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ANALYZING HOW THE FEDERAL GOVERNMENT'S BUDGETARY CONSTRAINTS IMPACT THE HELICOPTER PROGRAM (H-XBR PROJECT) IN THE BRAZILIAN AIR FORCE

by

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June 2019

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The purpose of this project is to analyze how the federal government's budgetary constraints, which impose limitations on the commitment and payment of budget appropriations, have influenced the creation of value and performance of the helicopter program (H-XBR Project) in the Brazilian Air Force. To accomplish this objective, this thesis models the application of investment and performance analysis techniques as specifically applied to project-related data based on net present value, internal rate of return, and earned value management. Such analysis is essential for comprehending how budgetary constraints affect the H-XBR Project. Going forward, decision makers can apply the demonstrated models when deciding about future projects in the Brazilian Air Force to assess their viability and to maximize the organizational resources based on viable projects.

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ANALYZING HOW THE FEDERAL GOVERNMENT'S BUDGETARY CONSTRAINTS IMPACT THE HELICOPTER PROGRAM (H-XBR PROJECT) IN THE BRAZILIAN AIR FORCE.

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The purpose of this project is to analyze how the federal government's budgetary constraints, which impose limitations on the commitment and payment of budget appropriations, have influenced the creation of value and performance of the helicopter program (H-XBR Project) in the Brazilian Air Force. To accomplish this objective, this thesis models the application of investment and performance analysis techniques as specifically applied to project-related data based on net present value, internal rate of return, and earned value management. Such analysis is essential for comprehending how budgetary constraints affect the H-XBR Project. Going forward, decision makers can apply the demonstrated models when deciding about future projects in the Brazilian Air Force to assess their viability and to maximize the organizational resources based on viable projects.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACWP	Actual Cost of Work Performed
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
COPAC	Comissão Coordenadora do Programa Aeronave de Combate (Coordinating Committee of the Program Combat Aircraft)
CPI	Cost Performance Index
CV	Cost Variance
END	Estratégia Nacional de Defesa (National Defense Strategy)
EVM	Earned Value Management
FAB	Força Aérea Brasileira (Brazilian Air Force)
IBGE	Instituto Brasileiro de Geografia e Estatistica (Brazilian Institute of Geography and Statistics)
IRR	Internal Rate of Return
LOA	Lei Orçamentária (Budget Law)
LRF	Lei de Responsabilidade Fiscal (Fiscal Responsibility Law)
NPS	Naval Postgraduate School
NPV	Net Present Value
PFS	Physical and Financial Schedule
PMB	Performance Measurement Baseline
PR	Presidência da República (Presidency of the Republic)
PV	Present Value
SPI	Schedule Performance Index
SV	Schedule Variance

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I. INTRODUCTION

A. BACKGROUND

In the 1990s, the reform of the Brazilian State was marked by the adoption of the principle of efficiency in Article 37 of the Constituição da República Federativa do Brasil de 1988 (Constitution of the Federative Republic of Brazil of 1988) and by Constitutional Amendment 19 of 1998 (Presidência da República [PR], 1988). From that amendment, the direct and indirect Public Administration of any governmental entity should obey the principles of legality, impersonality, morality, and publicity and follow the principle of efficiency (PR, 1988).

> The principle of efficiency implemented the managerial model of public management focused on the control of results in state performance. In this sense, economy, reduction of waste, quality, speed, productivity, and functional efficiency are values adopted by said principle. (DireitoNet, 2016, para. 1)

To achieve the principle of efficiency, the Força Aérea Brasileira (FAB) (Brazilian Air Force), an organization from the federal government's Direct Public Administration, fulfills its constitutional mission of defending the homeland and guaranteeing constitutional powers, as recommended in Article 142 of the Constitution (PR, 1988), aligned with the guidelines of the Estratégia Nacional de Defesa (END) (National Defense Strategy), and approved by Decree 6,703 of 2008 (PR, 2008). In doing so, the FAB acquires defense projects, such as the H-XBR Project, that ensure its operational autonomy through the execution of credit operations with external financial agents, who are responsible for financing the program in light of specific strategic actions.

1. The Helicopter Program (H-XBR Project)

The primary purpose of the H-XBR Project is the acquisition of medium-sized helicopters for the general use of the Brazilian Armed Forces to accomplish missions associated with the Tarefa de Suporte ao Combate (Combat Support Task). As a secondary objective, the acquired aircraft must attend the missions related to the Interdiction Task

and other purposes of the FAB, such as Civic-Social Action, National Integration, and Mercy and Humanitarian (FAB, 2018).

The H-XBR Project had its contract awarded on December 23, 2008 by the Commander of the FAB, which also represented the Brazilian Navy and Army. The H-XBR Project was the first joint program of the three forces to acquire a defense project since the creation of the Ministry of Defense (Ferreira, 2015).

According to Ferreira (2015), the H-XBR Project is a program of the Ministry of Defense, under the management of the FAB, to acquire 50 helicopter models EC-725 that are manufactured in Brazil by the company Helibras for the Navy, Army, and Air Force. The main objective of the H-XBR Project is the development of the national industry, with the transfer of technology and expansion of the Brazilian industry (TCU, 2013).

