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Exploration of logistics information technology (IT) solutions for the Royal Saudi Naval Force within the Saudi Naval Expansion Program II (SNEP II)

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EXPLORATION OF LOGISTICS INFORMATION TECHNOLOGY (IT) SOLUTIONS FOR THE ROYAL SAUDI NAVAL FORCE WITHIN THE SAUDI NAVAL EXPANSION PROGRAM II (SNEP II)

December 2017

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The Royal Saudi Naval Force (RSNF) is about to modernize its fleet under the Saudi Naval Expansion Program II (SNEP II). A part of this program includes upgrading and rebuilding its information technology (IT) infrastructure. The United States Naval Supply Business Systems Center (NAVSUP BSC) presented three strategies to the RSNF. The goal is to help RSNF set the direction for upgrading its IT logistics applications. This thesis evaluates the three options proposed by NAVSUP BSC. The aim is to recommend an IT solution to NAVSUP BSC and RSNF to support RSNF modernization efforts. This thesis illustrates how the commercial off-the-shelf SAP S/4HANA is the most favorable IT solution for the RSNF.

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EXPLORATION OF LOGISTICS INFORMATION TECHNOLOGY (IT) SOLUTIONS FOR THE ROYAL SAUDI NAVAL FORCE WITHIN THE SAUDI NAVAL EXPANSION PROGRAM II (SNEP II)

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The Royal Saudi Naval Force (RSNF) is about to modernize its fleet under the Saudi Naval Expansion Program II (SNEP II). A part of this program includes upgrading and rebuilding its information technology (IT) infrastructure. The United States Naval Supply Business Systems Center (NAVSUP BSC) presented three strategies to the RSNF. The goal is to help RSNF set the direction for upgrading its IT logistics applications. This thesis evaluates the three options proposed by NAVSUP BSC. The aim is to recommend an IT solution to NAVSUP BSC and RSNF to support RSNF modernization efforts. This thesis illustrates how the commercial off-the-shelf SAP S/4HANA is the most favorable IT solution for the RSNF.

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LIST OF ACRONYMS AND ABBREVIATIONS

ASW	Anti-Submarine Warfare
ASUW	Anti-Surface Warfare
C4I	Command, Control, Communications, Computers, and Intelligence
CIA	Central Intelligence Agency (U.S.)
CITD	Communication and Information Technology Department
COMPASS	Computerized Provisioning, Allowance, and Supply System
COTS	Commercial off-the-Shelf
DMS	Documents Management System
DOD	U.S. Department of Defense
DODIG	U.S. Department of Defense Inspector General
DOT&E	U.S. Director, Operational Test and Evaluation
ERP	Enterprise Resources Planning
FM	Financial Management
F/T	Field/Tactical
GB	Gigabytes
GCSS	Global Combat Support System - Army
HRM	Human Resource Management
IM	Inventory Management
IT	Information Technology
KANB	King Abdulaziz Naval Base
KFNB	King Faisal Naval Base
LMP	Logistic Modernization Program
NAVSUP BSC	Naval Supply Business System Center
PCG	Patrol Chaser-Missile Gunboat
PGG	Patrol Gunboat Guided Missile
RSNF	Royal Saudi Naval Force
SALE	Single Army Logistics Enterprise
SAP	Systems, Applications, and Products (Company)
SAR	Search and Rescue
SCM	Supply Chain Management

SNEP	Saudi Naval Expansion Program
TB	Terabyte

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I. INTRODUCTION

The information technology (IT) business environment is changing rapidly. Organizations of all kinds continually invest in new IT methods to improve their business. At the same time, organizations face challenges in updating their business practices and procedures to enhance their productivity. There are several goals of this improvement that includes reducing costs, making use of a single database, promoting ease of access, and gaining a unified interface. In the case of government agencies, a significant portion of their investment is to improve organizational performance. One of the critical elements to make any organization efficient is to have an adequate IT infrastructure that meets the organization's current and future needs. The IT system of an organization is the backbone that allows the delivery of business value through a fully integrated set of applications and solutions for the organization's operations success.

A. PROBLEM STATEMENT

The Royal Saudi Naval Forces (RSNF) is about to modernize its existing ships and facilities, expand infrastructure, and develop forces by establishing the Saudi Naval Expansion Program II (SNEP II), with its partner the U.S. Navy. Ultimately, this modernization effort will bolster Saudi national security to meet future RSNF needs. Comprehensive naval force enhancement can deliver a fully integrated spectrum of warfare capabilities encompassing ships, aircraft, advanced weapon systems, communications and network systems, facilities, and training that requires fully automated logistics support. Continued RSNF ability to counter future traditional and asymmetric threats requires an adequate force structure package. As RSNF modernizes its fleet, current IT infrastructure will need to adequately support an increase in weapon systems. The decision to transition to an enterprise logistics IT solution will provide RSNF with the necessary tools to support its modern Navy.

The U.S. Naval Supply Business Systems Center (NAVSUP BSC) has presented three strategies to RSNF for updating and rebuilding its IT infrastructure. The three strategies are: "SAP out-of-the-box Enterprise Solution," "Customized SAP," and

"Custom-Built" (created from the ground up to accommodate RSNF's unique requirements). The goal of this study is to provide recommendations to the NAVSUP Business Systems Center and RSNF with the most adequate IT solution to support RSNF's modern Navy. The desired end state will include a fully automated logistics IT system to meet RSNF future needs.

B. THESIS STRUCTURE

(1) Chapter I: Introduction

This chapter is the introduction chapter that identifies the focus and purpose of this research in order to address the current RSNF IT systems and their problems.

(2) Chapter II: RSNF Background

This chapter provides an overview of the RSNF history and its developments until the present time, and the current IT systems that are used around the RSNF.

(3) Chapter III: Enterprise Resource Planning System

This chapter discusses the Enterprise Resource Planning (ERP) systems and their usage globally, as well as their implementations.

(4) Chapter IV: Qualitative Analysis of NAVSUP BSC Strategies

This chapter evaluates and compares the three options proposed by NAVSUP BSC.

(5) Chapter V: Conclusion

This chapter summarizes and concludes the findings, and provides recommendations for RSNF.

II. RSNF BACKGROUND

A. IMPORTANCE OF GEOGRAPHICAL LOCATION

The Kingdom of Saudi Arabia is located in the Arabian Peninsula, at the heart of the Middle East. It is bordered by the Arabian Gulf and four Gulf countries on the east and the Red Sea on the west. Jordan and Iraq share the kingdom's northern border, and Yemen and Oman are to the south (Central Intelligence Agency [CIA], 2017; see Figure 1). The kingdom's location is distinctive economically, religiously, and politically.

Figure 1. Map of Saudi Arabia. Source: CIA (2017).

Economically, Saudi Arabia is a major player in the international petroleum industry and was a founder of the Organization of the Petroleum Exporting Countries (OPEC; Champion, 2003). The kingdom possesses around 22 percent of the world's

proven crude oil reserves and is the largest exporter of petroleum globally, contributing approximately 14 percent of daily oil production worldwide (OPEC, 2017). These numbers designate Saudi Arabia as one of the world's leading economies, and Saudi Arabia is the only Arab country to be part of the Group of Twenty (G20).

From a religious perspective, Saudi Arabia has the most sacred Islamic sites, located in the cities of Makkah (Mecca), which is the birthplace of the Islam founder Prophet Muhammad—pace be upon him—and Al-Medina, which became the Prophet's capital later (Champion, 2003). In 2015, Saudi Arabia received 8,000,000 pilgrims who performed the Hajj and Umrah, and the country plans to increase this number by expanding its infrastructure capacity to reach 15,000,000 Muslims per year by 2020 (Saudi Vision 2030, 2016).

Politically, Saudi Arabia plays a pivotal role in the Middle East due to its economic and religious weight. Moreover, the Middle East is going through a period of significant transformation, and Saudi Arabia has a vital influence in working toward a peaceful future for the region (U.S. Department of State, 2017).

1. Need for a Naval Force

In 1938, Standard Oil of California (SOCAL)—now known as Chevron Corporation—discovered oil in eastern Saudi Arabia. This discovery would turn out to be the first of many to eventually reveal the largest source of crude oil in the world (Zagorin, 2003). In 1951, the Texas Company (TEXACO), one of Chevron Corporation's subsidiaries, discovered the Safaniya oil field, which is known today as the largest offshore oil field in the world (Pentland, 2013). This discovery raised the inevitable need for a naval force to protect the offshore oil fields.

2. Beginnings of the RSNF

The RSNF was formed almost a decade after the end of the World War II, specifically, in the mid-1950s when the first naval force started as an extension of the Saudi Army (Benghaith, 2013). The navy started with few old units, small patrol boats, landing crafts, and utility boats (Metz, 1993). In 1969, the RSNF received three Jaguar fast-attack torpedo boats from West Germany, which expanded the RSNF's naval capability slightly. The

sole mission of the Navy at that time was to protect territorial waters by providing basic coast guard services (Gray, 2014).

