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Comparison of Naval Acquisition Processes between the United States and Taiwan

June 2021

LCDR Chih-chieh Liu, ROCN

Thesis Advisors: Dr. Robert F. Mortlock, Professor
Dr. Charles K. Pickar, Senior Lecturer

Graduate School of Defense Management

Naval Postgraduate School

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ABSTRACT

This research uses a case study approach to analyze the respective naval acquisition processes of the United States and Taiwan. The methodology enables a comparison of the acquisition systems used by the U.S. Navy (USN) and Republic of China Navy (ROCN) related to specific naval acquisition programs. The researcher identifies that both countries have established similar structures in their respective acquisition systems; however, the U.S. acquisition system is overall more comprehensive and systematic than Taiwan's system. As for the implementation of the respective systems, the U.S. Navy made several mistakes caused by adopting an experimental acquisition strategy in the process of its Littoral Combat Ship program. By contrast, Taiwan adopted a more conventional approach for the Tuo Chiang-class corvette program, hence mitigating risk. Recommendations for the United States include to conduct sufficient analysis before taking experimental approaches and to value the importance of requirement identification, and test and evaluation. In contrast, Taiwan needs to complete its acquisition regulations to cover the process of a program's full life cycle and organize these steps in a systematic manner. Moreover, the test and evaluation processes should not be ignored to expedite the progress of a program. Finally, Taiwan also needs to develop strategic guidance that directs requirements identification beyond the next decade.

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ABOUT THE AUTHORS

LCDR Chih-chieh Liu is a Financial Officer of Taiwan Navy. He graduated from Taiwan National Defense University, where he received a Bachelor degree. After graduating from the Naval Postgraduate School he will be reporting to the Comptroller Department of the Taiwan Navy Headquarter.

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LIST OF ACRONYMS AND ABBREVIATIONS

AAF	Adaptive Acquisition Framework
AAP	Annual Administrative Plan
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
BES	Budget Estimate Submission
CBA	Capabilities-Based Assessment
CDD	Capability Development Document
CFO	Chief Financial Officer
DAS	Defense Acquisition System
DCAPE	Director of the Cost Assessment and Program Evaluation
DFRG	Defense Finance Resource Guidance
DFRJ	Defense Finance Resource Judgment
DOD	Department of Defense
DPG	Defense Planning Guidance
DRFPRD	Development RFP Release Decision Point
DT&E	Developmental Test and Evaluation
EMD	Engineering and Manufacturing Development
FOC	Full Operational Capability
FRPD	Full-Rate Production Decision
FYAP	5-Year Administrative Plan
FYDP	Future Years Defense Program
FYFCP	5-Year Force Construction Plan
IAD	Integrated Assessment Department
IAP	Integrated Acquisition Plan
ICD	Initial Capabilities Document
IOC	Initial Operating Capability
JCIDS	Joint Capabilities Integration and Development System
JROC	Joint Requirements Oversight Council
JWCP	Joint Warfighting Capability Planning
KPP	Key Performance Parameters

KSA	Key System Attributes
LRIP	Low-Rate Initial Production
MDA	Milestone Decision Authority
MDD	Materiel Development Decision
MND	Ministry of National Defense
MSA	Materiel Solution Analysis
NCSIST	National Chung Shan Institute of Science and Technology
NDS	National Defense Strategy
NMS	National Military Strategy
NSS	National Security Strategy
O&S	Operations and Support
OA	Operational Assessments
OT&E	Limited Deployment, Operational Test, and Evaluation
OMB	Office of Management and Budget
ORD	Operational Requirement Document
P&D	Production and Deployment
PDR	Preliminary Design Review
PM	Program Manager
POM	Program Objective Memorandum
PPBE	Planning, Programming, Budgeting, and Execution
PPBS	Planning, Programming, and Budget System
R&D	Research and Development
RDT&E	Research, Development, Test, and Evaluation
RDA	Research, Development, and Acquisition
RPD	Resource Planning Department
SAR	System Analysis Report
SPD	Strategic Planning Department
TMRR	Technology Maturation and Risk Reduction
TRA	Technology Readiness Assessment
TYFBC	10-Year Force Buildup Concept
USD(C)	Under Secretary of Defense (Comptroller)

I. NTRODUCTION

Taiwan has been facing fast-growing military threats from Mainland China since the civil war in the 1940s. As a result of pressure from China, Taiwan is not recognized by most of the countries in the world, which makes it difficult for Taiwan to acquire its armaments from most countries, despite being a U.S. ally in the West Pacific against China. All of Taiwan's weapon acquisition programs came through either indigenous development or procurement from the United States or France, only when political conditions allowed. Examining the efficiency of the system is crucial as Taiwan considers its limited options and the growing threat it confronts from the People's Liberation Army. By analyzing and comparing the acquisition system of the United States and Taiwan, the pros and cons of each system can be identified and recommendations for further improvement can be provided.

A. PURPOSE OF RESEARCH

The purpose of this research is to analyze the differences between acquisition processes in the United States and Taiwan using a case study approach. The methodology compares acquisition systems in the U.S. Navy (USN) and the Republic of China Navy (ROCN) by studying two specific naval shipbuilding programs, the U.S. littoral combat ship (LCS) program and Taiwan's Tuo Chiang–class corvette program. At the conclusion of this research, the researcher identifies advantages in certain processes of one system over the other and provides recommendations for the USN and the ROCN to improve their acquisition processes.

B. PROBLEM STATEMENT

Marcum and Milshyn (2014) noted in their research that many countries are in the process of transforming their defense acquisition process, in large part because of shrinking budgets and industrial globalization, as new international partnerships are formed and new applications for advanced technologies are developed. They argued that the United States has been experiencing defense budget cuts since the economic crisis in 2008; however, technology development and new global threats keep increasing the demand for defense expenditure. Since the acquisition system was developed, it has gone through several changes in process. Nevertheless, there are still many obvious problems in the U.S. acquisition system in terms of requirement identification, resources, technology, and threats evolution. These factors cause defense acquisition reform initiatives to be ineffective, as Mortlock (2016) stated in his research that "decades of acquisition reform initiatives have failed to produce true innovation and change within defense acquisition" (p. 121).

Similarly, Taiwan has faced difficulties in acquiring armaments that meet its requirements with a limited budget for decades. There is not a clear guideline covering all different defense acquisition cases in terms of the processes of a program. Setzekorn (2014) indicated that the cost and time spent on previous programs were often considered by the public to be inefficient, especially the political scandal involving the purchase of Lafayette-class naval frigates. His research also implied that the scandal exposed Taiwan's military to allegations of corruption, political cronyism, and even murder. As the scandal was slowly uncovered, efforts by opposition legislators and public calls for significant defense reforms culminated in the passage of two national defense laws that radically restructured Taiwan's defense establishment. It is essential for Taiwan to improve its armament acquisition system, and studying the practices of other countries such as the United States might provide valuable insights into how it could be done.

C. METHODOLOGY

This research uses the case study method and statistical analysis to provide a thorough insight into the acquisition processes of the United States and Taiwan. Analyzing one specific Navy ship acquisition program from each country not only enables the researcher to narrow the research down to focused aspects but also provides examples of real-life applications of those theoretical regulations and processes. The information mentioned in this research was collected from periodical journals, research of other analysts, governmental reports, directives, instructions, and regulations.

D. SCOPE AND LIMITATIONS

In acquisition, all cases differ from one another, and it is impossible to establish an overall understanding without studying each one. Notwithstanding, this research focuses only on specified Navy shipbuilding programs from both countries due to the limited time for research. In addition, some detailed acquisition guidance and documents are classified and are not available to the public. The analysis can be based only on accessible information and documents.

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II. BACKGROUND

This chapter introduces the broad concept of the acquisition systems in the United States and Taiwan, starting with introducing the basic concepts of defense acquisition and the three major systems of requirement, resources, and management. Although there are certainly differences between the two countries' acquisition procedures, these three systems represent fundamental processes that every country goes through when developing, manufacturing, and procuring military systems.

The detailed processes of each system in the two countries are then discussed for further comparison. Key departments and agencies are introduced to demonstrate their responsibilities in the process. The chapter ends with a conclusion showing the similarities and differences of the two systems.

A. DEFENSE ACQUISITION SYSTEMS

Marcum (2013) defined *defense acquisition systems* as a set of processes a government must undertake to "transform internal and external resources into weapon systems" (p. 2). According to Brown (2010), acquisition in general contains processes of "design, engineering, test and evaluation, production, and operations and support of defense systems" (p. 1). He also mentioned in the same article that "the term *defense acquisition* generally applies only to weapons and related items" (p. 1).

1. U.S. Acquisition System

In Mortlock's (2021) study, he identified that the program manager in the U.S. Department of Defense (DOD) is responsible for cost, schedule, and performance of assigned projects, which requires the program manager to utilize three support systems to operate the program:

- the Joint Capability Integration and Development System (JCIDS) for generating the requirements for formal programs of record,
- the Defense Acquisition Management System (recently renamed as the Adaptive Acquisition Framework) for controlling the progress of each phase through milestones, and
- the Planning, Programming, Budgeting and Execution (PPBE) System for the allocation of resources (Mortlock, 2021).

The three systems are commonly known as the "big 'A' acquisition," whereas the Defense Acquisition System (DAS), which emphasizes the actual process of acquiring the capability, is often referred to as "little 'a' acquisition" (see Figure 1; Schwartz, 2013). Hence, big "A" acquisition, which this article adopts to analyze case programs, covers a more complete view regarding the evolution of a program from the birth of an idea to the end of its life cycle.

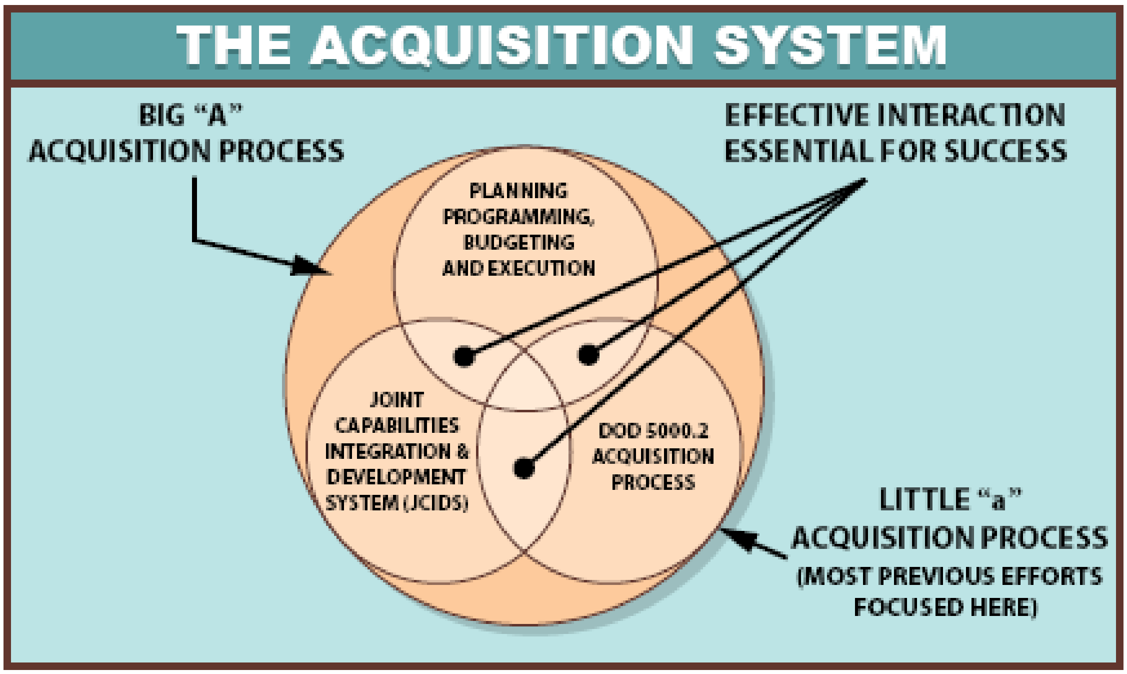

Figure 1. DOD's Defense Acquisition Structure. Source: Department of Defense (DOD, 2006).

2. Taiwan's Acquisition System

The National Armed Forces Armament Acquisition Programming Regulation incorporates the requirement and defense acquisition systems into one integrated process. The regulation was revised in 2016, leading to some changes in the acquisition process.

Apart from the acquisition system, the Planning Budget System governs the resource allocation process. Both the acquisition system and budget system of Taiwan follow a phase-based framework, including design phase, programming phase, and budget/execution phase (Ministry of National Defense [MND], Taiwan, 2017). This framework is structured similar to the PPBE System of the United States (Yao, 2020).

Although Taiwan does not address the big "A" acquisition framework in its acquisition system, the three components of it can be identified in the process. Figure 2 shows how each system of big "A" acquisition interacts with every step of Taiwan's acquisition processes.