The H-XBR Project has been impacted directly by the determinations of the Brazilian Federal Government, which constrain the resources necessary to carry out the program phases according to its Physical and Financial Schedule (PFS). To undertake the determination of the Brazilian Federal Government, the H-XBR Project has the periods of its PFS extended due to budgetary constraints, which limited the movement, commitment, and payment of its budget appropriations starting in 2012 and had significant impacts in the subsequent years.

As stated by Padilha (2015), budget cuts for the development and nationalization of helicopters for the Armed Forces, known as the H-XBR Project, causes loss of human capital, delays the delivery of steps, and extends the deadline for the conclusion of the contract. The stakeholders involved in the program are obliged to reconsider the timelines of the agreement to adapt to the new budgetary situation. According to Porto (2015), "budget cuts carried out by the federal government have knocked at the door of the Ministry of Defense, and the impacts are perceived in contracts already signed. The so-called new budgetary reality stretched the delivery deadline of the 50 aircraft ordered to Helicopters of Brazil SA (Helibras) in two years" (para. 1).

2. The Rationale for the H-XBR Project

In the FAB, the H-34 helicopters and the H-1H helicopters fulfill the following missions: “Search and Rescue; Aeromedical Evacuation; Exfiltration and Air Infiltration; Logistic Air Transport; Civic-Social; National Integration; Mercy; and Humanitarian” (FAB, 2018, para.1).

Currently, the H-1H helicopter presents several logistical and operational deficiencies. The U.S. Army’s planned deactivation of its H-1H helicopters has directly impacted the maintenance of the FAB fleet, mainly in the logistics sector, with significant effects on the availability of resources for the operational area. Consequently, with limited autonomy and the reduced cargo carrying capacity, H1-Hs do not adequately fulfill their missions.

The H-34 aircraft also presents a critical logistics situation regarding the availability of engines. The lack of self-defense equipment and operation at any time makes it very risky to enter an unfavorable employment scenario, which affects its operability.

Based on the operational and logistical problems faced by the H-1H and H-34 aircraft, the FAB justified the imperative need to acquire the medium-sized helicopter model called H-XBR, which is designed to execute effectively the missions that are inherent to it despite environmental adversities (FAB, 2018).

3. The Initial and Current Planning of the Helicopter Program (H-XBR Project)

The initial plan of the H-XBR Project consisted of an initial investment of EUR 1,847M, as of 2008, based on a contract term awarded between FAB and the Helibras/Eurocopter Consortium – Project H-XBR (FAB, 2008). The Contract Term established the conditions of the acquisition and the agreement of compensation and industrial cooperation linked to the H-XBR Project.

Table 1 shows the initial plan of the H-XBR Project for payment of the initial investment provided for in the TC 008/CTA-SDDP/2008, as defined by the parties involved in the process:

Table 1. The Initial Planning of the H-XBR Project.
Adapted from FAB (2008).

	Year	*Planned Payments EUR (1,000,000)
Initial investment	2008	**1,847.35
	2009	***(277.10)
	2010	(97.18)
	2011	(361.32)
	2012	(310.64)
	2013	(331.66)
	2014	(257.55)
	2015	(149.70)
	2016	(62.21)

*Nominal value.
**Amount of the initial investment agreed upon in the H-XBR Project.
***Planned disbursements (2009–2016).

The initial plan of the H-XBR Project, during the contractual execution, has undergone numerous changes using Additives to the original Contract. The main events leading to the amendments to the agreement are listed below (FAB, 2018):

1. The Contract Term TC 008/CTA-SDDP/2008, signed between FAB and the Helibras/Eurocopter Consortium – Project H-XBR, entered into force on December 23, 2008 and had its First Amendment Term signed on December 4, 2009. During the contractual execution, there was a need for adjustments to clarify or modify the contract terms.

2. On November 11, 2011, the Second Addendum to TC 008/CTA-SDDP/2008 was signed to include clarifications of technical functionalities, performances, and requests for changes in the configuration of EC-725 aircraft by the Armed Forces. It also contemplated the review of the process of receipt of steps, as well as the revision of some contractual clauses and annexes.

3. Since 2012, the Project has been subject to significant budgetary constraints that have triggered delays in receiving stages, requiring adjustments to the

PFS. This situation was aggravated in 2015 when there was a restriction on the Project Payment Limit.

4. On December 3, 2015, the Third Amendment Term to TC 008/CTA-SDDP/2008 adjusted aircraft configuration changes in the Requirements Compliance Matrix, among other contractual clauses. Because of the federal government's budgetary constraints that accumulated from 2013 to 2015, there was a need to adjust the PFS in the Third Amendment Term to TC 008/CTA-SDDP/2008 to extend the execution of the Project H-XBR until 2022. Consequently, there was an increase of EUR 44.16M in the value of the project as a function of monetary updating.

5. On December 20, 2016, the Fourth Addendum to TC 008/CTA-SDDP/2008 adjusted the PFS, observing the Annual Budget Law – Lei Orçamentária (LOA) 2016 (Budget Law 2016) due to exchange variation. With this Addendum, the contract had a reduction of EUR 0.13M related to the Third Addendum. Thus, the total increase in the TC 008/CTA-SDDP/2008 was EUR 44.03M.

Because of budgetary constraints, initial project planning for the TC 008/CTA-SDDP/2008 took place as shown in Table 2:

Table 2. Current Planning for the H-XBR Project (2008–2022), including Effective Payments up to 2018. Adapted from FAB (2018).