On November 1971, Iranian forces seized three islands that belong to the United Arab Emirates: Abu Musa, Greater Tunb, and Lesser Tunb (Caldwell, 1996). At that time, the Iranian maritime forces were dominant in the region, which provided a new reason for Saudi Arabia to develop its military capabilities, especially a naval force capable of protecting the kingdom and its maritime resources (Gray, 2014).

B. SAUDI NAVAL EXPANSION PROGRAM (SNEP)

In the early 1970s, the RSNF had only about 1,000 men and a dozen vessels (Gray, 2014). After the aggressive Iranian actions on the three islands, the Saudi government started a line of negotiations with its allies—especially the United States—to escalate its naval force. After three months of negotiation, the United States and Saudi Arabia reached an agreement for technical and advisory assistance to modernize and expand the Saudi navy. Between 1970 and 1977, the Saudi government initiated massive programs with the U.S. government to enhance its different military forces. The Saudi Naval Expansion Program (SNEP) was the main program for matching the Imperial Iranian Navy. The goal was to develop fleets to patrol the country's two coasts and to defend the shipping and supply lines in the region.

Once a contract was assigned, the U.S. Army Corps of Engineers began to shape the modern RSNF, including its onshore and offshore facilities. These facilities included the RSNF headquarters in Riyadh, King Abdulaziz Naval Base (KANB) in Jubail on the Arabian Gulf, and King Faisal Naval Base (KFNB) in Jeddah on the Red Sea (Metz, 1993). The onshore facilities included ship docking and repair facilities, breakwaters, housing, administrative buildings, training facilities, and mess halls (Metz, 1993).

The United States delivered warfighting ships to Saudi Arabia, including four patrol chaser missile (PCG) craft—Bader-class corvettes—equipped with eight Harpoon anti-ship missiles and six torpedo tubes, as shown in Figure 2; nine patrol-gunboat guided missile (PGG) craft—Al-Siddiq class, also shown in Figure 2—equipped with four Harpoon missiles; four Al-Diriyah class coastal minesweepers (MSC; decommissioned in

2009); and eight patrol craft fast (PCF) boats. All of these were delivered between 1980 and 1983.

Another part of the program was the Saudi Naval Expansion Program-Communications (SNEP-C) system, which provided the RSNF with command-and-control capabilities between its vessels at sea and its command sites at RSNF HQ in Riyadh, KANB in Jubail, and KFNB in Jeddah. The SNEP program was the actual operational beginning of the RSNF and the backbone of the RSNF's future expansion and modernization.

PCG on the left, followed by three PGGs

Figure 2. SNEP program ships. Source: RSNF (n.d.).

1. Sawari Program

The Iranian Revolution took place in 1979, which involved the overthrow of Mohammad Reza Shah Pahlavi, who was supported by the United States (Encyclopedia Britannica, 2016). The Iranian Revolution came with a new threat to the area: the exporting of the revolution. According to an intelligence assessment done by the U.S. Central Intelligence Agency (CIA) in 1980:

> Iran's efforts to export its revolution are a threat to key U.S. interests. U.S. allies in the area would have reason to be nervous if the Iranians were to play a more active role. Iranian-supported unrest could lead to sabotage and strikes by oil workers, since Shias inhabit many of the oil-producing areas of the Arabian Gulf states. One year after the fall of the Shah, Iran's leaders appear more determined than ever to export their Islamic revolution to other countries in the Near East and South Asia. (CIA, 1980, p. iii)

The outcome of the Iranian Revolution raised new challenges for the Saudi military in general, and the navy in particular. Since the Arabian Gulf is shared between the two countries, further naval expansion was necessary. Consequently, Saudi Arabia initiated the Sawari program with France in 1980. The program included four F-2000 Al-Madinah-class frigates, as shown in Figure 3. Each ship was armed with eight Otomat surface-to-surface missiles (SUSM), an eight-cell Crotale surface-to-air missile (SAM) launcher, another 18 missiles in reserve (26 missiles total), one 100-mm multipurpose gun, two 40-mm antiaircraft (AA) guns, four torpedo tubes, and helicopter deck and hangar that could fit one Dauphin helicopter (Cowin, 1985). In addition, two Boraida-class logistic replenishment tankers (LRT) were delivered, as shown in Figure 3, equipped with two 40-mm guns and a helicopter deck that can carry either two AS365 Dauphins or one AS332 Super Puma (Cowin, 1985). Each ship can carry 4,350 tons of diesel, 350 tons of aviation fuel, 140 tons of fresh water, 100 tons of ammunition, 100 tons supplies, and 70 tons of dry goods (Cowin, 1985).

The program also included 20 multipurpose Eurocopter AS332(B/F) Super Pumas (now Airbus Helicopters H215), as shown in Figure 3, capable of antisurface warfare (ASUW), search and rescue (SAR), VIP transport, and troop transport in hostile environments (Cordesman, 2009). In addition, Saudi Arabia received 24 Eurocopter AS365F Dauphins for antisubmarine warfare (ASW), ASUW, and SAR missions (Cordesman, 2009). These helicopters were the beginning of RSNF Aviation (RSNFA).

The RSNF commissioned Sawari ships between 1984 and 1986 and based them at KFNB in Jeddah. In 2013, the RSNF signed a modernization program for Al-Medinah-class frigates and Boraida-class tankers. According to the DCNS Group's (2014) annual

report, the RSNF awarded the DCNS with the Sawari 1 Life Extension (LEX) program, estimated at more than 1.2 billion dollars.

Figure 3. Sawari I program ships: LRT in the middle, two FFGs on the side. Source: RSNF (n.d.).

2. Sawari II Program

The Sawari II program was signed in 1994 between France and Saudi Arabia and included three Al-Riyadh-class (F3000S) multipurpose frigates, as shown in Figure 4, along with logistics, training, and infrastructure development. The frigates were designed with innovative stealth features, including a reduced radar cross-section and infrared signatures (Cordesman, 2009). The Al-Riyadh-class is a modified version of the French La Fayette-class frigate but about 25 percent larger and with additional capabilities, including enhanced anti-air warfare (AAW) and ASW capabilities (Cordesman, 2009).

According to Naval-Technology (n.d.), the ships possess an advanced technology akin to that installed on the Charles de Gaulle, France's only nuclear-powered aircraft carrier. Some of these technologies are the Arabel multifunction fire-control radar and the

Aster missile system (Naval-Technology, n.d.). Moreover, each ship is armed with eight Exocet MM40 Block II surface-to-surface missiles (SSM) and two eight-cell Sylver vertical launch systems for the Eurosam Aster 15 surface-to-air antimissile (SAAM) (Cordesman, 2009). The ships' main gun is the Oto Melara 76-mm Super Rapid gun, and the ships also have four 533-mm aft torpedo tubes with DCNS F17 heavyweight antisubmarine torpedoes (Cordesman, 2009). The helicopter deck at the stern has a single landing spot for a medium helicopter and a hangar that can fit one helicopter (Cordesman, 2009). The Sawari II ships were commissioned between 2002 and 2004 and are based at King Faisal Naval Base in Jeddah.

Figure 4. HMS Al Riyadh (812), part of the Sawari II program.
Source: RSNF (n.d.).

3. Further Expansion

In addition to the massive programs that reshaped the Saudi Navy and enhanced the RSNF's maritime capabilities, the RSNF entered several small programs—compared to the previously described programs—with different countries. One was an arms agreement with Great Britain in 1988, which resulted in three Sandown-class

minehunters being delivered between 1991 and 1993 (Cordesman, 2009). These ships were designed to detect and destroy sea mines and were armed with 30-mm dual guns.

In another arms deal with the United States that took place in 2013, Saudi Arabia requested the sale of 30 Mark V patrol boats with their corresponding equipment, parts, training, and logistical support for an estimated of 1.2 billion dollars (Cordesman, 2015). According to a Defense Security Cooperation Agency (DSCA) news release at the time, "The Mark V patrol boats will provide additional capability to rapidly identify, engage, and defeat maritime security threats in the near-offshore region of the Saudi littorals" (DSCA, 2013b, p. 30). Moreover, the RSNF signed another contract with the United States in 2013 for a command, control, communications, computers, and intelligence (C4I) system upgrade and maintenance. This contract included Link-16 Multifunction Information Distribution System low-volume terminals (MIDS-LVTs); Global Command and Control Systems—Joint (GCCS-J); identification, friend or foe (IFF); commercial satellite communications (SATCOM); a Combined Enterprise Regional Information Exchange System (CENTRIXS); commercial high-frequency (HF) radios; commercial ultra-high-frequency/very high frequency (UHF/VHF) radios; HF voice and data; HF SubNet Relay (SNR); commercial HF Internet protocol (IP)/SNR; Global Positioning System (GPS); and Air Defense System Interrogator (ADSI; DSCA, 2013a).