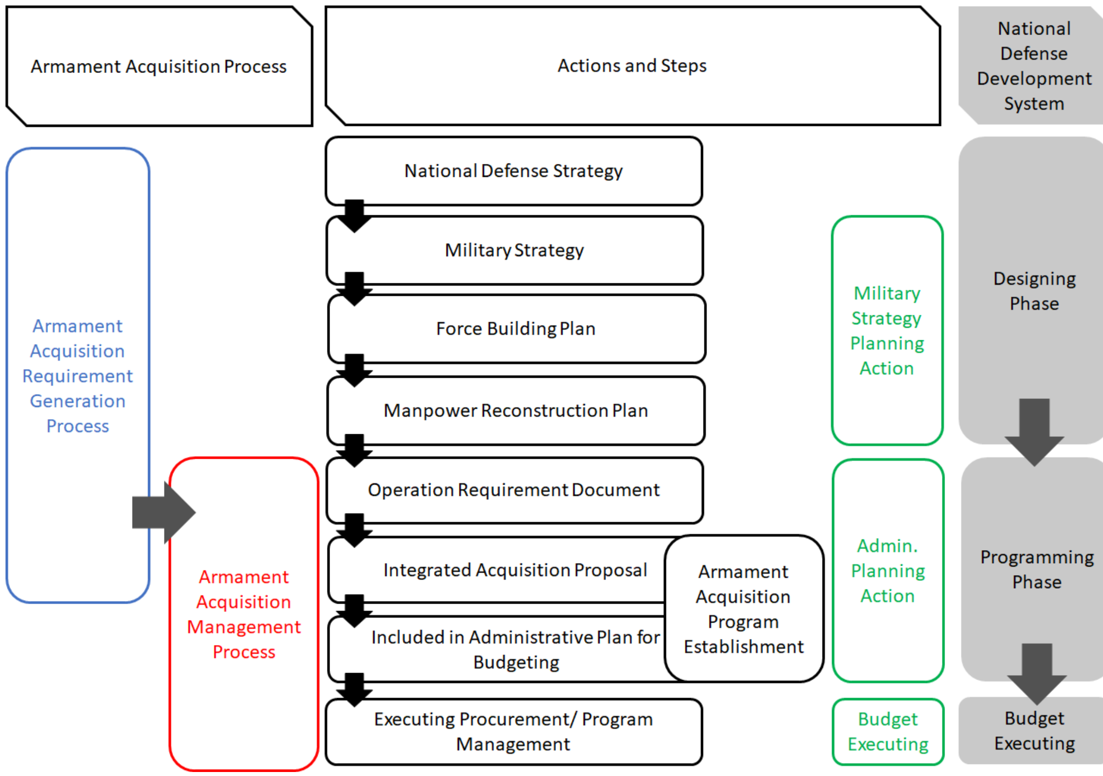

Figure 2. Flowchart of Taiwan's Defense Acquisition Process. Source: Yao (2020).

B. REQUIREMENTS SYSTEM

Government acquisition needs, based on the agency's core mission, are identified during the agency's strategic planning process. They can be driven bottom-up by the end users, top-down by the management, or a combination of both. The needs are discovered in the capability gap (Federal Acquisition Institute, 2016). As to defense acquisition, Mortlock (2021) noted in his study that "the requirements generating system is driven primarily by a combination of capability needs and an evolving threat."

Once requirements are identified, they must be defined, developed, vetted, and prioritized to fit into the limited budget. This step is crucial to the whole program, as program failure—including cost overruns, schedule delays, and less optimal solutions to meet the needs—is often primarily due to poorly designed and constantly changing requirements (Federal Acquisition Institute, 2016).

1. U.S. Requirements Process

The U.S. military uses the Joint Capabilities Integration and Development System (JCIDS) to identify its requirements for the core missions of national defense. It enables the DOD to identify, assess, and prioritize requirements the military desires to fill the capability gap (Schwartz, 2013). The assessments are made with nation-level strategic guidance documents, such as the National Security Strategy (NSS), National Defense Strategy (NDS), and National Military Strategy (NMS). JCIDS also provides the baseline for documentation, review, and validation of capability requirements across the DOD. The Joint Requirements Oversight Council (JROC) is the supreme agency that governs the JCIDS process (Joint Chiefs of Staff [JCS], 2018a).

According to *Manual of Operation for the Joint Capabilities Integration and Development System* by the Joint Chiefs of Staff (JCS, 2018b), the JCIDS process consists of several steps, starting with the identification of joint military capabilities by Capabilities-Based Assessment (CBA), "an analytic basis to identify capability requirements and associated capability gaps" (Enclosure C). If the CBA identifies a capability gap and no similar capabilities exist in the Joint Force, the next step is to generate an Initial Capabilities Document (ICD). Schwartz (2013) noted in his research that the JROC reviews and validates whether the capability in the ICD fulfills the gap in joint military capabilities before the approval of the ICD, which is followed by a recommendation of a materiel or non-materiel solution. He also mentioned that if a materiel solution is recommended, the process moves into the DAS. Throughout the acquisition process, the JCIDS keeps interacting with the DAS in terms of the subsequent development of requirements documents. Figures 3 and 4 illustrate the JCIDS deliberate process and how JCIDS interacts with the DAS throughout the program (JCS, 2018a).

There are methods other than JCIDS that the U.S. military adopts to identify requirements, which are determined by DOD components (DOD, 2019). These methods may use other documents besides the ICD, such as directed requirements and urgent need statements, to support middle tier acquisition or urgent capability acquisition.

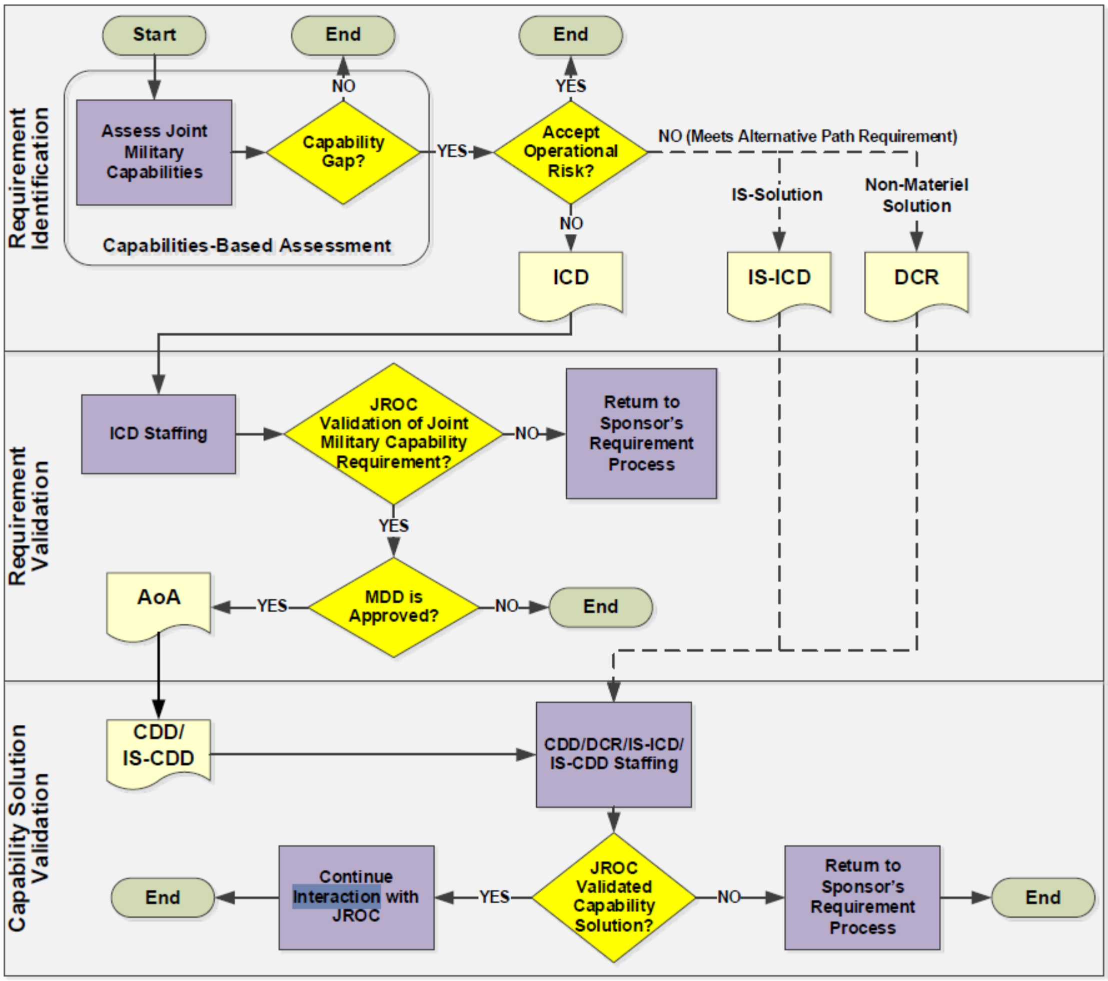

Figure 3. JCIDS Deliberate Process. Source: Joint Chiefs of Staff (2018b).

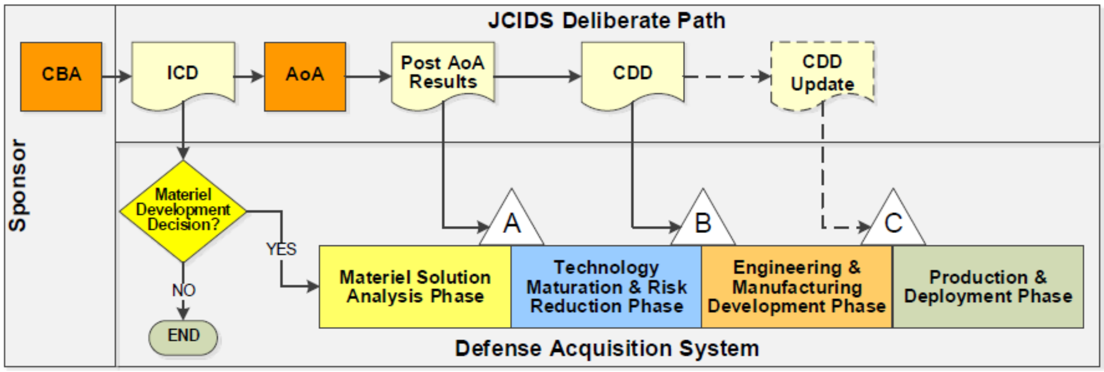

Figure 4. Interaction of JCIDS Deliberate Path and Defense Acquisition Systems. Source: Joint Chiefs of Staff (2018b).

2. Taiwan's Requirements Process

The New Frontier Foundation Defense Policy Advisory Committee (2014), in the Defense Policy Blue Paper No. 7 (2014), discussed Taiwan's requirements definition process, which happens in the design phase and includes several steps. First, the Office of the Deputy Chief of the General Staff for Operations and Planning (J-3) generates Joint Warfighting Capability Planning (JWCP) based on the services' operational requirements. Next, the MND's Strategic Planning Department (SPD), the top leading organization of the process, considers the future technology trends and potential threats combining the requirements in the JWCP and produces the 10-Year Force Buildup Concept (TYFBC) document. Finally, the priorities of these requirements are determined in the SPD's following 5-Year Force Construction Plan (FYFCP) document, according to which the Joint Staff Headquarters directs services put forth in the Operational Requirement Document (ORD), leading the program into the programming phase.

In the revised process, the concept of top-down guidance along with the technology research and development capability are emphasized with the SPD directing the JWCP according to the TYFBC and, when applicable, the 5-Year Defense Science and Technology Research, Application, and Production Plan (FYDS&TAPP) developed by the National Chung Shan Institute of Science and Technology (NCSIST; MND, Taiwan, 2016). The NCISIST, supervised by the MND, is an administrative corporation in charge of Taiwan's defense technology establishment (Executive Yuan, Taiwan, 2014). The NCSIST acts as the main advisor and sponsor when the program involves defense technology research and development.

Figures 5 and 6 illustrate Taiwan's requirements process before and after revision, respectively.

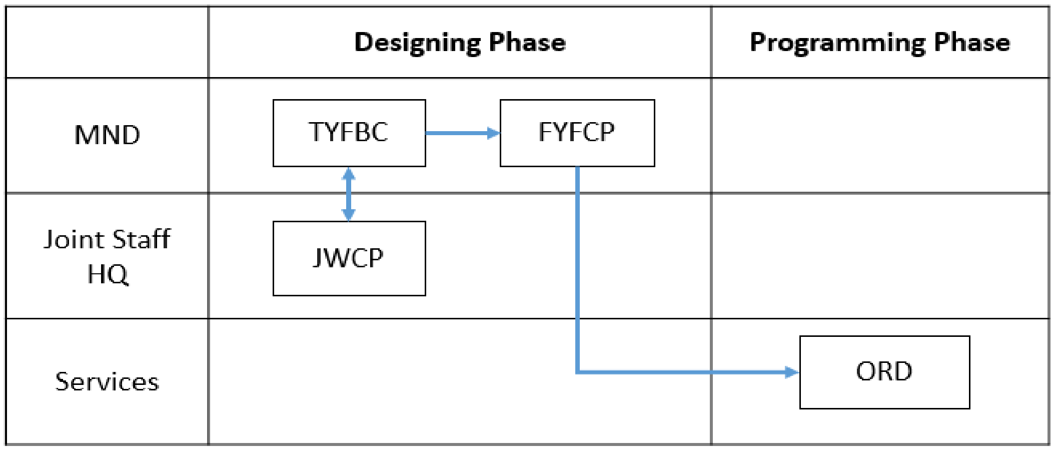

Figure 5. Taiwan's Requirements Process, Before Revision. Source: MND, Taiwan (2002).

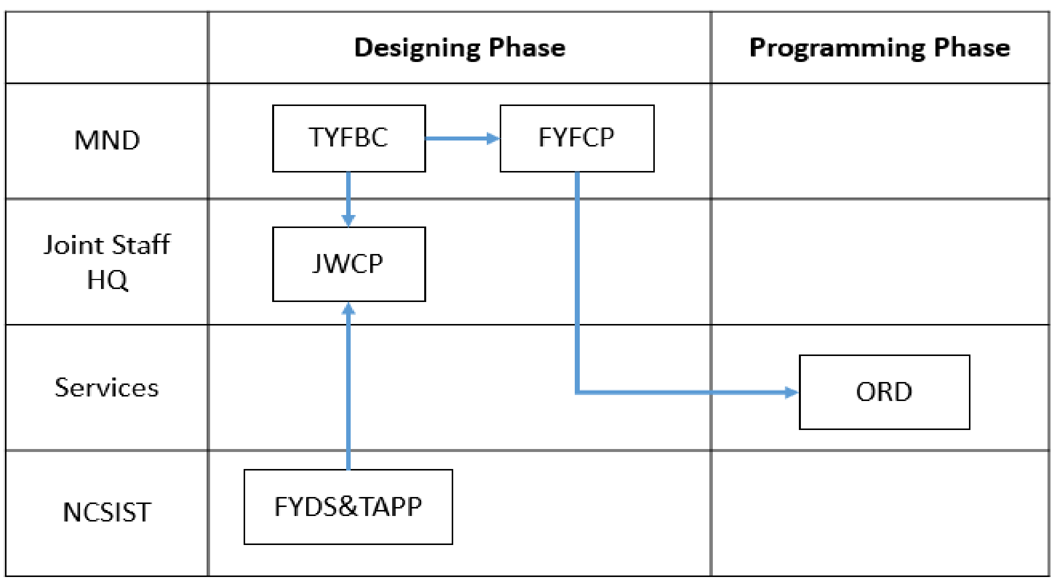

Figure 6. Taiwan's Requirements Process, After Revision. Source: MND, Taiwan (2002).

