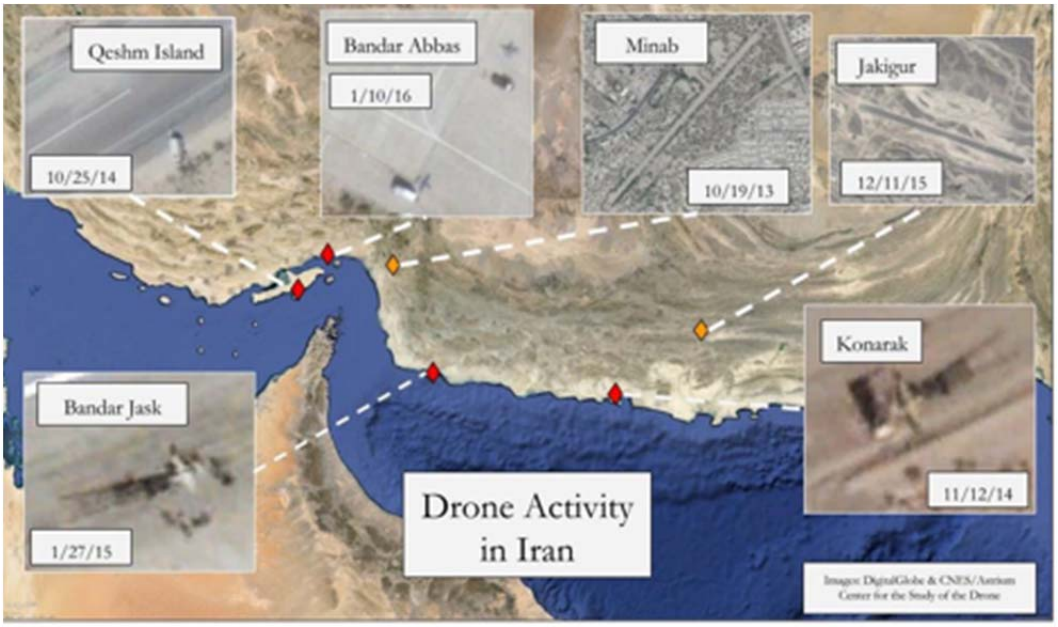

Figure 8. Iranian Drone Bases near Strait of Hormuz, Gulf of Oman.[177]

[174] Ibid.

[175] Gettinger, "Drone Activity in Iran."

[176] Ibid.

[177] Source: Gettinger, "Drone Activity in Iran."

Little is known publicly about Iranian UAV deployments. Iranian UAVs have infrequently been observed in the maritime environment operating over U.S. Navy vessels, particularly aircraft carriers transiting the Strait of Hormuz. Unmanned aircraft have not been reported in other parts of the Arabian Gulf or Gulf of Oman.[178] Exported versions of Iranian UAVs operated by groups including Hezbollah have been shot down in the Levant.[179] There is no indication that Iranian UAVs used in the maritime environment provide maritime domain awareness or cuing capability for military forces, suggesting that Iran does not have the information architecture required to use the information they are receiving. Instead it is likely that footage from the UAV is obtained by Iranian forces upon recovery of the aircraft. This method of imagery retrieval substantially increases the amount of time between UAV interception and the issuance of a tactical order. It also demonstrates the limited utility of unmanned systems when not connected to an information system enhanced by the IRMA.

3. Exploitation of the Information Revolution in Military Affairs

a. Sensors

Iran has an advanced sensor network for the region. It consists of surface and air radar sites, aging maritime patrol aircraft, and unmanned aerial vehicles.[180] Most maritime contacts are directly reported from Iranian naval vessels and paramilitary patrol boats. Iran's capabilities in manned and unmanned aircraft are limited both by technology and doctrine. Over the past decade, Iran has not improved from IHS Jane's assessment that Iran has a low capability in C4ISR across all warfare domains.[181] The limited nature of Iran's

[178] Source: Gettinger, "Drone Activity in Iran."

[179] Isabel Kershner, "Israel Shoots Down Drone Possibly Sent by Hezbollah," *The New York Times*, April 25, 2013, http://www.nytimes.com/2013/04/26/world/middleeast/israel-downs-drone-possibly-sent-by-hezbollah.html?_r=0.

[180] IHS Jane's, "Iran's Conventional Forces Remain Key to Deterring Potential Threats," *Jane's Intelligence Review*, January 19, 2006, https://janes.ihs.com/Janes/Display/1193176.

[181] IHS Jane's, "Iran: Armed Forces."

networked sensors reduces its situational awareness, its ability to effectively command and control its forces, its capacity to conduct precision strikes based on up-to-date intelligence, and ability to predict with any modicum of accuracy the effects of its decisions. UAVs capable of transmitting real-time or near-real-time data back to commanders on the ground could potentially improve the other aspects of Iran's IRMA exploitation.

b. Command and Control

Iran's command and control capability is limited both structurally and technologically. Iran adopts a decentralized C2 structure as part of its doctrine.[182] Iran's observation that adversaries like the U.S. target C2 facilities and structures early in combat leads Iran to adopt the decentralized method to increase resiliency in combat. Iran also divides its C2 structures between the regular Iranian forces and the Iranian Revolutionary Guard Corps leading to distinct chains of command. Iran's inability to easily communicate with its vessels at sea is indicative of considerable C2 challenges.

c. Precision Strike

Iran has a precision strike capability, particularly in its ballistic missile program. It has the capability of accurately striking targets regionally as well as in Eastern Europe.[183] Iran has coastal defense guided cruise missiles, advanced air defense missiles, and ship-launched guided cruise missiles. While Iran has an advanced cruise missile capability, it has a limited air-to-ground precision strike capacity.

Although Iranian media sources claim to use UAV-fired PGMs in Syria and Iraq, there is no evidence that the weapons employed were in-fact PGMs.[184]

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[182] Alireza Nader, "How Would Iran Fight Back," *RAND*, October 1, 2012, http://www.rand.org/blog/2012/10/how-would-iran-fight-back.html.

[183] Ibid.

[184] Jennings and Gibbons, "Iranian UAV Shown Striking Targets in Syria and Iraq."

According to IHS Jane's analysts, the weapons used were purportedly laser-guided Sadid-1 missiles carried by the Shahed 129. It is difficult to determine if the Sadid-1 represents an improvement in precision strike capability for Iran or is an exaggeration of its current capabilities.

d. Situational Awareness

The Islamic Republic of Iran has the ability to detect air and surface targets within its claimed air defense identification zone (ADIZ) and outside of its territorial waters. Maintaining an accurate maritime and air picture is substantially more difficult than simple detection. UAVs are one way that Iran could improve its situational awareness, but only if the data could be delivered quickly to Iranian commanders. Observations of IRIN and IRGCN reactions to foreign warship transits or presence suggest that tactical units are unaware of vessels that are operating in their immediate vicinity. Iran's challenges in fusing real-time coordinates on targets operating in the Arabian Gulf is largely a technological issue.[185] Direct video feeds from unmanned systems transmitted to command centers could alleviate problems that Iran faces with developing situational awareness. UAVs are not, however, a universal solution Iran's poor situational awareness.

e. Predictive Decision-Making

Iran is largely reactive to world events and perceived threats. Years of crippling economic sanctions have shifted Iran's tactics to more asymmetric methods. Since Iran has a lack of dedicated intelligence collection and poor situational awareness, it is forced to make decisions based on limited sensors or direct visual observation.[186] Without an accurate depiction of real events in Iranian operational areas and an intentionally decentralized C2, Iran has little

[185] Anthony H. Cordesman and Bryan Gold, *The Gulf Military Balance: The Conventional and Asymmetric Dimensions* (New York: Rowman & Littlefield, 2014): 53–54.