Lastly, in 2015, Saudi Arabia ordered from the United States ten MH-60R Sikorsky multimission helicopters with ASW and ASUW capabilities to upgrade RSNF Aviation in the Arabian Gulf (Blanchard, 2017). The estimated 1.9 billion dollar program includes associated equipment, spare parts, and logistical support.

C. SAUDI NAVAL EXPANSION PROGRAM II (SNEP II)

The escalating events in the Middle East left Saudi Arabia with no alternatives but to further improve its armed forces to protect and secure its mainland. These events included the Gulf War in 1991; the Iraq War in 2003; the Arab Spring in surrounding countries, which caused some instability in the region; and the emergence of terrorist organizations such as the Islamic State of Iraq and the Levant (ISIL). Furthermore, there

is the constant Iranian threat to block the Strait of Hormuz, which is a vital waterway through which about one-third of all oil traded by sea globally passes (McDevitt, 2013).

Another threat to international waters that has affected Saudi shipping is piracy off the coast of Somalia. Multinational coalitions of naval task forces have formed to fight piracy. These forces are Combined Task Force 150 (CTF-150) and Combined Task Force 151 (CTF-151). Both of these forces are under the Combined Maritime Forces (CMF) command. According to the CMF website, “The mission of CTF-150 is to promote maritime security in order to counter terrorist acts and related illegal activities” (CMF, n.d.). Additionally, the CMF stated the CTF-151 mission is “to disrupt piracy at sea and to engage with regional and other partners to build capacity and improve relevant capabilities in order to protect global maritime commerce and secure freedom of navigation” (CMF, n.d.). Both of these forces operate in the Bab al-Mandeb Strait and the Gulf of Aden area. The RSNF participated in both coalitions and is still a member. Furthermore, Prince Mohammad bin Salman Al Saud, the crown prince of Saudi Arabia, first deputy prime minister, and the minister of defense, announced in 2015 a plan to construct a new, large southern fleet for the RSNF, based in Jazan on the Red Sea. The fleet will exclusively operate in the southern tip of the Red Sea, the Arabian Sea, the Gulf of Aden, and the critical and vital Bab Al Mandab Strait (Saudi Press Agency [SPA], 2015). All of these events have led Saudi Arabia to become the world’s fourth-highest military spender in 2016, right after the United States, China, and Russia (McCarthy, 2017).

Despite modernization plans for other Saudi armed forces branches, the RSNF is aware that its existing eastern fleet, supported by American-built ships that entered service in the early 1980s under the SNEP I program, is nearing the end of its serviceable life. Therefore, the RSNF began working on the Saudi Naval Expansion Program (SNEP II) almost a decade ago (Wolf, 2008). The main focus of SNEP II is on substituting ships from SNEP I that will shortly become outdated. The program was officially agreed upon during President Donald Trump’s visit to Riyadh in May 2017 as part of a massive arms deal between the United States and Saudi Arabia, estimated to be worth more than 350 billion dollars over the next ten years (David, 2017). This massive purchase will include

four Multi-Mission Surface Combatant (MMSC) ships, a derivative of the Freedom variant of the U.S. Navy Littoral Combat Ship (LCS) class, small patrol craft; helicopters; ground vehicles; other platforms; warehouses; and substantial upgrades to port infrastructure (O'Rourke, 2017).

The modernization program is a comprehensive naval force improvement to deliver a fully integrated spectrum of warfare capabilities encompassing ships, aircraft, advanced weapon systems, communications and network systems, facilities, and training, which all require fully automated logistics support. Included with SNEP II is an integrated enterprise resource planning (ERP) solution to substitute all of the RSNF's currently used systems and networks, as well as support for different modules for supply, maintenance, finance, human resources, and document management. As part of the RSNF's modernization, fully automated logistics support will continue the RSNF's ability to counter future traditional and asymmetric threats, which requires an adequate force structure package. Modernizing existing ships and facilities, expanding infrastructure, and developing forces to bolster Saudi national security will enable the RSNF to meet future needs. As the RSNF modernizes, current information technology (IT) infrastructure will need to support the increase in weapon systems adequately. The decision to transition to enterprise logistics IT solutions will provide the RSNF with necessary tools to support its modern navy.

1. Networks and Computer Usage in the RSNF

Ever since the establishment of the RSNF, the growing use of computers and their applications has allowed the RSNF to build and expand its networks. Most, if not all, departments rely on computers to accomplish their jobs, whether for word processing or sophisticated network management applications. The RSNF mainly uses four separate networks: an administration network, a tactical network (Benghaith, 2013, p. 15), a document management system (DMS) network, and Computerized Provisioning, Allowance and Supply System (COMPASS) network. In other words, the RSNF's current IT landscape consists of several disconnected IT systems with a mixture of coding languages (COBOL, .Net, and Java).

a. Administration Network

The administration network mainly focuses on human capital in the RSNF (see Figure 5). It is managed and maintained by the Communication and Information Technology Department (CITD). The five primary users of the network are the Officers' Affairs Department, Enlisted Affairs Department, Financial Department, Organization Department, and Training Department. The Officers' Affairs Department uses the network and its database to monitor, update, and store RSNF's officers' information. The main mission of this department is to track all RSNF officers' deployments, leave, and training orders. The Enlisted Affairs Department has the same functions as the Officers' Affairs Department but for enlisted personnel. The Financial Department manages the RSNF's personnel salaries, bonuses, and allowances. The Organization Department is responsible for creating and updating the RSNF's billets, which describe the personnel positions and job descriptions in each unit. Lastly, the Training Department's role is to track, update, and assign each RSNF member's training requirements, whether the courses are in-country or outside the country.

All of these beneficiary departments use the same database with a different interface based on the department's use, as identified by CITD. The network can be accessed from RSNF HQ and both naval bases.

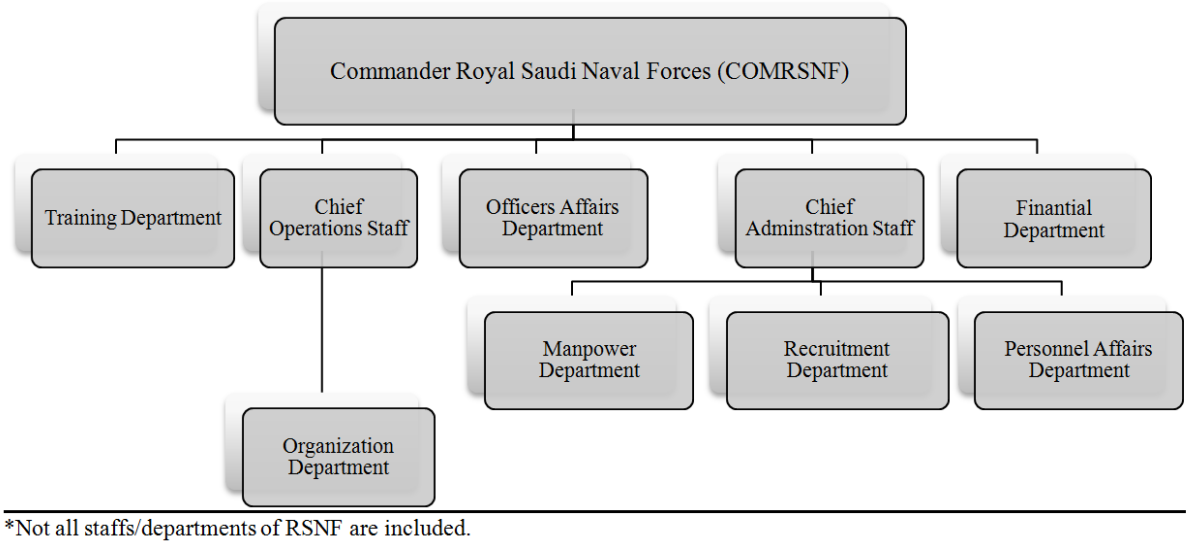

Figure 5. Departments of the RSNF's administration network. Source: Benghaith (2013).

b. Tactical Network

The tactical network is the most recently upgraded network within the RSNF. In 2013, the RSNF signed a contract with the U.S. Navy to upgrade and maintain its command, control, and communications (C3) network to a C4I network. This network is managed and maintained by the CITD. The network is mainly used by RSNF combat units and in RSNF C4I operations centers. The goal of this network is to integrate and connect RSNF units with each other and to provide communication channels to RSNF decision makers.

c. DMS Network

In 2010, the RSNF started to add another system with a separate network to its infrastructure: the DMS network, which is used to track, manage, and store documents electronically. The primary goal of this network is to enhance the organization's efficiency, reduce the transportation time of any document within different RSNF units, and minimize the use of paper. The DMS system is designed to reach every unit within the RSNF, including ships and other battle units. Once the system was implemented, it had a significant impact on the RSNF's efficiency. For example, if Unit A at the KANB

in Jubail wanted to send a document to Unit B at RSNF HQ in Riyadh, it would have had to transfer this document via a unique military mailing service and could take up to two weeks to reach its final destination. Now, with the DMS system, documents are scanned and sent to their destination with the click of a button.

d. COMPASS Network

COMPASS is a fully automated and integrated logistics system that includes supply, maintenance, technical, and financial processes. It is a single repository for common data. Moreover, it mainly supports logistical users in all locations of the RSNF. The RSNF requested the development of an automated supply management system (ASMS) as a part of SNEP I. Later, in the 1980s, the RSNF and NAVSUP BSC started working on a COMPASS vision plan. At the beginning of the 1990s, NAVSUP BSC began developing the system until 1996, when COMPASS became a fully operational system within the RSNF. NAVSUP BSC still maintains the system and provides training courses to RSNF COMPASS users.