C. RESOURCE ALLOCATION SYSTEM

Globally, the cost of national defense has been increasing significantly, while events such as the economic crisis in 2007 dramatically affect the allocation of defense budgets in most countries (Marcum & Milshyn, 2014). Hence, a resource allocation system is important for governments to invest in military, since the resources are limited for any country. The systems enable governments to allocate limited resources in order to make the most efficient and effective use of them and to meet national security objectives (Lorge, 2018). The United States developed the Planning, Programming, and Budget System (PPBS) in 1963 to measure the requirements for and sufficiency of defense programs. The system went through several modifications in following years and was changed to the PPBE System in 2003 (Grimes, 2008). Taiwan, similarly, referred to the PPBS of the United States and developed the Planning Budget System in 1971 (Huang & Wang, 2018).

1. U.S. Resource Allocation System

According to DOD Directive 7045.14, *The Planning, Programming, Budgeting, and Execution (PPBE) Process* (DOD, 2013), in the first phase of the PPBE process, "the planning phase, the military role and defense posture of the United States and the DOD in the world environment shall be examined, considering enduring national security objectives and the need for efficient management of defense resources" (p. 10). The under secretary of defense for policy leads the phase and reviews the NSS, the NDS, and the NMS to develop the Defense Planning Guidance (DPG) in accordance with national strategy (McGarry & Peters, 2018).

McGarry and Peters (2018) state in their Congressional Research Service report that the next step happens in the programming phase, led by the Director of the Cost Assessment and Program Evaluation (DCAPE) Office, and the purpose is to "analyze the anticipated effects of present-day decisions on the future force" (p. 1). In this phase, "The DoD Components shall develop proposed programs consistent with the planning guidance, programming guidance, and fiscal guidance" (DOD, 2013, p. 11). As McGarry and Peters (2018) mentioned, this step generates a Program Objective Memorandum (POM), which contains a description of each DOD component's budget requirements for upcoming years. "Once each service submits a POM, CAPE leads the reviews of the programs, forecasts the resource requirements for the next 5 years, and updates the Future Years Defense Program (FYDP)" (McGarry & Peters, 2018, p. 2).

The budgeting phase, led by the under secretary of defense (comptroller)/chief financial officer (USD(C)/CFO), takes place simultaneously with the programming phase (Schwartz, 2013). In this phase, military services complete a Budget Estimate Submission (BES), which is then reviewed by the USD(C)/CFO in accordance with guidance from the Office of Management and Budget (OMB). After the BES is approved, it is submitted to the OMB to be included in the president's annual budget request to Congress (McGarry & Peters, 2018).

In the final execution phase, the performance evaluation of the programs, also known as execution review, takes place along with the program review and the budget review (McGarry & Peters, 2018). The evaluation includes metrics of funding obligations and expenditures (Schwartz, 2013). Figure 7 demonstrates the U.S. PPBE process.

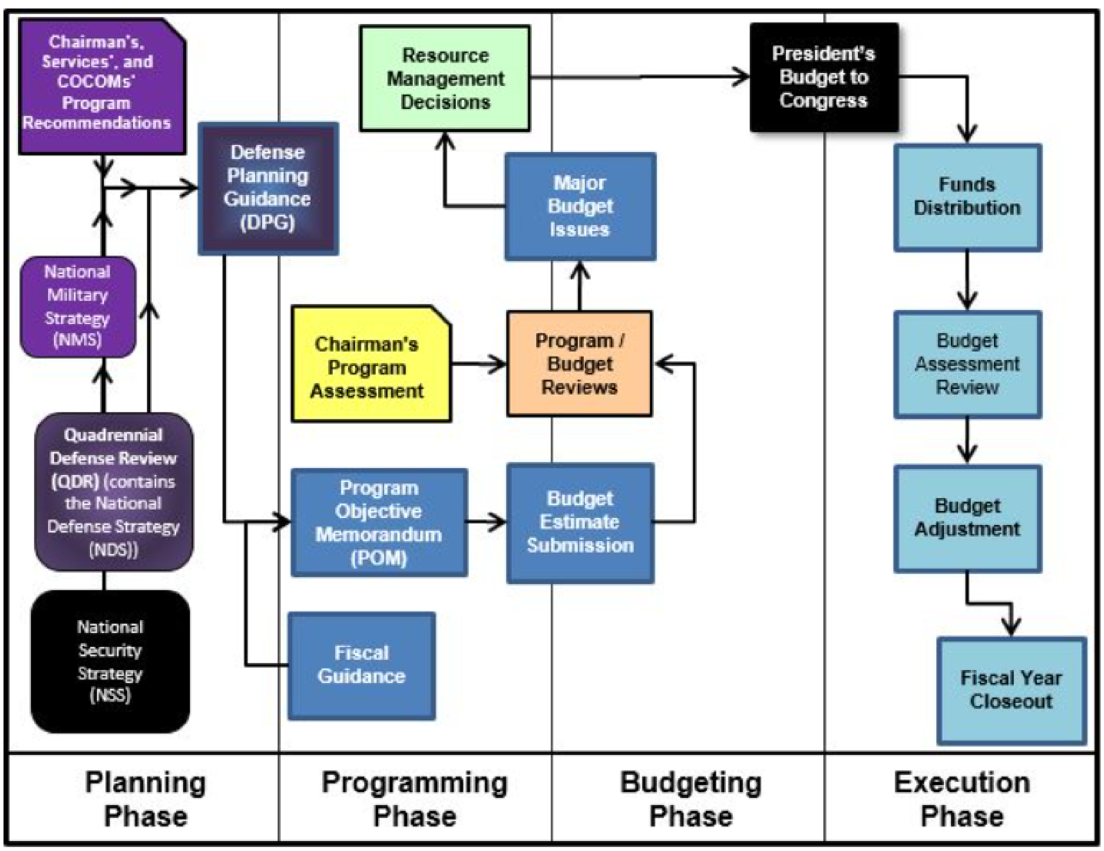

Figure 7. PPBE Process. Source: AcqNotes (2020).

2. Taiwan's Resource Allocation System

Taiwan developed its Planning Budget System in 1971, based on the U.S. PPBS. Unlike the PPBE system currently adopted by the United States, Taiwan's system lacks the execution phase and is divided into the design phase, programming phase, and budgeting phase, which are also reflected in the whole acquisition process (Huang & Wang, 2018).

In the design phase, the TYFBC and FYFCP, completed by the SPD in the requirements process, act respectively as the criteria for Defense Finance Resource Judgment (DFRJ) and Defense Finance Resource Guidance (DFRG; Yang, 2007). The DFRJ and DFRG, conducted by the Comptroller Bureau of the MND, work as the national long-term and mid-term finance resource plan (MND, Taiwan, 2012b).

Moving to the programming phase, the Resource Planning Department (RPD) of the MND establishes the 5-Year Administrative Plan (FYAP) according to the DFRJ and DFRG. The services and departments of the MND then develop the Annual Administrative Plan (AAP) for the next fiscal year accordingly.

According to Taiwan's Budget Act (2016), there are four stages of the budget legislation process in the budgeting phase. First, once the MND collects the AAPs from all its subordinates, the Budget Estimate of MND is established and submitted to the Executive Yuan (the administrative organization that governs all the ministries in Taiwan). Next, the Executive Yuan organizes the budget estimate from all the ministries and forms the Budget Proposal of the central government for the next fiscal year. After the Legislative Yuan (the congress of Taiwan) reviews and approves the Budget Proposal, the Legal Budget is determined and announced by the president 15 days before the fiscal year starts. Finally, the annual budget distributed to all government agencies for execution is then called the Distribution Budget. Figure 8 shows Taiwan's Planning Budget System.

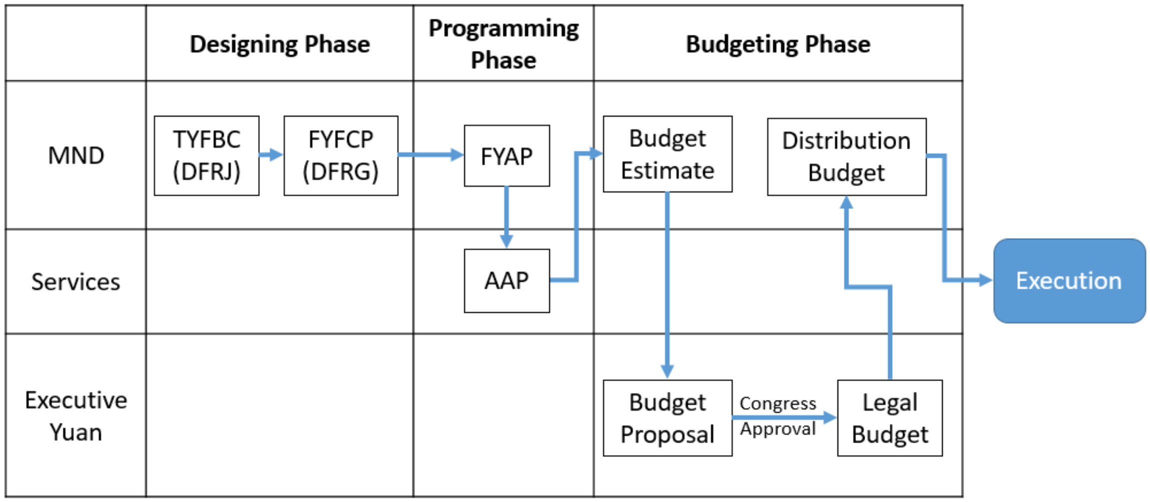

Figure 8. Taiwan's Planning Budget System

D. DEFENSE ACQUISITION SYSTEM

U.S. defense acquisition programs facilitate the development, testing, procurement, and fielding of capabilities to warfighters (Mortlock, 2021). The processes require significant effort for researching new technologies and testing the capabilities, which takes a long time to accomplish. A well-developed system is essential for the program managers to follow and overlook the progress to ensure that capabilities can be delivered to warfighters on time. Although acquisition systems might differ between countries, they often share the same concept of dividing the process into phases for better control of the progress (Lorge, 2018).

1. U.S. Defense Acquisition Process

The U.S. DAS, driven by milestones, is governed by DOD Directive 5000.01, *The Defense Acquisition System*, DOD Instruction 5000.02T, *Operation of the Defense Acquisition System*, and DOD Instruction 5000.02, *Operation of the Adaptive Acquisition Framework.*

As stated in DODI 5000.02, *Operation of the Adaptive Acquisition Framework* (DOD, 2020a), the DOD implemented the Adaptive Acquisition Framework (AAF) in order to update the DAS, which provides six pathways for different types of acquisition programs, including urgent capability, middle tier, major capability, software, defense business systems, and services. My research focuses on the major capability acquisition pathway, which "is designed to support major defense acquisition programs, major systems, and other complex acquisitions [with the purpose to] acquire and modernize military unique programs that provide enduring capability" (DOD, 2020a, p. 12). Figure 9 demonstrates the six pathways of AAF.

The structure of the major capability acquisition sets "milestones" to separate phases apart from each other. An acquisition program, led by a program manager (PM), must complete regulatory requirements before entering the next phase (Schwartz, 2013). The Milestone Decision Authority (MDA) can decide if the program is approved to enter the next phase (DOD, 2018).

