NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

BRAZILIAN NAVY UNIFORM SUPPLY CHAIN: A COST-BENEFIT ANALYSIS OF AN E-MARKETPLACE TO OUTSOURCE DISTRIBUTION

by

Igor T. de Andrade Cesar

June 2020

Thesis Advisor: Geraldo Ferrer
Second Reader: Ryan S. Sullivan

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** June 2020	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE BRAZILIAN NAVY UNIFORM SUPPLY CHAIN: A COST-BENEFIT ANALYSIS OF AN E-MARKETPLACE TO OUTSOURCE DISTRIBUTION	**5. FUNDING NUMBERS**
6. AUTHOR(S) Igor T. de Andrade Cesar	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000	**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A	**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

This paper estimates and monetizes the impact of a policy change in the Brazilian Navy's uniform supply chain. This policy change includes a revision to part of its process flowchart and the creation of a new design for the uniform distribution and selling processes (e-marketplace), by which authorized companies would be able to sell uniforms directly to military personnel. Using a cost-benefit analysis as a systematic quantitative method of assessing the alternative policy and comparing it to the status quo, this thesis projects that the positive impacts are significantly higher than the negative impacts. Even with some intangible aspects to consider, the net benefits are approximately R$73 million in the next five years, which is the project's time frame. Overall, the analysis suggests that the Brazilian Navy should implement the new policy because it has substantial economic benefits.

14. SUBJECT TERMS uniform supply chain, electronic marketplace, process design	**15. NUMBER OF PAGES** 93
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release. Distribution is unlimited.

BRAZILIAN NAVY UNIFORM SUPPLY CHAIN: A COST-BENEFIT ANALYSIS OF AN E-MARKETPLACE TO OUTSOURCE DISTRIBUTION

Igor T. de Andrade Cesar
Lieutenant Commander, Brazilian Navy
BS, Brazilian Naval Academy, 2007
MBA, Federal University of Rio de Janeiro, 2012
MPA, Federal University of Rio de Janeiro, 2013
Master of Logistics, Pontifical Catholic University of Rio de Janeiro, 2016

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
June 2020

Approved by: Geraldo Ferrer
Advisor

Ryan S. Sullivan
Second Reader

Eddine Dahel
Academic Associate, Graduate School of Defense Management

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This paper estimates and monetizes the impact of a policy change in the Brazilian Navy's uniform supply chain. This policy change includes a revision to part of its process flowchart and the creation of a new design for the uniform distribution and selling processes (e-marketplace), by which authorized companies would be able to sell uniforms directly to military personnel. Using a cost-benefit analysis as a systematic quantitative method of assessing the alternative policy and comparing it to the status quo, this thesis projects that the positive impacts are significantly higher than the negative impacts. Even with some intangible aspects to consider, the net benefits are approximately R$73 million in the next five years, which is the project's time frame. Overall, the analysis suggests that the Brazilian Navy should implement the new policy because it has substantial economic benefits.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION....1
A. WHAT IS THE NEW POLICY?....2
B. RESEARCH QUESTION....3
C. SCOPE OF THE THESIS....4
D. LIMITATIONS....4

II. BACKGROUND AND INSTITUTIONAL DETAILS....5
A. THE SUPPLY CHAIN MANAGEMENT (SCM)....5
B. SCM FOR APPAREL AND UNIFORMS....6
C. OUTSOURCING DECISIONS IN BUSINESS LOGISTICS AND IN SCM....7
D. MILITARY LOGISTICS....8
E. THE BRAZILIAN NAVY'S SUPPLY SYSTEM....9
F. THE UNIFORM SUPPLY CHAIN *STATUS QUO*....11
G. EXPENDITURES LIMITATION – "SPENDING CEILING"....11
H. E-COMMERCE GROWTH: ADVANTAGES AND DISADVANTAGES....13
I. OMNICHANNEL STRATEGY....16
J. INVENTORY LOSSES....20

III. METHODOLOGY....25

IV. ANALYSIS....27
A. INVENTORY LEVEL REDUCTION....27
B. ACQUISITION COSTS....29
C. DEMAND FORECAST, PROCUREMENT AND ORDERING COSTS....38
D. STORAGE – HOLDING COSTS....40
E. TRANSPORTATION COSTS....43
F. SELLING COSTS....45
G. SALES REVENUE....46

V. RESULTS / COST-BENEFIT ANALYSIS....49
A. STEP 1: SPECIFY THE SET OF ALTERNATIVE PROJECTS (COURSES OF ACTION, COA):....49
B. STEP 2: DECIDE WHOSE BENEFITS AND COSTS COUNT (WHO HAS STANDING).....50

C. STEP 3: IDENTIFY IMPACTS, CATALOGUE THEM, AND SELECT MEASUREMENT INDICATORS. 50
D. STEP 4: PREDICT THE IMPACTS OVER THE LIFE OF THE PROJECT. 52
E. STEP 5: MONETIZE ALL IMPACTS 55
F. STEP 6: DISCOUNT BENEFITS AND COSTS TO OBTAIN PRESENT VALUES. 60
G. STEP 7: COMPUTE THE NET BENEFITS OF EACH POLICY ALTERNATIVE 60
H. STEP 8: PERFORM SENSITIVITY ANALYSIS 62
I. STEP 9: MAKE A RECOMMENDATION 65

VI. CONCLUSION 67
A. SUGGESTIONS FOR FUTURE STUDIES 69

LIST OF REFERENCES 71

INITIAL DISTRIBUTION LIST 75

LIST OF FIGURES

Figure 1. Some steps of a generic supply chain. Source: Box Around the World (2019).....2

Figure 2. Apparel supply chain tiers. Source: World Resources Institute (2018).....6

Figure 3. The structure of the BN supply system.....10

Figure 4. Government's primary expenditures (% of GDP). Source: Appy et al. (2015).....12

Figure 5. Evolution of gross public debt in relation to GDP. Source: Tendências Consulting (2016).....13

Figure 6. Stakeholders along the supply chain. Source: World Economic Forum report (2019).....15

Figure 7. Omni-channel experience representation. Source: Dalsey Hillblom Lynn International GmbH (2015).....17

Figure 8. Exponential data growth between 2010 and 2020. Source: Dalsey Hillblom Lynn International GmbH (2013).....19

Figure 9. Survey: For fiscal year 2018, what was your company's inventory shrinkage percentage calculated at retail? Source: NFR (2019).....21

Figure 10. Loss per segment indexes. Source: Abrappe, 2019. 22

Figure 11. The main causes for shrinkage in Brazil. Source: Abrappe, 2019.....23

Figure 12. Uniform budget from 2009 to 2019. Source: Singra. 31

Figure 13. Demand vs budget (2011–2020). Sources: Singra and Siafi. 34

Figure 14. Budget risk simulation (Oracle Crystal Ball) – Uniform Distribution 35

Figure 15. Budget risk simulation (Oracle Crystal Ball) – Triangular Distribution 36

Figure 16. Budget risk simulation (Oracle Crystal Ball) – Lognormal Distribution 37

Figure 17. Budget risk simulation in the new policy (Oracle Crystal Ball) – Lognormal Distribution 38

Figure 18. Comparison between revenue and losses. Source: Singra. 42

Figure 19. Uniform transportation costs. Source: Singra. 44

Figure 20. The BN's sales revenue for military personnel ranked higher than E3. Source: Singra. 46

Figure 21. Target Selic interest rate between 2010 and 2020. Source: BCB (2020). 56

LIST OF TABLES

Table 1. U.S. retail sales by segment, 2018 and 2019 (billions). Source eMarketer (2018). 14

Table 2. Inventory value reduction by reducing inventory levels. Adapted from Singra. 28

Table 3. BN's average monthly inventory levels from October/2018 to December/2019. Source: Singra. 29

Table 4. The BN uniform real demand for the last ten years (in million R$). Source: Singra. 30

Table 5. Uniform budget from 2009–2019. Source: Singra. 30

Table 6. Acquisition Costs forecast using Exponential Smoothing method. Source: Siafi. 33

Table 7. BN monthly wages for each rank between 2021 and 2025 and total budget spent with all personnel from uniform demand forecast office. 39

Table 8. BN monthly wages for each rank between 2021 and 2025 and total budget spent with all personnel from uniform acquisition office. 40

Table 9. Uniform acquisition and losses in the last 11 years. Source: Singra. 41

Table 10. Projection of annual spending on wages in the uniform warehouse in the actual policy. Source: Law 13,954 / 2019. 43

Table 11. Uniform Transportation Costs between 2009 and 2019. Source: Singra. 44

Table 12. Exponential smoothing table for the uniform transportation's forecast for 2021 to 2025, considering the actual budget from 2009 to 2019. Source: Siafi. 45

Table 13. Microsoft Excel's Regression Analysis tool Statistics – Sales revenue. 47

Table 14. Summary of positive and negative impacts of the new policy. 52

Table 15. Total average uniform inventory reduction. 53

Table 16. Total weight and volume of uniform transported by the BN between 2009 and 2018 and their average value. Source: Singra. 53

Table 17. Projection of Acquisition costs of status quo, new policy and cost savings for the period between 2021 and 2025. 55

Table 18. Inventory projection and opportunity costs for the period between 2021 and 2025. 56

Table 19. Brazilian Navy's uniform transportation projected costs in the status quo and in the course of action from 2021 to 2025. 57

Table 20. Projection of losses of status quo, new policy and cost savings for the period between 2021 and 2025. 58

Table 21. Expected lost sales from 2021 to 2025 (R$). 59

Table 22. Expected wages for military personnel related to quality monitoring. 59

Table 23. Total expected yearly costs and benefits between 2021 and 2025. 61

Table 24. Net benefits of the new policy for a discount factor of 4% and an inflation rate of 3.75%. 62

Table 25. Net benefits of the new policy – Upper bound. 63

Table 26. Net benefits of the new policy upper bound for a discount factor of 4% and an inflation rate of 3.75%. 63

Table 27. Net benefits of the new policy – Lower bound. 64

Table 28. Net benefits of the new policy lower bound for a discount factor of 4% and an inflation rate of 3.75%. 65

LIST OF ACRONYMS AND ABBREVIATIONS

4IR	fourth industrial revolution
Abrappe	Associação Brasileira de Prevenção de Perdas (Brazilian Association for Loss Prevention)
APICS	American Production an Inventory Control Society
ASCM	Association for Supply Chain Management
BA	Brazilian Army
BAC	Brazilian Air Force
BCB	Banco Central do Brazil (Brazilian Central Bank)
BN	Brazilian Navy
CBA	cost-benefit analysis
COA	course of action
CSCMP	Council of Supply Chain Management Professionals
DoT	Department of Transportation
FY	fiscal year
GDP	gross domestic product
IPCA	Índice Nacional de Preços ao Consumidor Amplo (National Consumer Price Index)
NRF	National Retail Federation
NPS	Naval Postgraduate School
NPV	net present value
OMB	Office of Management and Budget
SAbM	Sistema de Abastecimento da Marinha (Brazilian Navy's Supply System)
SCM	supply chain management
Selic	Sistema Especial de Liquidação e de Custódia (Brazilian Central Bank's Special Settlement and Custody System)
SGM	Secretaria-Geral da Marinha (General Secretary of Navy)
Siafi	Sistema Integrado de Administração Financeira (Brazilian Federal Government Integrated Financial Administration System)
Singra	Sistema de Informações Gerenciais do Abastecimento (Supply General Informations System)

SKU	stock keeping unit
SQ	status quo
WEF	World Economic Forum

ACKNOWLEDGMENTS

To God, for all protection and for being my lord, savior, counselor, and guide.

To my wife and best friend, Heloísa, for all the love, affection, care and dedication. For always being by my side, no matter what it takes.

To my parents, Neuza and Ademir, for their love, education, and values, and for always offering me their support and giving me the certainty of being my safe haven.

To my in-laws, Moasir and Joçania, for their love, care, affection, and support, even from a distance.

To my new Brazilian Navy and Brazilian Air Force friends, with whom I began a closer contact and friendship here in Monterey, CA, and shared much joyfulness and moments of difficulty.

To my advisor, Professor Geraldo Ferrer, and second reader, Professor Ryan Sullivan, for all the teachings, contributions, time, and dedication.

To all professors and employees of the Graduate School of Defense Management, for their understanding and attention, especially the Operations and Logistic Management team.

To my friends and colleagues at the Masters, for the company, for the support and for the friendship.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

In recent years, the Brazilian Navy (BN) did not have all the budget needed to manage its Uniform Supply Chain. Additionally, in 2015, the Brazilian congress approved an amendment in the constitution that froze public spending, which prevented raising the budget for many areas of the government. To address this problem, an electronic marketplace was created with the support of the BN, a marketplace in which authorized companies would be able to sell uniforms directly to military personnel. Several questions were asked regarding this new policy's efficiency and effectiveness. This project attempts to identify the impact of changing the process flow, reducing the inventory levels and the number of participants in the uniform supply chain by adopting an on-line marketplace for uniforms.

Today, the Brazilian Navy provides the basic and complement uniform items for personnel recently recruited and, once a year, gives new uniforms to the beginning enlisted ranks. These personnel have a "credit" that they can use in some uniform stores managed and sustained by the BN. Additionally, personnel ranked above E3, once every three years, earn a specific amount of money to buy new uniforms and they can buy them at these uniform stores, even though the BN is only required by law to provide uniforms for enlisted personnel E1 and E2, and for those personnel recently recruited. So, the BN has available on the shelves, nowadays, uniforms for higher ranking personnel that it is not required to provide.

To make this distribution happen, the BN has a systemic process as part of its Supply System that is responsible for uniform design, demand forecasting, procurement, storage, transportation, selling and delivery in the whole country. This requires high logistic and capital costs, most of which are common to all companies, but some are related specifically to the public management itself, because of the legislation and bureaucracy involved in public spending.

As Figure 1 demonstrates, the BN is involved in five or more steps in the whole Uniform Supply Chain. The BN is the wholesaler, buying uniform in a great quantity and distributes them among some small distribution or sales points.

Figure 1. Some steps of a generic supply chain. Source: Box Around the World (2019).

For those personnel that the BN is required by law to provide uniforms, the BN does have to get involved. But is it efficient to keep providing uniforms to all personnel, instead of letting these personnel buy uniforms in the open market, from pre-approved suppliers?

A. WHAT IS THE NEW POLICY?

Creating an e-commerce platform that gathers different stores to sell uniforms for all Brazilian Navy and Marine Corps can directly influence the products' price, supply time, and convenience for the personnel. Today, to provide uniforms for all its military personnel, the BN has a systemic process responsible for demand forecasting, procurement, storage, transportation, selling and delivery to the whole country. Being a government organization, this process is naturally inefficient because of the bureaucracy involved. In addition, it is known that there are some specialized brick and mortar shops that sell uniforms according to the BN and other Armed forces rules.

The Brazilian legislation, specifically Law 12,664 / 2012, restricts military uniform sales to establishments (brick and mortar or on-line stores) accredited by the Brazilian Navy, the Brazilian Army (BA) or the Brazilian Air Force (BAF). Nowadays, this control

is not effective. Thus, the platform proposed by his thesis would also enable the regulation and effective application of the above-mentioned law by helping the BN to regulate which companies would be allowed to sell their products in the e-marketplace, creating a business license that would be utilized for brick and mortar stores as well.

This platform will promote collaboration between the Brazilian Navy and many uniform suppliers that, today, sell uniforms individually to the military personnel as a retail and, as a wholesale, to the BN Supply System. With this proposed platform, the BN would outsource part of its selling items, thus increasing those uniform suppliers demand and they would be able to sell with lower prices to the military personnel.

According to Ballou (2007), "Collaboration and coordination are the keys to achieving the benefits of supply chain management. When the parties in a supply chain relationship win equally due to their cooperative actions in the supply channel, the benefits are likely to be realized and the relationship remains intact."

B. RESEARCH QUESTION

How much could the Brazilian Navy save by changing part of its uniform supply chain, creating a new process for the sale and distribution of uniforms (e-marketplace)?

Which financial and operational benefits would be observed if the BN stopped being involved in some parts of the uniform supply chain and started focusing on those operations that are mandatory by law?

To answer these questions, a cost-benefit analysis is performed in this thesis. According to OMB Circular A-94, cost-benefit analysis is a "systematic quantitative method of assessing the desirability of U.S. government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects" (Office of Management and Budget [OMB], 2016).

Still, according to the Circular, "This analysis is used to support the U.S. Government decisions to initiate, renew, or expand programs, policies or projects and applies to all agencies of the Executive Branch of the Federal Government."

The net present value is the standard criteria to decide if a government's program is economically viable and to justify if it should be implemented, comparing its benefits minus its costs (OMB, 2016).