The system has had several enhancements throughout the years. In 2010, the RSNF requested a study from NAVSUP BSC to upgrade COMPASS. For different reasons, the upgrade program has been postponed several times until a few months ago, when an agreement was reached for a RSNF modernization (SNEP II) program.

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III. ENTERPRISE RESOURCE PLANNING

In the previous chapter, we described the current RSNF IT networks and systems. An option for RSNF to upgrade its IT existing infrastructure is to implement Enterprise Resource Planning (ERP) based software. The ERP systems will provide a fully integrated and automated system to enhance the RSNF productivity and meet its future need.

There are several definitions for ERP, but they all agree that ERP includes almost any integrated software applications. Kumar and van Hillegersberg (2000) describe the ERP system as "configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization." Organizations are increasingly turning to ERP systems. The ERP, in essence, is one of the critical broad information systems that facilitate the constant flow of information and the coordination of various crucial resources and activities found in the business organization. The typical functions supported by an ERP system comprise the logistics, distribution, invoicing, human resources, shipping process, and accounting. Some of the crucial solutions are mainly focused on the relationship that exists between the customer and the functionality of all management.

A majority of the business processes, including sales, billing, marketing, production, human resource management, inventory management, and general control, depend on these systems. Various ERP systems manage the different links with stakeholders who exist outside the business, as well as endeavoring to improve performance management. Thus, these systems employ a kind of centralized database and often rely on a common computing scale. It gives the end user a unified, uniform, and consistent environment. The solutions of the ERP arose from the various applications concentrated in the materials requirements, resource management, and computer integrated production.

Based on the setup of various organizations, the ERP has the potential to have a direct, profound impact on reducing costs. Many small startup businesses, for example,

will opt to use ERP to reduce cost of enhancing operating margins. The process of boosting customer-oriented service is also a significant factor that contributes to the adoption of ERP.

The ERP market across the world witnessed a growth rate around 10 percent annually since 2006 and is projected to continue at a similar rate until 2020 (PR Newswire Association LLC, 2015). This growth has contributed to rapid technology development and the advent of ERP Cloud services. The main players within the market and vendors are SAP, Microsoft, and Oracle. These three vendors have around 75 percent of the overall market share across the globe (Panorama Consulting Solutions, 2016). Moreover, other smaller vendors are also emerging in the market. All of these vendors provide their services to a variety of customers, from small-scale businesses to massive governmental organizations.

A. THE VALUE OF ERP TO ENTERPRISES

The majority of business organizations are hungry for proven approaches to streamline operations, enhance the experience of the customers, improve their organization's competitive position, and to grow. The value of ERP solutions stems from how they enable organizations to achieve their needed level of enhancement.

The firms that focus on containing costs with the intention to increase revenues that will ultimately lead to higher profits will, in context, have a better competitive advantage. The presence of well-developed ERP systems will also lead to the reduction of the costs and consequently improve the daily operations of the business. Some of the standardized business based on operations must execute a successful implementation of ERP to create the fundamental ground for the process of achieving improved reliability. An efficient deployment of ERP systems ensures better use of facilities and workforce. This will consequently increase the value of ERP capabilities such as the scope of resource planning and also the aspect of scheduling (Gulledge & Sommer, 2003).

B. MAIN FEATURES OF ERP SYSTEMS

As previously mentioned, ERP systems provide many advantages to an organization. These advantages include improving productivity, increasing efficiencies, decreasing costs, and streamlining processes. There are three main features that make an ERP system efficiently deliver these benefits:

(1) Integration Capabilities

The most important feature of ERP systems is that they are formed on a single comprehensive database to share information across the enterprise (Scapens & Jazayeri, 2003). The goal of this feature is to allow everyone in the organization, especially the decision makers, to be confident that data is correct, up to date, and complete. ERP allows all information to be stored in a single location and accessed from different locations. This helps the organization to minimize the redundancy of the information and ensures that it is the most up to date.

(2) Capabilities of Customization

Various businesses operate in diverse ways. Most of them require a unique way of operating. An ERP system allows custom changes to its core code to fulfill an organization's needs. Customizing the ERP system to precisely fit the organization's business process minimizes the need to change standard operating procedures, limits the number of management issues, and reduces implementation time. However, there are some limits to the level of customization that can be implemented in an ERP system. According to a Panorama Consulting Solutions study (2016), the ideal level of ERP customization that they recommend should affect less than 20 percent of the core code of the system. Furthermore, exceeding this limit would probably impose an unexpected financial burden on overall project costs, such as maintenance, feature upgrades, and sometimes excessive customization breaks the predeveloped ERP modules' connections.

(3) Third-Party Interoperability

Although this feature is sometimes considered to be under ERP integration capabilities, it is important for an ERP system to interoperate with other third-party

systems. Almost all enterprises are required at some point to expand and incorporate additional systems that are not included in the current ERP system. It is important, therefore, that any third-party application has to be written to integrate with other applications in the current ERP system.

C. ERP SYSTEM MODULES

In several ERP systems, there are standard and basic modules that come with the system. These modules can be tailored to fit an organization's specific needs. Typically, these modules are specific to a functional area of operation. The following are some of the essential modules in most ERP systems:

(1) Financial Management (FM)

The financial or the accounting management module can be viewed as one of the most important modules of the entire system. An FM module can assist in the process of improving cash flow, lowering costs, and increasing the profitability of an organization while maintaining more accurate and transparent reporting (Scapens & Jazayeri, 2003). It provides organization-wide control and integration of financial information, and it gives the ability to monitor financial accounting data centrally. Furthermore, there are processes included in this module that ensure the full capabilities of FM.

(2) Human Resource Management (HRM)

This is another crucial module present in most EPR systems. The importance of this module is that it mainly handles information about the organization's workforce, which is itself the most significant factor within the business in general. There are many diverse subsystems under the HRM module. These subsystems are often customized to meet the specific requirements of the users. The HRM module handles employee information, tracks employee records related to performance, personal development and training, and skills identification. Another essential submodule in HRM is the payroll system, which manages payments reports, salaries, etc. (Association for Computing Machinery, 2000).

(3) Supply Chain Management (SCM)

In the modern fast-paced, highly competitive marketplace, firms require the ability to easily monitor demand, supply, status of manufacturing, and distribution. Failing to access the right information, such as the location of a product's primary components, and being unable to share the gathered data with the other supply collaborators, can negatively impact the supply chain of the firm. The use of the SCM module within ERP assists in the process of the supply chain, which originates in the design, planning, and procurement processes. Further, SCM involves supply and demand management, sales, shipping, and transportation tracking (Akkermans, Bogerd, Yücesan, & Van Wassenhove, 2003).

(4) Customer Relationship Management (CRM)

CRM is one of the broad, implemented concepts for the process of managing and also nurturing the various interactions with an organization's clients. It encompasses the employment of technology to organize, automate, synchronize, and store details about a customer.

The presence of a comprehensive CRM module can enhance sales performance by providing improved customer service to establish a strong relationship with customers (Chen & Popovich, 2003).

(5) Inventory Management (IM)

The primary function of the inventory management module is to optimize replenishments, which means fewer purchases that lead to better inventory level estimate accuracy. This feature comprises inventory requirements, setting of targets, provisioning of replenishment approaches, monitoring the usage of an item, and spotlighting any surpluses of the stock (Miller, 2014).

D. ERP LIMITATIONS

Despite the many advantages associated with them, ERP systems do have several limitations. Chiefly, the cost of purchasing the ERP software, the scale of planning, the customization process, training, configuration, testing, and implementing the system is relatively high (UK Essays, 2015). The presence of high scale of overheads will render the majority of the businesses to be in a position in which they cannot run their daily operations. The deployment of ERP in a company is often time-consuming. The average project time from business process analysis to a complete and fully functional system is about 20 months, or in some cases, an ERP project may take up to three years (De Toni, Fornasier, & Nonino, 2015).