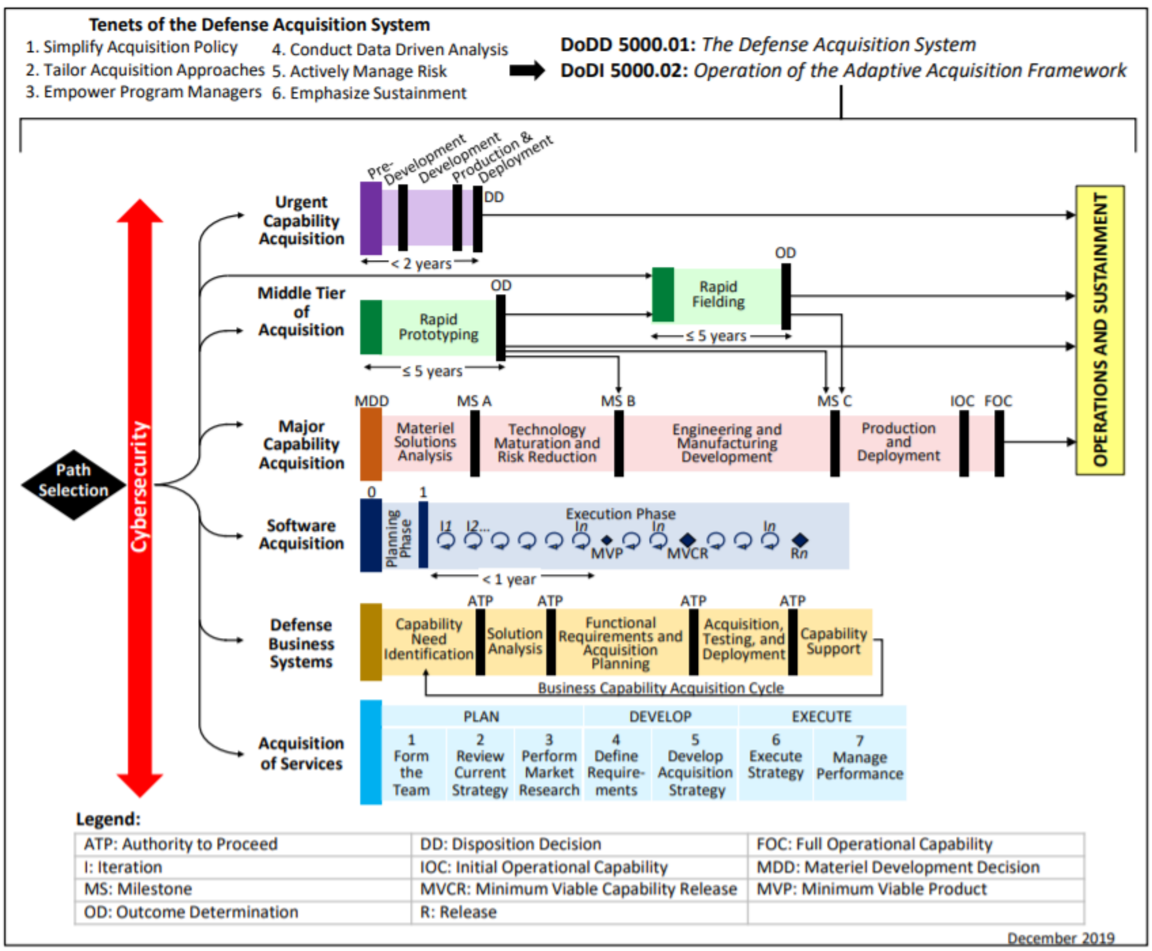

Figure 9. Six Pathways of AAF. Source: DOD (2020a).

The DOD issued DODI 5000.02T, *Operation of the Defense Acquisition System*, in 2015, according to which a Materiel Development Decision (MDD) review must be done to decide on a materiel or non-materiel solution and review the Analysis of Alternatives (AoA) when an ICD is completed from the JCIDS. The instruction also states that if a materiel solution is approved, the program enters the Materiel Solution Analysis (MSA) phase, in which the validated capability gaps are translated into "system-specific requirements including the Key Performance Parameters (KPPs) and Key System Attributes (KSAs), and to conduct planning to support a decision on the acquisition strategy for the product" (DOD, 2015, p. 18). Key activities in this phase include "AoA solutions; key trades among cost, schedule, and performance; affordability analysis; risk analysis; and planning for risk mitigation" (DOD, 2015, p. 18).

The program must pass the Milestone A review to enter the next phase, the Technology Maturation and Risk Reduction (TMRR) phase, according to the same instruction. At the Milestone A review, the MDA examines the program's acquisition strategy, risk assessment, and affordability analysis. The purpose of the TMRR phase is to "reduce technology, engineering, integration, and life-cycle cost risk" (DOD, 2015, p. 21). The instruction identifies the key activities in this phase including Preliminary Design Review (PDR), competitive prototyping, and Technology Readiness Assessment (TRA). Also, a Capability Development Document (CDD), which "provides a basis for preliminary design activities and the PDR" (p. 23), should be developed to replace the original ICD in this phase. Following the validation of CDD is the Development Request for Proposal Release Decision (DRFPRD), in which the acquisition strategy is determined. The program passes Milestone B when it is approved in the DRFPRD, unless any significant changes occur or additional information is unavailable. Once Milestone B is completed, the MDA approves the Acquisition Program Baseline (APB), signifying the official initiation of the program and the beginning of the next phase.

The purpose of the next phase, the Engineering and Manufacturing Development (EMD) phase, as DODI 5000.02T describes, is to "develop, build, and test a product to verify that all operational and derived requirements have been met, and to support production or deployment decisions" (DOD, 2015, p. 27). Key activities in this phase, according to the same instruction, include Developmental Test and Evaluation (DT&E),

Operational Assessments (OA), and critical design review. When the program meets all the EMD criteria, the phase ends and the program reaches Milestone C, in which the MDA considers “any new validated threat environments that might affect operational effectiveness” (p. 31).

After the approval of Milestone C is the Production and Deployment (P&D) phase, the purpose of which, as the DOD defines in DODI 500.02T, is to “produce and deliver requirements-compliant products to receiving military organizations” (DOD, 2015, p. 30), meaning that the identified capabilities can be delivered to the demanding units and can be used in operations. The instruction also notes that this phase incorporates activities such as Low-Rate Initial Production (LRIP), Limited Deployment, Operational Test and Evaluation (OT&E), and the Full-Rate Production Decision (FRPD) or the Full Deployment Decision followed by full-rate production or full deployment. According to Schwartz’s (2013) research, he concludes the process afterwards as,

- upon completion of OT&E,
- demonstration of adequate control over manufacturing processes,
- and with the approval of the MDA,
- a program can go into full-rate production (p. 10).

He also adds, in his research, the difference between Initial Operating Capability (IOC) and Full Operational Capability (FOC). He describes them as follows:

- IOC can be attained when enough systems are delivered and other predefined criteria are met, allowing for some degree of operations.
- FOC is achieved when the system is ready to operate as required (Schwartz, 2013, p. 10).

The final Operations and Support (O&S) phase, which comes after but often overlaps with the P&D phase, focuses on capability sustainment all the way to disposal (DOD, 2015). Figure 10 briefly shows the process of the U.S. DAS.

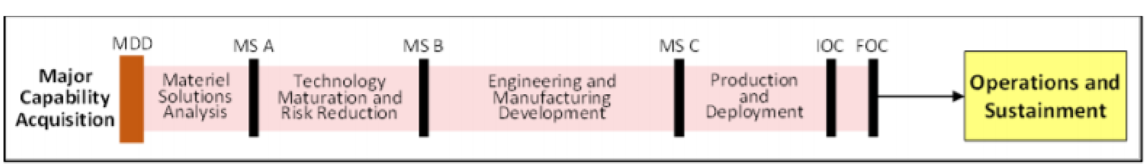

Figure 10. U.S. DAS Process. Source: DOD (2020a).

Shipbuilding programs, compared to other acquisition programs, are different in some respects. Drezner et al. (2011) described in their research that "the quantities, the amount of time to build, and the overlap between the design and construction phases make it difficult for ships to fit in the DODI 5000 process" (p. 23). The researchers also stated that programs are officially initiated after the authorization of Milestone B in most cases, whereas shipbuilding programs can be initiated earlier at Milestone A once required processes are completed. Similarly, the approval of Milestone B, rather than Milestone C in other programs, authorizes the construction of the lead ship, which can be considered the LRIP for shipbuilding programs.

As a result, the Department of the Navy (DON) established Navy-specified policies to supplement DOD instructions for the JCIDS and DAS within the DON. Two-Pass, Seven-Gate Governance procedures were formalized to provide an integrated, collaborative, and disciplined framework for Navy leaders to resolve the inconsistence between DOD regulations and the practice of actual shipbuilding programs (Department of the Navy [DON], 2019). Pass 1 comprises the three requirements gates, including the concept refinement phase. Pass 2 starts at the completion of Pass 1, just before Milestone A, and ends at program completion (Drezner et al., 2011). The process and required documents or activities at each gate are shown in Figure 11.

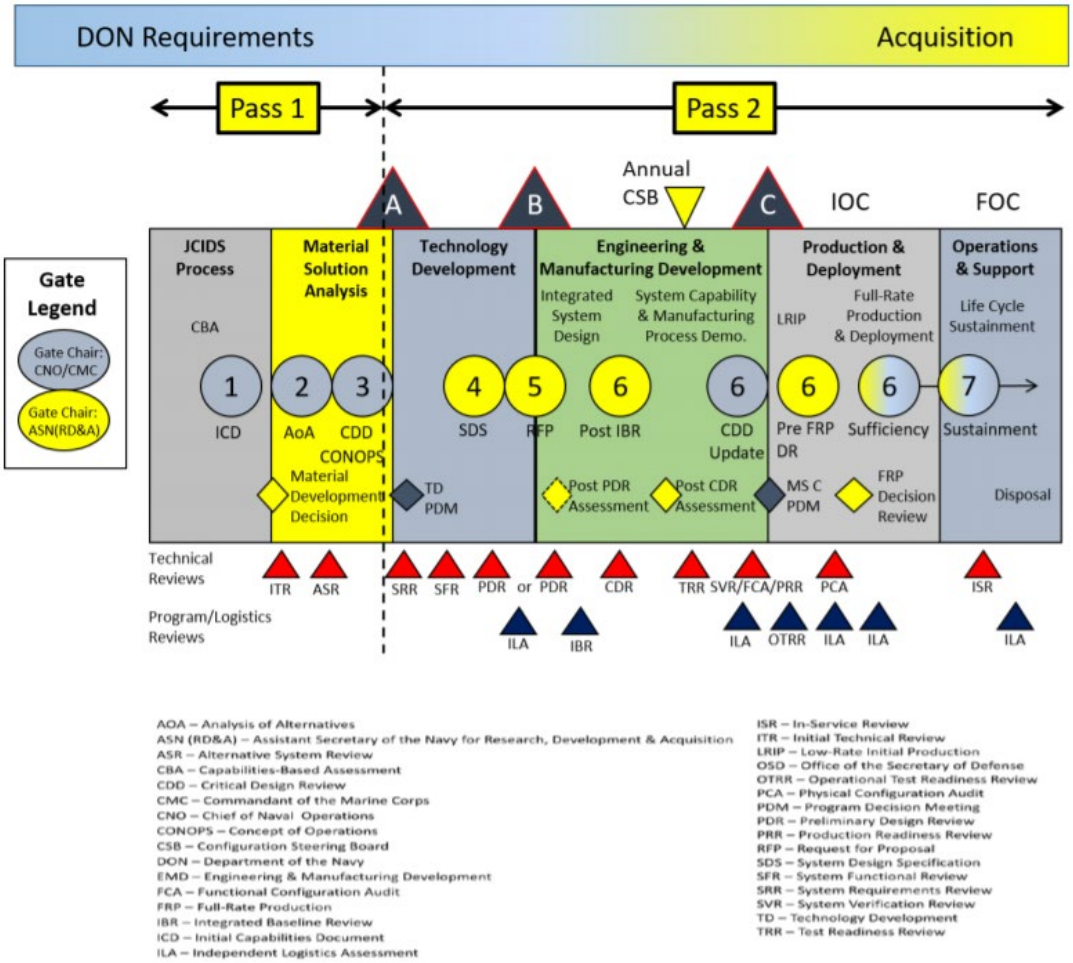

Figure 11. Two-Pass, Seven-Gate Process. Source: DON (2019).

2. Taiwan's Defense Acquisition Process

In Taiwan's defense acquisition process, the requirement is identified in the design phase, and the ORD is developed at the beginning of the programming phase. The process continues with the service producing a System Analysis Report (SAR), in which the cost-performance of the program is assessed (MND, Taiwan, 2002). After the Integrated Assessment Department (IAD) approves the SAR, the service needs to develop an Investment Outline, which is then reviewed by the Armaments Bureau and the General Staff Headquarters. Once the Investment Outline is approved, the documents (ORD, SAR, and Investment Outline) are integrated into the FYAP and reviewed in the Planning Budget System. After the program undergoes the budgeting process and is approved by the Legislative Yuan, the program is executed by the service that puts forward the requirement (MND, Taiwan, 2002). In the execution phase, the program is reviewed and supervised by the MND, the Executive Yuan, and the Legislative Yuan; however, the specifics of how the review and supervision are conducted are not incorporated in this regulation.

In the revised process, the SAR and Investment Outline are combined into the Integrated Acquisition Plan (IAP), which is produced by the services, the NCSIST, or both, depending on the amount of budget and whether the program involves technology research and development (R&D). Considerations in the IAP include assessment on indigenous development capability, logistics planning, acquisition approaches, cost-performance analysis, program management planning, and budget allocation (MND, Taiwan, 2016). After the IAP is reviewed and approved by the MND, the program enters the budgeting process. Once it is approved by the Legislative Yuan, the program is executed by the service or the Armaments Bureau if the program is led by NCSIST (MND, Taiwan, 2016). Figures 11 and 12 illustrate Taiwan's acquisition process before and after revision, respectively.

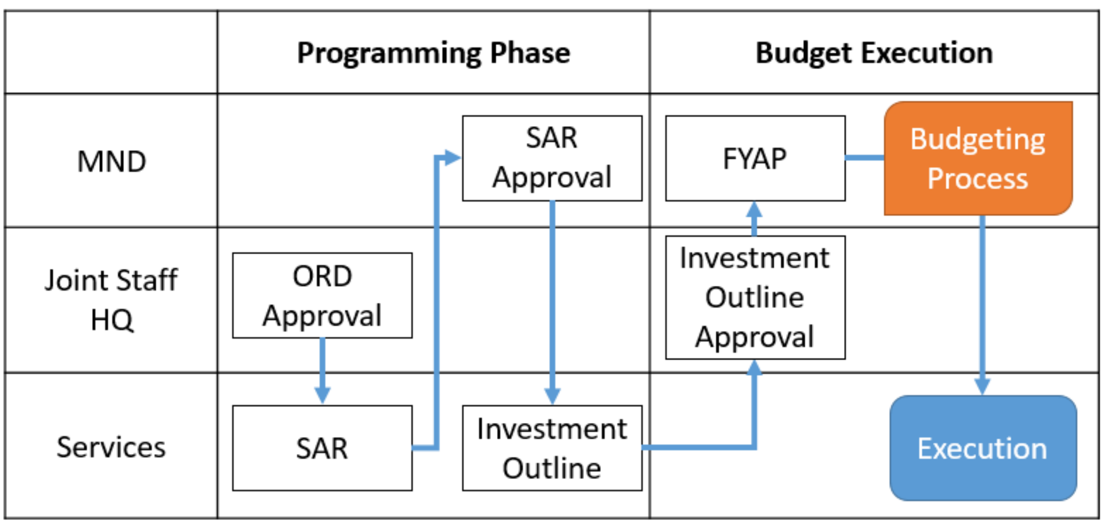

Figure 12. Taiwan's Acquisition Process, Before Revision. Source: MND, Taiwan (2002).