C. SCOPE OF THE THESIS

The purpose of this study is to investigate the main logistics costs for the Brazilian Navy of its uniform supply chain in the last ten years, considering procurement, storage, transportation, selling and acquisition costs, and forecasting for the next five years to verify the benefits of reducing or even excluding these costs, taking in consideration the new policy suggested.

D. LIMITATIONS

The study considers the total application of the policy, disregarding any management or execution problems or policy exceptions that may occur during the policy's implementation.

The raw data in this study was extracted from Singra, that is the main system used by all organizations related to the BN Supply System and its users and customers, and Siafi, the Federal Government Integrated Financial Administration System.

The impacts on other parties, as the military personnel or any organization is not within the scope of this thesis.

II. BACKGROUND AND INSTITUTIONAL DETAILS

This chapter presents some important concepts related to logistics and supply chain management, how they impact organizations nowadays and, specifically, how they can be implemented in this project and the importance of these concepts for the BN overall.

A. THE SUPPLY CHAIN MANAGEMENT (SCM)

The American Production and Inventory Control Society (APICS), now part of the Association for Supply Chain Management (ASCM), according to its Dictionary's 13th edition (2010), defines supply chain management as "the design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally."

Supply Chain Management (SCM) also includes "coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies" (Council of Supply Chain Management Professionals [CSCMP], 2019).

According to Ballou (2007), "supply chain management is concerned with realizing the opportunities from integrated management of product flow processes across functions and between channel members."

From the raw material to the final product, a huge path is trodden to satisfy the customers' needs and demands. For each class of material singularities are observed. For each step on the supply chain, the more specialized the company is the better.

Rather than having full logistic capacity or a large organizational structure, it may be a smart strategy for any organization to make alliances that can share logistic capacity with other companies. This partnership, different from just outsourcing, can bring some important advantages like cost reduction, lower investments on assets, reduction on

uncertainties and risks, reduction on personnel or labor hours and lower distribution costs (Ballou, 2006).

B. SCM FOR APPAREL AND UNIFORMS

Trying to reach efficiency and effectiveness in all supply chain tiers is good for everybody, starting with those responsible for producing raw material until the final consumer (Ballou, 2007). The flow of information and data including all tiers (companies) in the chain makes better production, transportation planning and demand forecasting possible, as shown in Figure 2. Consequently, better overall lead times and final prices are reached at the end of the chain.

Figure 2. Apparel supply chain tiers. Source: World Resources Institute (2018).

According to Williams (2014), the apparel supply chain starts with the farming industry (agriculture and livestock) when cotton, fibers, leather, and similar material are produced. An interesting aspect about agricultural production is that it is usually expected or assumed to have a buyer. Exact alignment of agricultural industry with consumption is rare, they are produced opportunistically in the hope that there is a buyer (Williams, 2014).

Still, according to Williams (2014), the beginning of this supply chain is "characterized by the dynamics of change in production operations and business

relationships." It is shown the importance of an integrated supply chain and the communication between these tiers.

After this first tier, a supplier consolidates the producers' production and sells to the manufacturers' tier, where the raw material is transformed into final product or part of it. The final product can be transferred or sold to a wholesale or straight to retailers. Then, it is sold to the final customer (Ballou, 2006).

In the Brazilian Navy's Uniform Supply Chain, these steps happen almost in the same way. The first tiers are the same, including the manufacturer. After this step, the manufacturer sells its products to the BN, as a wholesaler, and to some retailers, those brick and mortar stores specialized in selling military uniforms.

The Brazilian legislation, specifically the Law 12,664 / 2012 restricts military uniform selling to establishments (brick and mortar or on-line stores) accredited by one of the three services, the Brazilian Navy, the Brazilian Army or the Brazilian Air Force. Nowadays, this control is not effective.

After buying in large scale, the BN distributes the uniform items to some small stores that provide and/or sell these uniforms to the military personnel (Secretaria-Geral da Marinha [SGM], 2009).

C. OUTSOURCING DECISIONS IN BUSINESS LOGISTICS AND IN SCM

> "The main reason behind decisions to outsource business logistics is usually cost savings" (Boyson et al., 1999; Lieb, 2008).
>
> "Yet another important dimension which relates to outsourcing decisions is the use of strategic alliances and long-term partnerships to secure both goods and services" (Juntenen et al., 2011).

Supply Chain agility itself is another important factor for outsourcing logistic decisions and for the military (Juntenen et al., 2011). For any government organizations that must follow some rules enforced by law, it can be a smart option in a world where time is an important asset and logistics efficiency is now a competitive differential, not just means to an end: "Cost efficiency and service levels are two value dimensions that also affect logistics outsourcing decisions" (Juntenen et al., 2011). At what point is providing a

service that is not mandatory important for the BN? Is there a risk of being out of the market? It is important to analyze the costs related to that service and assess whether it is worth it or not.

Another important dimension to be assessed when outsourcing is considered to be an option is the possibility of having strategic alliances and long-term partnerships to secure both goods and services (Juntenen et al., 2011). Assessing the market to see if there are competent third parties that can execute that service well is important.

D. MILITARY LOGISTICS

According to Ballou (2007), "Before the 1950s, logistics was thought of in military terms. It had to do with procurement, maintenance, and transportation of military facilities, materiel, and personnel." During those days, companies did not give importance for the competitive differential that a good logistics management could give to them. The concept was very narrow, "getting the right goods to the right place at the right time, although the organization within the typical firm around the activities currently associated with logistics was fragmented" (Ballou, 2007).

According to Sutherland (2008), "The practice of logistics in the military sector has been in existence for as long as there have been organized armed forces and the term describes a very old practice: the supply, movement, and maintenance of an armed force both in peacetime and in battle conditions."

Some historic events corroborate this idea. For example, Alexander the Great and his father Philip recognized logistics as an art and made some improvements (Sutherland, 2008). Still according to Sunderland (2008), "Philip realized that the vast baggage train that traditionally followed an army limited the mobility of his forces. In order to compensate he made the troops carry their own weapons, armor, and some provisions while marching, minimizing the need for a transportation infrastructure."

A failure in logistics management can destroy an Army or bring a company to bankruptcy. Another famous military example was when Napoleon failed the attempt to conquer Russia in 1812. According to Sutherland (2008), "Napoleon's method of warfare

was based on rapid concentration of his forces at a key place to destroy his enemy. When he found out that Russia had a very poor road network, it was too late."

"The practice of logistics in the business sector, starting in the latter half of the twentieth century, has been increasingly recognized as a critical discipline" (Sutherland, 2008), even for the Armed Forces from different countries themselves. The improvement on logistics techniques from this moment are very important and we have to be prepared to adapt.

E. THE BRAZILIAN NAVY'S SUPPLY SYSTEM

The Brazilian Navy's Supply System (SAbM) is the set of organizations, processes and resources of any nature, interconnected and interdependent, structured with the purpose of promoting, maintaining and controlling the supply of the material necessary for the maintenance of the Forces and other Naval organizations in conditions of full efficiency (SGM, 2009). Its structure includes the following organizations, as shown in SGM (2009):

> a) General Supervision, an organization responsible for giving high level orientations, coordinating, and controlling the activities of the Superintendence and Technical Supervision Organizations related to Navy Supply. The Brazilian Navy's General Supervision Organization is the General Staff.
> b) Superintendence Organization, responsible for the managerial supervision and ensuring strict compliance with the guidelines, relevant standards, orders, and instructions and for the efficiency and coordination of the SAbM. The General Secretary of Navy (SGM) is the Superintendence Organization.
> c) Technical Supervision Organizations, responsible for guiding, coordinating, and controlling the technical activities of the supply system.
> d) Management Organization, responsible for the design, planning, execution, control, and monitoring of all Navy's supply chain activities. The Navy's Supply Directorate is the Management Organization.
> e) Execution Organizations, responsible for the operational level activities. Thus are divided into three parts:
>
> 1. Acquisition Organizations: Responsible for the material procurement and purchasing inside the country and overseas. The main Acquisition Organizations are Navy's Acquisition Center in Rio de Janeiro, Brazilian Naval Commission in Washington and Brazilian Naval Commission in London;

2. Control Organizations: They are responsible for maintaining the balance between the demand and the availability of material at the warehouses all over the country, through the inventory levels management, resulting in replenishment actions, redistribution, and material disposal; and
3. Distribution Organizations: Responsible for the transportation of the material between warehouses and all military organizations all over the world.

Figure 3 shows the general structure of the BN supply system, considering the strategic, management and operational levels and all organizations related to them.

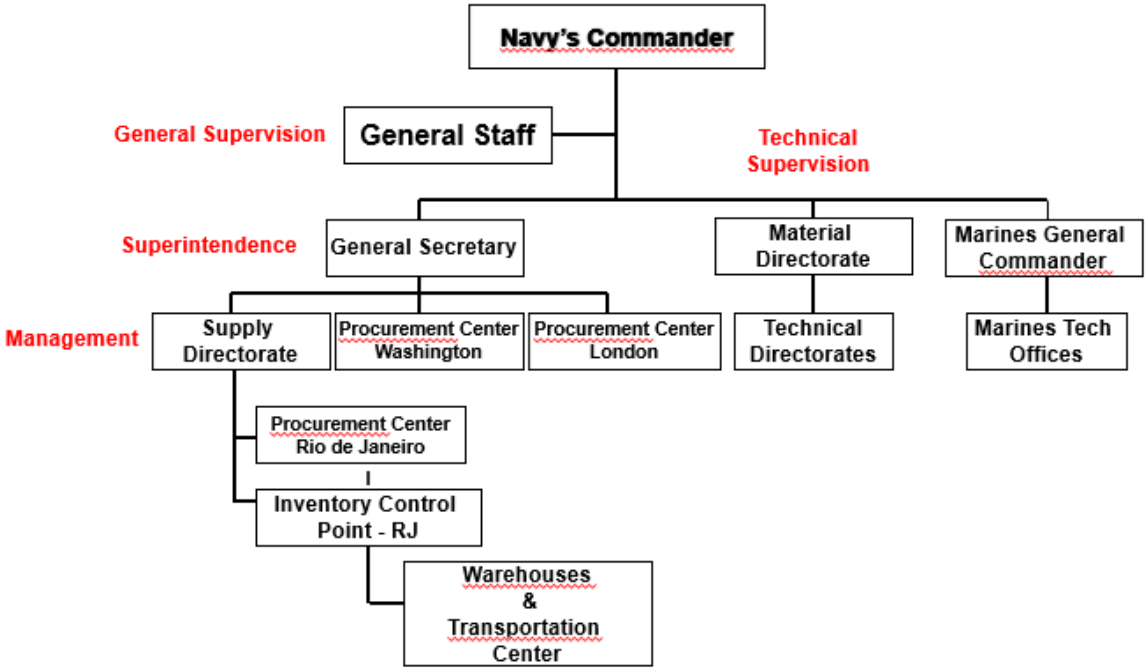


Figure 3. The structure of the BN supply system.

The Brazilian Navy classifies its material into seven different classes: Ordinary Material (office, cleaning, paint etc), Uniform (Clothing and Textiles), Subsistence, Ammunition, Fuel (lubricants and greases), Medical and Spare Parts (SGM, 2009).

F. THE UNIFORM SUPPLY CHAIN *STATUS QUO*

The Brazilian Navy is the first provider of military clothing items to new officers and recruits. The uniform set consists of the "Basic Set," "Complement Set," and "Special Set."

The "Basic Set," mandatory, is that one necessary for all personnel's daily activities and it is the same for people from the same ranks.

The "Complement Set," mandatory as well, is that one that includes service-specific utility uniforms that are not for general public and use.

The "Special Set," is that one that is only requested for very specific situations and, because of this, is not mandatory. Some specific military organizations have this uniform in their property and, when needed, they lend them to those that will need them.

G. EXPENDITURES LIMITATION – "SPENDING CEILING"

In 2015, the Brazilian Congress approved an amendment in the Constitution (the 95th Amendment) that froze public spending for the next 20 years, avoiding the growth of the public debt / gross domestic product (GDP) ratio by containing public spending (Appy et al., 2015). Since 1991, government expenditures have grown at rates above the average GDP, as shown in Figure 4.

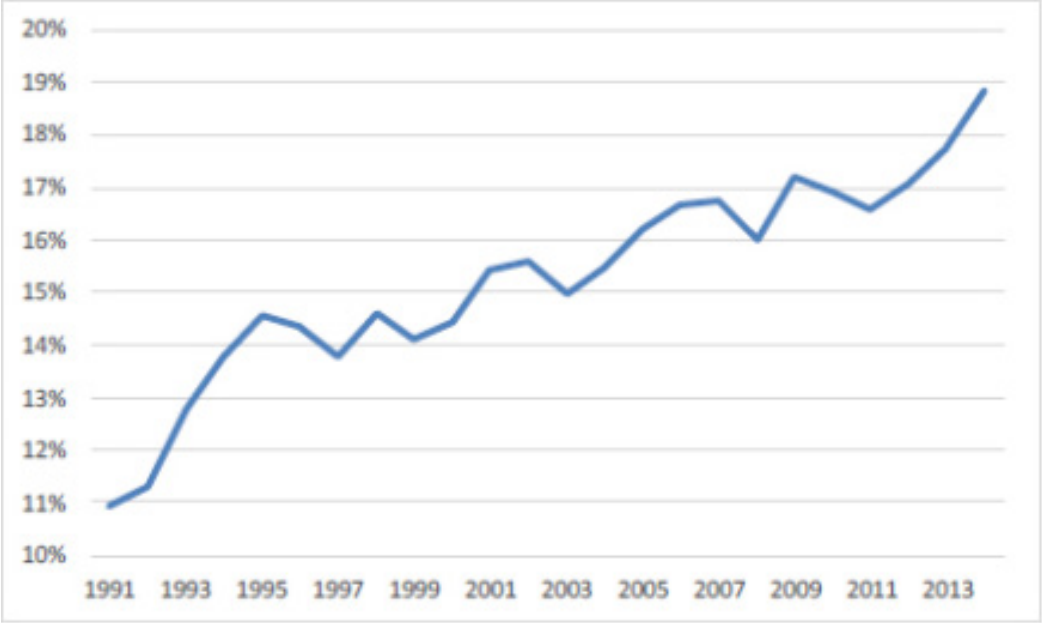


Figure 4. Government's primary expenditures (% of GDP). Source: Appy et al. (2015).

Public expenditures and investments are limited to the same amounts spent in the previous year, adjusted only for inflation measured by the National Consumer Price Index (IPCA). Education and Health are the only exceptions. This proposal is initially valid for the next 20 years, but as of the tenth year, the President in office of the Federative Republic of Brazil may change this correction of expenses through a complementary bill.

Figure 5 shows the evolution of gross public debt in relation to GDP and a forecast with and without the constitutional amendment.

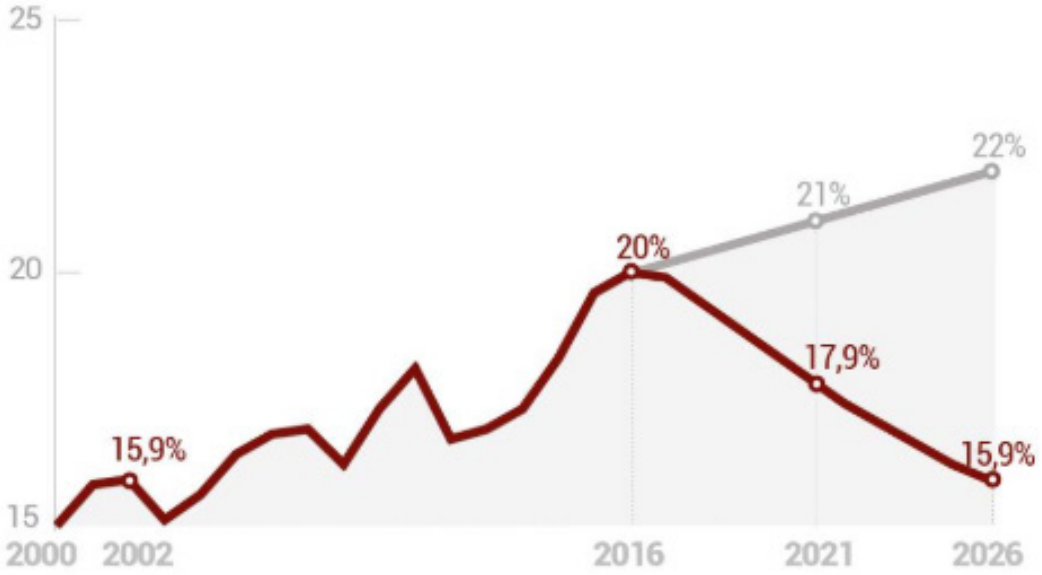


Figure 5. Evolution of gross public debt in relation to GDP. Source: Tendências Consulting (2016).