Another apparent limitation associated with ERP systems is customization, which is also considered to be an of ERP feature, as previously noted. Customization is not considered to be a good way of solving a problem in the long term (Deakins, 2015). Adopting an ERP system as it is delivered or slightly customizing it may not properly address the enterprise business process. On the other hand, a substantial amount of customization may slow down the deployment of the project and make it hard to upgrade and maintain. Furthermore, the cost savings of implementing an EPR solution cannot be realized immediately, and it can be quite hard to quantify the cost savings. Over time, there are also indirect costs that accrue due to the deployment of an ERP solution.

To ensure the success of an ERP project, an organization must take as much time as necessary to analyze what processes and operations within their business may benefit from the ERP solution, determining how this application is expected to help, and then documenting clear and measurable goals of the proposed ERP solution. Because ERP systems are quite sensitive when it comes to planning and implementation, the organization has to execute the aforementioned steps effectively to maximize the benefits from the implemented ERP system.

E. EXAMPLES OF ERP IN THE MILITARY

Over the past few decades, the United States Army and the United States Navy have both made significant steps in the process of upgrading their business operations and also implementing business processes using ERPs with the associated business processes of re-engineering. To demystify this further, in 2003, the United States Army decided to implement an SAP commercial off-the-shelf (COTS) ERP solution through the Logistics Modernization Program (LMP), which is one of the comprehensive integrated enterprise systems (Carroll & Coker, 2007). The goal of the system is "to revolutionize the Army's national-level logistics systems and business processes" (Carroll & Coker, 2007, p.2). Moreover, the Army has a broader "vision of integrating business processes across logistics systems Army-wide. This vision is the Single Army Logistics Enterprise (SALE)" (Carroll & Coker, 2007, p. 3). The SALE vision has three elements: the LMP, the Global Combat Support System-Army (Field/Tactical, or F/T), and the Global Combat Support System-Army, Product Life Cycle Management Plus (GCSS-Army [PLM+]) (Carroll, & Coker, 2007).

Carroll and Coker elaborate on the SALE program by illustrating that LMP will provide a supply chain capability to the U.S. Army on a national level, which will replace the Army legacy systems that work independently (2007). GCSS-Army (F/T) "will provide all combat support and command and control functions with an interactive information management and operations system" (Carroll, & Coker, 2007, p. 5). After GCSS-Army is fully fielded at the end of 2017, "the Army expects the system to provide more than $11.8 billion in financial benefits from fiscal years 2018 through 2027" (Wittman & Bordallo, 2015, p. 3). GCSS-Army (PLM+) serves as the technical enabler linking the GCSS-Army (F/T), with the national-level system, the LMP (Carroll, & Coker, 2007).

The three systems are coherent and can be used to share data among them. The main significance of the system is that it will allow the process of full financial-based auditing. The system can also be used to track the general spending process of a particular serial number on the equipment that is used, the personnel carrying out the work, and also the specific appropriation that is employed.

Decision assistance for logistics revolves around the process of assisting various decision makers at different levels of the Army to come up with the best possible logistics decisions through the use of the prevailing data and information. The multiple decisions, in essence, can be extremely sophisticated and may depend mostly on extensive data. Regardless of the given level and point at which the decision is developed, it is rather hard for the decision makers to come up with sound and informed decisions without having to acquire support through some aspects of analysis.

In the case of the U.S. Navy, they went through a series of failures before implementing the current robust system. In 1998, the Navy started what was known as "the ERP pilot project," which "failed due to redundant and incompatible installations and its inability to meet Navy requirements because of their limited scope" (Government Accountability Office [GAO], 2005, p. 3). The estimated sunk cost for this project was about 1 billion dollars (GAO, 2005).

Ultimately, the Navy deployed a world-class ERP system in 2003 with an estimated cost of 800 million dollars (GAO, 2005). The primary goal was to modernize its legacy system and overcome the costly failure of four earlier pilot projects in addition to having a standardized process across the U.S. Navy (Director, Operational Test and Evaluation [DOT&E], 2013). This system "combined financial, acquisition, and logistics information technology system that provides financial and budgetary management for all Navy system commands" (DOT&E, 2013, p.217). The Navy ERP is used across its major System Commands: Naval Air Systems Command (NAVAIR), Space and Naval Warfare Systems Command (SPAWAR), Naval Supply Systems Command (NAVSUP), Naval Sea Systems Command (NAVSEA), Office of Naval Research (ONR), and Strategic Systems Programs (SSP). The system was completed and became fully functional in 2011. However, the Navy still needs to develop an information technology strategy to manage its financial management systems effectively (Department of Defense Inspector General [DODIG], 2017). The current financial system did not comply with Standard Financial Information Structure (SFIS) standards that standardize financial reporting across the U.S. Department of Defense (DOD) (DODIG, 2017).

F. RSNF NEEDS FOR AN ERP SYSTEM

In general, the primary usage of ERP systems in military organizations is for logistics. It is notable that the process of handling logistics within the military is a complicated matter. It is estimated that around 75 percent of the total budget of the military in many cases is impacted by the logistic decisions (Aronson, Liang, & Turban, 2005). The ERP, in this case, is used to provide the much-needed logistics support for the combat formations.

Military organizations, in general, and the RSNF, in particular, can use the ERP system to create a common database for the workforce and keep track of the performance of its individuals, as well as monitor and track all logistics systems and advanced financial systems. All these features will be in one comprehensive system that unifies business processes throughout the RSNF. Furthermore, "the extensive databases created by the ERP system provide the platform for decision support, data warehousing, data mining, and executive support systems" (Sean, 2001, p. 12). ERP's decision support examines, analyzes, digests and then offers better options for decision makers. Facilities, ranging from typical applications to the complex modeling and simulation tools and the individuals who use them, are necessary to acquire the needed content from the data to enhance the best decision-making process.

G. SELECTING A SUITABLE ERP

In general, the critical drivers for selecting an ERP system are system quality and costs (Leyh, 2012). The new system's compliance with the organization's requirements is important to keep in mind when examining the differences between the current processes and the new ERP system's built-in process (Leyh, 2012). In the case of the RSNF, it should perform a thorough GAP analysis to set these requirements.

H. IMPLEMENTING AN ERP SYSTEM IN THE RSNF

The implementation process of the ERP system within various military institutions is rather challenging. The many different and unique characteristics of military organizations contribute to the complexity of implementation. The successful

implementation process of critical ERP systems within a military setting requires significant planning to make it work effectively. To put this into perspective, there are particular areas within military institutions that can introduce various issues with the process of implementing the ERP (Allen & Kern, 2001). The following are the most important ones:

1. Change Management

It is too hard to persuade system users to adopt a drastically new system when their old system is functioning correctly. It is even harder to do so with a military organization workforce. Trying to ask such individuals to leave their regular routines and embrace something else is challenging (Allen & Kern, 2001). To minimize this resistance, the RSNF has to develop a change management plan that eases the transition to the new ERP system. The plan would include briefing users, using an integrated approach to the new system, supplying multiple user workstations, and offering extensive training for all users.

2. Communication Challenges

Many of the departments within military agencies often carry out their duties independently. To effectively implement such a system that covers many departments within the RSNF, it is essential to keep the multiple lines of communication open. The process of implementing an ERP system within the RSNF needs people to share the same point of view and expectations. Based on the general size of some of the military agencies, it is necessary to develop concise goals and a sound plan from the start (Lam, 2005).

Nonetheless, it is essential to state that none of the aforementioned observations implies that the process of implementing the ERP system within this type of organization is entirely impossible. Although the process of deploying a new kind of solution is not easy, through the use of proper planning and the right support, the RSNF has a higher likelihood of the system implementation process being successful (Lam, 2005).

IV. ERP SYSTEM COMPARISON

Now that the need for an ERP system for the RSNF has been established, the next step is to articulate and compare the three different approaches that NAVSUP BSC suggested to RSNF to implement. The three strategies are: "SAP Out-of-the-box Enterprise Solution," "Customized SAP," and "Custom-Built." One of these plans can set the direction for how the RSNF will implement the technology upgrade of its Logistics applications. To compare these systems accurately, a unified set of criteria will be used for all of them. The set of criteria is based on the work of Pearlson, Saunders, & Galletta, (2016), which guides decision makers in determining the appropriate IT infrastructure for an organization. These criteria are adaptability, scalability, maintainability, training and resource availability, estimated time frame, and estimated cost.