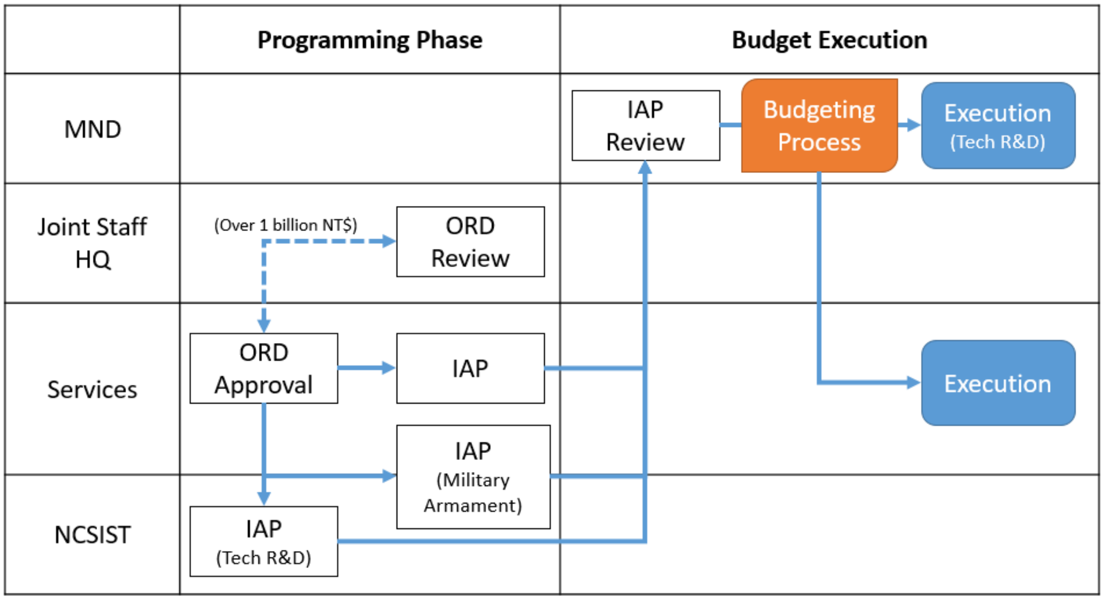

Figure 13. Taiwan Acquisition Process, After Revision. Source: MND, Taiwan (2016).

Most shipbuilding contractors in Taiwan are not capable of designing and developing ships that fit in the Navy's future operation requirements considering the foresight technology they demand. The design and R&D processes need to be done (mostly by the Navy Shipbuilding and Development Center and Ship and Ocean Industries R&D Center) before contractors can start to build ships. The weapon systems, on the other hand, are developed and constructed separately by the NCSIST (Shiu, 2018). The ship design procedures, including feasibility study, preliminary design, contract design, and detail design, often begin simultaneously with the programming process.

Research by Ou (2017) illustrated how Taiwan's shipbuilding process works. First, after the ORD is completed, the process starts with the conception design phase, in which the feasibility analysis and concept design are done by the Navy Headquarters and the Navy Shipbuilding and Development Center. Second, the preliminary design and contract design are made in the exhibition phase by a separate contractor, which is not necessarily the same as the contractor that builds the ships. Third, in the engineering development phase, the shipbuilding contractor conducts the detail design and acquisition/building regulation, and starts to build the prototype ship after the AAP is approved in the Legislative Yuan. Finally, after the prototype is built, the Navy begins test and evaluation for potential design modification in follow-up ships, which may then be further modified or adjusted along their life cycle according to their operational performance (see Figure 14; Navy Command R.O.C., n.d.-c).

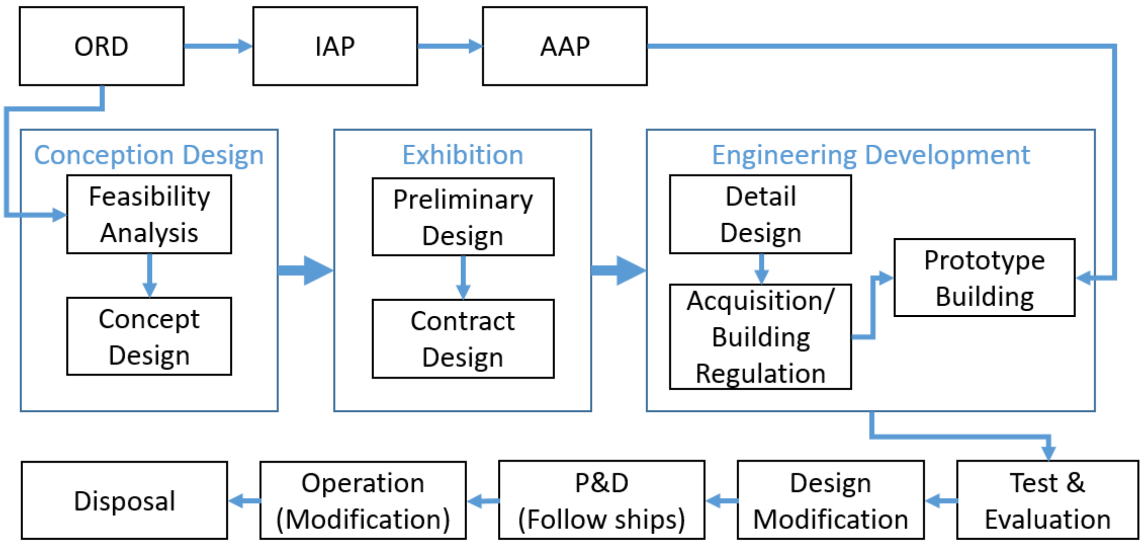

Figure 14. Taiwan Shipbuilding Process. Source: Navy Command R.O.C. (n.d.-c).

E. COMPARISON

The overall structures of the acquisition components of the United States and Taiwan are quite similar to each other, as both incorporate requirement, resource allocation, and acquisition management processes. In addition, being based on the U.S. PPBE system, Taiwan's resource allocation system is almost identical to the U.S. system with planning, programming, and budgeting phases. Although the execution phase is not included, the MND has its own regulations for controlling the budget execution progress. Furthermore, both countries implement unique regulations for shipbuilding programs considering their complexity and uncertainty, and the huge amount of time and cost they require.

However, the two countries' acquisition frameworks do differ in some ways. First, unlike the U.S. JCIDS system, Taiwan does not have an independent system to govern the requirement identification process. The requirement procedures are only roughly mentioned in the same regulation for managing acquisition processes. Second, the acquisition regulation in Taiwan only incorporates the process to the approval of the program. How MND components manage the execution of the program is not noted. On the contrary, the U.S. system covers the process all the way to the deployment and disposal, forming a more complete guidance for the whole life cycle of the weapon system. Finally, the U.S. AAF framework includes different pathways for different types of acquisitions. Taiwan, on the other hand, only includes two different types of acquisition pathways, which differ from each other in terms of whether the NCSIST is involved in the program.

Regarding shipbuilding processes, the U.S. Navy has a special instruction that is applicable to managing shipbuilding programs, since shipbuilding programs often cannot fit in the time frames of the regular acquisition process. The specified instruction controls the shipbuilding progress by setting seven "gates" as the junctures of time for critical documents or actions. The framework, despite having its own distinct process, still follows the three-milestone structure of the DOD's overall acquisition system. In contrast, Taiwan's shipbuilding process only emphasizes the order of major actions along the way but does not stress on the required documents along each step in the process. Instead of introducing a different process, the pathway for shipbuilding programs brings in additional procedures, which is parallel to the regular acquisition process and illustrates the prerequisite analytical works exclusively for designing warships. The additional procedures, conducted by the Navy Headquarters, the Navy Shipbuilding and Development Center, and the contractor for preliminary design and contract design, interact with the ordinary pathway only at the very beginning—after the ORD is developed and at the point when the AAP is approved and the contractor is awarded for detail design and prototype ship construction.

In summary, the acquisition systems of the United States are more completed, more detailed, and more clearly stated in instructions and directives compared to Taiwan's regulations. Moreover, even though Taiwan has a similar acquisition structure to run the same functions as the U.S. system, the borders separating requirement, resource allocation, and acquisition processes are not as clear as the U.S. structure since no specified instructions govern each of them. Although guidance specifying more detailed procedures and required documents might exist in each component of the Taiwan MND for staff members to follow, it is not available to the public or integrated as a series of systemic, organized, and numbered instructions, making it more difficult for researchers to analyze the system.

III. LITERATURE REVIEW

This chapter reviews previous work containing an analysis of acquisition processes in the United States and Taiwan, along with the constraints both countries have been facing.

A defense acquisition system can be defined as a set of processes that countries use to convert resources into weapon systems to satisfy national security requirements (Lorge, 2018). In both the United States and Taiwan, the process of defense acquisition is a complex and lengthy series of steps, walking through several departments in the government and reviewed by officials with various areas of expertise and responsibilities. Moreover, it often requires an enormous amount of budget to run a single acquisition project. According to Taiwan's 2019 National Defense Report, military acquisitions cost the MND of Taiwan NT$89.8 billion (US$3.09 billion) in 2019, approximately 26.3% of the total yearly defense budget (MND, Taiwan, 2019). The DOD, on the other hand, requested $243.4 billion in acquisition funding, including $134.9 billion for procurement and $106.6 billion for research, development, test, and evaluation (RDT&E) in Fiscal Year (FY) 2021 (DOD, 2020b).

Marcum and Milshyn's (2014) research analyzed global economics and new challenges, demonstrating the changes occurring in global defense research, development, and acquisition (RDA) systems. The challenge for most nations in the coming decade will be how to articulate and achieve national security requirements. While the defense budget is under the pressure of growing demands, many nations still face the issue of budget cuts in defense (Marcum & Milshyn, 2014).

Lorge (2018) conducted a research comparing the efficiency of naval acquisitions in the United States and in China. In the research, he analyzed the acquisition efficiency of both countries in terms of 10 key areas; in seven of those areas, the United States outperformed China. However, the research also pointed out that China stood out in cost and schedule performance, and the United States had to improve its acquisition systems in order to secure its leading position.

As for Taiwan, there is an analysis of Taiwan's self-reliance of armaments acquisition that illustrates Taiwan's insufficient self-reliant capability in national defense compared to other nations that are also considered U.S. allies, such as South Korea and Israel. After the implementation of the National Defense Act in 2002, Taiwan set a goal to establish a self-reliant national defense. Nevertheless, due to both internal and external factors, there has been only limited achievement in terms of indigenously developed armaments. External factors include intervention by the United States and China. Despite the fact that Taiwan is a U.S. ally, the United States prefers that the development of Taiwan's armed forces be under U.S. control. The best balance for the United States is keeping Taiwan away from Chinese invasion without allowing them the capability to attack across the Taiwan Strait. China, on the other hand, has always firmly claimed the "one China policy" to other countries, making them reluctant to collaborate with Taiwan regarding national defense affairs.

One internal factor is the constant personnel changes at the leadership and management level. Taiwan is a democratic country, where the president and congressmen are elected every 4 years. Because the two major political parties have different approaches to foreign policy, especially toward China, transition of the administrations and changes to public political stances often discontinue the progress of certain programs. Second, according to the government structure of Taiwan, self-reliant defense involves the MND, the Ministry of Economy, and the Ministry of Technology. There is not a concentrated leading organization managing the process, making it hard for the MND to acquire all the resources it needs to develop self-reliant defense. Last, guidance on the defense acquisition process is not complete. Different leaders can often alter the priority of different armaments according to their preferences, making it hard to sustain a long-term defense development strategy. The possible solutions are integrating the systems and developing supportive regulations (Yao, 2020).

Throughout Taiwan's history, most of its Navy's ships were purchased or supported by the United States. After the official foreign relationship with Taiwan ended, the United States was allowed to provide Taiwan only defensive weapons in limited numbers (Peng, 2016). Taiwan had to rely on indigenous developed weapon systems to sustain defensive capabilities. The proportion of warships built domestically hence increased. Since 1989, the MND has implemented "new generation shipbuilding" programs, including Cheng Kung–class frigates, Chin Chiang–class frigates, Tuo Chiang–class frigates, and Kuang

Hua VI–class missile boats (see Figure 15; Peng, 2016). Considering Taiwan's demand in Navy combat capability, it is important to analyze previous warship acquisition performance to identify potential improvement.

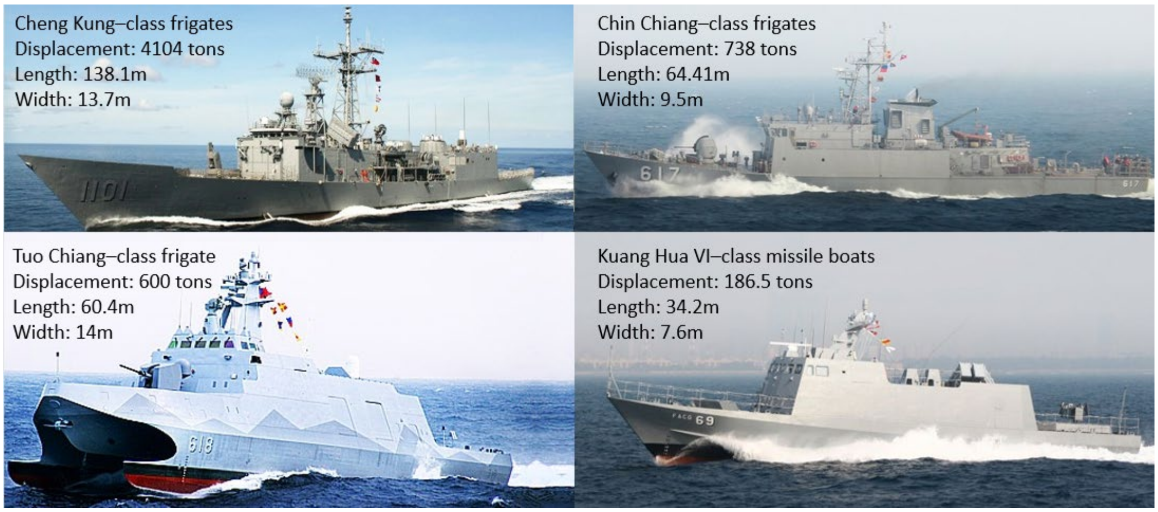

Figure 15. Taiwan Indigenous Built Ships. Source: Navy Command R.O.C. (n.d.-b).