This amendment, though, limited the budget increase for all public organizations of the Executive, Legislative and Judiciary branches and many other public related organizations. For this reason, it became hard for the Brazilian Navy to increase its budget for any area. Thus, a policy that can reduce the budget and spending on the BN Uniform Supply Chain would be very important to reduce progressively the mandatory expenditures and enable the BN to keep making important investments in the area.

H. E-COMMERCE GROWTH: ADVANTAGES AND DISADVANTAGES

Creating an on-line sales platform that gathers several companies to sell Navy uniforms will bring the uniform distribution to the "modern world." In the United States, e-commerce is growing in a much faster way in the last years compared to brick-and-mortar stores, as we can see in Table 1.

Table 1. U.S. retail sales by segment, 2018 and 2019 (billions). Source eMarketer (2018).

	2018	2019	% change	% of total 2019 spending	% of 2019 growth contribution
Brick-and-mortar/ in-store	**$4,827.09**	**$4,924.12**	**2.0%**	**89.1%**	**55%**
Ecommerce	**$525.69**	**$605.30**	**15.1%**	**10.9%**	**45%**
Desktop	$317.55	$334.92	5.5%	6.1%	10%
Mobile	$208.13	$270.38	29.9%	4.9%	35%
—Smartphone	$148.79	$205.15	37.9%	3.7%	32%
—Tablet	$57.71	$63.49	10.0%	1.1%	3%
—Other mobile	$1.64	$1.74	6.3%	0.0%	0%
Total	**$5,352.78**	**$5,529.42**	**3.3%**	**100.0%**	**100%**

Note: includes products or services ordered using the internet, regardless of the method of payment or fulfillment; excludes travel and event tickets, payments such as bill pay, taxes or money transfers, food services and drinking place sales, gambling and other vice good sales

"Brick-and-mortar's definitely not going away," said Erin Jordan, senior director and partner at Walker Sands Communications. "It's just shifting into more experience-led opportunities, and that looks different for every store" (Emarketer, 2019).

We can observe an e-commerce growth tendency for the next years and the uniform selling must follow this tendency: "Mobile retail (m-commerce) has been a growing in the past few years driven by purchases made by smartphones and it is expected to grow 37.9% per year in the next years and to be responsible for 76% of mobile spending" (Emarketer, 2019).

A new way of thinking supply chain management in the Fourth Industrial Revolution (4IR) and its technologies across the supply chain emerged in the last few years. Understanding its results in business models is important for every company and/or organization.

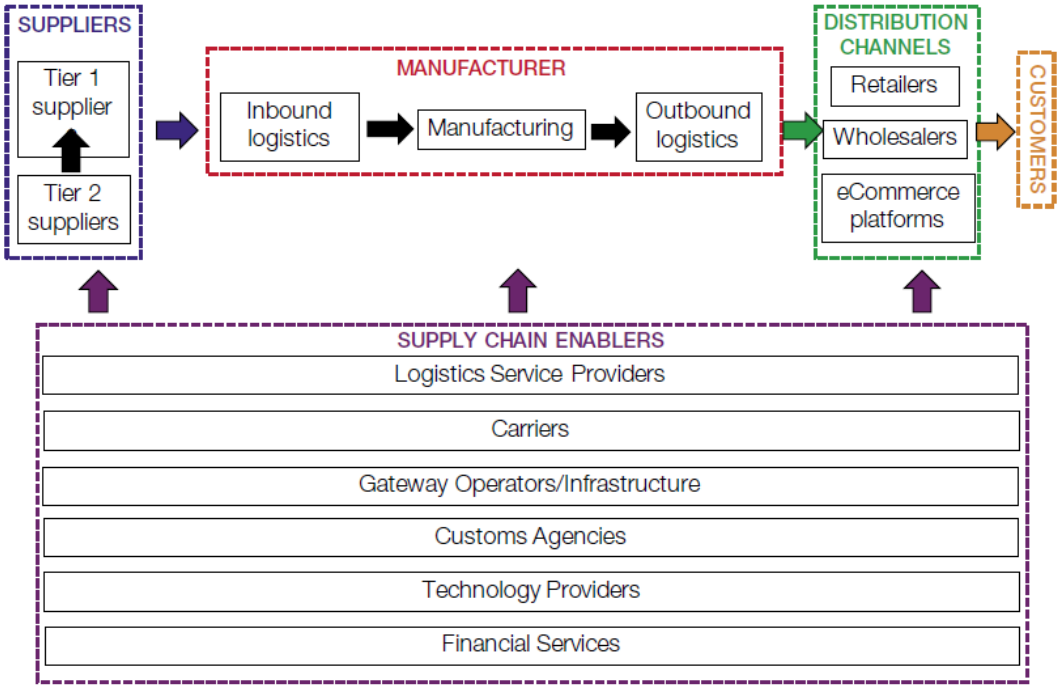


Figure 6. Stakeholders along the supply chain. Source: World Economic Forum report (2019).

As shown in Figure 6, e-commerce platforms are now an inherent part of the stakeholders along the supply chain.

> Some governments are already formulating national plans to support the transition to the future of production, such as Industries 4.0 in Germany, *Industria Conectada* 4.0 in Spain and Manufacturing Innovation 4.0 in South Korea. The public sector is involved in joint initiatives with the private sector to develop roadmaps or "how to" books to help private-sector companies launch their digital transformation journey. (WEF report, 2019, p. 12)

Advantages and Disadvantages of E-commerce and E-marketplace

Niranjanamurthy et al. (2013) bring us some basic advantages and disadvantages of e-commerce, as follows:

a. Advantages

1. Faster buying/selling procedures, as well as easy to find products
2. Buying/selling 24/7
3. More reach to customers; there is no theoretical geographic limitations

4. Low operational costs and better quality of services
5. No need of physical company set-ups
6. Easy to start and manage a business
7. Customers can easily select products from different providers without moving around physically. (p. 2362

b. Disadvantages

1. Anyone, good or bad, can easily start a business. And there are many bad sites which eat up customers' money.
2. There is no guarantee of product quality.
3. Mechanical failures can cause unpredictable effects on the total processes. As there is minimum chance of direct customer to company interactions, customer loyalty is always on a check.
4. There are many hackers who look for opportunities, and thus an ecommerce site, service, payment gateways, all are always prone to attack. (p. 2362)

As "ecommerce opens new markets for ecommerce businesses" (Niranjanamurthy et al., 2013), providing remote access to stores for those military personnel who are not situated close to major military centers in big cities, for the Brazilian Navy's case, is another big advantage.

I. OMNICHANNEL STRATEGY

Another important benefit that the platform proposed in this thesis will bring is a fully-integrated shopping experience (personal computers, cellphones, tablets and stores), what is called *omnichannel* experience. This concept is perceived as an evolution of multichannel retailing.

According to Juaneda-Ayensa (2016), "An omnichannel strategy is a form of retailing that, by enabling real interaction, allows customers to shop across channels anywhere and at any time, thereby providing them with a unique, complete, and seamless shopping experience that breaks down the barriers between channels".

According to the Dalsey Hillblom Lynn International GmbH (DHL) Trend Report (2015), "Consumer buying behavior is changing drastically with growing adoption of the Internet, smartphones, and handheld devices worldwide. To stay awake in the market, retailers and manufacturers in all industries will need to adapt to this new reality to thrive."

As a trend, “Omnichannel will be a key requirement in the future presenting challenges and significant opportunities to all businesses” (Dalsey Hillblom Lynn International GmbH, 2015), as represented in Figure 7.

Figure 7. Omni-channel experience representation. Source: Dalsey Hillblom Lynn International GmbH (2015).

According to the DHL trend report, “A study conducted in June 2015 among more than 2,600 consumers in Asia found the top two reasons that prevent shoppers from buying products in shops: the time it takes and the inconvenience of the shopping experience” (Dalsey Hillblom Lynn International GmbH, 2015).

Let us imagine an officer that needs an important piece of uniform, but he is in a deployment or another mission. He needs the uniform as soon as he gets home. When he arrives from the deployment, he is tired of all duties and still has to go to a brick and mortar store (inside or outside the Navy) to buy it. We are speaking of time that otherwise could be spent with his family. That is what happens nowadays. The electronic marketplace will have a direct influence on price, time and convenience These are the factors most valued by consumers today in the city of Rio de Janeiro, for example (Cesar, 2018).

The implementation of an e-marketplace can bring some other benefits for the Brazilian Navy Uniform Supply Chain Management. First, the Navy will be able to improve its focus in uniform design and specifications, uniform and sellers quality control, and provide a better service to those personnel that it is required by law to provide uniforms (Law no. 6,880 / 1980 and MP 2215-10 / 2001), the beginning enlisted ranks (E1 and E2) and all those recently recruited.

Another important benefit that the marketplace will bring is that it will enable the regulation and effective application of Law No. 12,664 / 2012, which restricts the sale of uniforms to establishments accredited by the Brazilian Navy. Every marketplace seller will have to be accredited by the structure that will be created to run the platform. Therefore, those companies will have the permission to sell uniforms on-line and inside the store.

Additionally, the electronic marketplace will stimulate competition between sores from different locations. From now on, all of them will be able to sell their items all over the country, with no boundaries.

At last, but not least, the e-marketplace will provide a better data collection for decision making—Big Data. We are experiencing a secular shift to digital and data-driven retail and logistics operations.

According to the World Economic Forum report (2019), Big Data / Data Analytics is defined as "the capability of processing extremely large data sets to identify patterns of relationships (correlation, causality) among data to be used in detecting market trends, consumer behavior and preferences. Most common applications in business operations range from demand forecasting to quality control and predictive maintenance."

"Companies in every sector are making efforts to trade gut-feeling for accurate data-driven insight to achieve effective business decision making. No matter the issue to be decided—anticipated sales volumes, customer product preferences, optimized work schedules—it is data that now has the power to help businesses succeed," according to the DHL trend report (Dalsey Hillblom Lynn International GmbH, 2013). Although we see the importance of accurate data, missing data is still a problem for logisticians (Ballou, 2007). During the effort to gather all the BN's data, we observed that the data is not well

consolidated. It is difficult to use them on decision-making processes: “The logistics sector is ideally placed to benefit from the technological and methodological advancements of Big Data. Besides resources, labor, and capital, there is no doubt that information has become an essential element of competitive differentiation” (DHL, 2013).

Figure 8 shows that the data growth between 2010 and 2020 have been following an exponential tendency, which enhances the importance of a better data management and utilization on decision-making.

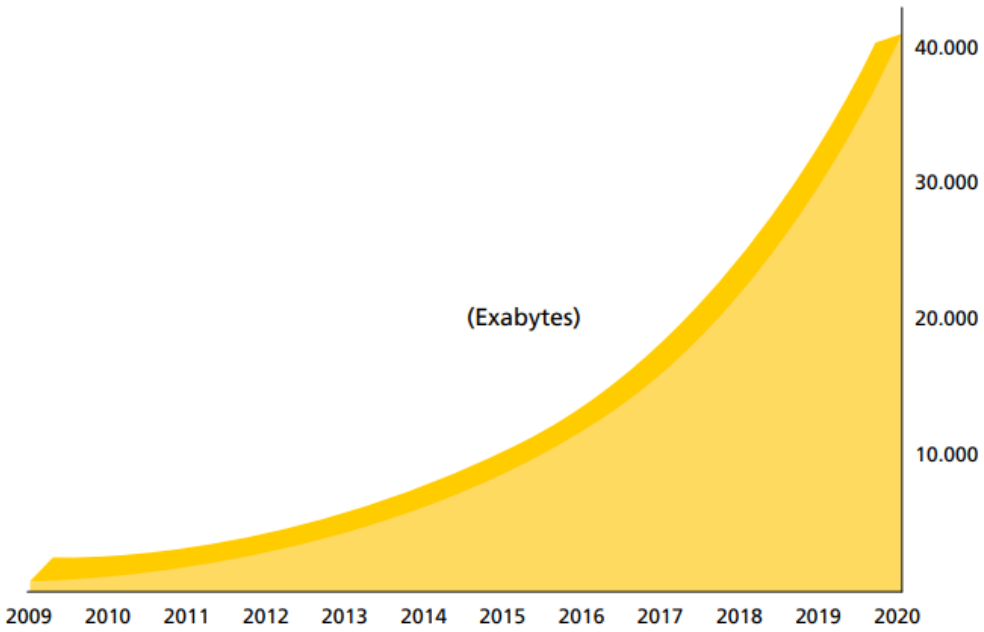


Figure 8. Exponential data growth between 2010 and 2020. Source: Dalsey Hillblom Lynn International GmbH (2013).

Related to this data growth usage tendency, E-marketer (2019) says that “at the same time brick-and-mortar transitions to the future, consumers are adapting to digitally-enabled shopping experiences. More purchases than ever before are influenced by digital touchpoints on the path to purchase, and these engagements provide data that informs inventory management, merchandising and shopper experience”.

J. INVENTORY LOSSES

According to *APICS Dictionary* 13th edition (2010), shrinkage is a "term used to describe loss of inventory, reductions of actual quantities of items in stock, in process, or in transit. The loss may be cause by scrap, theft, deterioration, evaporation and so forth."

Administrative errors are also related to inventory management: "In the retail world, shrinkage, or shrink, is the term used to describe a reduction in inventory due to shoplifting; employee theft; administrative errors such as record keeping, pricing, and cash counting; and supplier fraud" (Hudson, 2020).

According to the U.S. National Retail Federation (NRF) 2019 National Retail Security Survey, "the average shrink rate in the retail industry was 1.38% of sales in 2018." This has remained steady over the last few years. The year 2018's survey showed that the "apparel sector was slightly above the overall average at 1.7%, edging up from 2017's 1.4%" (NRF, 2018).

Figure 9 shows the results for the 2019 National Retail Security Survey in the U.S., considering all surveyed companies' inventory shrinkage percentage calculated at retail and its percentage related to the total; the survey makes a brief comparison with FY 2016, 2017 and 2018. The results, for example, are that 27.3% of the surveyed companies have lost 0.49% and below of its inventory, 21.8% have lost between 0.50 and 0.99%, 3.6% have lost between 1% and 1.24%, 10.9% have lost between 1.25% and 1.49%, 10.9% have lost between 1.50% and 1.94%, 14.5% have lost between 2% and 2.99%, and 10.9% have lost between 3% or more.

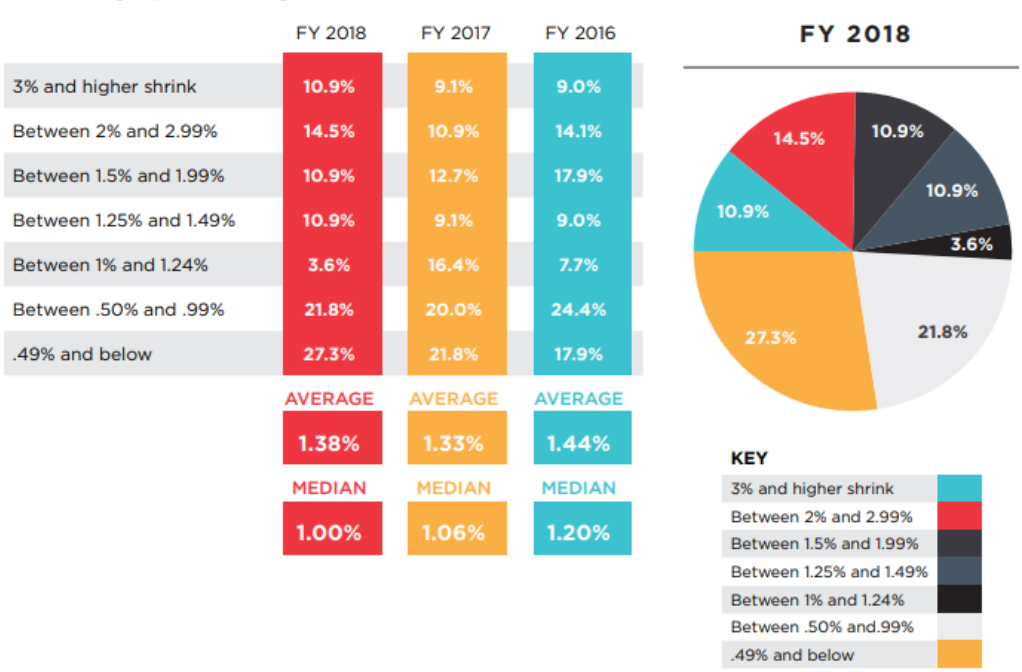


Figure 9. Survey: For fiscal year 2018, what was your company's inventory shrinkage percentage calculated at retail? Source: NFR (2019).