	Year	*Planned Payments EUR (1,000,000)	*Effective Payments EUR (1,000,000)
Initial Investment	2008	1,891.38	
	2009	(83.33)	(83.33)
	2010	(248.98)	(248.98)
	2011	(42.35)	(42.35)
	2012	(330.04)	(330.04)
	2013	(196.96)	(196.96)
	2014	(114.02)	(114.02)
	2015	(81.19)	(81.19)
	2016	(106.57)	(106.57)
	2017	(113.86)	(113.86)
	2018	(119.03)	(118.77)
	2019	(234.36)	
	2020	(123.73)	
	2021	(64.94)	
	2022	(32.01)	

*Nominal value.

The Ministry of Defense, in coordination with the Ministry of Finance, the Ministry of Development, the Ministry of Industry and Foreign Trade, the Ministry of Planning, Budget and Management, and the Ministry of Science and Technology, is accountable for providing the essential resources for the achievement of the constitutional mission imputed to FAB related to the H-XBR Project. Thus, the Ministry of Defense establishes by legal action the guarantee of the necessary resources to carry out projects related to national defense for reaching the guidelines to protect the nation (PR, 2008).

In accordance with the agreed-upon disbursement schedule, the guarantee of continuous and permanent allocation of credit and financial resources by the competent authorities is fundamental to the maintenance of the viability of projects. By a federal government decree, however, there are limits for the movement, commitment, and payment of budget appropriations. These limits, known as budgetary constraints, directly influence

the creation of value[1] and performance[2] of projects in development, especially the H-XBR Project, which is the subject of this thesis.

B. PURPOSE OF THE RESEARCH

As noted in the previous section, the H-XBR Project's PFS has changed due to the necessity of adapting the project to budgetary constraints imposed by the federal government, starting in 2012, with significant impacts in the subsequent years.

Understanding the effects of the budgetary constraints compelled by the federal government on the H-XBR Project is essential for strengthening the decision-making process and maximizing the resources applied to the program.

Therefore, the objective of this MBA project is to analyze how the federal government's budgetary constraints, which impose limitations on the commitment and payment of budget appropriations, have influenced the creation of value and performance of the H-XBR Project in the FAB.

C. FUNDAMENTAL RESEARCH QUESTION

This MBA project pursues a response to the fundamental question: How have the federal government's budgetary constraints, which impose limitations on the commitment and payment of budget appropriations, influenced the viability of the H-XBR Project in the FAB?

The following assumptions guide this research:

- The federal government's budgetary constraints, which impose limitations on the commitment and payment of budget appropriations, have created value for the institution that is financing the H-XBR Project.

[1] Creation of value is related to the Net Present Value (NPV) Theory. If the multiperiod investment has a positive NPV, the project creates value (Harris, 2008).

[2] Performance is related to "the financial and schedule health of the program" (Mislick & Nussbaum, 2015, p. 66).

- The H-XBR Project, due to the federal government's budgetary constraints, has faced delays and spent more money during its execution, which affects its performance.

D. RESEARCH RELEVANCE

This MBA Project is relevant because it contributes to the application, within the framework of the FAB, of an essential model for the analysis of the viability of existing projects, as well as future ones. An application of investment and performance analysis techniques for understanding the influence of budgetary constraints is fundamental for improving the decision process in the FAB when selecting projects.

This work promotes the discussion by the students of financial management and corporate finance on the analysis of these types of projects. It can also serve Federal Public Managers as an instrument for verifying the viability of their programs and the managers of other public entities that deal with the difficult task of providing efficient projects to benefit society.

E. RESEARCH LIMITATIONS

As a limitation of this MBA Project, the socioeconomic benefits of the H-XBR Project, such as direct and indirect jobs yielded and technology transferred, were not included as positive inputs in the cash flow of the program. The use of these inputs would increase the likelihood of a positive Net Present Value (NPV), which creates value for the H-XBR Project.

Moreover, this MBA Project did not analyze the political and market benefits that result from the external and commercial relations between the stakeholders involved in the program due to insufficient data in the records. Complex econometric assumptions for the on-screen study would be required to determine the cash flow returns of the investment in its political and market aspects. Furthermore, the cash flow of the H-XBR Project does not consider interest rates and financial adjustments for delaying payments because of the unavailability of these data. Lastly, this thesis recognizes that its results may vary due to the existence of errors of exchange and inflation rates forecast.

For a better understanding of this work, the next section presents the literature review with an approach to the FAB mission in aspects related to budget constraints and investment analysis. Then, the methodology describes the instruments applied to understand how budgetary constraints influenced the viability of the H-XBR Project. After that, the examination of data, collected through documentary research at Comissão Coordenadora do Programa Aeronave de Combate (COPAC) (Coordinating Committee of the Program Combat Aircraft), provides the essential elements for the conclusion of this MBA project.

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II. LITERATURE REVIEW

To obtain the necessary understanding of the appropriate methodology for the research, analysis, and discussion of the data, the literature review adopted the following sections: The constitutional mission of the FAB and the END and budgetary constraints within the federal government.

A. THE CONSTITUTIONAL MISSION OF THE BRAZILIAN AIR FORCE AND THE NATIONAL DEFENSE STRATEGY

The Federative Republic of Brazil, as established in its Constitution, is a democratic state of law and has, as one of its foundations of sovereignty, the freedom to decide the future of the nation in the face of internal and external society (PR, 1988).