Tekinerdogan and Aksit define adaptability as “the ease with which a system or parts of the system may be adapted to the changing requirements” (1997, p. 6). By comparison, Andresen and Gronau define adaptability in the IT world as “a change in the system to accommodate a change in its environment. More specifically, adaptation of an IT system is caused by change from an old environment to a new environment” (Andresen & Gronau, 2005, p. 883). Scalability measures the ability of the system to adapt to an increase, or in some cases a decrease, in business demands (Pearlson et al., 2016). This factor assesses the ease with which a system can expand in the future. According to Radatz, Geraci, and Katki, system maintainability is “the ease with which a software or hardware of system can be modified to correct faults, improve the performance or other attributes” (Radatz, Geraci, & Katki, 1990, p. 46). Training and resource availability, estimated time frame, and estimated cost are self-explanatory.

A. SAP S/4HANA COMMERCIAL OFF-THE-SHELF (COTS) SOFTWARE SOLUTION

The Systems, Applications, and Products (SAP) company is a German multinational firm that leads the market in providing ERP systems solutions. SAP S/4HANA is the next generation of ERP systems. It provides a simple, fully digitized,

and entirely connected new business suite of applications (Wagner & Mathäß, 2016). Similarly, Wagner and Mathäß offer that the software is “built on the advanced in-memory platform, SAP HANA, and can be deployed either on premises or in cloud or hybrid” (Wagner & Mathäß, 2016, p. 3). It is an ERP software package based on the industry standard, and its purpose is to cover the day-to-day processes of an organization. Acquiring SAP S/4HANA COTS means that RSNF will have to adapt the system, which can accommodate the customization of up to 20 percent of its core code. The 20-percent limit on customization will be the key differentiator between this option and the second one. Moreover, it is important to state that this level of customization does not include any change to the system core code. Customizing the core code of the system presents another differentiator between the SAP COTS option and the customized SAP option.

Moreover, the RSNF can use the data migration tools that SAP offers. These tools can help the RSNF to load the data from its legacy systems to the new ERP solution, which required for implementing the SAP S/4HANA COTS system.

1. Adaptability

Davenport mentioned in his article that "most companies installing enterprise systems will need to adapt or even completely rework their processes to fit the requirements of the system" (Davenport, 1998, p. 3). Thus, heeding Davenport’s caution, the RSNF also will have to adapt to the new system functionality, and because SAP S/4HANA is based on private industry standards and RSNF processes differ from these standards, RSNF business processes will need to be altered accordingly. To mitigate this issue, the RSNF has two choices, neither of which is ideal. RSNF can rewrite some of the SAP S/4HANA code, which means exceeding the 20-percent limit on customization. On the other hand, it can use the SAP Fiori tool to build a custom interface between the system and the end-users to speed up the adaptability process. Both of these choices add time and cost to the implementation effort (Davenport, 1998). Under those circumstances and to allow RSNF to run its day-to-day operations, the RSNF will have to modify its process to mirror more closely what is already installed in SAP S/4HANA.

Additionally, time is another critical factor in the adoption process (Fang & Patrecia, 2005). Adapting to the ERP system, according to Fang and Patrecia (2005), is difficult and cannot be rushed. They believe users are often too eager to start using a new ERP system to solve their existing problems, and fail to consider that "the rushed act of implementation may create even larger and long-term problems" (Fang & Patrecia, 2005, p. 24). These considerations about the adaptability level of SAP S/4HANA solution indicate that SAP S/4HANA is the least adaptable solution for the RSNF.

2. Scalability

Since the RSNF is still growing and expected to expand by opening new naval bases like the new naval base in Jazan, it is important to test the scalability of the proposed systems. Such testing can help to avoid any additional costs that may be incurred when expanding the RSNF's IT infrastructure. Scalability of SAP S/4HANA is based on the amount of data that one server can hold (Meine, 2016). In order to increase the scalability of the system, there are two possibilities available: Scale-Up (vertical scalability) and Scale-Out (horizontal scalability) (Färber et al., 2012; see Figure 6). Scale-up means increasing the size of one server by adding more resources, such as more RAM and CPU (Färber et al., 2012). On the other hand, scale-out means adding multiple servers to support the growth of data (Meine, 2016). Both of options are feasible, and they depend on the size of the expansion that is desired. To avoid being locked into a limited database size, the RSNF has to enlarge its scope of planning to include any near future expansion. Regardless of the method of scaling the system, SAP HANA offers flexible data storage (Färber et al., 2012). Based on the scalability factor, the SAP S/4HANA solution is the highest ranked of the three options. The term scalability, however, is based only on the ability to expand the system infrastructure. That means it does not include adding new modules or activities to the SAP software because those were assumed to have been already planned for and implemented.

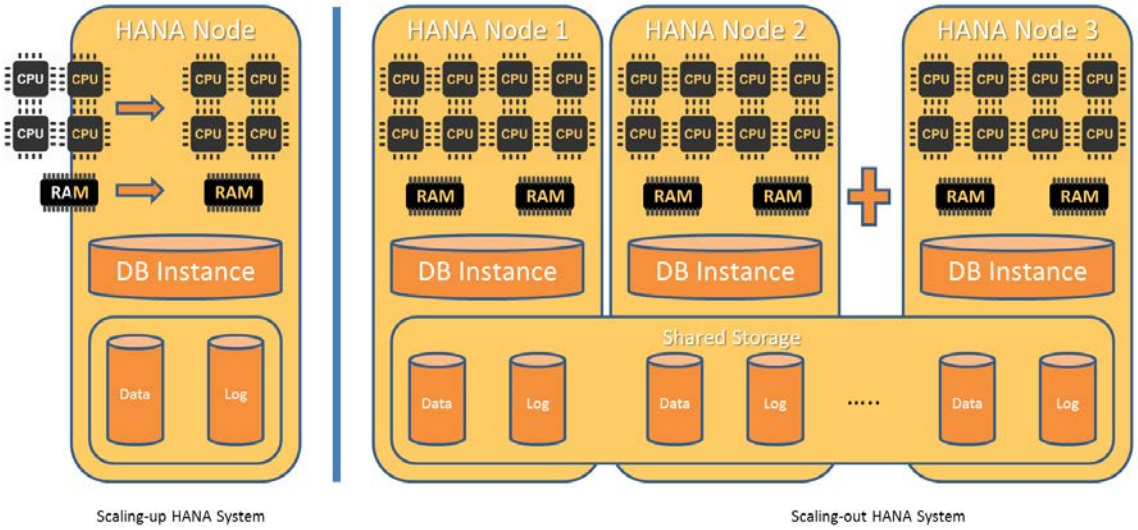

Figure 6. SAP HANA scale-up and scale-out methods. Source: AddOn (2016).

3. Maintainability

Recently, SAP announced that it would continue to provide maintenance of SAP S/4HANA until at least 2025 and this date may extend (Prior & Rayner, 2017). This movement of SAP is to encourage most of its older ERP system users to transition their system to S/4HANA. This offers the RSNF almost a seven-year support period for the system. In addition, SAP has developed Maintenance Planner, which is a cloud-based tool that plans all technical activities for the system (Prior & Rayner, 2017). Before this announcement, the maintenance of the SAP ERP system had an industry average cost of 20–22 percent of the purchase cost annually. SAP support covers technical issues only and does not include the maintenance. It expands to include an annual upgrade for the system (Prior & Rayner, 2017). Both of these ensure overall sustainability of the system. The annual update is optional for the RSNF to do. However, it is advisable to implement any system upgrade after looking at its new features to determine what may affect the RSNF business process (Prior & Rayner, 2017). Furthermore, the SAP S/4HANA application source code is standard among all SAP customers, which means the RSNF will have the same level of system maintenance that SAP currently provides to its other customers. All the previously mentioned factors make the SAP S/4HANA option easy to maintain and upgrade.

4. Training and Availability of Resources

In any ERP system implementation, training is a critical factor that can ensure ease of migration to the new system. In the case of SAP S/4HANA, SAP has extensive training programs through its regional consultants (Fedorowicz, Gelinas, Ulric, Usoff, & Hachey, 2004). SAP is a market leader and experienced in satisfying different customer needs, allowing them to achieve the level of proficiency necessary to train system users effectively (Central Michigan University [CMU], n.d.). However, these training programs are generic; they are only meant to provide a high-level understanding of their system. The training points out only the main features of each module and helps users navigate the system (Fedorowicz et al., 2004). These programs will benefit the RSNF end-users to explore the new system and will help them to get familiar with it. On the other hand, this option for RSNF ERP system, which is a commercial off-the-shelf solution, means that there is a large pool of third-party private companies who have detailed training programs. The RSNF can hire these vendors to plan, train, and evaluate the learning outcomes of the RSNFtrainees.