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IV. THE CASE STUDY

In this chapter, real life shipbuilding acquisition programs are analyzed to examine how acquisition systems work in both the United States and Taiwan. The national strategies and objectives of the two countries are different from each other. The United States is a maritime nation with its security and prosperity depending on the seas. The U.S. Navy's ultimate strategic goal is to maintain the capability of projecting operations globally to sustain its military influence (DON, 2020). In comparison, the vision and main mission of the Taiwan Navy focus on conducting defense operations and protecting sea power in Taiwanese maritime space against China's threat of blockade and interception (MND, Taiwan, n.d.).

Despite of the differences between the Navy's strategic goals of the two countries, the U.S. littoral combat ship (LCS) program and Taiwan's Tuo Chiang[1]–class corvette program share some similarities in terms of the design concept. The two classes of ships were both designed with the capabilities of stealth, high speed, and littoral combat. Moreover, both the programs have been through major changes regarding the design concepts, shipbuilding schedules, and budget (Chu, 2018a; Work, 2014). Hence, analyzing these two programs can yield information regarding how the acquisition processes govern the acquisition programs and how they can be improved.

A. U.S. LITTORAL COMBAT SHIP PROGRAM

The LCS program, launched on November 1, 2001, is aimed at acquiring next-generation surface combatants with relatively lower cost. The LCS is focused primarily on antisubmarine, mine countermeasure, and surface warfare against small boats particularly in littoral areas, rather than other multi-mission combatants. With the modular design, the ships' mission orientation can be changed by replacing the mission packages (O'Rourke, 2012). The LCS class consists of two variants, the Freedom variant and the Independence variant, designed by Lockheed Martin and General Dynamics, respectively. To date, 35 LCSs have been awarded, and 19 ships have been delivered. FY2019 was the final year

[1] *Tuo Chiang* is also translated as *Tuo River* or *Tuo Jiang*.

programmed for LCS seaframes (America's Navy, n.d.). Table 1 shows the characteristics and ship lists of the two variants of LCS.

Table 1. Ship List of LCSs. Source: (America's Navy, n.d.).

Freedom variant	**Independence variant**
	
General Characteristics: **Builder:** Lockheed Martin **Length:** 387.6 ft (118.1 m) **Beam:** 57.7 ft (17.6 m) **Displacement.:** approximately 3,450 MT full load **Draft:** 14.1 feet (4.3 m) **Speed:** 40+ knots	**General Characteristics:** **Builder:** General Dynamics (LCS 2 and LCS 4), Austal USA (LCS 6 and follow) **Length:** 421.5 ft (128.5 m) **Beam:** 103.7 ft (31.6 m) **Displacement.:** approximately 3,200 MT full load **Draft:** 15.1 feet (4.6 m) **Speed:** 44 knots
Ships: USS *Freedom* (LCS 1), San Diego, CA USS *Sioux City* (LCS 11), Mayport, FL USS *Wichita* (LCS 13), Naval Station Mayport USS *Billings* (LCS 15), Mayport, FL USS *Indianapolis* (LCS 17) - Mayport, FL PCU *St. Louis* (LCS 19) - undergoing trials PCU *Minneapolis-St. Paul* (LCS 21) - under construction PCU *Cooperstown* (LCS 23) - under construction PCU *Marinette* (LCS 25) - under construction PCU *Nantucket* (LCS 27) - in preproduction phase PCU *Beloit* (LCS 29) - in preproduction phase USS *Fort Worth* (LCS 3), San Diego, CA PCU *Cleveland* (LCS 31) - in preproduction phase USS *Milwaukee* (LCS 5), Mayport, FL USS *Detroit* (LCS 7), Mayport, FL USS *Little Rock* (LCS 9), Mayport, FL	**Ships:** USS *Gabrielle Giffords* (LCS 10), San Diego, CA USS *Omaha* (LCS 12), San Diego, CA USS *Manchester* (LCS 14), San Diego, CA USS *Tulsa* (LCS 16), San Diego, CA USS *Charleston* (LCS 18), San Diego, CA USS *Independence* (LCS 2), San Diego, CA USS *Cincinnati* (LCS 20), San Diego, CA PCU *Kansas City* (LCS 22) - delivered PCU *Oakland* (LCS 24) - under construction PCU *Mobile* (LCS 26) - under construction PCU *Savannah* (LCS 28) - under construction PCU *Canberra* (LCS 30) - under construction PCU *Santa Barbara* (LCS 32) - in preproduction phase PCU *Augusta* (LCS 34) - in preproduction phase PCU *Kingsville* (LCS 36) - in preproduction phase PCU *Pierre* (LCS 38) - in preproduction phase

	USS *Coronado* (LCS 4), San Diego, CA USS *Jackson* (LCS 6), San Diego, CA USS *Montgomery* (LCS 8), San Diego, CA

1. Requirements Process

According to a Congressional Research Service report conducted by O'Rourke (2003), the Navy's need for LCSs was first mentioned in the Mission Need Statement (MNS) of the DD-21 destroyer program in 1994, which was terminated in following years; however, the program "did not focus on potential littoral challenges" (p. 30). In 2001, the Navy conducted an analysis identifying gaps or weaknesses in Navy capabilities, which emphasized littoral anti-access capabilities. The DOD's 2001 Quadrennial Defense Review (QDR) further identified increasing threats of adversaries' anti-access and area-denial capabilities, which affected the United States' force projection and sustainment in critical areas. As described in the same report, "Anti-ship cruise missiles, advanced diesel submarines, and advanced mines could threaten the ability of U.S. naval and amphibious forces to operate in littoral waters" (DOD, 2001, p. 31). The QDR also directed the requirements for rapid response to events and task-organized modular units to deter or defeat an adversary.

Former Under Secretary of the Navy Robert Work illustrated the process of the LCS program in his article, "The Littoral Combat Ship: How We Got Here, and Why" (Work, 2014). He noted, "On November 1, 2001, the Navy announced it would build a small, fast, and stealthy Littoral Combat Ship as part of its new DD(X) surface combatant family of ships" (p. 2). Next, throughout 2002 and 2003, Navy leaders developed "the key conceptual principles and characteristics that would guide the subsequent development of the LCS program" (p. 6). The article also indicated that documents illustrating the development include "Sea Power 21: Projecting Decisive Joint Capabilities," by Admiral Vern Clark in 2002; the Draft Littoral Combat Ship Interim Requirements Document (IRD), also finished in 2002; and the initial LCS Concept of Operations (CONOPS), approved in 2003.

The Preliminary Design Interim Requirements Document (PD-IRD) of LCSs was then issued by the DON in February 2003, which demonstrated the mission requirements for LCSs. According to the document, "The LCS will deliver focused mission capabilities to enable joint and friendly forces to operate effectively in the littoral" (DON, 2003, p. 2). These focused mission capabilities are

- an enhanced mine warfare capability,
- a better shallow-water antisubmarine warfare capability,
- an effective counter to small craft,
- and other missions such as Maritime Interdiction Operations and Intelligence, Surveillance, and Reconnaissance (DON, 2003, p. 2).

In 2004, the CDD of LCS programs was approved. Instead of being developed through the JCIDS process, the requirements of the LCS were directed by the Navy leaders. Without clear guidance to follow, some analytical procedures were not conducted timely through the requirements process. Congress once expressed its concern that "rigorous analysis" (Morgan, 2003) of the need for the LCS came mainly after the Navy's decision to develop the program, including the AoA, which was typically performed before the start of a major acquisition program. Without the AoA, the program raised arguments about whether this kind of smaller combatant could be the best answer to the identified threats (O'Rourke, 2003).

2. Resource Allocation Process

After the capability gaps for the Navy were identified, the DPG for FY2003 to FY2007 directed the Navy to develop the "capability to maintain an Aircraft Carrier Operating Area clear of submarine-delivered and floating mines." The guidance also indicated the demand to "improve the capability to destroy or evade large numbers of submarines operating in littoral areas," and "the capability to destroy large numbers of small anti-ship cruise missile-armed combatants, or armed merchant vessels in littoral areas, without relying on carrier-based air" (DOD, 2002). In accordance with the DPG, the LCS program was designed and built to counter these three threats (Work, 2014). Chief of Naval Operations Vernon E. Clark then declared the LCS program his budget priority as it represented the idea of "transformational" system, which Secretary of Defense Donald H. Rumsfeld emphasized. The LCS program was approved by Secretary Rumsfeld in 2002 and was incorporated in the DOD's FY2003 President's Budget submission (Work, 2014).

Concerned by the Navy's lack of analytical research before the program, Congress authorized the Navy $4 million for requirements development for the LCS in the National

Defense Authorization Act (NDAA) 2003 and 2004 and mandated the Navy to address the plan and schedule for meeting the requirements stated in DOD instructions before the Milestone A decision for initiation of concept and technology development (O'Rourke, 2003). In the NDAA 2005, Congress approved the Navy's plan to build the first two LCS seaframes (one ship for each variant), with the first ship (LCS 1) funded in 2005 (O'Rourke, 2012). The second ship (LCS 2) was then funded in 2006, along with two additional ships (LCS 3 and LCS 4). In the same year, Congress also addressed a procurement budget limit of $220 million per ship on the fifth and sixth ships, which were both funded later in 2007 (O'Rourke, 2012).

Because of the loss of internal control, the Navy found that the budget projection of the LCS program increased significantly. As a result, the Navy requested the cancellation of LCSs 3 through 6 and began to restructure the program in 2007, including increasing the procurement cost cap to $460 million per ship (Work, 2014). Congress accepted the cancellation and agreed with the increased cost cap but requested the cost cap to be addressed not only in FY2008 but in the subsequent years (O'Rourke, 2012). The Navy proposed to implement a dual-award acquisition strategy in 2010, awarding each of both bidders (Lockheed Martin and General Dynamics) a 10-ship block buy contract to reduce the procurement cost. This was in contrast to the down select strategy the Navy originally proposed, in which the Navy planned to select one contractor to build all following ships with a single design. After a hearing held by the Senate Armed Services Committee to review the strategy, Congress granted the Navy authority to implement the new strategy (O'Rourke, 2016).

The original plan for the Navy was to procure 52 LCSs in 2019 and subsequent years. However, as a result of the Force Structure Analysis (FSA) the Navy conducted in 2016, the 335-ship force-level goal was established, in which the 52 small surface combatants were divided into 32 LCSs and 20 frigates. Hence, as the Navy shifted its procurement priority to a new frigate called FFG(X), the target number for LCSs was reduced to 35 ships, making FY2019 the final year for LCS procurement (O'Rourke, 2019).

3. Acquisition Process

The acquisition process of the LCS program differs from DOD and DON instructions in terms of the time each decision point was made. The program was initiated when the PD-IRD was released along with the RFP in 2003, 1 year before the completion of the official CDD, meaning the program was initiated way before the Milestone A decision (Murphy, 2017). In defense of Congress's concern that the Navy did not complete an official AoA and other required documents regulated by DOD instructions (such as ICDs and CDDs) before releasing the RFP for LCSs, the Navy claimed that proper prerequisite analyses and research had been made in several research studies that led to the concept of LCSs, such as SC-21 Mission Needs Statement, the Naval War College's Focused Mission Ship Characteristics Study, Focused Mission Ship Technologies Opportunities Study, and the LCS Analysis of Multiple Concepts (O'Rourke, 2003). Despite the fact that there might be some gray area as to whether these previous research studies provided sufficient analytical support for the requirement documents, the Navy conducted supplemental analyses and completed the official CDD in response to Congress's demand in 2004, making the formal mark of Milestone A behind the initiation of the program (Murphy, 2017).

The development of the LCS program can divided into three major parts. The first part is the designation development, including the Flight 0 prototype seaframe building. In the LCS solicitation documents, there were fewer defined parameters for the contractors to follow but more conceptual materials, which provided more space for creativity (Murphy, 2017). This kind of approach led to two very different design variants, the pros and cons of which could not be identified without further test and evaluation (T&E) of the prototype ships. The second part of the program is the changeable modular mission package, which reflects one of the requirements shown in the PD-IRD: "The LCS shall be configured with core systems and a Mission Package that will enable the ship to perform all core ship functions and at least one focused mission or inherent capability" (DON, 2003). The chief of naval operations at that time, Admiral Vern Clark, mentioned in his statement before the House Appropriations Committee that "it will be the first Navy ship to separate capability from hull form" (*Statement*, 2003), implicating the risk under the new kind of shipbuilding approach. The major operational capabilities of mission module packages include mine countermeasures, surface warfare, anti-submarine, and surface-to-surface missiles (Work, 2014). The final part of the program is the building of the final designed form of the LCS seaframe, the Flight 1 ships, which would be down selected from one of the two Flight 0 design variants and refined after the operational T&E of the first two prototype ships (Work, 2014).