In Brazil, the numbers are very similar. The average loss index identified in this year's Abrappe survey was 1.38% on retail companies' net sales. Abrappe is the Brazilian Association for Loss Prevention. In 2017, the loss rate was 1.29%, in 2016, 1.32%, and in 2015, 1.40%. This loss growth can be partially explained by analyzing the economic scenario experienced these last years, such as optimism; the investment appetite of entrepreneurs was higher compared to 2017 and many companies invested in higher inventory levels (Brazilian Association for Loss Prevention [Abrappe], 2019).

Figure 10 shows the loss indexes per segment. The segments most related to our study are Fashion (*Moda*), Footwear (*Calçados*) and Department Stores (*Lojas de Departamento*). These losses are below the average, 1.18%, 0.70% and 0.62%, respectively (Abrappe, 2019).

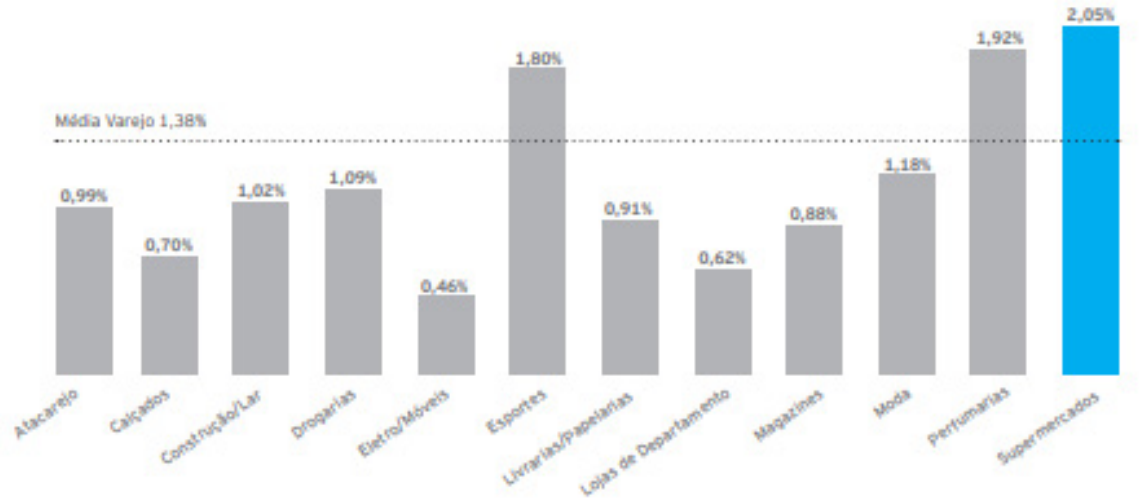


Figure 10. Loss per segment indexes. Source: Abrappe, 2019.

The main causes for shrinkage in Brazil are operational "breaks" (*quebras operacionais*) 36%, which result from failure, deficiency or inadequacy of any internal processes involving people, systems or external and unexpected events, shoplifting (*furto externo*) 20%, inventory errors (*erros de inventário*) 13%, employee theft (*furto interno*) 11% and administrative errors (*erros administrativos*) 9% (Abrappe, 2019), as we can see in Figure 11.

Figure 11 shows the main causes for shrinkage in Brazil in 2018 and their percentage compared to total losses. Among the causes of operational "breaks," the expiration date is the biggest cause, with a 24% share of the total breaks in the average. Deterioration and Perishability appear second place with an 18% result due to the influence from supermarkets (Abrappe, 2019).

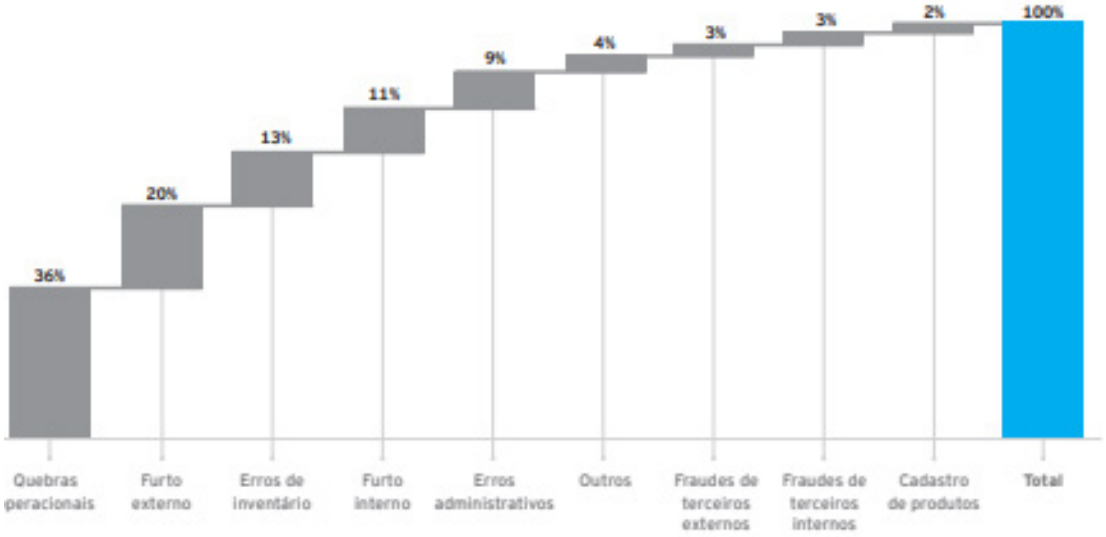


Figure 11. The main causes for shrinkage in Brazil. Source: Abrappe, 2019.

Chapter IV presents a shrinkage analysis in the BN uniform warehouse and compare the results with the average losses for retail companies in Brazil.

THIS PAGE INTENTIONALLY LEFT BLANK

III. METHODOLOGY

The methodology adopted in the preparation of this thesis was a qualitative study based on a systematic bibliographic review of specialized literature. The articles, papers, handbooks, reports, government documents and texts studied were found in national and international scientific textbooks and journals available in on-line databases and in the NPS library.

Some keywords or expressions were used for searches, like "supply chain management," "logistics costs," "inventory reduction," "military logistics," "omnichannel," "e-commerce," "electronic marketplace," "apparel supply chain" etc., all related to the scope of the thesis, to orientate the search in the chosen databases. Then, a manual review of the selected abstracts was carried out and, finally, the best texts were read in full.

This thesis prioritized the available data from official/government sources, without, however, abandoning the academic database, in order to not limit the conclusions to the reading of only a few articles.

To make this study possible, a cost-benefit analysis compared the alternative policy (Course of Action, COA) and the status quo, that is keeping the Brazilian Navy's uniform supply chain the way it is, in which the BN is responsible for demand forecasting, procurement, storage, transportation, selling and delivery to the whole country.

According to the Office of Management and Budget (OMB) Circular A-94 (2016), Cost-Benefit Analysis is a "systematic quantitative method of assessing the desirability of U.S. government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects".

The research method includes "collection of actual data on the amounts of all relevant costs, statistical analysis to determine the expected value of such costs, and discounting to determine the lowest present value of the alternative policy," as recommended in the aforementioned Circular.

To collect all the data needed, such as quantity and prices of SKU (stock keeping units) in the warehouse, all uniform procurement, storage, transportation and selling costs and all related losses, we used Singra, that is the Brazilian Navy's supply management information system, controlled by the BN Supply Directorate.

IV. ANALYSIS

In this chapter, the data collected from the period between 2009 and 2019 is presented and analyzed. With this data, we are able to measure and compare the actual and the new policies, by measuring the cost-reducing acquisition costs, inventory levels, human resources, transportation, holding, and opportunity costs.

A. INVENTORY LEVEL REDUCTION

To estimate the possible inventory size after implementing the new proposed policy, first the on-time inventory position of August 23, 2019 was extracted from Singra. Then, all stock-keeping units (SKU) were separated according to each rank that uses them.

Because the new policy requires that the Brazilian Navy should stop selling uniforms for Officers and enlisted personnel higher ranked than Petty Officer Third Class (PO3), the data was organized according to the following criteria:

1. Uniforms exclusive for Officers and enlisted personnel higher ranked than PO3.
2. Uniforms for general use.
3. Uniforms for military organizations' use.
4. Uniforms for ranks below PO3.

After the above separation, we got the quantity and price of each SKU and calculated the total inventory value for the four groups created above. Then, it was calculated the total inventory reduction, as shown in Table 2.

Table 2. Inventory value reduction by reducing inventory levels. Adapted from Singra.

GROUP	UNIFORM TYPE	ACTUAL (R$)	REDUCTION	PROPOSAL (R$)
1	**ITEMS EXCLUSIVE FOR OF AND PO3+**	21.280.839,94	100%	0,00
2	**ITEMS GENERAL USE**	56.419.777,21	52%	27.081.493,06
3	**MILITARY ORGANIZATION ITEMS**	327.097,41	0%	327.097,41
4	**ITEMS EXCLUSIVE FOR PO3-**	16.886.756,80	0%	16.886.756,80
TOTAL		**94.914.471,36**	53%	**44.295.347,27**

The 100% reduction on Group 1 is based on the premise that the policy will be fully implemented. The 52% reduction in Group 2 is because the number of military personnel in ranks below PO3, since 2010, is 48% of the total BN's personnel (Navy Statistical Yearbook, 2010–2019). Groups 3 and 4 will not be modified in the new policy.

Considering the reductions above, the total inventory level reduction with the proposed change was estimated using the average inventory levels for the last 15 months, shown on Table 3.

Table 3. BN's average monthly inventory levels from October/2018 to December/2019. Source: Singra.

Month	Avg Inventory
2018-10	R$ 94.441.272,53
2018-11	R$ 93.321.096,14
2018-12	R$ 96.504.498,83
2019-01	R$ 98.067.294,61
2019-02	R$ 98.665.234,47
2019-03	R$ 98.103.265,84
2019-04	R$ 96.291.300,51
2019-05	R$ 94.439.529,35
2019-06	R$ 94.275.183,71
2019-07	R$ 93.607.374,95
2019-08	R$ 95.779.886,68
2019-09	R$ 95.905.104,03
2019-10	R$ 95.645.467,69
2019-11	R$ 94.321.265,08
2019-12	R$ 95.156.278,28
Average last 15 months	**R$ 95.634.936,85**

Thus, considering a 53% reduction, the new inventory levels are in the range of R$ 44.948.420,32, after implementing the new policy.

B. ACQUISITION COSTS

Acquisition costs are those related to raw materials, purchase planning, quality, taxes, purchase price, and financing (Association for Supply Chain Management [ASCM], 2017). Purchasing price and order quantity will determine the company's financial demand for the period.

Reassessing these costs, we prevent the cost of concurrent procurement and disposal or the cost of repair of unserviceable items when serviceable items are available as well. The amount required to supply all uniform demand in the last few years is represented in Table 4.

Table 4. The BN uniform real demand for the last ten years (in million R$). Source: Singra.

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
28.5	36.6	46.4	46.6	52.0	52.0	55.0	57.0	59.0	60.7

The annual budget is not enough for this demand, disregarding the outlier years (2012 and 2013).

Table 5 represents the total acquisition cost for the last 11 years. The values vary a lot in some years, although we can find an approximate distribution pattern. Since the Brazilian Navy spends all its budget every year, we can consider that the yearly uniform budget for the last ten years is equal to the acquisition expenditures.

Table 5. Uniform budget from 2009–2019. Source: Singra.

UNIFORM BUDGET (R$)				
YEAR	**2009**	**2010**	**2011**	**2012**
ACQUISITION	20.954.163,16	13.996.501,36	20.339.697,17	112.212.208,45
YEAR	**2013**	**2014**	**2015**	**2016**
ACQUISITION	107.712.243,55	46.330.326,72	43.581.488,50	44.011.019,82
YEAR	**2017**	**2018**	**2019**	
ACQUISITION	44.105.336,03	36.292.819,22	36.495.031,41	

The demand does not depend on BN needs, technically speaking. It follows a political trend, since it depends on the government's annual budget, and this increases the uncertainty.

Figure 12 gives a better idea of how the budget (acquisition costs) varied in the last eleven years. Fiscal years of 2012 and 2013 were outliers in this data series.

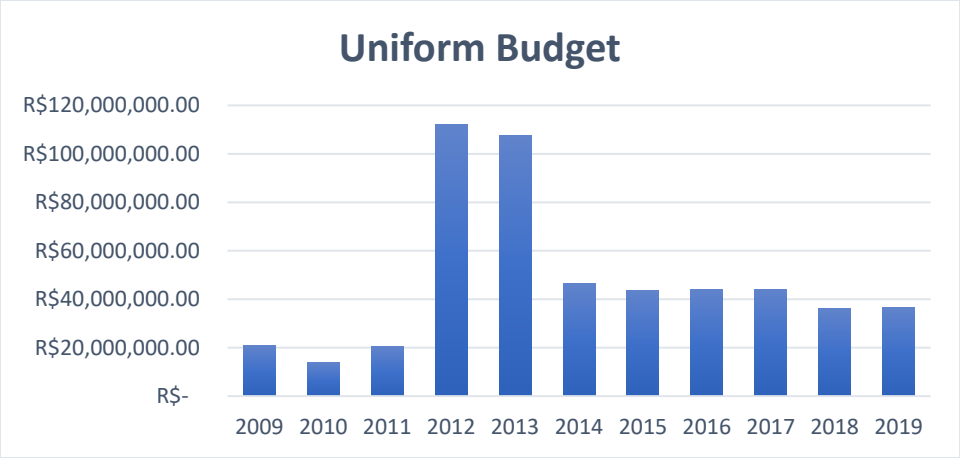


Figure 12. Uniform budget from 2009 to 2019. Source: Singra.

In order to project the acquisition costs for the next five years (project timing) we use a double exponential smoothing method, which incorporates a trend element.

A trend element is considered because of the high demand variability and because, according to the Brazilian Navy's Commander Memorandum 2/2017, the BN will readjust its manpower annually until 2030, by reducing the number of military personnel by 1% per year.

The double exponential smoothing method is a two-step smoothing process, as follows (Ferrer, 2019):

1. Apply the smoothing constant α to estimate the intrinsic demand level Lt as the weighted average between the actual demand At and the demand forecast Ft. The intrinsic demand level is what the demand should be, if we could remove the trend and the randomness. It is estimated after we obtain the values for the actual demand and the forecast.
2. Apply the smoothing constant β to estimate the trend Tt as the weighted average between the change in the intrinsic demand level ($Lt - Lt_{-1}$) and the previously estimated trend Tt_{-1}.

According to Ferrer (2019), good values of smoothing constants α and β lie in the range between 0.01 and 0.35. In this study we use both constants α and β equal to 0.35, because it turns the forecast more responsive to the variance between years. The smoothing parameters must be selected independently. With the intrinsic demand level and the trend

estimates we can forecast the next period's demand by using the formulas below (Ferrer, 2019):

$$Lt = \alpha \times At + (1-\alpha) \times Ft$$

$$Tt = \beta \times (Lt - Lt-1) + (1-\beta) \times Tt-1$$

3. Obtain the next period's demand forecast Ft_{+1} as the sum of the intrinsic demand level Lt and the trend Tt.

As we do not have the actual budget values before FY 2014, we have to estimate the starting conditions for both level (L_1) and trend (T_1) by using the equations below (Ferrer, 2019):

$$T_1 = \frac{A_n - A_1}{n-1}$$

$$L_1 = \frac{\sum_{i=1}^{n} A_i}{n} - \frac{(n-1) \times T_1}{2},$$

where "T" represents the estimated trend, "A" represents the actual budget for each year, "n" the number of years and "L" the intrinsic level.

Finally, to estimate the future values, we will use the final step equations as shown in Ferrer (2019):

$$F_{t+1} = L_t + T_t$$

$$F_{t+k} = L_t + k \times T_t$$

The equation above shows the forecast expression for next period (t+1) and for any period in the near future (t+k) where k is the number of future years. Assuming that the rate of decline remains the same, we may use the trend estimate to forecast demand of a few periods in the future. For this reason, the forecast is more accurate for small values of k. Thus, we estimate the future values until FY 2022 and repeat this value until 2025, last year of the project.

Table 6 shows the actual budget from 2014 until 2019 and the calculated forecast, intrinsic levels and estimated trends considering the formulas presents above. In order to calculate the starting value, it was used n = 4.