[186] IHS Jane's, "Iran: Armed Forces," *Jane's Sentinel Security Assessment – The Gulf States*, July 28, 2016, https://janes.ihs.com/Janes/Display/1303495.

hope to control its actions, let alone predict their subsequent outcomes. There is no evidence to suggest that Iran makes, or is successful in making, predictions about the future implications of its actions.

4. Conclusion

Iran's primary maritime disputes exist in defense of its territorial waters in the Arabian Gulf and Gulf of Oman. Iran is sensitive to vessels or aircraft, particularly warships, that transit close to its claimed territorial waters and airspace. Like Southeast Asian states, Iran's maritime disputes, regardless of legality, occur between it and larger powers. Iran's principal policy goal is to defend the sovereignty of its claimed territorial seas and airspace.

To assist in monitoring its lengthy coastline, Iran employs a number of domestically produced unmanned aerial vehicles in the maritime domain. With a history of UAV deployment dating back to the early 1980s, Iran has fielded increasingly sophisticated platforms like the Mohajer-4 and Shahed 129 to monitor activity in the Arabian Gulf, Gulf of Oman, and Strait of Hormuz.[187] Iran is developing a number of unmanned platforms for use in combat, with an expectation of use in the maritime domain. Iran's UAV development takes place through state-owned enterprises that were financially impacted by international sanctions intended to curtail Iran's nuclear program. Although Iran frequently touts its technological superiority, in practice, there is little evidence to suggest that the information received from their unmanned sensors cue Iranian military assets. Iran's failure to exploit the IRMA drastically constrains the effectiveness of its UAV systems. Time-critical UAV data cannot be received, processed, or disseminated with the speed necessary to make timely military decisions. UAVs appear to be little more than propaganda to project competency.

[187] Sam LaGrone, "U.S. Navy Confirms."

B. OTHER NON-IRMA EXPLOITING STATES

With 46% of the world's countries having an unmanned aerial capability, and almost 30 states having an armed drone capacity, UAV systems are beginning to see use outside of wealthy countries.[188] Whether intended for ISR or precision strike, UAV platforms are a more cost-effective solution to traditional manned alternatives, especially in the maritime domain. This enables more countries to operate UAVs, even if they have not developed the IT infrastructure or doctrinal competence to do so effectively. Although UAVs are cheaper to acquire than their manned counterparts, it takes a large number of trained personnel with access to advanced information systems to operate the platforms for ISR or strike missions. Brazil currently operates a total of five MALE unmanned aerial vehicles purchased from Israel.[189] Italy operates an estimated six MQ-9 Reapers.[190] Japan is on the verge of operating RQ-4 Global Hawks for ISR in east and Southeast Asia.[191] Even countries like Greece and Nigeria have armed development programs. These are advanced systems that were developed in concert with a developed, IRMA-enabled information architecture. To return to the analogy, purchasing a SAM system without its radar does not translate to an integrated air defense system (IADS).

What these countries lack, without exception, are the IRMA-related capabilities and exploitation that would optimize their UAV use. Flying a UAV is relatively easy. The ability to fly the airframe effectively in the pursuit of ISR or strike missions has a much higher barrier to entry. Maintaining the level of

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[188] Michael C. Horowitz and Matthew Fuhrmann, "Droning On: Explaining the Proliferation of Unmanned Aerial Vehicles" (Master's thesis, University of Pennsylvania, 2015), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2514339.

[189] IHS Jane's, "Navigating the Emerging Markets: Brazil," *Navigating the Emerging Markets*, June 6, 2016, https://janes.ihs.com/DefenceIndustryMarkets/Display/1524884.

[190] IHS Jane's, "Navigating the Emerging Markets: Italy," *Navigating the Emerging Markets*, July 27, 2016, https://janes.ihs.com/DefenceIndustryMarkets/Display/1725605.

[191] Masayuki Hironaka, "Proliferated Drones: A Perspective on Japan," *Center for a New American Security*, Accessed August 6, 2016, http://drones.cnas.org/reports/a-perspective-on-japan/.

analytic support necessary to effectively use data coming from unmanned systems is expensive in both physical and human capital. The manpower required to process ISR data is a resource that most countries cannot afford.

Brazil's military exhibits poor C4ISR capabilities in ground, maritime, and other domains.[192] It also performs poorly across the board in all indicators of IRMA exploitation. Italy and Spain have been slow to integrate modern C4ISR as well. Despite having capable UAV platforms, EU border states like Italy and Greece are not effectively employing unmanned platforms to find refugees bound for European countries. The Syrian and Libyan refugee crises in the Mediterranean Sea elucidated the relative inability of UAV-using countries like Greece and Italy to integrate UAV-derived information into the intelligence resources of organizations like the EU's Frontex.[193]

Japan budgeted approximately $149 million in FY15 for the acquisition of the RQ-4 Global Hawk. Long endurance systems are wanted by the Japanese Maritime Self-Defense Forces (JMSDF) and Japanese Air Self-Defense Forces (JASDF) to help combat fatigue from maritime patrol aircraft (MPA) crews.[194] While Japan certainly has the IT infrastructure necessary to exploit the IRMA, domestic political and social constraints hold it back from embracing the revolution.[195] Constitutional restrictions on military force for anything other than defense complicate Japan's path to IRMA exploitation. Without IRMA exploitation, Japan is going to be limited in how effectively it is able to operate its UAVs. Although Japan requires a different path to IRMA exploitation from other

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[192] IHS Jane's, "Armed Forces: Brazil," *Jane's Sentinel Security Assessment – South America,*" May 13, 2016, https://janes.ihs.com/Janes/Display/1304565.

[193] Ioannis Parisis, "The Maritime Dimension of European Security: Strategies, Initiatives, Synergies," (Working Paper, The Fletcher School of Law and Diplomacy, 2015), http://fletcher.tufts.edu/~/media/Fletcher/Microsites/Karamanlis%20Chair/Docs/KARAMANLIS%20%20Working%20Papers%202015%20No%201.pdf,

[194] Hironaka, "A Perspective on Japan."

[195] Thomas G. Mahnken, "Conclusion: The Diffusion of the Emerging Revolution in Military Affairs in Asia: A Preliminary Assessment," in *The Information Revolution in Military Affairs* ed, Emily O. Goldman and Thomas G. Mahnken (New York: Palgrave Macmillan, 2004), 214–215.

countries who utilize it to support offensive operations, its ability to exploit the IRMA will bear heavily on whether its investment will have been in vain.[196] Until Japan solves its domestic challenges to IRMA exploitation, it will be limited both in how it employs UAVs like Global Hawk and in the information it hopes to incorporate into its decision making processes.

C. SUMMARY AND ASSESSMENT

This chapter examined UAV adoption from multiple countries that have yet to fully exploit the IRMA. Though almost half of the world's countries now have a military UAV capability, the number of countries that can effectively use these unmanned platforms in the collection of intelligence or execution of precision strikes remains extremely low. Failure to exploit the IRMA is the primary factor limiting UAV effectiveness.

Iran has demonstrated little more with their UAVs than the ability to capture footage of vessels at sea. The country does not appear to use UAV footage for anything beyond projecting military competence to the Iranian people. Failing to exploit the IRMA effectively negates Iran's capital investment in unmanned platforms.