According to Napoleão (2004), sovereignty has an inner face, which represents the capacity to maintain peace between the components of society, and an external one based on equilibrium relations—always unstable and questionable—between the different states, who have in war a powerful instrument.

For Bastos (1994), sovereignty is the foundation of the Brazilian State and the guarantee that within the national territory the intervention of internal or external adverse forces will not be admitted; rather, there will only be democratic improvement by the harmonious application of the powers constituted and emanated by the people.

In Article 3 of the Constitution, the State of Brazil established the guarantee of national development as one of its fundamental objectives to consolidate essential elements within reach of sovereignty, without forgetting the employment of the principle of efficiency (PR, 1988). The Brazilian State requires it in the application of the resources of the Federal Public Administration when pursuing a public purpose.

Napoleão (2004) notes that there is a relationship between sovereignty and national development. Sovereignty will only be guaranteed if the state is in an environment of peace in internal and external relations, with the possibility of financing the necessary structures for the construction of essential elements for the development of the country. Among these structures, the guarantee of national defense stands out.

According to an excerpt from the PR (2008), approved by Decree 6,703 of 2008, a country's national development strategy cannot be separated from the national defense strategy, as a relationship of interdependence exists between the two:

> The national defense strategy is inseparable from the national development strategy. Development strategy motivates the defense strategy. Defense strategy provides a shield for development strategy. Each reinforces the other's reasons. In both, one awakens to nationality and builds the Nation. Defended, Brazil will have to say no, when it has to say no. Brazil will have the capacity to produce its development model. (p. 30)

Based on Article 142 of the Constitution, the National Defense has its support in the "Armed Forces, constituted by the Navy, the Army and the Air Force, permanent and regular national institutions, organized by hierarchy and discipline" (PR, 1988, p. 65). They are responsible for allocating the necessary resources of the treasury "to the defense of the Motherland, to the guarantee of constitutional powers and, at the initiative of any of them, law and order" (PR, 1988, p.65).

The FAB, aware of its constitutional mission and aligned with the guidelines of defense (PR, 2008) that were approved by Decree 6,703 of 2008, awards Credit Operations. In other words, it assumes financial obligations, as defined in the Lei de Responsabilidade Fiscal (LRF) (Fiscal Responsibility Law) (PR, 2000), to acquire defense projects, which are guided by specific strategic actions and characteristics (PR, 2008).

To carry out the constitutional mission imputed to FAB, the Ministry of Defense establishes by legal action the guarantee of the necessary resources to carry out the projects related to national defense (PR, 2008). The Ministry of Defense undertakes this guarantee in coordination with the Ministries of Finance, Development, Industry and Foreign Trade, Planning, Budget and Management, and Science and Technology.

The FAB, as part of the direct administration of the Union, requested authorization to contract the H-XBR Project to the Ministry of Finance, through the Procuradoria-Geral da Fazenda Nacional (Attorney General of the National Treasury), based on the rules of the Manual of External Financing of the Public Sector (Ministério do Planejamento, Orçamento e Gestão, 2005).

Thus, in 2008, the FAB signed the contract for the H-XBR Project, in which the Federative Republic of Brazil, represented by the Ministry of Defense, acting by and through the FAB, was responsible for paying the amount financed under the terms of the Commercial Contract and the Financing Agreement.

1. Operational Cycle of Financing Structure in the Brazilian Air Force

According to Marques (2010), the cycle of operation of the financing structure consists of steps repeated throughout the existence of the financing. The delivery of goods and services by the supplier to COPAC, as well as the actual receipt, is the first stage of the cycle. This first phase of the cycle indicates compliance with the conditions established in the commercial contract. Subsequently, COPAC issues a request for disbursement to the financial institution abroad, which makes payment to the supplier. With the issuance of the payment to the supplier, the debt on behalf of the Federative Republic of Brazil arises. After the incorporation of the external debt of the Republic by the Diretoria de Economia e Finanças da Aeronáutica (Directorate of Economy and Finance of Aeronautics), organization subordinated to the Secretaria de Economia e Finanças da Administração (Secretariat of Economy and Finance of the Administration), the repayment occurs according to the rules of the financing agreement. Figure 1 summarizes the operational cycle of the financing structure:

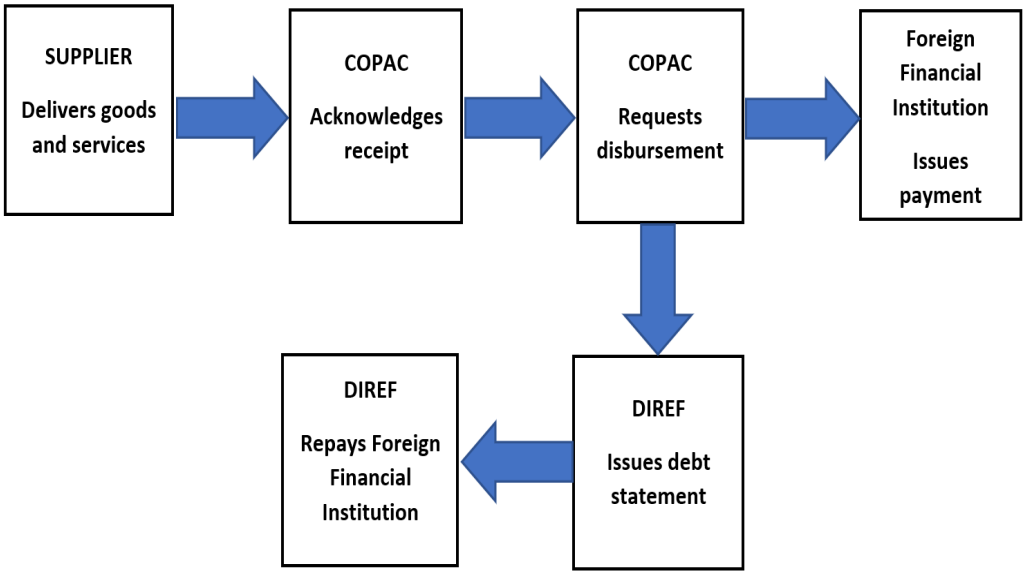

Figure 1. Operational Cycle of the Financing Structure in the Brazilian Air Force. Adapted from Marques (2010).

Constraints within the scope of the federal government now follow the institutional role of the COPAC.

2. Institutional Role of the Coordinating Committee of the Program Combat Aircraft

In the FAB, the organization responsible for the management of defense projects is the COPAC, subordinated to the Departamento de Ciência e Tecnologia Aeroespacial (Department of Aerospace Science and Technology). Figure 2 shows the structure of the FAB related to the H-XBR Project.

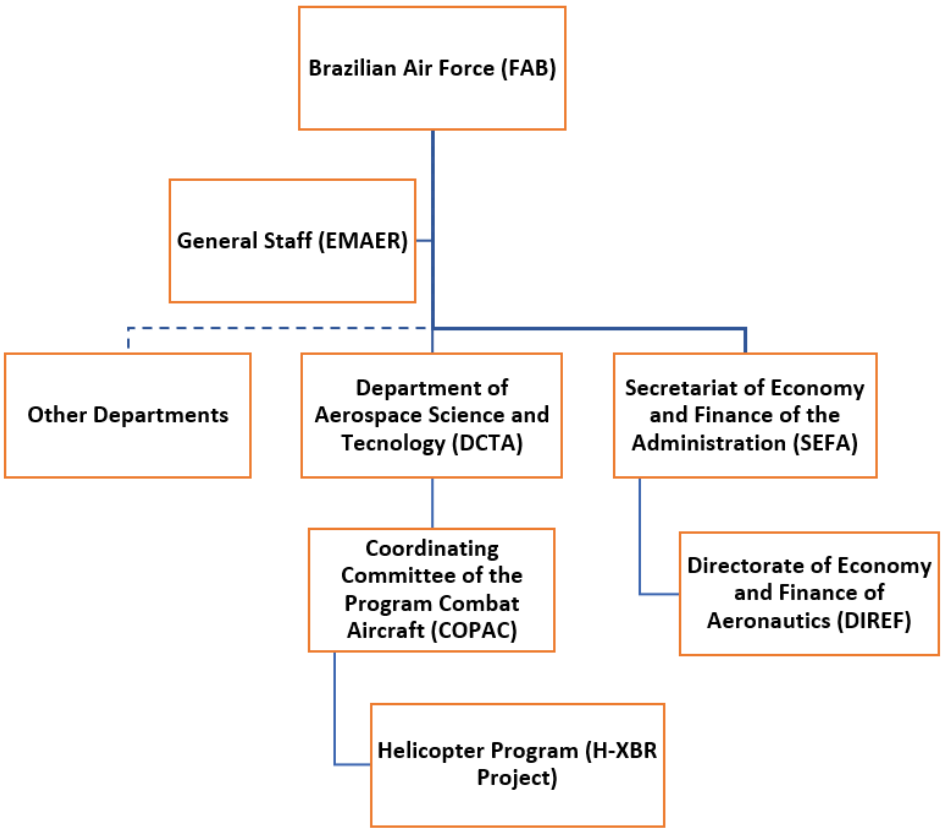

Figure 2. Extract of the Brazilian Air Force Organizational Chart. Adapted from FAB (2019).

According to FAB (2017a, 2017b), the mission of COPAC is to coordinate work on the development and procurement of combat aircraft and related systems for FAB, as well as coordinate with the Aeronautical Sector Management Bodies the actions required to implement these aircraft and systems. To carry out this coordination, the Estado-Maior da Aeronáutica (General Staff of the Air Force) oversees COPAC.

One of the programs that COPAC is responsible for is the project denominated H-XBR, which is the subject of this research.

B. BUDGETARY CONSTRAINTS WITHIN THE FEDERAL GOVERNMENT

The continuous and permanent flow of financial resources, following the disbursement schedule and agreed upon in the financing agreement and the commercial contract, is fundamental for the maintenance of the viability of any projects. By a federal decree, however, limits exist for the movement, commitment, and payment of budget appropriations (PR, 2000). These limits, known as budgetary constraints, directly influence the viability of the projects during their execution.