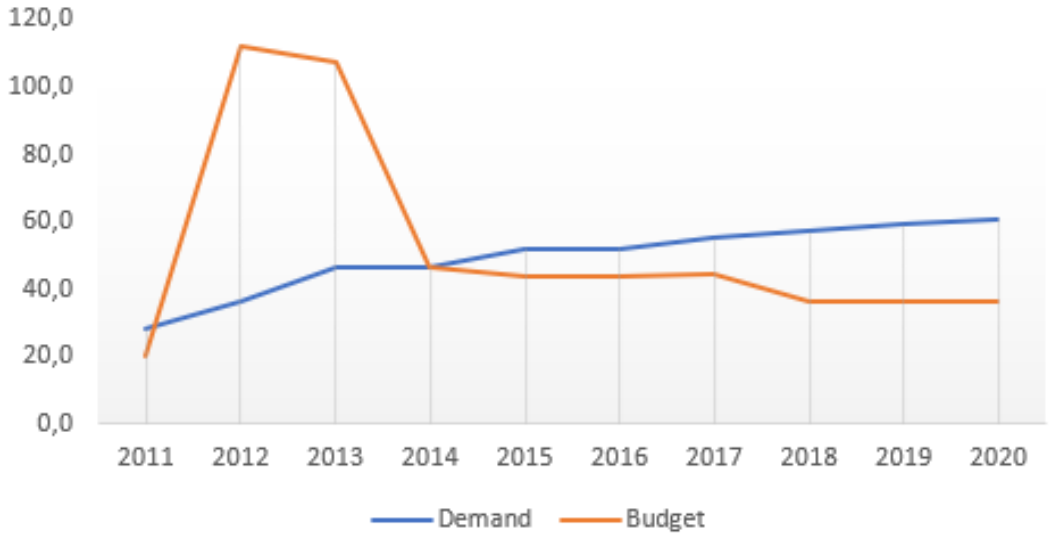
Table 6. Acquisition Costs forecast using Exponential Smoothing method. Source: Siafi.

FY	Actual Budget (R$)	Forecast (R$)	Intrinsic Level-t	Estimated Trend-t
2014	46.330.326,72		45.619.538,11	-741.663,56
2015	43.581.488,50	44.877.874,55	44.424.139,43	-900.470,85
2016	44.011.019,82	43.523.668,58	43.694.241,51	-840.770,33
2017	44.105.336,03	42.853.471,19	43.291.623,88	-687.416,88
2018	36.292.819,22	42.604.207,00	40.395.221,28	-1.460.561,89
2019	36.495.031,41	38.934.659,39	38.080.789,60	-1.759.416,31
2020		36.321.373,28		
2021		34.561.956,97		
2022		32.802.540,65		
2023		32.802.540,65		
2024		32.802.540,65		
2025		32.802.540,65		

Budget Risk

Comparing both demand and budget, we observe that every year there is a considerable risk of the annual budget not reaching the real demand.

As we can see in the Figure 13, which compares the Brazilian Navy's uniform demand and the actual budget received, there is a trend that the difference between these numbers will increase in the next years, because demand tends to increase in a higher pace than the budget does.



Note: 2020s value is a projection

Figure 13. Demand vs budget (2011–2020). Sources: Singra and Siafi.

In order to estimate the size of FY 2020 budget risk, as an example, we use Oracle Crystal Ball to make an efficient simulation, and to improve our estimate of the risk of the annual budget not reaching out the real demand for the next years.

Crystal Ball calls “forecast” an estimate of the distribution of an outcome of the spreadsheet model. Based on a quick analysis about the data gathered, we simulate using three types of distribution: uniform, triangular and lognormal. To generate the forecasts, first we need to define the them, using the BN budget for the last ten years, as shown on Figure 13.

For the uniform distribution, we use the minimum value of R$ 13,996,501.36 (FY 2011) and the maximum value of R$ 112,212,208.45 (FY 2012). Figure 14 represents the uniform distribution simulation considering 10,000 trials. In this case, the risk that budget does not meet supply is 46.63%.

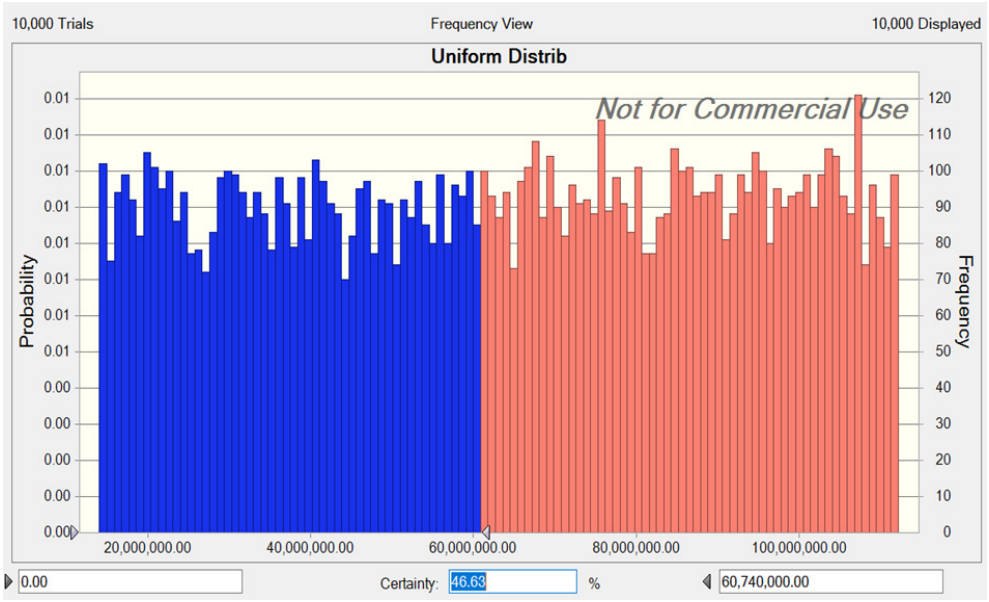


Figure 14. Budget risk simulation (Oracle Crystal Ball) – Uniform Distribution

For the triangular distribution, we use the minimum value of 13,996,501.36 (FY 2011), the maximum value of 112,212,208.45 (FY 2012) and the median for the period, which is 43,581,488.50. Figure 15 represents the triangular distribution simulation considering 10,000 trials. For the triangular distribution, the risk that budget does not meet supply is 60.3%.

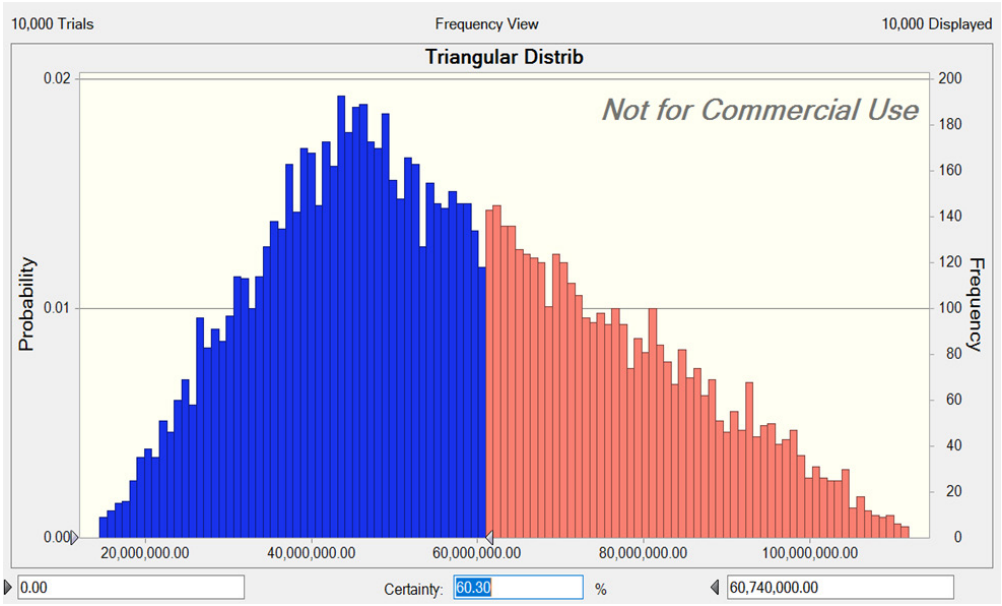


Figure 15. Budget risk simulation (Oracle Crystal Ball) – Triangular Distribution

For the lognormal distribution, we use mean of 47,820,985.04, the standard deviation of 32,655,824.29 and the location equals to zero, which represents where on the x-axis the graph is located. Figure 16 represents the lognormal distribution simulation considering 10,000 trials. For the lognormal distribution, the budget risk is 76.69%.

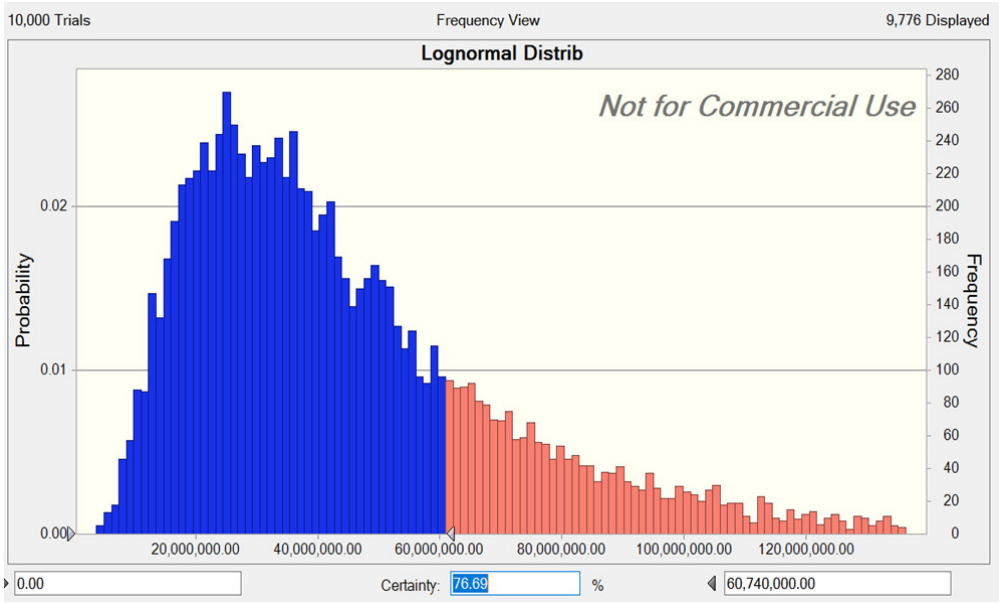


Figure 16. Budget risk simulation (Oracle Crystal Ball) – Lognormal Distribution

For each simulation, we followed Crystal Ball's usual steps to create simulations and interpret them (Oracle, 2020):

1. Create a spreadsheet model in Microsoft Excel format with data and formula cells that represent the situation to analyze.
2. Start Crystal Ball.
3. Load a spreadsheet model.
4. Using Crystal Ball, define assumption cells and forecast cells.
5. Set run preferences for the simulation. In our case, we used the number of trials = 10,000.
6. Run the simulation.
7. Analyze the results. (p. 29).

To find which distribution best represents the Brazilian Navy's annual budget, we will pick the distribution that maximizes entropy. Entropy denotes the uncertainty involved in the incident (Dong et al., 2016). The principle of maximum entropy asserts that "the probability distribution with maximum entropy, satisfying the prior knowledge, should be used in the decision problem" (Bucley, 2006).

Based on the graphics above, the distribution that maximizes entropy is the lognormal distribution and there is a 76.69% risk that the budget will not meet the real

demand in 2020 (R$ 60.740.000,00), which have been happening in the last decade, except for the outlier years (2012 and 2013).

Implementing the new policy, considering the inventory and uniform acquisition reduction of 53%, the new demand would be R$ 28.547.800,00. Figure 17 represents the new lognormal distribution simulation, also for 10,000 trials. It is observed that the risk that the budget will not meet the real demand would fall to 31.51%.

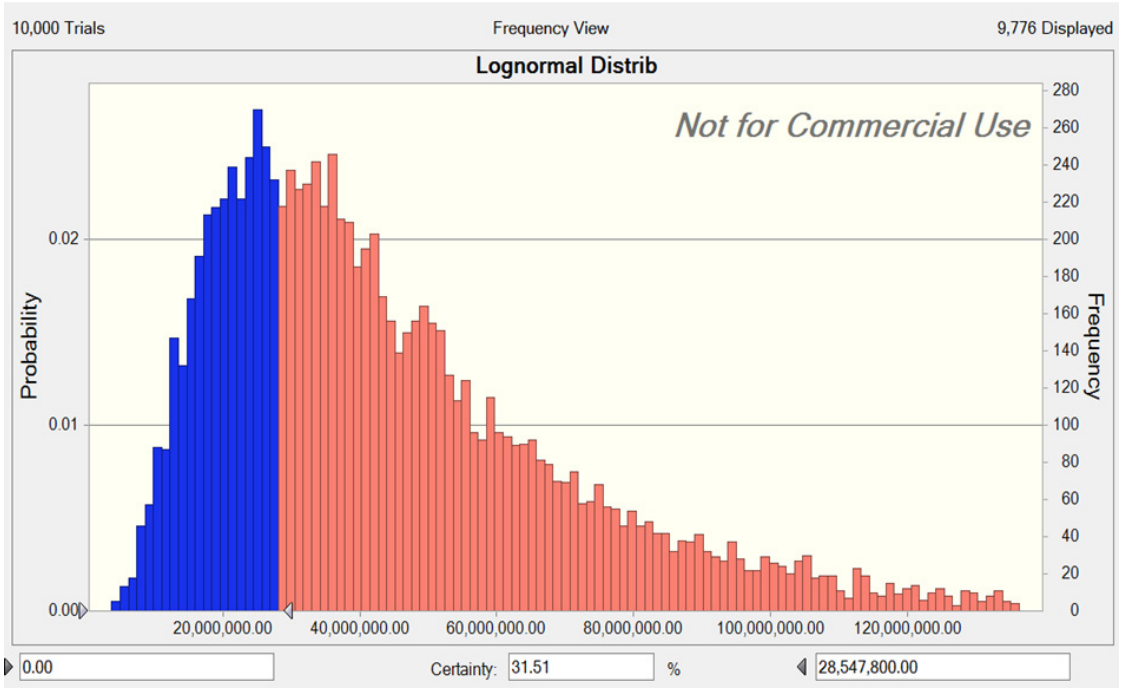


Figure 17. Budget risk simulation in the new policy (Oracle Crystal Ball) – Lognormal Distribution

C. DEMAND FORECAST, PROCUREMENT AND ORDERING COSTS

Ordering costs are those costs that occur when you place an order. For the Brazilian Navy, all buying processes are made following a public bidding. Some costs like shipping and handling from the supplier to our warehouse and postage costs are incorporated in the products' prices.

Thus, we will consider for procurement and ordering costs only the administrative costs, which corresponds to the uniform management team, at the Brazilian Navy's

Inventory Control Center and the acquisition team, at the Brazilian Navy's Acquisition Center.

The direct labor hours allocated in acquisition, demand forecast, inventory management and storage will be saved, because these activities will be made by the e-commerce sellers.

Today, the number of people involved in uniform management is the following:

- Demand Forecast / Managers

Table 7 shows the projection of annual spending on wages in the demand forecast and inventory management office for the next five years, based on the Brazilian military payment law. By reducing approximately 47% on inventory levels and the numbers of stock keeping units, the operations (inbound and outbound logistics, picking and packing) could be managed by 50% of the actual manpower.

Table 7. BN monthly wages for each rank between 2021 and 2025 and total budget spent with all personnel from uniform demand forecast office.

		Wages (R$)				
Rank	**Qty**	**2021**	**2022**	**2023**	**2024**	**2025**
LCDR	1	19.071,36	19.847,52	20.623,68	21.067,20	21.067,20
LT	1	14.707,35	15.346,80	15.986,25	16.351,65	16.351,65
CPO(TTC)	1	10.795,75	11.227,58	11.659,41	11.906,17	11.906,17
PO1(TTC)	1	8.855,79	9.236,10	9.616,41	9.833,73	9.833,73
PO2	3	7.393,50	7.727,40	8.061,30	8.252,10	8.252,10
PO3	1	5.393,25	5.508	5.622,75	5.699,25	5.699,25
E-3	1	3.546,45	3.546,45	3.546,45	3.546,45	3.546,45
Total	9	1.099.155,85	1.142.630,45	1.186.105,05	1.211.089,75	1.211.089,75

Note: Author, based on Law # 13,954 / 2019 (wages in Brazilian Reais – R$)

- Acquisition

Table 8 shows the monthly wages for each rank between 2021 and 2025 and the Brazilian Navy's total yearly wage cost spent with all personnel from the uniform acquisition office.

Table 8. BN monthly wages for each rank between 2021 and 2025 and total budget spent with all personnel from uniform acquisition office.

		Wages (R$)				
Rank	**Qty**	**2021**	**2022**	**2023**	**2024**	**2025**
LT	1	14.707,35	15.346,80	15.986,25	16.351,65	16.351,65
CPO(TTC)	1	10.795,75	11.227,58	11.659,41	11.906,17	11.906,17
PO1(TTC)	1	8.855,79	9.236,10	9.616,41	9.833,73	9.833,73
Total	3	446.665,57	465.536,24	484.406,91	495.190,15	495.190,15

Note: Author, based on Law # 13,954 / 2019 (wages in Reais – R$)

Due to frequent manpower labor shortage in the BN, it is suggested to maintain the same number of people working in the acquisition office. For the demand forecast and inventory management office, as the new policy suggests an approximate 47% reduction on inventory levels and on numbers of SKU, the operations could be managed by 50% of the actual manpower.