There are a range of factors, usually political or technological, that prevent countries from exploiting the IRMA. Whether countries purchase a UAV system from another country or indigenously produce the platform, unmanned aerial vehicles are only effectively employed within a larger system that directly connects them with decision-makers.

[196] Sugio Takahashi, "The Japanese Perception of the Information Technology-Revolution in Military Affairs: Toward a Defensive Information-Based Transformation," in *The Information Revolution in Military Affairs* ed, Emily O. Goldman and Thomas G. Mahnken (New York: Palgrave Macmillan, 2004), 91–93.

IV. PREDICTING SOUTHEAST ASIAN MARITIME UAV EFFECTIVENESS

Proliferation of unmanned systems in Asia is progressing at a blistering pace. According to aerospace consultants, the market for UAV technologies in Asia is projected to be worth at least $7 billion from 2010–2020.[197] Southeast Asia's UAV capability, in particular, is growing at a rapid rate. As described in Chapter I, Singapore, Vietnam, Malaysia, Indonesia, and the Philippines have all acquired a military UAV capability. Some countries acquired their UAV assets commercially while others have focused more heavily on indigenous production. Thus far, UAV acquisition in Southeast Asia has been constrained to surveillance platforms; however, armed UCAVs may be expected in the near future.[198] Building an unmanned ISR, let alone precision strike capability, without exploiting the IRMA calls into question the strategic importance of regional UAV proliferation. Is the rise of the drone in Southeast Asia as revolutionary or dangerous a development as analysts and pundits have asserted?[199] The short answer is no.

There are a range of factors driving the adoption of unmanned technologies in Southeast Asia. Scholars including Bitzinger assert that Southeast Asian UAV proliferation is symptomatic of regional insecurities and the rise of a technologically superior Chinese military.[200] While UAVs are part of a potential solution to increase regional security, even Bitzinger notes that "except

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[197] Wong, "Armed Drones."

[198] Ibid.

[199] There are a number of publications that raise concerns about UAVs and the security situation in East and Southeast Asia. For examples see: Shawn Brimley, Ben Fitzgerald, and Ely Ratner, "The Drone War Comes to Asia," Foreign Policy, September 17, 2013, http://foreignpolicy.com/2013/09/17/the-drone-war-comes-to-asia/; Tobias Burgers and Scott N. Romaniuk, "Unmanned Systems and manned Conflict in East Asia," The Diplomat, August 2, 2016, http://thediplomat.com/2016/08/unmanned-systems-and-manned-conflict-in-east-asia/.

[200] Richard Bitzinger, "Southeast Asian Approaches to Military Technology and Defense S&T," *Policy Brief 7*, United States Naval War College, Newport RI, (January 2012), http://escholarship.org/uc/item/1837k4vb.

for Singapore, no SEA country has begun to embrace network-centric warfare (NCW). Of the rest, only a few possess more than a handful of network or info-based systems."[201] With a regional military focus on platforms rather than an IRMA-enabled information system, the prospects for effective UAV use in Southeast Asia are limited.

This chapter will examine the maritime challenges that Southeast Asian countries face and the current state of their maritime UAV capacity. IRMA exploitation is critical to the effective employment of UAVs. Because unmanned technology is relatively new to the region, evidence of regional UAV employment in the maritime domain is extremely limited. This analysis will assess which Southeast Asian countries are most likely to effectively deploy unmanned systems in the future by examining current IRMA exploitation in terms of the five categories of sensors, C2, precision strike, situational awareness, and predictive decision-making. Using Emily Goldman's Diffusion Diagnostic model, this chapter will also attempt to identify potential barriers to IRMA exploitation that will ultimately constrain the utility of unmanned systems in several Southeast Asian countries.

A. SINGAPORE: THE ONLY SOUTHEAST ASIAN COUNTRY LIKELY TO USE UAVS EFFECTIVELY

Singapore is the only Southeast Asian country likely to be effective in its employment of UAVs, particularly in the maritime domain, because of its exploitation of the IRMA. The country's strong IT capabilities and doctrinal reliance on technology gives it an advantage in the effective deployment of an increasing number of unmanned platforms. Singapore utilizes its IKC2 architecture to feed sensor data into its Information Fusion Centre (IFC),

[201] Bitzinger, "Southeast Asian Approaches."

synthesizing data access and C2.[202] Singapore's exploitation of the IRMA makes effective UAV employment for ISR highly probable in the future.

1. Maritime Challenges

Singapore has relatively few maritime challenges compared to its neighbors. The country has no controversial claims in the South China Sea and has positive bilateral relationships with its neighbors. The only recent notable maritime dispute involving Singapore occurred between Malaysia and Singapore over a series of maritime features east of the Singapore Strait. Competing claims to Pedra Branca, the Middle Rocks, and the South Ledge were resolved by the International Court of Justice (ICJ) in 2008.[203] The court ruled that Pedra Branca and the Middle Rocks belonged to Singapore and Malaysia, respectively.[204] The South Ledge was determined to be a low-tide elevation not subject to territorial claim. There is no evidence that Singapore utilized unmanned systems for any purpose during the dispute, though they could have been useful in identifying a Malaysian presence near the disputed areas.

There are a number of transnational challenges that Singapore faces because of its geographic location. From 1995-2013, 65% of worldwide piracy incidents were reported in Southeast Asia.[205] Singapore, Malaysia, and Indonesia developed the MALSINDO Coordinated Patrol (MCP) in concert with the Eyes-in-the-Sky (EIS) program to provide combined security patrols in and

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[202] Van Jackson, et al. "Networked Transparency: Constructing a Common Operational Picture of the South China Sea," Center for a New American Security, March 21, 2016, http://www.cnas.org/sites/default/files/publications-pdf/CNAS%20Report-COP-160331.pdf.

[203] Center for Strategic and International Studies, "The Evolution of Asia's Contested Waters," CSIS Asia Maritime Transparency Initiative, Accessed August 29, 2016, https://amti.csis.org/maritime-disputes/.

[204] Center for Strategic and International Studies, "The Evolution of Asia's Contested Waters."

[205] Adam McCauley, "The Most Dangerous Waters in the World," Time, Accessed August 29, 2016, http://time.com/piracy-southeast-asia-malacca-strait/.

over the Strait of Malacca.[206] The EIS program provided combined and coordinated ISR to help increase maritime domain awareness and reduce piracy. Information obtained during flights was combined with surface reporting at the IFC in Singapore.[207] Unmanned aerial vehicles were not used specifically for the EIS program but could have easily replaced manned maritime patrol aircraft. The EIS and the IFC demonstrated that fusing sensor intelligence to create near-complete situational awareness for deployed units can improve efficiency in the use of force. Piracy attempts in the Strait of Malacca have drastically reduced and moved primarily to the stationary maritime traffic in the Singapore Strait, where commercial vessels are easy targets. Having an effective unmanned ISR capability could be particularly useful in identifying potential pirates or responding to hijackings in the Strait.

2. Unmanned Aerial Vehicle Capability

Singapore's military possesses around 100 UAVs in a variety of configurations ranging from tactical to MALE platforms.[208] It has a long commercial relationship with Israel Aerospace Industries (IAI). Singapore's first military acquisition was in the 1980s with IAI's Scout and Searcher tactical UAVs.[209] More recently, the Singapore Air Force (SAF) purchased IAI's Heron and Hermes MALE UAVs which increase its surveillance capabilities in day or night conditions.[210] Singapore's Navy began operating the Insitu ScanEagle from its corvettes at sea in 2002.[211] The navy demonstrated its capabilities during the

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[206] Yann-huei Song, "Security in the Strait of Malacca and the Regional Maritime Security Initiative: Responses to the US Proposal," in International Law Studies 83 (2007): 125.