> If … the revenue is not expected to meet the primary or nominal income targets established in the Fiscal Targets Annex, the Government Branches and the Public Prosecutor shall … impose the limitation of commitment and financial movement, according to the criteria established by the law of budget guidelines. (p. 27)

The budgetary constraints, defined in the LRF, is a mechanism of risk control when it becomes evident that the realization of revenues will not entail the fulfillment of the goals of the primary or nominal result set out in the Fiscal Targets Annex (PR, 2000). In other words, it is a mechanism for avoiding expenditures in excess of the country's ability to pay.

Machado and Costa (2003) affirm that the mechanism provided in Article 9 of the LRF for setting limits of movement, commitment, and payment of budget appropriations is a rule of the greatest importance for the control of budgetary and financial resources in Brazil. They believe that this mechanism is reasonable if revenue does not include compliance with the primary and nominal targets outlined in the fiscal targets.

For Giacomoni (2005), flexibility should be a characteristic of the disbursement schedule, which may vary during the year, given changes in priorities and especially in the behavior of collection. For him, the mechanism of limitation of commitment and financial movement is fundamental for the balance of the public accounts.

On the other hand, Bosco (2010) affirms that the constraints of the budget to fix limits of movement, commitment, and payment of budget appropriations is an artifice of the Federal Executive power for achieving fiscal targets. In the same section, Protásio,

Burgarin, and Burgarin (2004) corroborate that instrument used by the government only to reduce public expenditure.

The budgetary guidelines within the federal government, which provide direction for the elaboration of the budget law, have set in their repertoire provisions on budgetary and financial limitation since 2000. This has been done to define the qualifying criteria of limitation of commitment and financial movement, which are materialized through the issuance of a Decree limiting commitment and financial movement.

The following excerpt, outlined in Article 56 of the LOA2018 (Budget Law 2018), is similar to that of previous legislation because it reflects the federal government's concern in limiting commitment and financial movement, which directly has influenced the viability of the H-XBR Project (PR, 2017):

> If it is necessary to carry out the limitation of commitment and financial movement referred to in article 9 of the Law of Fiscal Responsibility, the Executive Power will determine the necessary amount and will inform to each budgetary organ of the Legislative and Judicial Branches, of the Public Ministry of the Union and the Public Defender of the Union. (p. 14)

The next section will discuss aspects of investment analysis and earned value management (EVM) to understand the methodology applied for verifying the cash flow of the H-XBR Project.

Having explained the role of the FAB to accomplish its constitutional mission and the meaning of budgetary constraints within the federal government in Brazil, the next section presents the methodology applied in this thesis to achieve its primary objective.

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III. METHODOLOGY

A. PRELIMINARY ASPECTS OF THE METHODOLOGY

For undertaking the objective of this MBA project, bibliographical research was carried out to investigate the legislation related to the constitutional mission of the FAB, which is to guarantee the national defense of Brazil. Reviewing the Brazilian Federal Constitution and the END was essential to demonstrate the assumptions that compel the FAB to acquire items of defense, such as the H-XBR Project. Also, books by renowned authors were critical for understanding the idea of budgetary constraints within the scope of the Brazilian Federal Government, the criteria for analysis of investment, and performance in projects and applying the NPV, Internal Rate of Return (IRR), and EVM techniques.

According to Vergara (2007), this research is also documented research because documents preserved inside the public administration were necessary for the analysis of the subject of this MBA Project. The COPAC, which is responsible for the H-XBR Project, provides the documents related to the program's commercial contract. Furthermore, this research is an ex post facto investigation because the variables involved could not be manipulated or controlled. It is also explanatory, as it aims to clarify how the variable budgetary constraints influenced the viability of the H-XBR Project.

This research also adopted both the qualitative and quantitative approach based on an empirical analysis of the quantitative results obtained through investment analysis of the cash flow of the H-XBR Project, applying NPV, IRR, and EVM techniques. Furthermore, the deductive method was essential to gather empirical evidence related to the assertions of this thesis.

B. PROJECT ANALYSIS ON INVESTMENTS

In the following sections, this thesis discusses the investment analysis considering when the project creates value and how to measure value creation. Also, it presents the EVM technique for project performance analysis.

1. When the Project Creates Value for the Organization on its Cash Flow

In any operating company or public organization, in general, day-to-day work is carried out using real assets. As the investment project, an initial and defined effort is undertaken to create a unique product or service to the company, according to Lapponi (2007).

Brealey, Myers, and Allen (2013, p. 1) say that "corporations invest in real assets, which generates income. Some of these assets, such as plant, and machinery, are tangible; others, such as brand names, and patents are intangible. Corporations finance their investments by borrowing, by retaining and reinvesting cash flow." In this vein, investing commits financial resources on a specific date and for a certain period, during which return or disbursement flows will be generated to compensate the investor for the time the money was compromised by that period's inflation and by the uncertain flow of returns and disbursements.

For Carvalho (2014), any investment has embedded a portion of the risk; that is, every bet carries risk. Thus, within the scope of the investment decision, which materializes by sacrificing an immediate and certain satisfaction in exchange for a future expectation (bet), it is no different.

As stated by Brealey et al. (2013), managers make investment decisions to maximize value creation for the organization. According to Lapponi (2007), company management must detect, develop, evaluate, and execute investment opportunities that are more valuable than costs, including opportunity cost, which is the value of the best-abandoned alternative in favor of the chosen option with the same level of risk.