D. STORAGE – HOLDING COSTS

Storage and handling are supplementary activities that assume a high importance because they are strongly related to the order processing time. These are costs that vary with the inventory size.

According to Ballou (2006), storage and handling costs correspond to about 25% of total logistics costs, not considering warehouse maintenance costs. From this 25%, about 50% are costs related to employees, 25% related to space (real state) and the other 25% related to power, equipment, material etc.

The other costs are strongly related to the inventory size. Thus, inventory size reduction can bring storage and handling costs and an opportunity cost, while we can use that capital in some other effective projects.

Insurance

The Brazilian Navy does not pay insurance for its items stored in the warehouse (T. Martins, email to author, March 2, 2020).

Obsolescence and losses

Table 9 represents the Brazilian Navy uniform total annual selling and losses from 2009 to 2019 and what do losses represent compared to the total yearly revenue. In this case, we will consider revenue all uniform sold to personnel ranked higher than E3 and the cost of the uniform provided ("for free") for personnel in the first ranks.

Table 9. Uniform acquisition and losses in the last 11 years. Source: Singra.

Year	**2010**	**2011**	**2012**	**2013**
Revenue	14.357.718,30	16.566.844,50	16.015.727,50	14.731.945,50
Losses	1.927.382,81	6.596.662,16	23.798.815,36	3.502.522,15
Losses / Revenue	13%	40%	149%	24%
Year	**2014**	**2015**	**2016**	**2017**
Revenue	18.770.785,40	21.455.905,00	23.631.642,00	21.921.105,00
Losses	4.040.122,35	3.212.522,71	3.932.302,91	8.496.769,17
Losses / Revenue	22%	15%	17%	39%
Year	**2018**	**2019**	**Average**	
Revenue	24.265.301,00	21.793.081,58	19.351.005,58	
Losses	2.556.067,87	2.161.420,40	6.022.458,79	
Losses / Revenue	11%	10%	31%	

Figure 18 shows a comparison between the total revenue and total losses for the period. There is an average of 31% of yearly losses compared to items sold. Numbers are extremely higher than the national average, as shown in Chapter 2 (1.38%). A new policy that reduces the number of items stored would help reduce these yearly losses linearly.

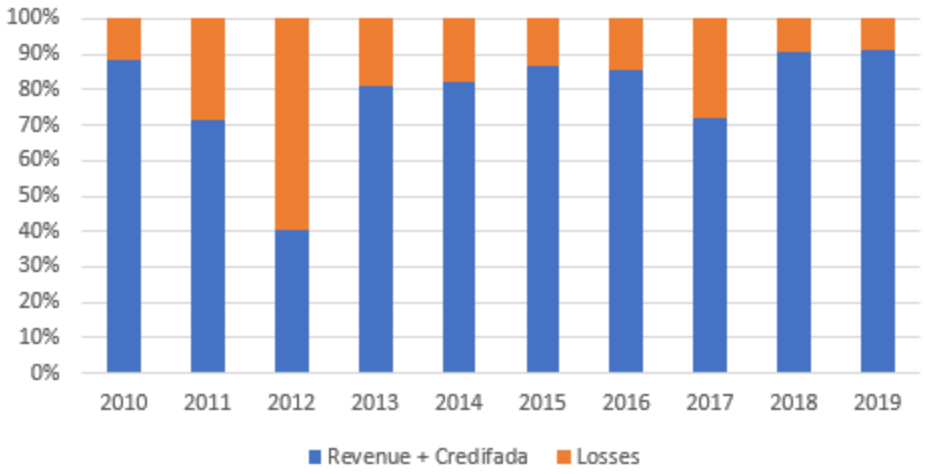


Figure 18. Comparison between revenue and losses. Source: Singra.

We can see, for example, that in FY 2012 the losses value was higher than the revenues value.

Warehousing and Maintenance

Stocking and material handling activities are responsible for 25% of logistics expenses, of which inventory maintenance costs are excluded. Of these expenses, about 50% occur with employees, 25% are related to space, and the rest cover maintenance costs, such as energy, equipment, maintenance materials, and others (Ballou, 2006).

The Uniform Warehouse had an average maintenance cost of R$ 192.680,00 in the last five years. It is difficult to predict the reduction in the new policy with the data we have. So, we will underestimate it and consider only a 10% reduction on maintenance costs.

The direct labor hours allocated in acquisition, demand forecast, inventory management and storage will be saved, because these activities will be made by the e-commerce sellers.

For the warehouse, as the new policy suggests an approximate 47% reduction on inventory levels and on numbers of SKU, the operations could be managed by 50% of the actual manpower.

Table 10 shows the projection of annual spending on wages in the uniform warehouse for the next years, based on the Brazilian military payment law. By reducing

approximately 53% on inventory levels and the numbers of stock keeping units, the operations (inbound and outbound logistics, picking and packing) could be managed by 50% of the actual manpower as well.

Table 10. Projection of annual spending on wages in the uniform warehouse in the actual policy. Source: Law 13,954 / 2019.

		Wages (R$)				
Rank	**Qty**	**2021**	**2022**	**2023**	**2024**	**2025**
LT	2	14.707,35	15.346,80	15.986,25	16.351,65	16.351,65
CPO	10	10.795,75	11.227,58	11.659,41	11.906,17	11.906,17
PO1	2	8.855,79	9.236,10	9.616,41	9.833,73	9.833,73
PO2	8	7.393,50	7.727,40	8.061,30	8.252,10	8.252,10
PO3	5	5.393,25	5.508	5.622,75	5.699,25	5.699,25
E-3	15	3.546,45	3.546,45	3.546,45	3.546,45	3.546,45
E-2	2	2.294,50	2.294,50	2.294,50	2.294,50	2.294,50
Steved.	17	4.183,81	4.183,81	4.183,81	4.183,81	4.183,81
Total	61	4.811.410,89	4.936.246,90	5.061.082,91	5.133.128,13	5.133.128,13

Note: Author, based on Law # 13,954 / 2019 (wages in Reais – R$)

E. TRANSPORTATION COSTS

Physical distribution usually represents about two-thirds of the total logistic costs for a company (Ballou, 2006).

Transportation costs are those related to moving a cargo or good from a starting point to an ending point. This transportation can be performed by any mode of transportation: Aviation, Maritime, Pipelines, Railroads and Roadway modes (Department of Transportation [DoT], 2020).

To measure this cost, we have to list the total of items transported during the period and measure their weight and volume to calculate the freight and insurance tariffs, depending on the mode of transportation.

Table 11 shows the total freight and insurance costs of uniforms transported between 2009 and 2019.

Table 11. Uniform Transportation Costs between 2009 and 2019. Source: Singra.

Uniform Transportation Costs (R$)												
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Freight	240.637.96	260.495.42	230.215.69	400.998.42	313.207.95	510.912.72	646.872.65	461.192.94	468.295.79	389.222.01	446.530.03	397.143.78
Insurance	46.942.05	15.832.63	14.348.02	19.422.09	17.993.21	59.093.79	28.080.79	36.359.98	23.319.72	19.173.79	21.675.60	27.476.52
Total	287.580.01	276.328.05	244.563.71	420.420.51	331.201.16	570.006.51	674.953.44	497.552.92	491.615.51	408.395.80	468.205.63	424.620.30

A better way to visualize these costs and their relation to the inventory size and acquisition is creating a line graphic, as we can see below. As we saw in Figure 12, the acquisition costs of 2012 and 2013 were the highest in the historic series. As a consequence, transportation costs were higher on 2014 and 2015.

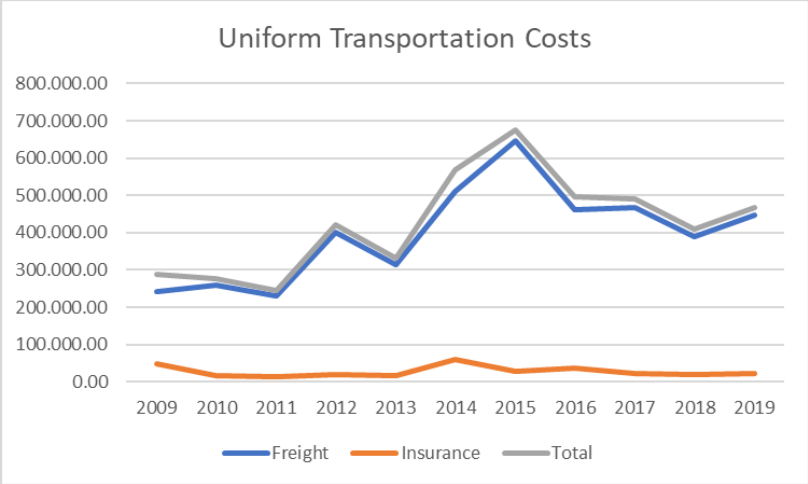


Figure 19. Uniform transportation costs. Source: Singra.

Figure 19 represents the evolution of uniform transportation costs between 2009 and 2019. We can observe that FY 2014 and 2015 have the highest costs and it can be explained because, as we can see in Figure 12, FY 2012 and 2013 had the higher uniform acquisition costs (outliers) and these uniforms must have been transported in years 2014 and 2015 to resupply all uniform points of accumulation.

For the transportation costs forecast, we will use the double exponential smoothing, because of the same reasons of Acquisition Costs. Table 12 shows the forecast for the transportation costs from 2021 to 2025.

Table 12. Exponential smoothing table for the uniform transportation's forecast for 2021 to 2025, considering the actual budget from 2009 to 2019. Source: Siafi.

FY	Actual Budget (R$)	Forecast (R$)	Level-t	Trend-t
2009	287.580,01	287.580,01	287.580,01	-11.251,96
2010	276.328,05	276.328,05	276.328,05	-12.377,16
2011	244.563,71	263.950,89	258.134,74	-14.196,49
2012	420.420,51	243.938,25	296.882,93	-10.321,67
2013	331.201,16	286.561,26	299.953,23	-10.014,64
2014	570.006,51	289.938,59	373.958,97	-2.614,06
2015	674.953,44	371.344,90	462.427,46	6.232,79
2016	497.552,92	468.660,25	477.328,05	7.722,84
2017	491.615,51	485.050,90	487.020,28	8.692,07
2018	408.395,80	495.712,35	469.517,38	6.941,78
2019	468.205,63	476.459,16	473.983,10	7.388,35
2020		481.371,45		
2021		488.759,80		
2022		496.148,15		
2023		503.536,50		
2024		510.924,85		
2025		518.313,20		

For transportation costs, a linear reduction will be considered, based on the inventory reduction of 53%, to estimate the projections for the new policy.

F. SELLING COSTS

Considering that the Brazilian Navy will keep the structure and personnel (already small) in the selling stores to attend the demand of the recently recruited and beginning enlisted ranks personnel, we do not propose any changes in this item.

G. SALES REVENUE

Figure 20 represents the revenue on sales for those military personnel that the Brazilian Navy would stop selling uniforms in the new policy.

Year	Revenue
2010	2.797.010,50
2011	2.644.941,00
2012	2.395.191,00
2013	3.121.192,00
2014	4.112.569,00
2015	5.424.538,00
2016	5.779.933,00
2017	6.545.288,00
2018	7.612.026,00
2019	6.454.419,00

Figure 20. The BN's sales revenue for military personnel ranked higher than E3. Source: Singra.

In order to project the sales revenue for the next five years (project timing) and find the best distribution that represents this data series, Microsoft Excel's Regression Analysis tool will be used.

As *input X range*, will be considered the years between 10 (FY2010) and 19 (FY2019). For the input Y range, the annual revenues, as shown on Figure 20. The Confidence Level will be 95%.

After running the Regression Analysis tool, Table 13 was created, and we can observe an extremely small p-value. A p-value less than 0.05 (typically $\leq$ 0.05) is statistically significant. It indicates strong evidence against the null hypothesis, as there is less than a 5% probability the null is correct.

Additionally, the R square is about 0.886. "In statistics, the coefficient of determination, pronounced "R squared," is the proportion of the variance in the dependent variable that is predictable from the independent variable(s). It is a statistical measure of

how well the regression predictions approximate the real data points. An R^2 of 1 indicates that the regression predictions perfectly fit the data" (Hughes, 1971).

It is observed in Table 13 that $R^2 = 0.886$ and p-value = $4.77 * 10^{-5}$, that shows that it is significant.

Table 13. Microsoft Excel's Regression Analysis tool Statistics – Sales revenue.

Regression Statistics	
Multiple R	0,941508412
R Square	0,88643809
Adjusted R Square	0,872242851
Standard Error	680762,5031
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2,89399E+13	2,89399E+13	62,44615571	4,77021E-05
Residual	8	3,7075E+12	4,63438E+11		
Total	9	3,26474E+13			

	Coefficients	*Std Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95%*	*Upper 95%*
Intercept	-3899239,27	1107884,21	-3,519536819	0,007851222	-6454024,84	-1344453,699	-6454024,84	-1344454
Year	592272,4152	74949,48486	7,902288005	4,77021E-05	419438,5931	765106,2372	419438,5931	765106,24

Thus, to obtain the sales revenue forecast for the next five years, considering the linear regression, we will use the formula $Y = A + Bx \pm E$.

Where:

A: Independent variable (intercept)

B: Dependent Value

X: Fiscal Year (FY); [21, 22, …, 25]

Y: Sales Revenue forecast for the FY 'x'

E: Error

In order to estimate the sales revenue for FY 2021 to 2025, we will follow the expression:

$$Sales\ Revenue = -3899239.27 + 592{,}272.42 * FY \pm 680{,}762.50$$

THIS PAGE INTENTIONALLY LEFT BLANK

V. RESULTS / COST-BENEFIT ANALYSIS

According to OMB Circular A-94 (2016), Cost-Benefit Analysis (CBA) is "a systematic quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects."

In the U.S., "CBA is recommended as the technique to public managers use in a formal economic analysis of government programs or projects" (OMB, 2016).

From now on, we will use CBA methodology to verify if the benefits of the new policy, specified in Step 1 below, are going to offset the costs so that we can propose its application.

A. STEP 1: SPECIFY THE SET OF ALTERNATIVE PROJECTS (COURSES OF ACTION, COA):

Creation of an electronic marketplace platform to gather companies that sell military uniforms, modifying the Brazilian Navy (BN) uniform supply chain, so that it could stop supplying uniforms to officers and enlisted personnel above the rank of E3, in order to reduce logistic costs throughout the uniform supply chain.

Status-quo (SQ): Keep the BN uniform supply chain the way it is, where the BN is responsible for demand forecasting, procurement, storage, transportation, selling and delivery of uniforms to all military organizations and personnel spread in the whole country.

Narrow policy change: moving from SQ to COA

Timing: This policy change requires long-term planning and execution. Transition time is needed to fully readjust inventory levels to the new policy, change BN standards and procedures, sign new contracts with suppliers, as well as train the staff about the new methodology and, principally, change BN personnel culture. We will consider a project time of five years, transitioning inventory at a rate of approximately 20% per year.

Prospective analysis: After implementing the new policy, the forecast is that the benefits will overweight the costs, comparing increments and changes in costs and benefits of the project proposal versus the status quo.

B. STEP 2: DECIDE WHOSE BENEFITS AND COSTS COUNT (WHO HAS STANDING).

Brazilian Navy – Institutional perspective

"Some investments provide "internal" benefits which take the form of increased Federal revenues or decreased Federal costs" (OMB, 2016). In this case, the benefits and costs of the new project will be observed directly by the Brazilian Navy, its organizations and, indirectly, its personnel as well.

C. STEP 3: IDENTIFY IMPACTS, CATALOGUE THEM, AND SELECT MEASUREMENT INDICATORS.

To identify the impacts of the new policy on the BN, we will consider all inputs (required resources) and possible outputs, after the implementation of the policy.

Positive Impacts (Benefits)

- Inventory and stock keeping units (SKU) reduction and all related cost reduction (R$ - Brazilian Reais).
- Cost reduction by reducing procurement, ordering, acquisition, transportation, and storage (R$ - Brazilian Reais).
- Opportunity costs (R$ - Brazilian Reais).
- Reduction on processing steps (to reduce inefficiency), losses and demand uncertainty (R$ - Brazilian Reais).
- Human resources savings on demand forecasting, inventory management procurement, ordering, transportation, and storage (Labor Hours and R$ - Brazilian Reais).