[207] Scott Cheney-Peters, "Patrolling International Skies: Understanding Joint Air Patrols," CSIS Asia Maritime Transparency Initiative, July 29, 2016, https://amti.csis.org/patrolling-international-skies-understanding-joint-air-patrols/.

[208] Barry Desker and Richard A. Bitzinger, "Proliferated Drones: A Perspective on Singapore," Center for New American Security, Accessed August 29, 2016, http://drones.cnas.org/reports/a-perspective-on-singapore/.

[209] Desker, "A Perspective on Singapore."

[210] Ibid.

[211] Ibid.

2015 Cooperation Afloat Readiness and Training (CARAT) exercise with the United States.[212] Singapore has not expressed any desire to obtain an armed UAV capability, and is not engaged in missions that require it.

In addition to its daytime and infrared imaging capabilities, Singapore's UAVs enable the country to conduct communications intelligence (COMINT), electronic intelligence (ELINT), communications relay and jamming missions.[213] The UAVs provide a range of advanced ISR capabilities without the need to acquire additional, or improve current, manned ISR platforms. Overall, Singapore has a suitable UAV force for its security needs. Tactical and MALE platforms combined with the ability to launch airframes at sea give Singapore a formidable maritime ISR capability.

3. Exploitation of the Information Revolution in Military Affairs

Singapore is the one country in Southeast Asia that has clearly exploited almost all aspects of the IRMA. Despite its size, the country has developed a networked sensor and C2 capability, has a precision strike capacity, and fuses information to develop advanced situational awareness in a notoriously congested maritime transit corridor. Though little is known publicly about how Singapore's military officials make decisions, doctrinal writings show a proclivity for informed mission command at the lowest level possible.[214] A focus on war-gaming further reflects the Singaporean military's preference for accurate prediction of a decision's potential implications.

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[212] Prashanth Parameswaran, "US, Singapore Launch Maritime Warfare Exercise," The Diplomat, July 14, 2015, http://thediplomat.com/2015/07/us-singapore-launch-maritime-warfare-exercise/.

[213] Desker, "A Perspective on Singapore."

[214] Tim Huxley, "Singapore and the Revolution in Military Affairs," in The Information Revolution in Military Affairs in Asia, ed. Emily O. Goldman and Thomas Mahnken (New York: Palgrave MacMillan, 2004), 199–201.

a. Sensors

Due of a lack of strategic depth, Singapore relies heavily on advancements in sensor technology to ensure a prudent military response. Ground-based surveillance radars and airborne early warning (AEW) aircraft sense air contacts while coastal sites receive data from satellites, "shore-based military and civilian radars, ships at sea, maritime patrol aircraft, and shore-based electronic and signals intelligence."[215] UAVs are a critical sensor for land and maritime reconnaissance, search and rescue, and target acquisition and tracking.[216] Data from these sensors feed back into processing facilities that fuse it with information from other sensors.

b. Command and Control

As early as 1991, Singapore's Ministry of Defense (MINDEF) sought proposals for an all-encompassing C4I network including resilient communications paths between shore sites, ships, and aircraft.[217] Singapore's armed forces now have a networked command and control capability that includes multiple communications paths including satellite. Singapore co-locates its C2 capabilities with intelligence fusion cells at its Changi Command and Control Centre. The C2 organization is home to the Singapore Maritime Security Centre (SMSC), IFC, and Multinational Operations and Exercises Centre (MOEC).[218] This structure enables informed decision making for military commanders.

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[215] Huxley, "Singapore and the Revolution in Military Affairs," 196.

[216] Desker, "A Perspective on Singapore."

[217] Huxley, "Singapore and the Revolution in Military Affairs," 195.

[218] Singapore Ministry of Defense, "Factsheet: Changi Command and Control Centre," Singapore Government, March 27, 2007, https://www.mindef.gov.sg/imindef/press_room/official_releases/nr/2007/mar/27mar07_nr/27mar07_fs.html.

c. Precision Strike

Although Singapore has not expanded its precision strike capabilities to include unmanned aircraft, it does have PGMs in the air and maritime domains. With its advanced air and surface platforms, Singapore can strike targets with laser guided munitions like the AGM-65 Maverick, AGM-84 Harpoon, and AGM-114 Hellfire.[219] Singapore also has advanced air-to-air and cruise missiles.[220]

d. Situational Awareness

Singapore's establishment of the Information Fusion Centre in 2009 vastly expanded its maritime domain awareness capabilities. According to the head of the IFC, the organization's aim is to "ensure that actionable information can be delivered to regional partners for further collaboration or to cue timely operational responses."[221] The IFC utilizes a combined information system called Open and Analysed Shipping Information System (OASIS) and its Sense-Making, Analysis and Research Tool (SMART) in its fusion of data from commercial sources like AIS, international partners, national sensors, and the shipping community. These tools and data sources generate a common view of the maritime environment immediately surrounding Singapore.[222] Singapore's IFC is considered by regional experts to be the most mature MDA capability in Southeast Asia.[223]

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[219] Jon Grevatt, "Navigating the Emerging Markets," *IHS Jane's*, May 20, 2016, https://janes.ihs.com/Janes/Display/1525368.

[220] Huxley, "Singapore and the Revolution in Military Affairs," 195.

[221] Nicholas Lim, "The Information Fusion Centre (IFC) – A Case for Information Sharing to Enforce Security in the Maritime Domain," *Pointer: Journal of the Singapore Armed Forces* (2011): https://www.mindef.gov.sg/content/imindef/publications/pointer/supplements/IFC/_jcr_content/imindefPars/0006/file.res/MINDEF_Pointer%20IFC%20Supplement%20FINAL.pdf.

[222] Dexter Chia, "Navies and Maritime Security: Singapore Navy Perspective," in *Freedom of the Seas, Passage Rights, and the 1982 Law of the Sea Convention*, ed. Myron H. Nodrdquist, Tommy Thong Bee Koh, and John Norton Moore (Leiden, Netherlands: Martinus Nijhoff Publishers, 2009), 616.

[223] Jackson, "Networked Transparency."

e. Predictive Decision Making

With a technologically advanced sensor, C2, and MDA capability, Singapore can make informed decisions based on real-time data. Without explicit examples of armed force responses to real-world problems, it is impossible to ascertain whether Singapore considers the implications of its decisions ahead of time; however, its doctrinal focus on generating actionable intelligence make informed decision-making a probability.

4. Conclusion

Singapore continues to expand its unmanned ISR capabilities by acquiring technically sophisticated platforms. Land-based Hermes and Heron MALE UAVs and sea-based ScanEagle tactical UAVs provide Singapore with one of the most advanced regional unmanned orders of battle. Singaporean UAV operations have not been observed in sufficient numbers to gauge if they are being effectively employed.

Singapore's thorough exploitation of the IRMA makes future effective UAV employment far more likely. The country's ability to fuse data from a variety of sensors to achieve a synthesized picture of the operational environment in the same building as its principal C2 functions is likely to lead to informed and predictive decision-making. Together with the capacity to deliver PGMs from modern platforms that have secure, redundant communications with commanders, Singapore has demonstrated the force-multiplying characteristics of an informationalized military. With timely access to information in the maritime domain, Singapore's armed forces are likely to effectively deploy their unmanned assets in a way that enhance its combat capabilities.