In this treadmill, as stated by Carvalho (2014), value is created for a company or organization when the projects' costs are lower than their returns based on a forecast of revenues and costs. Therefore, companies look for and select investments whose value is higher than their costs to execute. In other words, they look for projects considered feasible, which create value for the organization.

> A smart and effective manager makes decisions that increase the current value of the company's shares and the wealth of its stockholders. This

> increased wealth can then be put to whatever purposes the shareholders want. They can get their money to charity or spend it in glitzy nightclubs; they can save it or spend it now. Whatever their tastes or objectives, they can do more when their shares are worth more (Brealey et al., 2013, p. 7).

2. How to Measure the Project's Creation of Value on its Cash Flow

For measuring the value creation of the project, this thesis considered the models of NPV and IRR as follows:

a. Net Present Value

From an organizational point of view, the decision process for choosing an investment must always yield value for the institution to provide benefits for all their members, especially shareholders.

> A company's shareholders prefer to be rich rather than poor. Therefore, they want the firm to invest in every project that is worth more than it costs. The difference between a project's value and its cost is its net present value (NPV). Companies can best help their shareholders by investing in all projects with a positive NPV and rejecting those with a negative NPV. (Brealey et al., 2013, p. 105)

To measure the project's creation of value, Lapponi (2007) applies the NPV of the project cash flow, considering the opportunity cost of capital related to the inflation rate or interest rate. If the NPV is greater than zero, the project must be accepted because it will create value for the organization in regard to monetary aspects. On the other hand, if the NPV is less than zero, the project should not be approved because it will destroy the company's value.

From this same perspective, Carvalho (2014) defines that if the NPV is positive, it means that the value of the entries deflated by the inflation rate is higher than the present value of the outputs deflated by the same rate. In this case, project approval will mean financial gain. If the value of the NPV is negative, it will mean financial loss, being indifferent from the financial point of view, in the hypothesis of NPV null.

An essential feature of the NPV calculation is that, in general, the initial date capital has a negative signal and the remaining capital flows have a positive sign because they are returns generated by the investment. As stated by Lapponi (2007), another aspect of

consideration is that the increase in the required inflation rate or interest rate decreases NPV, and vice versa.

Carvalho (2014) states that the NPV method consists of calculating the present value of all cash flow terms and then adding this present value to the initial investment of each alternative. In other words, all the installments of receipts and disbursements are included in the cash flow of the enterprise, bringing them to the same date (usually the base date).

Brealey et al. (2013) comment that there are three critical points to consider about NPV. NPV assumes that a cash today is worth more than a cash tomorrow. Also, NPV relies on the estimated cash flow from the project, the inflation rate when deflating, and the interest rate when discounting. Furthermore, as present values are all measured in today's cash, it is possible to add them up.

Following the same reasoning, Lapponi (2007) states that the use of NPV in feasibility analysis of investment projects has many advantages. Among them, he highlights the fact that the NPV considers the entire cash flow of the project; considers the value of money over time with the required rate, which includes the risk of the project; informs and measures the value created or destroyed by the project; and applies to projects with any type of cash flow.

On the other hand, there are disadvantages of NPV that must be considered, such as the need to determine the required project rate a priori; being a monetary value rather than an interest rate; and the possibility of reinvesting project returns at the same rate required to ensure NPV.

(1) How to Calculate Net Present Value

Calculating the NPV consists first in adding all disbursements deflated, in constant value (the base year 2008), of the current cash flow of the H-XBR Project. The next step is adding the disbursements deflated, in constant value (the base year 2008), of the initial cash flow of the H-XBR Project. In sequence, one must obtain the difference between the

amount of disbursements of the current cash and initial cash flow. The equation applied for calculating the NPV is the following:

$$NPV = \sum_{t=1}^{m} X_t - \sum_{t=1}^{n} Y_t$$

NPV – Net Present Value
X_t – Disbursements deflated of the current cash flow of the H-XBR Project
Y_t – Disbursements deflated of the initial cash flow of the H-XBR Project
m – Number of periods of the current cash flow of the H-XBR Project
n – Number of periods of the initial cash flow of the H-XBR Project
t – Period

b. Internal Rate of Return

To complement the analysis of a project, one must also consider the effective project interest rate, which is the expected project rate defined only by project estimates recognized as the IRR of the project. As stated by Lapponi (2007), if the opportunity cost is lower than the IRR, the project must be accepted because it will be profitable for the institution that is financing the program. On the other hand, when the opportunity cost is higher than the IRR, the project should not be accepted because it will not be profitable for the institution that is financing the program.

For Carvalho (2014), the IRR is an indicator of the project's profitability. The investor compares the IRR to the minimum rate of the attractiveness in which he can obtain the best remuneration with the use of investment capital alternative.

Brealey et al. (2013) clarify that there are differences between IRR and opportunity cost of capital: "The internal rate of return is a profitability measure that depends solely on the amount and timing of the project cash flows. The opportunity cost of capital is a standard of profitability that we use to calculate how much the project is worth" (p. 113).

When compared to the opportunity cost, the IRR only informs if the project will be profitable or not, without measuring the value created or destroyed, since the IRR is the expected or effective rate of the project in which the NPV is null.

According to Lapponi (2007), the use of IRR in the analysis of investment or financing projects has the advantage of considering the entire cash flow of the project and

the value of money in time. Also, the IRR informs if the project is profitable or not profitable. Moreover, IRR is a relative ratio, rather than an absolute value like the NPV.