Negative impacts (Costs)

- Cultural change:
    - The inertia of traditions and conventions can be a hindering agent while the new policy is being implemented (Ballou, 2007). Nowadays, military personnel buy their uniforms in some few Navy uniform shops or in specialized brick and mortar shops that sell uniforms according to Navy rules at the same or better prices.
    - Later, the advantages of e-commerce will surpass these difficulties and the change will be naturally accepted. Some main advantages of e-commerce are (Niranjanamurthy et al., 2013):

- faster buying/selling procedures, as well as easy to find products
- buying/selling 24/7
- no theoretical geographic limitations
- low operational costs and better quality of services
- customers can easily select products from different providers without moving around physically. (p. 2362).
    - To quantify this change, the BN could develop a survey measuring the negative impact of this change in the way of buying. We understand that, at first, there will be a negative impact, because of human nature of avoiding changes.

- Lost sales (R$ - Brazilian Reais).
    - Lost revenues for not selling uniforms anymore for military personnel ranked higher than E2.

- Cost of quality monitoring (R$ - Brazilian Reais).
    - To quantify this cost, we must measure the costs to build a quality monitoring team and the costs involved on visits and inspections.

Table 14. Summary of positive and negative impacts of the new policy.

Positive Impacts	Negative Impacts
Inventory and (SKU) reduction	Cultural change
Cost reduction by reducing procurement, ordering, acquisition, transportation, and storage	Lost sales
Opportunity costs	Cost of quality monitoring
Reduction on processing steps, losses and demand uncertainty	
Human resources savings	

D. STEP 4: PREDICT THE IMPACTS OVER THE LIFE OF THE PROJECT.

To predict the impacts over the policy change, we have to quantify the specific costs and/or benefits involved, as shown below:

Acquisition cost reduction

It will be considered the double exponential smoothing method (with trend) presented in chapter 4 to create a demand forecast for the next five years—timing of the project—to make a projection of the total acquisition cost reduction, considering a linear reduction of 53% in the inventory levels.

Opportunity Costs

To calculate the capital costs, we will consider the uniform inventory value reduction that the BN will have in the next five years, after implementing the new policy. The average uniform inventory total value is already represented on Table 3, after multiplying, for each SKU, its price times its quantity.

Considering that E1 and E2 represents 48% of the BN personnel, as shown in Chapter 4, Table 15 represents the approximate inventory level reduction in the alternative project.

Table 15. Total average uniform inventory reduction.

UNIFORM TYPE	REDUCTION
EXCLUSIVE FOR OFFICERS AND E3+	100%
GENERAL USE	52%
MILITARY ORGANIZATION	0%
EXCLUSIVE FOR E1 AND E2	0%
TOTAL (AVG)	**53%**

The OMB Circular A-94 defines Opportunity Cost as "the maximum worth of a good or input among possible alternative uses." In this case, we will consider the Central Bank's Special Settlement and Custody System (Selic) tax. The Selic is a computerized system that is intended for the custody of book-entry securities issued by the National Treasury, as well as for the registration and settlement of transactions with these securities (Banco Central do Brazil [BCB], 2020). Selic is considered Brazil's basic interest tax.

Transportation

To calculate transportation costs, we list the total of items transported during the period and measure their weight and volume to calculate the freight tariffs, depending on the mode of transportation.

Table 16 shows the total weight and volume of uniforms transported between 2009 and 2018 and their average value.

Table 16. Total weight and volume of uniform transported by the BN between 2009 and 2018 and their average value. Source: Singra.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average
Weight (Kg)	173.382,63	185210,58	268268,49	270217,35	174520,14	268000,31	226843,74	167405,9	189591,94	169634,17	209307,53
Volume (m3)	1246,525	1419,183	1534,489	1883,359	1186,813	1542,629	1550,001	1353,232	1404,883	1347,246	1446,836

Storage

To measure storage costs, we have to compare all actual administrative and operational costs of the BN's uniform warehouse and these costs in the new policy.

Reduction on losses

To predict the possible reduction on uniform losses, we have to measure the average value of losses in recent years and consider the linear reduction on inventory levels in the new policy.

Reduction on demand uncertainty.

Implementing the COA, we eliminate demand uncertainty for Officers and Enlisted above E3, eliminating the necessity of safety stock. This cost is already considered in acquisition costs and opportunity costs.

Human resources savings

The direct labor hours allocated in acquisition, demand forecast, inventory management and storage will be saved, because these activities will be made by the e-commerce sellers.

Today, the number of people involved in uniform management is represented in Tables 10 and 11 (Chapter 4).

We will consider a personnel reduction of 50% on warehouse operations and a small reduction on demand forecast. The acquisition team is already lean and will not be reduced.

Lost sales

With the new project proposed, we will consider that all sales for military personnel ranked higher than E3 will be lost.

Cost of quality monitoring

To build a team, is estimated it will consist of one junior officer (O3 or O2) and three enlisted. Additionally, we will have to consider the annual costs for monitoring in loco the companies, which are mostly located in the city of Rio de Janeiro, where the Supply Directorate is located.

E. STEP 5: MONETIZE ALL IMPACTS

In this step, we will give some examples of how to monetize the impacts related to the change in policy.

Positive impacts (Benefits):

Acquisition cost reduction (Improvement on the uniform budget utilization).

Considering the double exponential smoothing method presented in Chapter 4, we can create a demand forecast for the next five years and project the acquisition cost reduction for the new policy, as represented in Table 17.

Table 17. Projection of Acquisition costs of status quo, new policy and cost savings for the period between 2021 and 2025.

YEAR	2021	2022	2023	2024	2025
PROJECTION (SQ)	34.561.956,97	32.802.540,65	32.802.540,65	32.802.540,65	32.802.540,65
NEW POLICY	16.244.119,78	15.417.194,11	15.417.194,11	15.417.194,11	15.417.194,11
COST SAVINGS	18.317.837,19	17.385.346,55	17.385.346,55	17.385.346,55	17.385.346,55

Opportunity costs.

As we saw in Table 3, we will have an inventory level total cost reduction of approximately 53%. The total cost reduction will be approximately R$ 50,686,516.53 (R$ 95.634.936,85 to R$ 44.948.420,32). We will consider that this value will be smoothly reduced (divided) for the next five years (20% per year), totalizing R$ 10.137.303,31. The opportunity cost will be calculated based on this value.

Table 18 calculates the opportunity costs for the next five years, considering Brazilian Selic discount rate. As explained in step 4, we will consider the Brazilian Selic rate of 4% as the opportunity cost. Thus, it will be considered that these yearly reductions will be available to be invested or used in other uniform demands or new projects.

Table 18. Inventory projection and opportunity costs for the period between 2021 and 2025.

Inventory Projection for the next 5 years						
Capital costs	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Inventory	95.634.936,85	85.497.633,54	75.360.330,24	65.223.026,93	55.085.723,63	44.948.420,32
Difference	0,00	10.137.303,31	20.274.606,61	30.411.909,92	40.549.213,22	50.686.516,53
Opport. costs (Disc. Rate: 4%)		**405.492,13**	**810.984,26**	**1.216.476,40**	**1.621.968,53**	**2.027.460,66**

Figure 21 represents the variation of Selic rate from 2010 to 2020. We can observe that we are in a historical minimum nowadays and, thus, it will be an underestimated value for the opportunity cost.

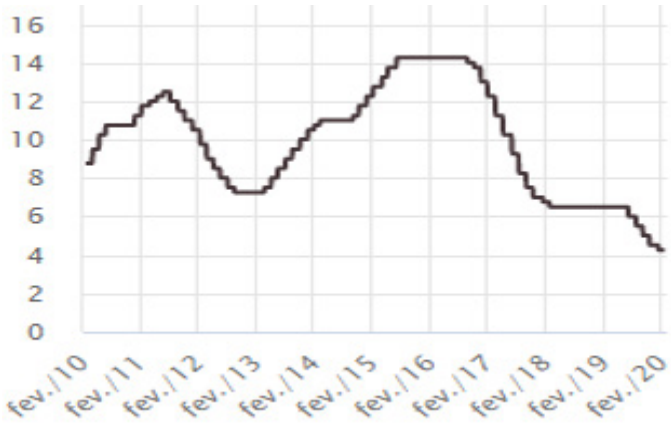


Figure 21. Target Selic interest rate between 2010 and 2020. Source: BCB (2020).

Transportation Costs

Considering the inventory reduction of 53% and a linear reduction on transportation costs (because the cost depends on weight and volume), Table 19 was built showing the estimate projection for the transportation costs between 2021 and 2025 for the status quo (SQ) and the new policy / course of action (COA).

Table 19. Brazilian Navy's uniform transportation projected costs in the status quo and in the course of action from 2021 to 2025.

	2021	2022	2023	2024	2025
SQ PROJECTION	488.759,80	496.148,15	503.536,50	510.924,85	518.313,20
COA PROJECTION	244.379,90	248.074,07	251.768,25	255.462,42	259.156,60

Maintenance Costs

As shown in Chapter 4, the Uniform Warehouse had an average maintenance cost of R$ 192.680,00 in the last five years. It is difficult to predict the reduction in the new policy with the data we have. So, we will underestimate it and consider only a 10% reduction on maintenance costs.

Thus, the approximate maintenance cost reduction that will be considered in this CBA is R$ 19.268,00 per year, in the next five years.

Reduction on Losses

During the last 10 years, the BN lost approximately 31% of the uniform bought on average per year, as shown in Table 9, which represents more than R$ 6 million per year on average.

In order to estimate the losses for the next five years, it will be considered the average value for the last five years, approximately R$ 4.072.000,00. The standard deviation, in this scenario, is approximately R$ 2.563.000,00, which represents 63% of the average, what increases the margin of error for this value.

Considering the inventory reduction of 53% and considering a linear reduction on losses as well as a percentage of yearly acquisition costs, the approximate cost reduction on losses is represented in Table 20.

Table 20. Projection of losses of status quo, new policy and cost savings for the period between 2021 and 2025.

	LOSSES / YEAR
PROJECTION (SQ)	4.072.000,00
NEW POLICY	1.913.840,00
COST SAVINGS	2.158.000,00

Human resources savings

The direct labor hours allocated in acquisition, demand forecast, inventory management and storage will be saved, because these activities will be made by the e-commerce sellers.

Due to frequent manpower labor shortage in the military, it is suggested to maintain the same number of people working on acquisition office. For the demand forecast and inventory management office and for the warehouse, as the new policy suggests an approximate 47% reduction on inventory levels and on numbers of SKU, the operations could be managed by 50% of the actual manpower.

With the new policy, as shown in Chapter IV, these costs could be reduced by 50%, as shown below.

- Demand forecast and inventory management office

	Annual Wages (R$)				
	2021	**2022**	**2023**	**2024**	**2025**
Actual Cost	1.099.155,85	1.142.630,45	1.186.105,05	1.211.089,75	1.211.089,75
New Policy (50%)	549.577,93	571.315,23	593.052,53	605.544,88	605.544,88

- Warehouse

	Annual Wages (R$)				
	2021	**2022**	**2023**	**2024**	**2025**
Actual Cost	4.811.410,89	4.936.246,90	5.061.082,91	5.133.128,13	5.133.128,13
New Policy (50%)	2.405.705,45	2.468.123,45	2.530.541,46	2.566.564,07	2.566.564,07

Negative Impacts (Costs):

Lost sales

As shown in item 4.7, we will consider the following expression to estimate the loss in sales revenue for the next five years.

$$Sales\ Revenue = -3{,}899{,}239.27 + 592{,}272.42 * FY \pm 680{,}762.50$$

Based on the expression above, Table 21 shows the expected lost revenues in sales from 2021 to 2025.

Table 21. Expected lost sales from 2021 to 2025 (R$).

2021	7.857.718,95
2022	8.449.991,36
2023	9.042.263,78
2024	9.634.536,19
2025	10.226.808,61

Cost of quality monitoring

Table 22 represents the expected wages value for the military personnel related to quality monitoring if the new policy is implemented.

Table 22. Expected wages for military personnel related to quality monitoring.

		WAGES (R$)				
RANK	Qty	2021	2022	2023	2024	2025
LT	1	14.707,35	15.346,80	15.986,25	16.351,65	16.351,65
PO1(TTC)	3	8.855,79	9.236,10	9.616,41	9.833,73	9.833,73
TOTAL	4	536.571,36	559.716,3	582.861,24	596.086,92	596.086,92

Additionally, the annual costs for monitoring in loco the companies, which are mostly located in Rio de Janeiro, where the Supply Directorate is located, are estimated in R$ 10.000,00.

F. STEP 6: DISCOUNT BENEFITS AND COSTS TO OBTAIN PRESENT VALUES.

According to OMB (2016), "It is appropriate to calculate such a project's net present value using a comparable-maturity Treasury rate as a discount rate. The rate used may be either nominal or real, depending on how benefits and costs are measured".

For the estimated benefits and costs of the COA, as explained in step 4, we will consider the Brazilian Selic rate of **4%** as the discount rate.

In order to estimate the accumulated inflation rate, we will follow that last BCB Normative (Resolution 4,671 / 2018); it stated that, for the year 2021, the inflation target of **3.75%,** with a tolerance interval of minus 1.50% and an additional 1.50% (BCB, 2018).

G. STEP 7: COMPUTE THE NET BENEFITS OF EACH POLICY ALTERNATIVE.

In this step, it will be created a table following the model presented on Appendix B of the OMB Circular A-94.

First, we need to calculate the total expected yearly costs and benefits for the five years period. Table 23 represents the total expected annual cost and benefits in the COA. The benefits are the sum of acquisition cost reduction, opportunity costs, holding costs (losses and maintenance cost) reduction, transportation costs reduction, and human resources reduction (demand forecast and warehousing manpower).

Table 23. Total expected yearly costs and benefits between 2021 and 2025.

	2021	2022	2023	2024	2025
Benefits	**24.114.923,39**	**23.675.996,01**	**24.169.559,27**	**24.627.482,18**	**25.036.890,14**
Acquisition Costs	**18.317.837,19**	**17.385.346,55**	**17.385.346,55**	**17.385.346,55**	**17.385.346,55**
Opportunity Costs	**405.492,13**	**810.984,26**	**1.216.476,40**	**1.621.968,53**	**2.027.460,66**
Holding Costs	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**
Reduction on Losses	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*
Maintenance	*19.268,00*	*19.268,00*	*19.268,00*	*19.268,00*	*19.268,00*
Transportation	**259.042,69**	**262.958,52**	**266.874,34**	**270.790,17**	**274.705,99**
Human Resources	**2.955.283,37**	**3.039.438,68**	**3.123.593,98**	**3.172.108,94**	**3.172.108,94**
Ordering	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Demand Forecasting	*549.577,93*	*571.315,23*	*593.052,53*	*605.544,88*	*605.544,88*
Warehousing	*2.405.705,45*	*2.468.123,45*	*2.530.541,46*	*2.566.564,07*	*2.566.564,07*
Costs	**8.404.290,31**	**9.019.707,66**	**9.635.125,02**	**10.240.623,11**	**10.832.895,53**
Lost Sales	**7.857.718,95**	**8.449.991,36**	**9.042.263,78**	**9.634.536,19**	**10.226.808,61**
Quality Monitoring	**546.571,36**	**569.716,30**	**592.861,24**	**606.086,92**	**606.086,92**

Now, a table following the model presented on Appendix B of the OMB Circular A-94 will be created. Note that the discount factor is calculated as $\frac{1}{(1+i)^t}$, where i is the discounted interest rate (.04), f is the inflation rate (0.0375) and t is the number of the year (period number).

Table 24 shows the policy's final Net Present Value (NPV), for the next five years, considering its expected yearly costs and benefits and the discount factor that consider a real discount rate of 4% and Brazil's inflation target for FY 2021 of 3.75%.

Table 24. Net benefits of the new policy for a discount factor of 4% and an inflation rate of 3.75%.

Year (1)	Expected yearly cost* (2)	Expected yearly benefit* (3)	Discount factors (4)	Present value of costs Col. 2 x Col. 4 (5)	Present value of benefits Col. 3 x Col. 4 (6)
2021	8.719.451,19	25.019.233,02	0,9615	8.384.087,68	24.056.954,82
2022	9.708.869,70	25.484.990,07	0,9246	8.976.395,80	23.562.305,91
2023	10.760.232,87	26.991.874,58	0,8890	9.565.807,84	23.995.678,22
2024	11.865.302,22	28.534.642,45	0,8548	10.142.510,06	24.391.531,96
2025	13.022.221,61	30.096.840,77	0,8219	10.703.316,93	24.737.409,26
Total				47.772.118,31	120.743.880,17
NPV		**R$ 72.971.761,86**			

Note: The values on columns 2 and 3 are already adjusted by inflation.

H. STEP 8: PERFORM SENSITIVITY ANALYSIS

Upper bound

To calculate the upper bound, we will assume a reduction of 75% on inventory levels and an opportunity cost rate of 10%. Thus, the new tables will be as we can see below.