After the contracts were awarded to Lockheed Martin and General Dynamics for the R&D along with the build of each variant, the Navy expected the first two Flight 0 ships to be delivered in 2005 and 2006, respectively. Hence, the Navy planned to build the Flight 1 follow-up ships in 2008 (Work, 2014). However, several obstacles showed up along the way, including the underestimated cost per hull of the first two ships (USS *Independence* and USS *Freedom*), the Budget Control Act in 2012, and the insufficient time frame for Navy leaders to down select the better variant for Flight 1 ships. As a result, the program delayed significantly from the original schedule, leading the Navy to make alternative decisions in order to keep the program going. One of these decisions was adding two more Flight 0 ships (LCS 3 and 4) in order to keep the two contractors busy before the down select decision was made. Moreover, the Navy later decided to build nine more ships (LCS 5–13, referred to as the Flight 0+ ships) in both design variants for delaying the final Flight 1 decision (Work, 2014). In 2010, with the competitive proposals from both builders, the Navy changed its strategy and decided to keep both designs for future Flight 1 shipbuilding (Work, 2014).

The other issue brought by the rising cost, arguably the worst one, was the delay of the mission package development. As mentioned in the Government Accountability Office (GAO)'s 2016 testimony, "Since 2007, delivery of the total initial mission package operational capability has been delayed by about 9 years (from 2011 to 2020) and the Navy has lowered the level of performance needed to achieve the initial capability for two packages—surface warfare and mine countermeasures" (*Littoral Combat Ship and Frigate*, 2016). It was also mentioned that many T&E works could not be done without the mission packages, despite the fact that the first LCS was delivered to the Navy in 2008. The mine countermeasure module, especially, was delayed 7 years from 2005 to 2020 before providing IOC to the program. Figure 16 shows the IOC delays of each mission package since 2007. With delays in different parts of the program and each one having impact on one another, it is difficult to define the milestone decision points along the process. If taking the delays in mission packages into consideration, the program as a whole did not reach Milestone B before 2013 when the cost estimate for the mine countermeasure module was delivered, even though several ships had already been in service for years (Sherman, 2013).

With the change of Navy strategy in 2019, the CONOPS for LCSs was substituted by a new class of frigates, the FFG(X). Despite the fact that designs and concepts of the LCS might be inherited by the new frigate program, this new strategy signals that the LCS program is heading towards its end (O'Rourke, 2019). Undergoing several cost overruns, delays in process, changes in design and concept, and reduction of production amount, some argue that the LCS program could not fully fulfill the capability the Navy designed at the beginning of the process (Work, 2014).

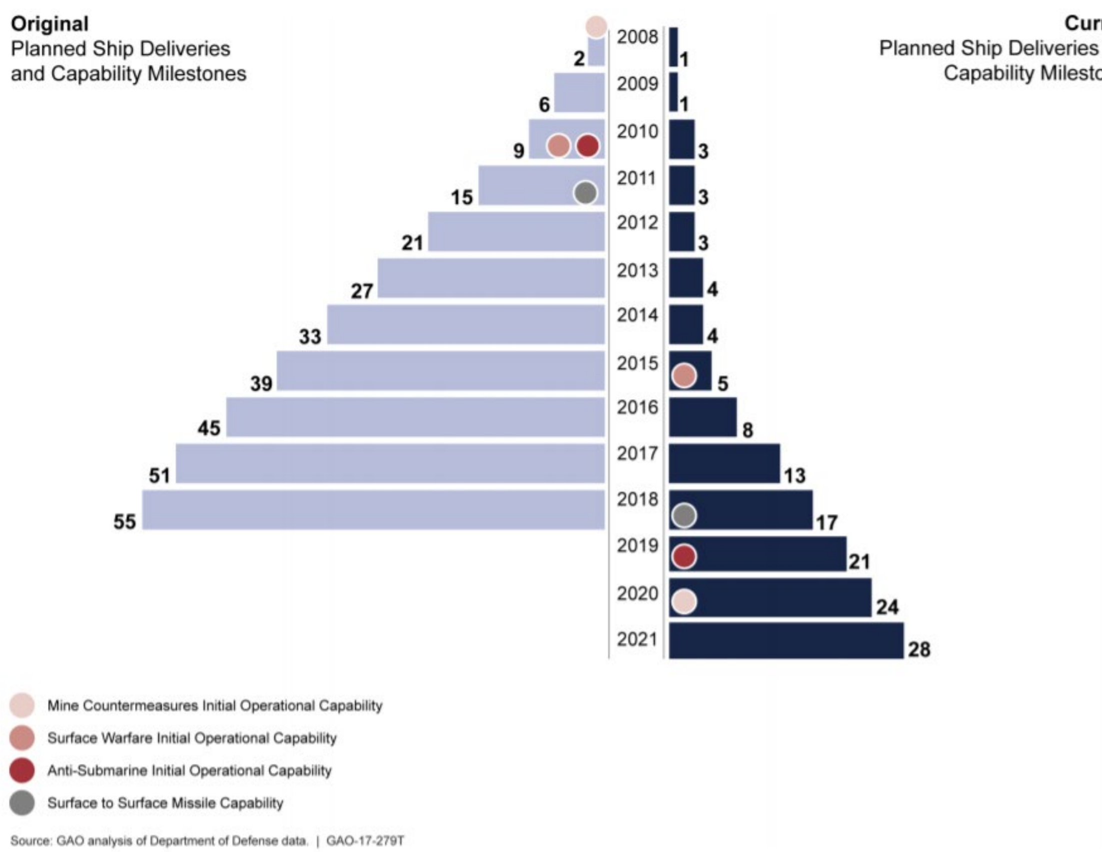

Figure 16. Littoral Combat Ship Mission Package Operational Delays Since 2007. Source: *Littoral Combat Ship and Frigate* (2016).

B. TAIWAN TUO CHIANG–CLASS CORVETTE

The Tuo Chiang–class corvette program was initiated in 2010 with a plan to build eight to 12 next-generation corvettes in response to China's fast growing naval power. This new class of indigenous designed warships was designed with emphasis on mobility, stealth, firepower, and capability to operate in harsh seas in order to fulfill "hit-and-run" tactics against People's Liberation Army Navy's (PLAN) aircraft carrier fleet (LaGrone, 2014). Moreover, the Taiwan Navy intended to enhance the capability of domestic shipbuilders to build advanced ships. The lead ship, PGG-618 *Tuo Chiang*, was built as the prototype ship and delivered to the Taiwan Navy in 2015, whereas the following ships were programmed into two batches. In 2020, the president of Taiwan announced that the first batch of six ships would be delivered before 2023. To date, the second ship, PGG-619 *Ta Chiang*, is currently under T&E and is expected to be delivered by July 2021 (Dominguez, 2020).

1. Requirements Process

Most requirements documents of the Tuo Chiang–class corvette program are still classified; thus it is difficult to get the details of its requirements process. However, the development of the corvette's concept can be understood by tracing back through Taiwan's national defense strategies and threats over recent years.

In Taiwan's 2009 QDR, the MND indicated that the People's Republic of China (PRC) had never given up occupying Taiwan with military force, and it had been developing its advanced aircrafts, submarines, amphibious operation capabilities, and even aircraft carriers, posing significant defense threats to Taiwan (MND, Taiwan, 2009b). In the face of the PRC's growing military capability and the increasing asymmetry of military scale between China and Taiwan, the national defense strategy of Taiwan has changed significantly over time (see Figure 17).

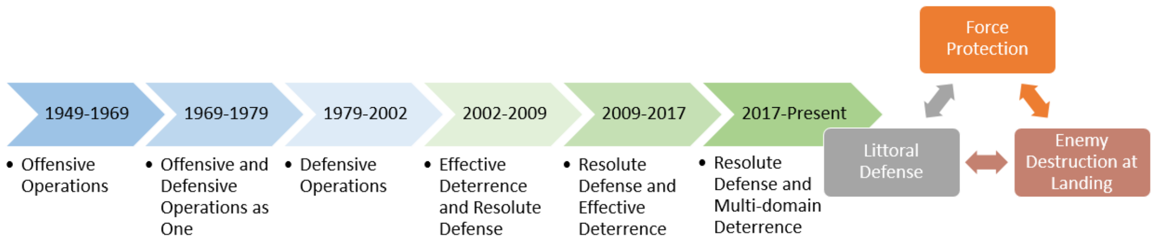

Figure 17. Taiwan Defense Strategy Evolution Since 1949. Source: MND, Taiwan (2019).

Under the national strategic trend from offensive posture to defensive stance, the MND incorporated several essentials in the 2009 National Defense Report regarding the Navy's strategic concepts and force buildup plan (MND, Taiwan, 2009a), including

- an indigenously developed system to enhance self-reliant defense capability and domestic shipbuilding industry;
- the establishment of capabilities for a three-dimension strike;
- a missile-oriented weapon system; and
- a strike force that is elite, highly efficient, rapidly deployable, and capable of performing long-range strikes.

Despite the difficulty of obtaining the detailed requirements development process, many characteristics of the Tuo Chiang–class corvette reflect these early strategic concepts, including smaller size (compared to Taiwan's other missile frigates), agility, a powerful missile weapon system, and—most importantly—indigenous development.

2. Resource Allocation Process

According to local media, the Taiwan Navy started the "Navy High-performance Ship" (code: "Hsun Hai [Swift Sea]") program in 2009, the goal of which was to build 12 to 16 littoral missile corvettes in future years (Guang, 2009). The program was originally planned to be included in the 2011–2015 FYAP. However, in 2010, the minutes of a meeting between the MND and the Committee of Foreign Affairs and National Defense indicated that and the program was postponed to FY2012 due to some issues encountered in the programming process (Legislative Yuan, Taiwan, 2010). The budgetary proposal totaling approximately NT$2.14 billion (US$71.4 million) was distributed into FY2012 to 2015 AAP (MND, Taiwan, 2012a).

After the T&E for the operational performance of the prototype ship (ROCS *Tuo Chiang*), which was delivered in 2015, the Taiwan Navy upgraded some of its design, including size, length, width, number of crew members, and weapon systems (Defense World, 2017). The Navy planned to build 11 upgraded version ships, which was originally divided into three batches with three, four, and four ships, respectively. The required budget, totaling NT$14.434 billion (US$471.68 million) for the first batch, was included in the MND's FY2017 budgetary proposal and distributed in FY2017 to FY2025 (Lo & Hetherington, 2017).

In 2018, the Navy proposed a budget increase for the construction of the first batch of ships by 13.63%, to a total of NT$16.4205 billion (US$547.205 million), causing some legislators doubts over the program's cost analysis procedure (Up Media, 2018b). The Navy replied in response to the issue that the increased cost was caused mainly by the additional anti-aircraft missile system. Under the direction of President Tsai Ing-wen in 2020 against the growing threats from China, the Navy intended to increase the quantity and expedite the production of the first batch of ships to six ships before 2023 with the total quantity of ships to be built remain unchanged (Van Trieste, 2020). While the budgetary proposal for FY2021 remains the same, the dynamic change of the production rate is likely to increase the budget request for the program in coming years.

3. Acquisition Process

According to the Government e-Procurement System of Taiwan's Public Construction Committee, the Navy started a public solicitation for the preparation for the reference material of the high-performance ship construction in March 2008. Shiu (2018) noted that the Hsun Hai program's preliminary design and contract design were also completed in 2008, after the Navy Shipbuilding and Development Center finished the feasibility analysis and concept design (Navy Command R.O.C., n.d.-c). However, no record on the Government e-Procurement System indicates that the contract for preliminary design and contract design were awarded that year. With the Legislative Yuan's approval for the Hsun Hai program in the MND's 2012 AAP, the MND's Armament Bureau issued a solicitation for building the prototype of the high-performance ships in 2011, which was eventually awarded to the LungTeh Shipbuilding Company in April 2012 (Lo, 2012).

Meanwhile, the NCSIST was appointed to initiate the development of the corvette's weapon system. It is also worth mentioning that in the same year, the Navy issued another solicitation for the contract design and technical consultant service for the program, which was awarded to the Ship and Ocean Industries R&D Center in November, 7 months after the construction contract was awarded.

The prototype ship, later named *Tuo Chiang* (PGG-618), was delivered to the Navy in 2014, equipped with Taiwan's indigenous designed "Hsun Lian" combat system and "Hsiung Feng III" supersonic anti-ship missile launcher developed by the NCSIST (LaGrone, 2014), marking the entrance to the program's T&E phase. As the Navy discovered several issues regarding the prototype ship's operational capabilities, including overweight weapon system, stability, and lack of air defense capability, the design of follow-up ships was adjusted with larger size and anti-aircraft missiles (Lo & Hetherington, 2017). In 2017, the Navy announced the "Cheng Hai" program to produce follow-up ships in three batches, the first batch of which contained three ships planned to be delivered by 2025 (GlobalSecurity, n.d.). The Navy originally planned to build the three ships of the first batch in the anti-aircraft configuration, one of the two variants the Navy designed with emphases on anti-surface and air defense capabilities respectively (Trevithick, 2018). The development of the weapon system and the solicitation for the ship hulls of the first batch of ships was commissioned to NCSIST in August 2018, with a budget increase from NT$14.4 billion to NT$16.1 billion (Lo, 2018). One of the reasons for the budget growth was the transformation of the MND's acquisition process in 2016, in which the head governor for managing the solicitation and contracting of any program related to the NCSIST was changed from the MND's Armaments Bureau to the NCSIST itself (Up Media, 2018a). The NCSIST was transformed from a government agency to an administrative corporation in 2015, as it could allow the NCSIST to adopt more flexible acquisition or contract strategies than government agencies could since the latter were limited by the government regulations (Li, 2014). In this case, the Navy adopted the lowest tender to select the contractor for the prototype ship, thus the bidders had to compete with one another in terms of price. In contrast, the NCSIST adopted the most advantageous tender for the follow-up ships, enabling the contractors to emphasize performance with tolerably higher cost.