B. SOUTHEAST ASIAN COUNTRIES UNLIKELY TO BE EFFECTIVE UAV USERS

According to analysis from McKinsey & Company, Southeast Asia is poised for tremendous military growth, especially in modernizing technologies like UAVs. A report from the company states that "Southeast Asia…is among the

top defense spenders globally," with budgets doubling over the past decade.[224] Drone manufacturers from Israel to Belarus are all hoping to capture a share of Southeast Asia's military procurement money. Malaysia, Indonesia, Vietnam, and the Philippines all have nascent UAV capabilities in various forms. While there is substantial regional interest in obtaining an unmanned capability, most Southeast Asian countries have focused heavily on indigenous development rather than commercial acquisition. These countries have only managed to reach the initial stages of UAV development and have not focused on exploiting the IRMA to make their future platforms more effective.

Southeast Asia has a variety of maritime challenges that could benefit from effective UAV use. In addition to ongoing maritime disputes in the South China Sea, UAVs could assist in humanitarian assistance/disaster relief (HADR) operations, piracy, terrorism, and drug trafficking. UAVs could drastically improve Southeast Asian countries' ISR for a variety of missions, but only if the infrastructure exists to support them. This section focuses on Malaysian, Indonesian, Vietnamese, and Filipino efforts to acquire UAVs, how they have exploited the IRMA, and what factors may hold them back from effective UAV employment.

1. Unmanned Aerial Vehicle Capability

Outside of Singapore, Vietnam, and Malaysia have the most sophisticated UAVs. This is due in large part to their development or commercial acquisition of MALE platforms from Belarus and IAI, respectively.

[224] John Dowdy et al. "Southeast Asia: The Next Growth Opportunity in Defense," McKinsey & Company, February 2014, http://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/aerospace%20and%20defense/pdfs/sea%20defense%20report%202014%20-%20final.ashx.

a. Socialist Republic of Vietnam

Vietnam has previously purchased Belarussian and Israeli tactical UAVs.[225] Vietnam's latest UAV is the indigenously produced the HS-6L MALE platform, although analysts claim that the aircraft was developed jointly with Belarus.[226] The airframe is still a prototype. In addition to the HS-6L, Vietnamese drone manufacturer Viettel's Patrol VT tactical UAV was reportedly delivered to the military in 2013. Neither the HS-6L nor the Patrol VT have been observed in an operational capacity. Beyond technical difficulties, there are political and legal reasons that Vietnam has not yet deployed its unmanned aircraft. According to analysts at the Center for a New American Security, "There are extensive debates in Vietnam about how to use UAVs for national defense purposes, and the general sense is that UAVs can be legitimately used for protecting independence, sovereignty, and territorial integrity."[227] With UAVs being a new issue for the Vietnamese government, UAVs are likely to only be deployed in the near future for national defense rather than maritime ISR.[228]

b. Malaysia

Malaysia has indigenously developed a number of tactical and MALE UAVs for ISR.[229] The Aludra Mk 1 and Aludra Mk 2 MALE platforms very closely resemble the IAI Heron UAV. Additionally, Malaysia has reportedly leased the Insitu ScanEagle tactical UAV from the United States.[230] In 2014, the Malaysian

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[225] Franz-Stefan Gady, "Vietnam Reveals New Drone For Patrolling the South China Sea," *The Diplomat*, December 28, 2015, http://thediplomat.com/2015/12/vietnam-reveals-new-drone-for-patrolling-the-south-china-sea/.

[226] Richard D. Fisher Jr., "New Vietnamese HS-6L HALE UAV Likely Aided by Belarus," *HIS Jane's 360*, December 22, 2015, https://janes.ihs.com/Janes/Display/1759105.

[227] Tran Viet Thai, "Proliferated Drones: A Perspective on Vietnam," *Center for a New American Security*, Accessed August 31, 2016, http://drones.cnas.org/reports/a-perspective-on-vietnam/.

[228] Ibid.

[229] IHS Jane's, "Malaysia Procurement."

[230] Ibid.

Maritime Enforcement Agency (MMEA) announced that it planned to utilize UAVs to identify maritime territorial incursions although there is no evidence to suggest this took place.[231]

c. Republic of Indonesia

Indonesia's most capable platform was acquired commercially. The military obtained and now operates an IAI Heron II MALE UAV.[232] The Israeli-produced Heron is far superior, technically, to the indigenously developed Crow, Woodpecker, and Wulung tactical platforms. Indonesia's military industry is experiencing technical difficulties in producing UAVs that are capable of long duration missions. Although Indonesia had experimented with unmanned platforms as early as 2003, it was not until the presidency of Joko Widodo that interest in UAV acquisition for border and EEZ monitoring began.[233] Most of the UAV platforms in use with the Indonesian military are DJI's commercially-available S800 EVO platform, designed for cinematographers.[234] Indonesia originally used UAVs only for domestic surveillance and disaster response.[235] From a military perspective, Indonesia financed new drone projects that were intended for use as *kamikaze*-style weapons against vessels operating illegally in Indonesian waters.[236] Despite the newfound interest, Indonesia still faces political and financial obstacles to developing an advanced UAV capability.

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[231] Putrajaya, ""Malaysia to Use Drones to Secure Maritime Security," *The Jakarta Post*, February 5, 2014, https://www.thejakartapost.com/news/2014/02/05/malaysia-use-drones-secure-maritime-security.html.

[232] Connie Rahakundini and Ade Prasetia, "Proliferated Drones: A Perspective on Indonesia," *Center for a New American Security*, Accessed August 31, 2016, http://drones.cnas.org/reports/a-perspective-on-indonesia/.

[233] Ibid.

[234] IHS Jane's, "Indonesia Procurement."

[235] Rahakundini, "A Perspective on Indonesia."

[236] Ibid.

d. Republic of the Philippines

There is extremely limited information available about Filipino UAV acquisition and use. In late 2013, the Philippine Army claimed to have utilized indigenously produced Raptor and Knight Falcon tactical UAVs during operations against the Moro Islamic Liberation Front (MILF).[237] There are reportedly two General Atomics Predator A airframes that are registered with the national security advisor, presumably for ISR against southern insurgents.[238] Reportedly, the use of UAVs, particularly UCAVs, is domestically controversial following a 2012 incident in which a U.S.–operated Predator conducted a precision strike against the Abu Sayyaf Group.[239] This marked the first time a UAV had conducted a strike operation in Southeast Asia.

2. Exploitation of the Information Revolution in Military Affairs

With Singapore a notable exception, most Southeast Asian countries have only partially exploited the IRMA. Even in these cases, partial exploitation occurred out of either a singular necessity or as a consequence of military modernization. Malaysia, Indonesia, Vietnam and the Philippines have not demonstrated a concerted effort to embrace the IRMA. U.S. capital investment and advice under its 2015 Maritime Security Initiative (MSI) aims to expedite the regional exploitation of IRMA. In December 2015, the United States announced that it would be committing more than $250 million in assistance over two years to develop maritime security in Southeast Asia.[240] That figure grew to $425

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[237] "Drones in Southeast Asia," *Center for the Study of the Drone at Bard College*, August 14, 2015, http://dronecenter.bard.edu/drones-in-southeast-asia/.

[238] IHS Jane's, "Philippines Procurement."

[239] Akbar Ahmed and Frankie Martin, "Deadly Drone Strike on Muslims in the Southern Philippines," *Brookings*, March 5, 2012, https://www.brookings.edu/opinions/deadly-drone-strike-on-muslims-in-the-southern-philippines/.