Table 25 represents the policy's final Net Present Value (NPV), for the next five years, like step 7, but it assumes a reduction of 75% on inventory levels and an opportunity cost rate of 10%.

Table 25. Net benefits of the new policy – Upper bound.

	2021	2022	2023	2024	2025
Benefits	**33.882.080,18**	**33.585.145,68**	**34.686.947,14**	**35.753.108,25**	**36.770.754,41**
Acquisition Costs	**27.476.755,79**	**26.078.019,82**	**26.078.019,82**	**26.078.019,82**	**26.078.019,82**
Opportunity Costs	**1.013.730,33**	**2.027.460,66**	**3.041.190,99**	**4.054.921,32**	**5.068.651,65**
Holding Costs	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**
Reduction on Losses	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*
Maintenance	*19.268,00*	*19.268,00*	*19.268,00*	*19.268,00*	*19.268,00*
Transportation	**259.042,69**	**262.958,52**	**266.874,34**	**270.790,17**	**274.705,99**
Human Resources	**2.955.283,37**	**3.039.438,68**	**3.123.593,98**	**3.172.108,94**	**3.172.108,94**
Ordering	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Demand Forecasting	*549.577,93*	*571.315,23*	*593.052,53*	*605.544,88*	*605.544,88*
Warehousing	*2.405.705,45*	*2.468.123,45*	*2.530.541,46*	*2.566.564,07*	*2.566.564,07*
Costs	**8.404.290,31**	**9.019.707,66**	**9.635.125,02**	**10.240.623,11**	**10.832.895,53**
Lost Sales	**7.857.718,95**	**8.449.991,36**	**9.042.263,78**	**9.634.536,19**	**10.226.808,61**
Quality Monitoring	**546.571,36**	**569.716,30**	**592.861,24**	**606.086,92**	**606.086,92**

Table 26 shows the policy's final Net Present Value (NPV) for the upper bound for the policy period, considering its expected yearly costs and benefits and the discount factor that consider a real discount rate of 4% and Brazil's inflation target for FY 2021 of 3.75%.

Table 26. Net benefits of the new policy upper bound for a discount factor of 4% and an inflation rate of 3.75%.

Year (1)	Expected yearly cost* (2)	Expected yearly benefit* (3)	Discount factors (4)	Present value of costs Col. 2 x Col. 4 (5)	Present value of benefits Col. 3 x Col. 4 (6)
2021	8.719.451,19	35.152.658,19	0,9615	8.384.087,68	33.800.632,88
2022	9.708.869,70	36.151.260,71	0,9246	8.976.395,80	33.423.872,70
2023	10.760.232,87	38.737.393,44	0,8890	9.565.807,84	34.437.401,71
2024	11.865.302,22	41.425.353,71	0,8548	10.142.510,06	35.410.565,97
2025	13.022.221,61	44.202.116,72	0,8219	10.703.316,93	36.330.917,91
Total				47.772.118,31	173.403.391,17
NPV		**R$ 125.631.272,86**			

Note: The values on columns 2 and 3 are already adjusted by inflation.

Lower bound

To calculate the lower bound, we will assume a reduction of only 25% on inventory levels, no manpower reduction and half of transportation costs reduction. Thus, the new tables will be as we can see below.

Table 27 represents the policy's final Net Present Value (NPV), for the next five years, like step 7, but it assumes a reduction of 25% on inventory levels, no manpower reduction and half of transportation costs reduction.

Table 27. Net benefits of the new policy – Lower bound.

	2021	2022	2023	2024	2025
Benefits	**11.871.200,08**	**11.812.404,80**	**12.219.854,84**	**12.627.304,89**	**13.034.754,93**
Acquisition Costs	**9.158.918,60**	**8.692.673,27**	**8.692.673,27**	**8.692.673,27**	**8.692.673,27**
Opportunity Costs	**405.492,13**	**810.984,26**	**1.216.476,40**	**1.621.968,53**	**2.027.460,66**
Holding Costs	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**	**2.177.268,00**
Reduction on Losses	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*	*2.158.000,00*
Maintenance	*19.268,00*	*19.268,00*	*19.268,00*	*19.268,00*	*19.268,00*
Transportation	**129.521,35**	**131.479,26**	**133.437,17**	**135.395,08**	**137.353,00**
Human Resources	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Ordering	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Demand Forecasting	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Warehousing	*0,00*	*0,00*	*0,00*	*0,00*	*0,00*
Costs	**8.404.290,31**	**9.019.707,66**	**9.635.125,02**	**10.240.623,11**	**10.832.895,53**
Lost Sales	**7.857.718,95**	**8.449.991,36**	**9.042.263,78**	**9.634.536,19**	**10.226.808,61**
Quality Monitoring	**546.571,36**	**569.716,30**	**592.861,24**	**606.086,92**	**606.086,92**

Table 28 shows the policy's final Net Present Value (NPV) for the lower bound for the period between 2021 and 2025, considering its expected yearly costs and benefits and the discount factor that consider a real discount rate of 4% and Brazil's inflation target for FY 2021 of 3.75%.

Table 28. Net benefits of the new policy lower bound for a discount factor of 4% and an inflation rate of 3.75%.

Year (1)	Expected yearly cost* (2)	Expected yearly benefit* (3)	Discount factors (4)	Present value of costs Col. 2 x Col. 4 (5)	Present value of benefits Col. 3 x Col. 4 (6)
2021	8.719.451,19	12.316.370,08	0,9615	8.384.087,68	11.842.663,54
2022	9.708.869,70	12.714.946,35	0,9246	8.976.395,80	11.755.682,65
2023	10.760.232,87	13.646.785,43	0,8890	9.565.807,84	12.131.942,56
2024	11.865.302,22	14.630.632,05	0,8548	10.142.510,06	12.506.325,59
2025	13.022.221,61	15.669.076,37	0,8219	10.703.316,93	12.878.838,61
Total				47.772.118,31	61.115.452,94
NPV		**R$ 13.343.334,62**			

Note: The values on columns 2 and 3 are already adjusted by inflation.

I. STEP 9: MAKE A RECOMMENDATION

Considering that the Net Benefit is positive for the policy proposed, we recommend that the Brazilian Navy implement the project. Although we have some intangible aspects to consider, financially speaking, the amount that we may consider for these aspects would not be enough to switch the Net Benefit tendency.

However, as the BN will be "out of the market" of selling uniforms, it means that it will decrease its inventory position to zero for about 50% of its SKU and will stop selling these items; a business risk plan should be created to mitigate the risk of supply interruption.

Finally, after implementing the new policy proposed, the BN should be concerned about being resilient enough to go back and restart selling the uniforms, if the private market shows that is not prepared to supply all new demand created for it.

THIS PAGE INTENTIONALLY LEFT BLANK

VI. CONCLUSION

The purpose of this paper was to discover how much savings could an outsourcing strategy bring to the Brazilian Navy, by changing part of its process flowchart of uniform supply chain, and creating a new design for the uniform distribution and selling process (e-marketplace). The strategy was elucidated by studying the most relevant costs related to the parts of the supply chain in which the BN is involved, and making a cost-benefit analysis to verify if benefits of the new policy are higher than the costs to implement it.

"The practice of logistics in the business sectors (business and military itself), starting in the second half of the twentieth century, has been increasingly recognized as a critical discipline" (Sutherland, 2008). The improvement on logistics techniques from this moment on are very important, and, nowadays, considered a competitive differential; companies have to be prepared to adapt.

Creating a platform (e-commerce) that gathers different stores to sell uniforms on-line for all Brazilian Navy and Marine Corps military can directly influence the products' price, supply time and convenience for the personnel. Today, to provide uniforms for all its military personnel, the Brazilian Navy (BN) has a systemic process responsible for demand forecasting, procurement, storage, transportation, selling and delivery to the whole country. Being a government organization, this process is naturally inefficient because of all the bureaucracy involved.

Additionally, in 2015, the Brazilian Congress approved the 95th Amendment in the Constitution, which froze public spending for the next 20 years, avoiding the growth of the public debt / gross domestic product (GDP) ratio by containing public spending. Public expenditures and investments are limited to the same amounts spent in the previous year, adjusted only by inflation measured by the National Consumer Price Index (IPCA).

This amendment, though, limited the budget increase for all public organizations of the Executive, Legislative and Judiciary branches, and many other public related organizations. For this reason, it became hard for the Brazilian Navy to increase its budget for any area and a policy that can reduce the uniforms budget and spending would be very

important to reduce progressively the mandatory expenditures and enable the BN to keep making important investments in the area.

The research method included “a collection of actual data of the amounts of all relevant costs, statistical analysis to determine the expected value of such costs for the following years, and discounting to determine the lowest present value of the alternative policy” (OMB, 2016).

The thesis prioritized the available data from official/government sources, without, however, abandoning the academic database. This was in order to not limit the conclusions of this study to the reading of only a few articles.

We divided the related logistics costs in acquisition, capital, transportation and storage costs and the human resources savings to compare the actual and the suggested policies in order to calculate all benefits and costs involved and to prepare the analysis. We can argue that many factors must be analyzed, but the financial aspects are always quite relevant indeed.

Since it is possible to obtain more efficient ways to manage uniforms inventory, by outsourcing some parts of its supply chain, without compromising the mission, our results suggest that the Brazilian Navy should implement the new policy. The benefits are much higher than the costs. Even with some intangible aspects to consider, the net benefits are approximately R$ 73 million in the next five years, which is the project’s timing. The amount that we may consider for them would not be enough to switch the Net Benefit tendency.

Additionally, considering that the military (and public sector as well) must be prepared for any crisis and be ready to mobilize quickly, during which times effectiveness somehow surpass costs relevance (Juntunen et al. 2012), the BN should be concerned about being resilient enough to go back and start buying and selling uniforms again, if the private market shows that is not prepared to supply all new demand created for it. A business risk plan must be created to mitigate the risk of supply interruption.

A. SUGGESTIONS FOR FUTURE STUDIES

1) Stablish the criteria for the inventory transition between the actual and the new policy (if implemented), considering:

- Supplier reliability (considering the whole supply chain)
- Demand uncertainty
- Vulnerability from interruption
- Inventory turnover (demand x inventory size)

2) Eliminating infrastructure and storage costs at the uniform warehouse

Considering that inventory costs may not get lower unless storage infrastructure is eliminated, it is suggested a study for a warehouse size reduction, with flexibility for demand peaks (Ballou, 2006).

3) Development of an omnichannel strategy that allows military personnel to shop between all possible channels, anywhere and at any time.

In this item, we can include the creation of pick-up points that can reduce freight costs for the customers, the implementation of automatic selling machines for small and fast mover items, home delivery, and workplace delivery etc.

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

Appy, B., Lisboa, M., Mendes, N., & Lazzarini, S. (2015, September 28). *Os desafios para sair da crise [The challenges to emerge from the crisis]*. Instituto Braudel. http://www.brasil-economia-governo.org.br/2015/09/28/os-desafios-para-sair-da-crise/

Associação Brasileira de Prevenção de Perdas. (2019). Pesquisa ABRAPPE de perdas no varejo brasileiro [ABRAPPE survey of losses in Brazilian retail]. http://www.abrappe.com.br/wp-content/uploads/2019/06/EY_Pesquisa_Abrappe_2019.pdf

Association for Supply Chain Management. 2019. *APICS Dictionary*, 13th ed. "https://www.academia.edu/31291212/APICS_Dictionary_13th_ed".

Ballou, R. H. (2006). *Business logistics / supply chain management*, 5th ed. Pearson.

Ballou, R. H. (2007). The evolution and future of logistics and supply chain management. *European Business Review 19*(4), pp. 332–348. https://doi.org/10.1108/09555340710760152

Banco Central do Brasil. (2020). Estatísticas [Statistics]. https://www.bcb.gov.br/estatisticas

Banco Central do Brasil. (2020). Resolução 4.671 / 2018. Fixa a meta de inflação e seu intervalo de tolerância para 2021 [Sets the inflation target and its tolerance range for 2021]. https://www.bcb.gov.br/pre/normativos/busca/downloadNormativo.asp?arquivo=/Lists/Normativos/Attachments/50618/Res_4671_v1_O.pdf

Banco Central do Brasil. (2020). Sobre o Selic [About Selic]. https://www.bcb.gov.br/htms/selic/selicintro.asp?idpai=SELIC&frame=1

Box Around the World. (2018). Understanding the different types of supply chain. https://boxaroundtheworld.com/supply-chain-modeling-101/

Boyson, S., Corsi, T., Dresner, M., & Rabinovich, E. (1999). Managing effective third party logistics relationships: What does it take? *Journal of Business Logistics. Vol. 20* (No. 1), pp. 73–100.

Cesar, I. (2018). Exploring omnichannel customer preferences in Latin America [Unpublished manuscript].

Dalsey Hillblom Lynn International GmbH. (2013). *Big data in logistics: A DHL perspective on how to move beyond the hype.* https://www.dhl.com/content/dam/downloads/g0/about_us/innovation/CSI_Studie_BIG_DATA.pdf

Dalsey Hillblom Lynn International GmbH. (2015). *Omni-channel logistics: A DHL perspective on implications and use cases for the logistics industry.* https://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/dhl_trendreport_omnichannel.pdf

Dong, X., Lu, H., Xia, Y., & Xiong, Z. (2016) Decision-making model under risk assessment based on entropy. *Entropy, Vol. 18* (Issue 11), *pp. 404.*

Ferreira, E. (2017, May 24). *Memorando de redução dos efetivos autorizados da Marinha do Brasil* [Reduction of the Brazilian Navy authorized personnel memorandum]. Brazilian Navy.

Ferrer, G. (2019). *Supply chain analysis for logistics professionals* [Unpublished manuscript].

Hudson, M. (2020, February 2). *The top sources of retail shrinkage.* The Balance Small Business. https://www.thebalancesmb.com/top-sources-of-retail-shrinkage-2890265.

Hughes, A., & Grawoig, D. (1971). *Statistics: A foundation for analysis*. Addison-Wesley Educational Publishers.

Juaneda-Ayensa, E., Mosquera, A., & Murillo, Y. S. (2016). Omnichannel customer behavior: Key drivers of technology acceptance and use and their effects on purchase intention. Front. Psychol. 7:1117. doi: 10.3389/fpsyg.2016.01117

Juntunen J., Juntunen M., & Altere, V. (2012). Outsourcing strategies of the security sector through acquisition procedures. *International Journal of Physical Distribution & Logistics Management, Vol. 42* (No. 10), *pp. 931–946*. www.emeraldinsight.com/0960-0035.htm

Lieb, R. (2008), "The north american third-party logistics industry in 2007: the provider CEO perspective," *Transportation Journal, Vol. 47* (No. 2), pp. 39–53. https://www.jstor.org/stable/20713705?seq=1

National Retail Federation. (2018). National retail security survey. https://cdn.nrf.com/sites/default/files/2018-10/NRF-NRSS-Industry-Research-Survey-2018.pdf

National Retail Federation. (2019). National retail security survey. https://cdn.nrf.com/sites/default/files/2019-06/NRSS%202019.pdf

Niranjanamurthy, M., Kavyashree, N., Jagannath, S., & Chahar, D. (2013). Analysis of e-commerce and m-commerce: Advantages, limitations and security issues. *International Journal of Advanced Research in Computer and Communication Engineering Vol. 2*, (Issue 6), pp 2360–2370. https://www.ijarcce.com/upload/2013/june/7-Niranjanamurthy-Analysis%20of%20E-Commerce%20and%20M-Commerce%20Advantages.pdf

Office of Management and Budget [OMB]. Circular A-94: Guidelines and discount rates for benefit-cost analysis of federal programs, 2016

Oracle Corporation. (2020, February 5). *Oracle Crystal Ball.* https://www.oracle.com/middleware/technologies/crystalball.html

Sutherland, L. J. (2008). Logistics from a historical perspective. [G. D. Taylor, Logistics Engineering Handbook]. DOI: 10.1201/9781420004588.sec1

U.S. Department of Transportation. (2020, February 23). *Research by mode of transportation*. https://www.transportation.gov/research-and-technology/research-mode-transportation

Williams, J. (2014). *Agricultural supply chains and the challenge of price risk*. Routledge.

World Economic Forum. (2019). Supply chain 4.0. Global practices and lessons learned for Latin America and the Caribbean. https://www.weforum.org/whitepapers/supply-chain-4-0-global-practices-and-lessons-learned-for-latin-america-and-the-caribbean-c4ffe6b1-b2f0-44f1-8b1d-c740cc11ca6f

World Resources Institute. (2018). Apparel and footwear sector science-based targets guidance. https://sciencebasedtargets.org/wp-content/uploads/2018/05/Draft-guidance-April-draft.pdf

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California