In terms of availability of resources, Anderson mentioned in his book that "SAP also has a wide range of resources to facilitate successful implementation of the system" (Anderson, 2003, p. 203). He elaborates that "these resources range from the highly skilled professionals that are required to carry out the implementation process equipped with the necessary tools for carrying out the tasks at every stage of the project" (Anderson, 2003, p. 203). Moreover, a significant number of resources for SAP S/4HANA COTS can be reached online since it is used globally. Therefore, SAP S/4HANA COTS is the best equipped solution in terms of training and resource availability.

5. Estimated Time Frame

There is no accurate fixed time for implementing an ERP system because implementation depends on many variables. Nevertheless, according to research done by Panorama Consulting Solutions in 2016, the average implementation time for a new ERP system is 21 months. In the case of the SAP S/4HANA COTS option, the implementation

period is relatively short. To clarify, SAP ensures fast implementation by providing support to its new customer who is migrating from a legacy system to SAP S/4HANA using the pre-implementation tools such as the SAP Rapid Deployment Solution and SAP Rapid Data Migration (Wagner, & Mathäß, 2016).

For the RSNF, the SAP S/4HANA COTS option could be implemented in a relatively short time.

6. Estimated Cost

Similar to the implementation time frame, it is hard to predict accurately the actual cost of the system. That is because every organization, in general, has its unique characteristics. In addition, SAP does not announce the system costs on its website or in SAP blogs for which the majority of the participants are SAP users. Furthermore, several costs are associated with an IT systems project. These costs include not only the upfront system purchase cost, but also software and hardware, maintenance, and support costs. Some articles uncovered in this research, however, do mention the system cost, which can help us to arrive at an estimate. To do so, several assumptions can be made about the RSNF situation. First, we have to predict the number of system users and for the RSNF that assumption will be 60,000 users. Second, Hirsch (2015) suggests that two terabytes (TB) is ideal for every 2,500 users, which means the RSNF would have to pay for 24 TB. On the other hand, SAP prices the HANA platform based on gigabytes (GB), and each GB costs about 3,000 dollars (Snapp, 2017). That means the RSNF would need a 24,000 GB system platform. Consequently, the upfront cost of the system would be around 72 million dollars.

For the maintenance and support cost, as mentioned earlier, that amounts to 20–22 percent of the purchase cost. Thus, it will cost the RSNF around 16 million dollars each year to maintain and support the system.

B. CUSTOMIZED SAP SOFTWARE SOLUTION

The second option that RSNF has is the customized SAP solution. Although this solution is similar to the previously described option, the main advantage of this one is

that it can bridge the gap between the organization's business processes and the ERP software application (Swanier, 2016). SAP S/4HANA code can be reconfigured to meet RSNF's exact requirements, which is crucial is crucial in order to achieve a successful implementation (Swanier, 2016). At the same time, however, the associated level of customization would exceed the 20-percent limit.

For SAP S/4HANA software, customization may be complicated for different reasons. First, the RSNF has to evaluate the system configuration already installed and plan how that the system can be customized. Second, the RSNF does not have SAP-specialized programmers to rewrite the system codes. That leads the RSNF to two options for customizing the system. The first is to let the SAP specialists redesign the system, and the second is to hire third-party consultants to reconfigure the system. The latter approach would be reflected in the system cost and the implementation time.

1. Adaptability

Organizations choose to customize its ERP system to mitigate the risks that associated with user's adaptability. Customization is a great idea to bridge this gap but it is also a bad one in the long term (Deakins, 2015). The customization of the system will slow the organization's ability to adjust to change and therefore grow (Deakins, 2015).

Despite the fact that part of the system is changed to fit the RSNF unique needs, the uncustomized part of the system will be new to RSNF users. This will slow down the implementation process and may affect the scoop of the customization that RSNF has determined. Changing the scope of the system customization will undoubtedly impact the project costs.

Customized SAP S/4HANA will have some potential adaptability issue since SAP designs some of its function to fit the industry standards. Furthermore, adapting to a hybrid system that has some aspects of SAP and other aspects of RSNF customized function might be confusing to the users. For these reasons, this solution is moderately adaptable.

2. Scalability

Although the system is the same as the first option, changing in the system scalability is hard to do. It is challenging for a customized solution to grow over time than it is (Deakins, 2015). That is because of the customization has changed the system functionality which will affect any further changes. This raises an issue with the ERP software that meant to support any growth in the organization actually prevents its ability to grow in the future (Deakins, 2015).

The scalability of a customized SAP software solution is relatively moderate compared to other options. That's because of the re-shaping process that occurs to it has changed the internal side of the system. In addition, RSNF may experience a hard time to add any changes to the system in the future since it's hard to get an outside support.

3. Maintainability

Even if RSNF managed to navigate the implementation risks associated with customization successfully, the organization would start to encounter maintainability problems soon after the implementation. Most times, organizations that choose to customize their ERP system fail to consider the complexity of the system maintenance needed to ensure sustainability and extend the system life-cycle (Swanier, 2016). In this case, SAP probably would not provide support for the system since code would have been rewritten and so completely changed that SAP would not recognize it (Morrison, 2013). This will be a substantial burden on RSNF shoulders to maintain the system.

The system upgrade is the most complicated issue with this option. Technology is changing rapidly and upgrading the system is essential to catch up with these changes. Customizing the core code of the system means adding or deleting features that have been written to fit the RSNF’s needs. Thus, the upgrade would require the RSNF to redo the customization process again to support the newer version. On the other hand, the RSNF can decline any future upgrades for the system; however, this will lead to a shortened life cycle for the system. Ultimately, that means replacing the entire system with a newer one much sooner (Kimberling, 2013). For all these reasons, this option receives to a low rank for maintainability.

4. Training and Availability of Resources

As mentioned earlier, training is crucial to the overall success of system implementation. It is important to note that customization affects not only the core code of the system, but it requires customizing the training materials also. SAP only provides resources for its COTS system. Thus, training resources must be redesigned to match the customized system. In this case, standard SAP courses will be invalid since these courses do not match the system that will be implemented for the RSNF. In addition, the vast pool of local third-party organizations who offer SAP courses may not be familiar with the reshaped system. In this case, the RSNF will have to redesign the training materials and try to find instructors to teach these courses. Based on these considerations, this option will be challenging but not impossible. In comparison to the other options, in terms of training and availability of resources, it will be at the moderate level.

5. Estimated Time Frame

Referencing Davenport (1998), Iskanius agrees that "ERP system implementation may last several years, particularly if the system is heavily customized to make it better suit the needs of the adopting organization" (Iskanius, 2006, p. 115). Compared to SAP COTS, this option will have additional phases of implementation. The first is the pre-installation phase that involves identifying all SAP S/4HANA system functions that are expected to be implemented. This will enable the RSNF to identify the functions that have to be customized. The next step is to apply the changes by rewriting the core code of the system to fit RSNF needs. Finally, the redesigned system must be implemented and its functionality tested.

As previously noted, this option will take a longer time to complete as compared to the first solution.

6. Estimated Cost

The costs of customized ERP solutions are ambiguous since the level of customization is unknown. Customized ERP system cost, however, can easily exceed the COTS option price by 50–100 percent (Swanier, 2016). This amount includes only the

cost of customizing the code of the system, not the maintenance, upgrades, and training costs. These together may triple the overall cost of the system.

Referring to the cost estimates of SAP S/4HANA COTS, the total cost of the hardware and software of the system was around 72 million dollars. In this option, the same components will cost roughly 140 million dollars. For maintenance, it is expected to cost 20–22 percent of the purchase price for the first option; however, this number may double since it is almost impossible to maintain the system customized by a third-party partner.

Consequently, this option is expected to cost RSNF at least 300 million dollars to implement. This does not include the cost of training or upgrades if RSNF decides to upgrade its system and redo the customization since it is hard to determine these costs.

C. CUSTOM-BUILT SOFTWARE SOLUTION

The third option that RSNF has to upgrade its IT infrastructure is the custom-built solution. This option involves building the software from scratch, which means that the RSNF would have to hire a company that provides software development services. The company would build and develop the system based on current RSNF business processes. There are many advantages to this option; the first is that RSNF will have a system that handles its day-to-day operation precisely. Another advantage of this option is the RSNF will "pay" for what it actually needs since ERP system providers typically target a vast audience (Sarantakes, 2016).

On the other hand, there are some drawbacks to this option. Theoretically, the process of coming up with a custom ERP solution to run the daily operations of a business may sound like a perfect strategy for enhancing performance; however, such practices are rare (Canes, 2015). In addition, custom-built systems are “one of a kind,” which means a limited number of people know how the system was built and designed (Canes, 2015). This can be problematic for the RSNF to keep those people for a long time or to replace them with a new staff that will need time to catch up and understand the system. Furthermore, despite the fact that the system is designed mainly to fit the requirements of the RSNF accurately, the benefits obtained from the system are often

surpassed by the resources needed to ensure proper maintenance of the perfectly-fit system (Canes, 2015). Lastly, the RSNF has to choose system developers wisely to ensure their professional experience. This is a crucial factor in determining the system's success. The developers should have a comprehensive understanding of the RSNF business process in addition to the requisite technical knowledge of building software.