[240] White House, "FACT SHEET: U.S. Building Maritime Capacity in Southeast Asia," *White House*, November 17, 2015, https://www.whitehouse.gov/the-press-office/2015/11/17/fact-sheet-us-building-maritime-capacity-southeast-asia.

million over five years.[241] The MSI is designed to "enhance 'sensing' of allies and partners in the South China Sea; technical 'supporting infrastructure' would facilitate 'sharing' maritime information across the region to build a COP."[242] Failing to exploit the IRMA will have a negative impact on the effectiveness of future UAV deployment and makes further unmanned acquisitions efforts an imprudent investment.

a. Sensors

All countries in Southeast Asia have some type of sensor capability in the maritime domain.[243] The Philippines has received extensive support from the United States to develop its sensor network. The sensor side of the Philippines' Coast Watch System (CWS) is comprised of networked coastal radar stations that provide a purported 96 nautical mile visibility.[244] Additionally, the Philippines is receiving an aerostat surveillance balloon from the U.S. with long-range radar detection capabilities as well as U.S.-funded improvements to existing manned ISR aircraft.[245] In December 2015, Malaysia upgraded its coastal ISR by ordering six new surveillance radars from Airbus.[246] All Southeast Asian countries receive data from maritime air and surface patrollers. The United States Navy is sending a team of UAV experts to Vietnam to "brief Vietnamese leaders 'on the concept of using different systems and create an opportunity for Vietnamese officials to visit a U.S. military unit with operational UAS assets,' in

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[241] Megan Eckstein, "The Philippines at Forefront of New Pentagon Maritime Security Initiative," *United States Naval Institute*, April 18, 2016, https://news.usni.org/2016/04/18/the-philippines-at-forefront-of-new-pentagon-maritime-security-initiative.

[242] Prashanth Parameswaran, "America's New Maritime Security Initiative for Southeast Asia," *The Diplomat*, April 2, 2016, http://thediplomat.com/2016/04/americas-new-maritime-security-initiative-for-southeast-asia/.

[243] Jackson, "Networked Transparency."

[244] Ibid.

[245] Eckstein, "New Pentagon Maritime Security Initiative."

[246] Michael Peck, "Malaysia Orders Coastal Radars," *C4ISRNET*, December 25, 2015, http://www.c4isrnet.com/story/military-tech/sensors/2015/12/25/malaysia-orders-coastal-radars/77842106/.

the hopes that Vietnam may find a system that would be useful for boosting its maritime domain awareness."[247]

b. Command and Control

Southeast Asian countries suffer from a number of C2 challenges ranging from highly centralized or politicized forces to a technological inability to effectively execute command. Due to the expensive price tag, most Southeast Asian militaries are in the preliminary stages of developing a net-centric C2 capability. Malaysia and Vietnam are examples of countries that are still developing the networks necessary for efficient command and control. Malaysia is currently modernizing its strategic and operational C4I network.[248] The country's 2015 C4I pilot ultimately provided a limited C2 capability.[249] MSI specifically addresses Malaysia's deficiencies in secure communications.[250] Vietnam has similar challenges in the development of its C4I network and also struggles with commanding joint forces.[251] The Philippines is receiving a secure communications system under MSI.[252] An inability to demonstrate unity of command over joint forces makes effective UAV employment difficult if, for example, air force assets are deployed in the maritime domain.

c. Precision Strike

Precision strike is the easiest of the IRMA categories to exploit because it can be commercially acquired. The identification and tracking of a target is

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[247] Eckstein, "New Pentagon Maritime Security Initiative."

[248] IHS Jane's, "Malaysia: Military Capabilities," *Jane's Sentinel Security Assessment – Southeast Asia*, July 11, 2016, https://janes.ihs.com/Janes/Display/1305045.

[249] Ibid.

[250] Eckstein, "New Pentagon Maritime Security Initiative."

[251] IHS Jane's, "Vietnam: Military Capabilities," *Jane's Sentinel Security Assessment – Southeast Asia*, May 18, 2016, https://janes.ihs.com/Janes/Display/1305172.

[252] Manuel Mogato, "U.S. to Give Philippines Eye in Sky to Track South China Sea Activity," *Reuters*, April 18, 2016, http://www.reuters.com/article/us-southchinasea-china-philippines-usa-idUSKCN0XF1GC.

considerably more difficult than the employment of a PGM against it. Vietnam and Indonesia have a highly advanced surface and coastal defense cruise missile capability in the Russian-exported SS-N-26 Yakhont.[253] Malaysia employs U.S.-supplied Joint Direct Attack Munitions (JDAM) from its F/A-18 Hornet aircraft. The Philippines is the only country of the group that has a limited precision strike capability. Filipino limitations are due largely to its aging tactical platforms. No Southeast Asian country has an armed drone capability.

d. Situational Awareness

Regional situational awareness is generally poor, but improving with external assistance under the MSI. The U.S. "will outfit Malaysia with $1.2 million in secure communications and an expanded Malaysia Armed Forces (MAF) common operating picture to connect the Royal Malaysian Flight Operations Center, Operational Forces, and MAF headquarters."[254] U.S. Pacific Command is providing Indonesia with the Field Information Support Tool to enable "greater interoperability, integrated data correlation, and analysis for a shared common operational picture."[255] The Philippines built, with financial assistance and guidance from the United States and Australia, their Coast Watch System in 2015. The CWS fuses data from multiple sources to form a common operational picture of the waters immediately surrounding the Philippine islands.[256] UAVs could feed a wealth of data into these regional COPs if they are connected to and tasked through the region's new networks.

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[253] IHS Jane's, "Navigating the Emerging Markets: Indonesia," *IHS Jane's*, August 18, 2016, https://janes.ihs.com/Janes/Display/1586067.

[254] Eckstein, "New Pentagon Maritime Security Initiative."

[255] Ibid.

[256] Republic of the Philippines, "National Coast Watch Center," *Republic of the Philippines*, Accessed September 1, 2016, http://gwhs-stg02.i.gov.ph/~s2ncwsgovph/?p=867.

e. Predictive Decision-Making

Military operations for Vietnam, Malaysia, Indonesia, and the Philippines are usually reactive. Unfortunately, without more detailed information about military operations, it is impossible to ascertain if commanders were making informed decisions or accurately predicting the outcomes of their commands. The MALSINDO patrols and EIS program could be used as a positive example of predictive decision-making for Indonesia and Malaysia. By deploying ISR and surface assets to the Strait of Malacca, the countries accurately predicted that piracy activity would either cease or relocate. For most countries, a lack of sensor data and situational awareness make the accurate prediction of any decision's implication remote. As countries begin to exploit the IRMA in more detail, tactical changes in Southeast Asian military responses to incidents or crises may provide greater clarity on the topic.

f. Conclusion

Most countries in Southeast Asia lag behind other regional actors in exploiting the IRMA. Despite regional interest in acquiring a UAV capability, the lack of C4I infrastructure and data fusion capabilities will render UAVs ineffective for military applications, especially in the maritime domain. A general lack of sensors, inefficient command structures, poor C4I infrastructure, and a lack of situational awareness disadvantage Malaysia, Vietnam, Indonesia, and the Philippines in the effective deployment of military assets to include UAVs.

The dramatic increase in capital and expertise invested by the U.S. under the 2015 MSI is likely to significantly change how Southeast Asian countries approach maritime domain awareness, net-centric warfare, and UAV employment. Southeast Asian military leaders will be required to shift doctrine in order to embrace IRMA exploitation and receive the revolution's advantages in the long term.