A legislator from the Committee of Foreign Affairs and National Defense told the media in November 2018 that the follow-up ships would remove the anti-submarine capabilities and that the Navy canceled the plan to build the ships in two variant designs (Hung, 2018). All 11 ships would be built in the same design with the emphasis on anti-surface and air defense capability. Furthermore, to expedite the production plan, in which all ships were scheduled to be completed by 2036, the Navy claimed that the ships would be built in only two batches instead of the original three, and all ships were expected to be completed by 2026. In 2020, Taiwan's president, Tsai Ing-wen, announced after the launch ceremony of the first upgraded version of corvettes, *ROCS Ta Chiang*, that the production of the first batch of six ships would be sped up and completed by 2023 (Van Trieste, 2020).

C. FINDINGS AND DISCUSSION

By analyzing the processes the two programs of the United States and Taiwan, the different approaches the two countries used are identified. These different approaches, instead of the differences in the systems themselves, might be the main causes of the programs' eventual success of failure. More detailed discussions of the two programs are as follows:

1. U.S. Littoral Combat Ship

In a testimony by the GAO, *Littoral Combat Ship and Frigate* (2016), the LCS program reportedly failed to meet expected goals in all cost, schedule, and capability areas (see Table 2). The GAO also identified several reasons for the program's failure, including the emphasis on quantity instead of capability, the experimental approach of the program's acquisition strategy, and the lack of T&E before production. Work (2014) stated in his research that one of the reasons the Navy started to develop the concept of LCSs, an affordable warship operating in littoral areas, was to form the Navy force with the desired number of surface ships. Furthermore, the experimental approach, to build two design variants and mission packages fitting in both variants separately, requires more time to test and compare the prototypes, integrate the hulls and the packages, and evaluate their performance to ensure that the desired capability is delivered. However, as the GAO stated in the report, the Navy made "major commitments to build large numbers of ships before proving their capabilities" (*Littoral Combat Ship and Frigate*, 2016, p. 4). As a result, the construction was initiated without "ensuring the maturity of technologies, requirements, and design" (p. 4). One of the evidences for the Navy's disregard of the capabilities is that the first ship was approved for construction before the CDD was completed.

Table 2. Evolution of Expectations for the Littoral Combat Ship (LCS) Program. Source: *Littoral Combat Ship and Frigate* (2016).

	Early Program	**Updated Program**
Quantity and Cost	55 seaframes @ $220 million each	40 seaframes @ $478 million each
Schedule	Ship IOC in 2007	Ship IOC with partial capability in 2013
Design	Leverage existing designs for reduced cost, rapid fielding	Considerable design changes, under revision throughout early construction
Seaframe	Sprint speed: 40–50 knots; range: 1,000 nautical miles @ 40 knots	Neither seaframe meets combined original speed and range expectations
Mission Packages	IOC for three mission packages by 2010	Revised IOC: one package in 2015, two more planned by 2020
Crewing	LCS would be minimally manned (55–60 crew)	Crew size has increased over time to 70

Not surprisingly, subsequent issues occurred with the Navy's "quantity first" approach. The Navy's original plan was to build four prototype ships and down-select to one of the two designs after testing and comparing their operational capabilities. However, the GAO (2017) noted that "this decision supports an aggressive testing schedule between fiscal years 2017 and 2022" (p. 10). Subsequently, insufficient timely testing caused deficiencies in follow-up ships, leading to higher cost for design modification. Moreover, higher cost brings obstacles for the program's approval in Congress. The budget cap was set and later lifted by Congress, and the Navy had to postpone the program several times to find ways to lower the cost. In addition, lack of T&E also affected the LCSs' capability. In the same report, the GAO identified that capability changes were inevitable due to more and more testing and operational experiments, and the Navy had to modify its original requirements for the LCS and reconsider how the LCS could be operated in the fleet.

In summary, the Navy's decision to deviate the LCS program's acquisition strategy from traditional processes might, judging by the results, not be a successful approach. To pursue the quantity of ships in an efficient way, the Navy abandoned the process regulated in the DOD- and Navy-specified instructions by focusing more on quantity over capability, by constructing the ships before conducting proper requirement identification processes, and by leaving insufficient time for T&E. As a result, the Navy failed in delivering the capability, controlling the budget, and managing the schedule.

2. Taiwan Tuo Chiang–Class Corvette

Taiwan's Tuo Chiang–class corvette program is only in the middle of the acquisition process, so it is uncertain whether it will eventually be a successful program. However, the decisions the Taiwan Navy has made can be analyzed to assess the program's performance. First, defense industries in Taiwan are not as mature as they are in the United States. Taiwan's MND and Navy have to take over the preliminary design and weapon system development work instead of authorizing them to civilian contractors. As a result, the programs are more manageable since the Navy controls more of the program's progress. In addition, the Taiwan Navy only needs to choose the contractors by their capability, proposed budget, and past performance, whereas the U.S. Navy has to select from two fundamentally different variants, which requires a lot more effort and time.

Second, the T&E works were more sufficient for the Tuo Chiang corvette's production. The prototype ship, ROCS *Tuo Chiang*, was deployed in 2015, and the Navy did not start the production of the first batch of upgraded version ships until the operational evaluation of the prototype ship was fully done in 2019. Furthermore, according to Chu (2018b), the Committee of Foreign Affairs and National Defense of the Legislative Yuan once doubted that the follow-up ships might encounter issues with the design changes after the T&E of the prototype. The Navy promised in response that all other ships of the first batch would not be constructed until after the first ship (ROCS *Ta Chiang*) was delivered and fully tested. Finally, the Taiwan Navy did not sacrifice the ships' core capability requirements in exchange for larger quantity or faster production rate. In fact, the Navy even enhanced the ships' anti-surface and air defense capability after the T&E of the prototype ship. Table 3 shows the changes in design of the prototype and upgraded ships.

Table 3. Design Changes of ROCS *Ta Chiang*

	ROCS *Tuo Chiang*	**ROCS *Ta Chiang***
Length	60.4 m	65 m
Width	14 m	14.8 m
Height	2.4 m	2.1 m
Displacement	600 ton	685 ton
Capabilities	Short-range air defense Anti-surface Anti-submarine	Long-range air defense Anti-surface

However, there are some concerns regarding the program despite the fact that fewer mistakes were identified so far in this program when compared to the U.S. LCS program. First, Taiwan's president announced in 2021 that the production of the ships will be increased and expedited, from three ships in 6 years to six ships in 3 years. Such a significant change in schedule, despite the contractor's confidence in achieving the goal, will challenge the Navy's ability to conduct a timely T&E process. Second, the NCSIST plays a more important role in the acquisition system after the MND's modification of the acquisition process. The solicitation of the upgraded version ships, for example, was conducted and awarded by the NCSIST. While the approach might allow more flexible contract strategies, it also brings inconsistency among other MND-managed programs. In this case, some legislators doubted the increased cost, which was partly caused by the NCSIST's contracting strategy. Finally, the program is expected to deliver its IOC by 2023, when the first batch of ships will be deployed. It will be 14 years after the program was initiated even with the President's order to expedite it. However, the requirements of a program is generated from the 10-Year Force Buildup Plan, which covers the threats in the future 10 years, which is not long enough to cover the schedule of a complex program such as this one. Strategic guidance for further into the future might be needed for shipbuilding programs.

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V. CONCLUSION

The purpose of this research is to compare and contrast the acquisition systems of the United States and Taiwan by analyzing two Navy shipbuilding programs in order to identify the pros and cons of the two systems and to provide recommendations for improvements. This chapter contains an analysis of the U.S. LCS program and Taiwan's Tuo Chiang–class corvette program and offers conclusions and recommendations.

A. CONCLUSION

The United States and Taiwan establish similar structures of the acquisition system, however, the U.S. acquisition system is overall more complete and systemic than Taiwan's system. As for the implementation, the U.S. Navy made several mistakes caused by the experimental acquisition strategy in the process of the LCS program, whereas Taiwan adopted a more conventional approach for the Tuo Chiang-class corvette program hence mitigated the risk.

1. The U.S. Acquisition System

The United States has more complete, thorough, and detailed regulations to govern the three systems of the big "A" acquisition framework. All the regulations interact with each other and cover the whole acquisition process all the way to the end of a product's life cycle. Different pathways are set for different types of programs to better manage each program. Furthermore, the U.S. Navy specifies a regulation to govern shipbuilding programs considering their complexity and required time. However, the experimental approach of the LCS program, the emphasis on quantity of ships instead of capability, and the disregard of T&E made the program fail in capability, cost, and schedule.

2. Taiwan Acquisition System

Taiwan imported many concepts and methodologies of acquisition from the United States, hence, many similarities can be found in Taiwan's acquisition processes. Nevertheless, Taiwan's acquisition regulations do not cover the process after the execution of a program, and the process descriptions are not as detailed as the U.S. regulations. The requirements system, for example, is only briefly mentioned in the same regulation governing the acquisition process. As to shipbuilding programs, the Navy does specify a special pathway for the R&D phase of the process. However, the more detailed descriptions for each activity are not obtainable to the public. The Taiwan Navy took a more conventional and safer approach in the Tuo Chiang corvette program, with the main focus on the capability and sufficient time for adequate T&E procedures. In addition, the fact that Taiwan lacks a mature defense industry in nature makes it necessary for the MND and Navy to take over the R&D of the corvette's concept, which leads to a more manageable schedule for the Navy. Despite the Tuo Chiang corvette program being in the middle of the process, the Taiwan Navy has avoided some major mistakes that the U.S. Navy made in the LCS program. However, concerns such as the significant expediting of the production rate and the more important role that the NCSIST plays in the newly reformed acquisition process might endanger the program in the future. Additionally, the 10-Year Force Buildup Plan, which is used to identify threats and requirements, cannot cover the schedule of longer programs, such as shipbuilding programs.

B. IMPLICATION AND RECOMMENDATIONS

The results of this research indicate that the U.S. acquisition processes are more complete, providing more guidance overall in details of the processes in all phases and in all kinds of programs, whereas Taiwan's acquisition system needs integration and supplements to cover the life cycle of a product. However, the two discussed programs reveal shortages of the acquisition systems of both countries in a practical manner. Although the United States' acquisition system has a more complete structure, the U.S. Navy failed in every dimension to achieve the LCS program's original goals, mostly because of the experimental approach the Navy took. On the other hand, Taiwan adopted a more conventional way to execute the Tuo Chiang–class corvette program with less risk. The program seems to be better under control compared to the U.S. LCS program; however, the recent aggressive expediting plan, if no further supporting measures are made, might bring higher risk to the program in the future. The following questions should be considered for both countries to improve their acquisition processes and strategies.

1. The U.S. Navy should conduct more thorough risk assessment and feasibility analysis before taking experimental acquisition strategies, which

deviates from the conventional process. Otherwise, the milestones and gates regulated in the DOD and Navy instructions should be followed to ensure that all requirements are met before entering the next phase. The price the Navy has to pay to modify the design, capability, or schedule of a program might be enormous after the ships are being constructed.

2. The United States should focus on capability over other targets. As the DOD's 2001 QDR directed, the defense strategy has shifted to a capability-based approach. An acquisition program's ultimate goal is to transform resources to desired capabilities, and its success should be judged mainly by the capabilities it forms. With the capability-based mindset, the officers can understand what to prioritize at decision points of inevitable compromise.

3. The U.S. Navy should take T&E processes seriously, especially in the shipbuilding process. There must be enough time frame for sufficient operational T&E before any decision of construction. The price of time and cost would be much higher if design or requirement changes occurred after the ships are built. Timely T&E might slow down the process in the beginning but could definitely lower the risk for the whole program.

4. The Taiwan Navy should establish a more complete acquisition guidance system that covers all processes from the birth of the idea to the disposal of the product. In addition, the regulations should also include the instructions and guidance regarding how the NCSIST interacts with the MND in terms of their responsibilities in the defense acquisition structure. Although such guidance might exist in relevant MND components that are not obtainable to the public, the fact that they are not integrated in a system makes it more difficult for the officers to review and follow.

5. The Taiwan Navy should not ignore the importance of T&E in pursuing the expediting of the Tuo Chiang–class corvette program. Despite the prototype being properly tested and evaluated for design improvements, the first ship of the upgraded version is just about to be delivered. New operational T&E

must be fully conducted before the construction of the follow-up ships to avoid the lessons learned from the U.S. LCS program, which is the failure in capability, schedule, and time due to insufficient T&E.

6. Taiwan needs to develop strategic guidance that covers the prediction of threats and capability gaps for more years to come. The current highest strategic guidance, the 10-Year Force Buildup Plan, can cover the analytical basis for requirements identification in only a future decade, which is often not sufficient for a shipbuilding program to be thoroughly executed. Such recommended guidance can not only provide better direction to generate requirements for the targeted years but also bring forward a program's early process, provide more schedule flexibility for a program to be completed in time, and further reduce the possible need for expediting the process in the future with the derivative risk.

C. FUTURE RESEARCH

The research is limited in time and scale and only compares the acquisition processes, especially shipbuilding processes, of the United States and Taiwan. Moreover, some resources are not accessible due to classification, and two discussed programs are not currently finished. Some possible future research relating to this topic includes

1. Analyzing acquisition programs other than shipbuilding programs. Every service might have its own unique pathways to govern the acquisition process, and the issues and problems along the way might be different from Navy shipbuilding programs.

2. Comparing and contrasting acquisition processes of other countries. Different countries might have different structures, focus on different aspects, or even adopt different philosophies to manage their acquisition process. It is always beneficial to learn as many different approaches as possible to come up with possible improvements to current systems.

3. Studying the two discussed programs in the future after the products are all produced, deployed, and operated. This research can only analyze the two

programs under current progress; however, a thorough understanding of a program's success or failure can only be learned at its end when all the outcomes can be taken into consideration.

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Acquisition Research Program
Graduate School of Defense Management
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

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