1. Adaptability

This system will be built to match the RSNF current business process, which indicates that the system is highly adaptable. At the same time, there may be some challenges associated with a custom-built system. The primary obstacle is exposing the RSNF users to a modern system even though they will be following the same business processes. This issue is time-consuming and can be mitigated sometime after implementing the system.

Therefore, the custom-built solution is the most adaptable ERP software solution for the RSNF as it most closely addresses the organization's specific needs.

2. Scalability

Most custom-built software solutions are designed to fit current organization needs. Unfortunately, this often represents the short-term needs of organizations (Deakins, 2015). This kind of option is meant to serve the organization for only a specific time and specific needs. This fact hampers the system's ability to grow in the future or the organization's ability to change its current business process. In the long term, organizations may find themselves in a position in which they could not grow with their current system, and that may force them to exchange their system for a newer one (Deakins, 2015). In addition, a custom-built system may not be flexible enough to meet new changes in technology.

It is incredibly complicated for a custom-built solution to evolve (Deakins, 2015). This type of system is typically a one-time purchase from a vendor that designs and builds the system specifically for a particular organization. There is likely no long-term relationship with the vendor that would enable more customization later for an evolving

system. Therefore, the custom-built solution is the least scalable solution among the three options.

3. Maintainability

In most cases, no outside support comes with custom-built systems (Canes, 2015). This is unlike other ERP options on the market, which have experts in maintaining the system (Canes, 2015). There is a need for highly skilled professionals to maintain the system even long after its implementation. Otherwise, any issues that occur may not be handled directly or properly, and inadequate maintenance may reduce the lifespan of the system after implementation. In that case, it will be the responsibility of the RSNF IT department to fix problems. The RSNF IT department has capable professionals who are generalists; their knowledge is limited in regard to these kinds of systems. In addition, the RSNF will have to rely on a small team of developers and designers to fix and/or maintain the system. Troubleshooting and maintenance can be difficult and time-consuming, affecting the IT team's workload and impacting their availability to manage other IT problems.

Custom-built solutions often require continuous updates in order to fix any system failure (Canes, 2015). Unlike an outside vendor, upgrading the system is easy to do since this vendor has developed the upgrade and test its functionality (Canes, 2015). Since the RSNF will own the system, it will have to manage any future updates by itself. These challenges indicate that it is even harder to maintain or run an update on this type of system.

4. Training and Availability of Resources

The RSNF will build this system based on its business processes, which means the RSNF will have to develop its own training resources. In order to do so, the RSNF will have to form a team of its members to allocate the training materials. Nonetheless, this process must be done with the help of the system provider to minimize knowledge gaps and avoid any misunderstanding. This is unlike the COTS ERP system that has more and readily accessible resources for training. This option may end up having insufficient resources available to support the project. Therefore, this option will be

ranked as the least favorable of the three options in terms of training and availability of resources.

5. Estimated Time Frame

The custom-built solution will take a very long time to implement because it will be developed in different phases. These phases include planning, designing, developing, documenting, transitioning and training. This whole process is expected to take around three to five years to complete. This option, therefore, ranks as the longest one compared to the others.

6. Estimated Cost

The price advantage of the custom-built system is that it will only entail the cost of system development, which means that once the system is implemented there is no extra cost. The RSNF will save on maintenance costs by maintaining the system through its IT department. However, this does not mean this option is relatively low cost. In fact, it is more expensive because all of the development is from scratch (Canes, 2013). Writing and building an ERP system from scratch is costly and time-consuming (Canes, 2013). Even with the savings that RSNF might gain, the long duration of the project contributes heavily to the extra cost. Deploying a custom-built system is likely to cost RSNF at least 200 million dollars.

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V. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

A. SUMMARY

In the 1950s, the RSNF was established as a small branch of the Saudi Army. Since then, RSNF is leapfrogging to modernize its forces to be able to protect Saudi Arabia's waters. The first jump for the RSNF was the massive SNEP I program with the U.S. Navy that provided the backbone of the RSNF and its real operational beginnings. That was followed by the Sawari I and Sawari II programs with the French Navy. Those programs allowed the RSNF to expand its geographic presence in Saudi Arabia's sea borders. Now, the RSNF is about to do its next jump with the SNEP II program that was signed six months ago with the U.S. Navy to modernize its ships and facilities in order to enhance RSNF's capabilities to defend Saudi Arabia in the escalating Middle East environment. This program requires an adequate IT infrastructure to support and coordinate with SNEP II components. The RSNF current IT infrastructure, however, is relatively old to integrate with SNEP II outcomes. This infrastructure consists of several IT systems that work independently from each other, and there is a lack of integration among them. Consequently, the RSNF is seeking to acquire an ERP system capable of solving the integration issues and enhancing RSNF business processes.

ERP solutions are the fundamental components of the success of any organization. That success can be attributed to the benefits associated with the ERP systems that enhance the performance of the various departments within the business. Yet, as noted, it is often hard to implement such systems and the implementation process may lead to some significant disruption in the workplace (Ehie & Madsen, 2005). Fortunately, there is a large pool of vendors who can offer the best kind of ERP solution that suits various customer specifications. Through the use of a custom-tailored solution that will cause minimum disruption, in turn, organizations can realize better business success. Selecting the right system, though, is a dilemma for any organization planning to implement an ERP solution that will have a positive impact on the general performance of the business.

Implementing an ERP system is complicated and requires a high-level plan to facilitate this process. A complex system, like the one the RSNF intends to implement, requires support and commitment from all levels within the RSNF to achieve the planned goal. Defining the new target and explaining the purpose of such a project will help the RSNF in speeding up the implementation. Additionally, the success (or failure) of the ERP implementation heavily depends on the system users themselves (Fang & Patrecia, 2005). Adequate training is required to ease the transition phase for RSNF members. "The best system in the world will be useless if the employees do not know how to operate it" (Jewell, n.d.). Insufficient training and lack of communication of the goals of the ERP implementation could lead to change management issues where employee resist the new system and may consider it a burden (Jewell, n.d.). The RSNF has to consider these factors in order to have a successful implementation.

To help RSNF choose the right approach for acquiring an ERP system, NAVSUP BSC has suggested three strategies for RSNF to consider (see Table 1). These three options are the SAP S/4HANA COTS, the customized SAP S/4HANA, and the custom-built ERP system. The process of integrating all of these proposed solutions into business has undergone various transformations over the past several years. Today, the majority of organizations embracing the use of this new technology do so because of the advantages associated with using these systems. This thesis has compared these options in terms of adaptability, scalability, maintainability, estimated time frame, and estimated cost. These factors must be considered by any decision maker to determine the right approach for acquiring such a system. A summary of the three options comparisons can be seen in the following table which illustrates the findings on each option.

Table 1. The three-option comparison

	SAP S/4HANA COTS	Customized SAP	Custom-Built Solution
Adaptability	Difficult	Moderate	Easy
Scalability	Easy	Moderate	Difficult
Maintainability	Easy	Difficult	Difficult
Training	Easy	Moderate	Difficult
Estimated Time Frame	Short	Long	Very Long
Estimated Cost	72 Million Dollars	300 Million Dollars	200 Million Dollars

B. CONCLUSION

From the findings of this research and based on the author's knowledge, the SAP S/4HANA COTS solution appears to be the most advantageous one for the RSNF. The main reason for favoring this option is that it comes with more benefits than the other options. Some of these benefits include a scalable system that will support any future needs, an easy to maintain system that is supported by professionals from SAP, and the availability of training courses provided by SAP or a large pool of third-party training institutions. Moreover, the RSNF can have this option installed in a relatively short time. Although the costs associated with this option are only estimated, the difference in price between this option and the other two is significant. This difference can be attributed to the fact that this system already exists and is ready to implement for any new SAP customer. On the other hand, this option lacks adaptability since it will reflect with the

industry standard business processes. Nevertheless, SAP has convenient and powerful tools that mitigate this issue and can help RSNF members to adapt to the system.

C. RECOMMENDATIONS

In order to choose one of these options to implement, the RSNF needs to conduct a thorough GAP analysis to assess its requirements and understand them. This will enable the RSNF to clearly identify the option that fits its needs. At the same time, the RSNF decision maker should keep in mind that there will be some trade-offs associated with each one of these options.

In the case that the RSNF chooses the SAP S/4HANA COTS option, it has to ensure that the amount of system customization does not exceed the limit of 20 percent. Respecting that limit will ensure an extended life for the system—perhaps beyond what it is planned.

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