3. Obstacles to IRMA Exploitation in Southeast Asia

Although countries like the United States, Australia, and Singapore are encouraging the spread of IRMA throughout Southeast Asia, there are factors that prevent the revolution's regional diffusion. Using Emily Goldman's Diffusion Diagnostic model for an analytic framework, this section will highlight the obstacles that slow Vietnamese, Malaysian, Indonesian, and the Filipino progress toward IRMA exploitation. Correcting these constraints to innovation could speed the diffusion of IRMA and provide the necessary infrastructure to effectively deploy UAVs.

a. Polity

The biggest political constraint to IRMA diffusion in Southeast Asia is the security focus of the military. Countries that have an inward security focus in order to ensure regime security tend to resist significant changes to military command and control. Vietnam, Indonesia, and the Philippines should refocus military attention on external security challenges in order to foster competitiveness between services vying for increased unit effectiveness. Maritime disputes with China are catalyzing the shift in regional focus from internal to external security.

b. Economy

The IRMA is heavily influenced by technological development in a range of military sectors. One of Southeast Asia's main obstacles to exploiting aspects of the IRMA is the cost associated with modernization. Southeast Asian governments should facilitate economic growth; encourage market liberalization, and expand indigenous research and development to meet their specific security needs. Foreign direct investment like MSI in the defense sector could enable further IRMA exploitation and advanced UAV development in countries like Malaysia and the Philippines, but only in the short-term. Acquiring advanced UAV systems from countries like Israel, China, and the United States help the exploitation of IRMA components like sensors and precision strike in the

short-term. Acquisition will reduce the long-term need for innovation and continued IRMA exploitation if countries fail to use acquired technology to inspire domestic UAV design and innovation. Reverse engineering acquired platforms will constrain innovation and minimize the economic value of the domestic defense industry.

c. Society and Culture

Characteristics of Southeast Asian society and culture prove that the region is fertile ground for innovative ideas like the IRMA. Southeast Asia has high levels of technical education, which are viewed as a key enabler of the IRMA. According to 2015 data from the Organisation for Economic Co-operation and Development, Southeast Asian countries were ranked highly for math and science at age 15.[257] Vietnam ranked 12th and Malaysia ranked 52nd while Singapore topped the global rankings.[258] Indonesia and the Philippines experience the highest social challenges to IRMA exploitation. The countries should focus on technical education and literacy to create a workforce that has the skills necessary to work in IRMA related fields.

d. Military Organizations

Politicization of the military, low levels of service interconnectedness, and asymmetry in power between the military branches are the principal military obstacles to exploiting the IRMA in Southeast Asia. Vietnam and Indonesia have highly politicized militaries with asymmetric power balances between branches. Indonesia's army is dominant in size, political influence, and power.[259] Vietnam's branches subordinate through its army, automatically elevating the power and

[257] Sean Coughlan, "Asia Tops Biggest Global Schools Rankings," *BBC*, May 13, 2015, http://www.bbc.com/news/business-32608772.

[258] Coughlan, "Asia Tops Biggest Global Schools Rankings."

[259] IHS Jane's, "Indonesia: Armed Forces," *Jane's Sentinel Security Assessment – Southeast Asia*, April 13, 2016, https://janes.ihs.com/Janes/Display/1305006.

prestige of the organization over its air and naval components.[260] Malaysia is known to have low levels of interconnectedness between its joint services, an issue it has been trying to rectify since 2007.[261] All of these countries have to learn to work jointly in an interconnected manner to be effective in their respective IRMA exploitation, deployment of UAVs, and cuing of air, surface, or land assets.

C. SUMMARY AND ASSESSMENT

This chapter examined the current state of UAV adoption and IRMA exploitation in Southeast Asia. With the exception of Singapore, most countries have a keen interest in obtaining a UAV capability but have not exploited the IRMA. UAV use in Southeast Asia is in its infancy, but set to mature in the near future. With a particular set of maritime challenges, Southeast Asian militaries would greatly benefit from the effective use of UAVs in the maritime domain.

Singapore has exploited the IRMA in every category. Its advanced network of sensors, C2, situational awareness, precision strike, and predictive-decision making capabilities give it a considerable advantage over any other regional military. As Singapore begins to build a larger and more capable UAV force, it will experience minimal challenges to the platforms' effective employment.

Other countries in Southeast Asia like Vietnam, Malaysia, Indonesia, and the Philippines have not exploited the IRMA to date and are therefore unlikely to deploy UAVs effectively in the near future. The countries are developing unmanned capabilities, though at a much slower pace compared to Singapore. ISR data from the unmanned aircraft are not supported by an IT infrastructure that enables analysis and delivery to policy-makers. The substantial human and

[260] IHS Jane's, "Vietnam: Armed Forces," *Jane's Sentinel Security Assessment – Southeast Asia*, May 18, 2016, https://janes.ihs.com/Janes/Display/1305172.

[261] IHS Jane's, "Malaysia: Armed Forces," *Jane's Sentinel Security Assessment – Southeast Asia*, July 11, 2016, https://janes.ihs.com/Janes/Display/1305045.

capital investments made by the U.S. in its 2015-2020 Maritime Security Initiative support regional ISR and MDA development. The effort has a good probability of pushing Southeast Asian countries into IRMA exploitation. If Vietnam, Malaysia, Indonesia, or the Philippines exploit the IRMA, they stand a good chance of effectively utilizing their unmanned platforms to enable efficient regional military operations. There are, however, several constraining factors in the political, economic, social, and military sectors that could cause IRMA exploitation to languish, along with their unmanned assets.

Exploitation of the IRMA is a necessary precondition to effectively deploy UAVs, but its exploitation does not ensure effective UAV use. Effective deployment of UAVs in the tactical environment requires operators, analysts, and decision-makers to work in concert to provide information advantage to a military force. UAVs provide little utility to a commander when employed outside of the information ecosystem.

Although much has been made of the UAV's prospects to change the balance of power in the South China Sea, and by extension Asia, such an assertion is currently hyperbolic. The more complex the unmanned system, the more mature the support must be to effectively deploy it. If a country truly wants to be effective in the information-age, look at the support system, rather than the drone.

V. CONCLUSION

The unmanned aerial vehicle is a powerful ISR tool, especially in the maritime domain where there are few alternative sources of intelligence. UAVs can meet a range of ISR needs in a more timely and cost-efficient manner than the training, maintenance, and development required to field a manned airborne reconnaissance capability. The effectiveness of UAVs is not, however, predetermined at acquisition. There is an extensive support network that has to be in place for UAVs to be of value to military forces. UAVs serve as an effective component of the larger information architecture available to countries that have exploited the IRMA. Most contemporary analysis on drone proliferation incorrectly focuses on the drone platforms themselves, rather than their role in a larger system.[262] Little attention is paid by analysts to the sensors, C2, precision strike, situational awareness, and predictive decision-making capabilities of UAV-operating militaries. Although regions like Southeast Asia are rapidly acquiring unmanned aircraft, the proliferation of UAV technology, especially in Southeast Asia, is not nearly as revolutionary or dangerous as it seems.

Chapter I explained that revolutions in military affairs are fundamental shifts in the nature or conduct of warfare. The Napoleonic and nuclear revolutions are examples of how the use of technology, rather than the technology itself, can prove to be revolutionary in combat. The most recent RMA is the information RMA. The IRMA is comprised of five categories: sensors, C2, precision strike, near-complete situational awareness, and an actor's ability to accurately predict a decision's implications. UAV adoption in Southeast Asia is on the rise, with Singapore, Malaysia, Vietnam, Indonesia, and the Philippines all acquiring unmanned ISR platforms but most have failed to exploit the IRMA.

[262] There are multiple scholarly and journalist writings that talk about the revolutionary nature of the drone, see: Richard P. Schwing, "Unmanned Aerial Vehicles: Revolutionary Tools in War and Peace" (master's thesis, United States Army War College, 2007), http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA469608.

The United States and China are UAV-using countries that have exploited the IRMA. The U.S. uses its UAV systems effectively, especially in the maritime domain, to feed data into a larger architecture that helps accelerate the military decision-making process. The U.S. deploys UAVs in ways that enhance other aspects of the IRMA. China has advanced UAVs, but fails to utilize them effectively. China has, to some degree, exploited all subcategories of the IRMA but does not appear to use UAVs regularly or to cue military forces. This chapter exhibits that effective UAV use is contingent on both IRMA exploitation and the incorporation of UAVs into a larger informationalized doctrine.

Iran and other countries have only partially exploited the IRMA. Despite Iran's long history with drone operation, its lack of IRMA exploitation restricts the sharing of UAV-derived information in a timely fashion. As a result, Iran's forces are forced to adopt a reactionary military strategy normally reserved for much smaller forces. Countries like Brazil and Greece have significant political obstacles to exploiting the IRMA and ineffectively deploy UAV assets. Japan faces legal and cultural challenges to developing the information ecosystem necessary to effectively deploy the highly-advanced UAVs it invested in.

Southeast Asia is rapidly acquiring UAV systems; however, most countries have not exploited the IRMA and are unlikely to use their systems effectively. Singapore is the only country that has exploited the IRMA. Singapore's forces have a variety of advanced tactical and MALE unmanned ISR aircraft and the information architecture to support them. Conversely, Vietnam, Malaysia, Indonesia, and the Philippines are focusing more heavily on acquiring or indigenously developing UAV systems rather than working to exploit aspects of the IRMA. Even if the four countries were to use their UAVs, they would have limited information on where and how to deploy them, experience difficulty in transmitting and analyzing the UAV-derived information, and would be incapable of efficiently exercising force to respond to UAV-detected threats. The United States is attempting to rectify Southeast Asia's IRMA-related shortcomings by investing a considerable amount of human and physical capital. The injection of

resources and expertise could be the catalyst that Southeast Asian countries need to effectively utilize their UAV systems and fundamentally change how force is used throughout the region.

A. ADDRESSING THE RESEARCH QUESTIONS AND HYPOTHESES

At the outset of this research, three possibilities were proposed to explain the relationship between IRMA exploitation and UAV effectiveness: one, that extensive exploitation is required to use UAVs effectively; two, that only partial exploitation was required for effective UAV use; and three, that UAVs are effective platforms regardless of IRMA exploitation.

1. Analysis of Hypotheses

Hypothesis one provides the most plausible depiction of the relationship between effective UAV employment and IRMA exploitation. Full IRMA exploitation ensures that information derived from the unmanned platform has the requisite architecture to be delivered to a decision-maker. The decision-maker needs to have the situational awareness and capacity to deliver informed commands to units capable of delivering predictable effects. By analyzing UAV capabilities and use by the United States, China, Iran, and other UAV-adopting countries, one can see that only the United States uses UAVs in an effective way.

The U.S. military's exploitation of the IRMA is what makes its UAV use a tactical, operational, and strategic advantage. The U.S. has advanced UAV capabilities that are supported by a network of alternative sensors, a connected C2 doctrine and system, informed situational awareness, and advanced precision strike capability delivered with a pre-determined understanding of its effects. All aspects of the IRMA work in concert and in a cyclical nature. UAV-derived information before, during, and after a strike can determine the continuing intelligence needs of the commander and ultimately impact future UAV use.

Partial exploitation of the IRMA, established in hypothesis two, is unlikely to enable effective UAV deployment. Failing to exploit any of the IRMA's components eliminates a force's ability to efficiently use information in the application of force. Removing any IRMA capability from an informationalized military affects the force's other capabilities. In a scenario where intelligence derived solely from a UAV is delivered to a C2-capable decision-maker, a lack of situational awareness would destroy any possibility of accurate prediction pertaining to potential decisions. A UAV is an information asset that is completely reliant on the functionality of the larger information system.

China's UAV technology is rapidly approaching parity with that of the United States but it has not been operationally effective, especially in the maritime domain. China has partially exploited the IRMA in sensors and precision strike, however, the country's C2 and situational awareness capabilities are still being improved. China's overall goal of developing an informationalized military is rapidly progressing. Once China achieves this goal, UAVs can be deployed more effectively.

This analysis found that in order to make complete use of the information that UAVs obtain, countries have to exploit all facets of the IRMA. Militaries that fail to fully exploit the IRMA are unable to process all UAV-derived information and therefore are incapable of using it to make timely, well-informed decisions. Actionable intelligence tends to have a short lifespan. A military's ability to quickly deliver battlefield intelligence to a commander is critical to the concept of net-centric warfare.

It is an important distinction that while IRMA exploitation is a necessary precondition for effective UAV use, IRMA exploitation does not guarantee that UAVs will be deployed effectively. Countries can ineffectively deploy UAVs, fail to correctly analyze UAV-derived information, or fail to deliver the information to commanders in an efficient manner. IRMA is a requirement for effective UAV employment, but IRMA-enabled UAVs may not necessarily be used effectively.

2. Unmanned Aerial Vehicles in Southeast Asia

Southeast Asia is an emerging market for UAVs. Although many countries in Southeast Asia are acquiring relatively advanced unmanned platforms, the lack of regional IRMA exploitation will continue to restrict UAV effectiveness. Singapore is the only Southeast Asian country to exploit the IRMA. Although Singapore has not been observed deploying UAVs in large quantities, they have the prerequisite IRMA exploitation to effectively do so. Vietnam, Malaysia, Indonesia, and the Philippines are in the early stages of partial IRMA exploitation.

Despite its potential as a low-cost asymmetric alternative to advanced Chinese MPA, actionable UAV-derived intelligence is beyond the grasp of most Southeast Asian countries. Political, economic, cultural, and military obstacles to regional IRMA diffusion currently exist; however, the 2015–2020 United States Maritime Security Initiative has the potential to jumpstart IRMA exploitation. Southeast Asian exploitation of the IRMA and effective UAV deployment in the South China Sea has the potential to increase the military capacity of Southeast Asian states and affect their respective maritime disputes. The proliferation of UAV technology in Southeast Asia is not nearly as revolutionary or dangerous as it seems.

3. Implications of Research Findings

Future analysis on military drone acquisition and use should focus more broadly on IRMA exploitation and the information ecosystems of drone users. While there are considerable advantages to operating UAV platforms, the support structure that makes them effective is anything but unmanned. Effective UAV operations are expensive in both physical and human capital. Doctrine also does not evolve overnight. Assessing a country’s military capability by measuring their unmanned platforms in quantity or quality is an inaccurate way to gauge military capability.

Countries that are seeking to utilize modern technologies like UAVs need to invest heavily in exploiting the IRMA to provide the infrastructure necessary for

UAVs to operate effectively. Additionally, the relationship between IRMA exploitation and UAV effectiveness requires countries like the U.S. to adopt a different model of military aid to countries seeking an information advantage. Supplying unmanned platforms through foreign military sales, as China does, is unlikely to significantly affect the status quo on the battlefield. If the U.S. is truly seeking to improve the capabilities of its allies, it must make simultaneous investments in all deficient aspects of a country's IRMA exploitation. An informationalized force is far more likely to make well-informed military decisions, effectively use unmanned assets, and ideally reduce conflict. IRMA exploitation and effective UAV use are a potent force multiplier for an informationalized military and holds the prospect of military supremacy in the modern way of war.

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