As for disadvantages of using IRR, we can mention the fact that it is only for the evaluation of projects with cash flow with a single change of the signal, called simple type projects; and an a priori determination of the required project rate is required.

According to Lapponi (2007), the NPV and IRR calculations can be used in the environment of certainty, when the likelihood of changes is very low, and in circumstances of uncertainty. For an environment of uncertainty, we can consider the variations in disbursement flows of financing projects caused by the budgetary constraints of the Brazilian Federal Government. In other words, cash flow uncertainty does not invalidate the project valuation procedure with NPV or IRR, considering a required rate.

For a better understanding, some focus on financing is necessary. Financing is useful for the purchase of a house, a car, and, in this specific case, for the replenishment of the FAB with the acquisition of items considered essential to the guarantee of national defense.

Thus, a Financing Plan defines the periodicity of payments, interest, partial repayment of the amount financed, called amortization, and the balance due on the payment date of each installment. According to Lapponi (2007), some rules apply to finance: Each benefit refers to a specific period, the value of each repayment is the sum of the amortization plus the interest, and the interest on each payment is always on the outstanding balance of the financing at the beginning of the payment's period.

Therefore, according to Lapponi (2007) and Carvalho (2014), NPV and IRR apply to the analysis of financing projects because these metrics are useful in any project, except IRR for specific cases of projects with different signs for returns.

(1) How to Calculate Internal Rate of Return

Calculating IRR consists of the summation of the difference of the payments in nominal value EUR of the initial cash flow of the H-XBR Project and those in nominal value EUR of the current cash flow of the H-XBR Project divided by the factor $(1+IRR)^t$,

based on the correspondent period, with the summation equal to zero. The equation applied for calculating the IRR is the following:

$$\sum_{t=1}^{m} \frac{(x_i - y_i)}{(1 + \text{IRR})^t} = 0$$

x_i – Planned payments in nominal value EUR of the initial cash flow of the H-XBR Project
y_j – Planned payments in nominal value EUR of the current cash flow of the H-XBR Project
IRR – Internal Rate of Return
m – number of periods of the current cash flow of the H-XBR Project
t – Period

For an analysis of the performance and efficiency of projects, the next section discusses relevant aspects of the tool known as EVM.

3. Earned Value Management

EVM is fundamental for analysis of project performance. In the following sections, this thesis discusses the importance and application of EVM for project analysis.

a. The Relevance of Earned Value Management for Analysis of Projects

From the previous section, we can infer that the creation of value, regarding financial aspects, provided by a project or program is fundamental to the process of choosing investments that will generate future economic benefits for the organization. More importantly, the value created must be maintained or expanded during the execution of the project through management actions to monitor the progress and performance of the program.

As stated by Mislick and Nussbaum (2015), one of the ways that the program manager must act to monitor the progress and performance of its projects is by means of the EVM technique: "EVM provides the capability to monitor these work packages in a time-phased way. It tracks not only 'Current Time Period' (i.e., this month or quarter), but it also then adds progress to a 'Cumulative to Date' tracking the program" (pp. 66–69).

For Rendon and Allen (2008), EVM is an essential tool for integrating cost, schedule, and performance measurements, being most appropriate for investments in which the government has a significant cost risk. In other words, these investments are more susceptible to changes in their environment. According to them, EVM contributes to the following:

> Planning all work for the contract period of performance (POP). Integrating all contract work scope, cost, and schedule objectives in a single performance baseline. Objectively assessing progress against that baseline. Analyzing variances and forecasting their impacts. Making meaningful information available to decision makers. (p. 231)

Based on the planning, it is reasonable to apply a tool for measuring the performance of any project: "EVM measures actual contract performance against an integrated baseline, called performance measurement baseline (PMB), which reflects a plan of cost, schedule, and technical progress for the POP" (Rendon & Allen, 2008, p. 233). Consequently, when applying EVM, the program manager must pay significant attention to the development of the PMB.

For the success of the EVM's application, the program manager must start the PMB with the work breakdown structure (WBS):

> The contractor decomposes WBS elements into individual 'work packages', which are … tasks with an identified product or outcome, an assigned start and finish date, a cost budget to accomplish the work, and an assigned office or individual with responsibility to accomplish the work. (Rendon & Allen, 2008, p. 233)

b. Application of Earned Value Management for Analysis of Projects

There are several metrics used in EVM for applying it to measure the performance of the project against the PMB, but Mislick and Nussbaum (2015) state that the primary three metrics are the following:

> Budgeted cost of work scheduled (BCWS): This is the amount budgeted for the totality of the work packages that we scheduled to accomplish in a certain period of time. Budgeted cost of work performed (BCWP): This is the amount budgeted for the work that we accomplished in that period of time. Actual cost of work performed (ACWP): This is what it actually cost us to accomplish the work while completing these work packages. (p. 69)

Based on these metrics, the program manager can calculate the Cost Variance (CV) and the Schedule Variance (SV): "A cost variance means that either more or less money was spent on a task than was budgeted for that task. Schedule Variance indicates whether contract tasks are on, behind, or ahead of schedule" (Rendon & Allen, 2008, p. 236).

In the same vein, Mislick and Nussbaum (2015, p. 69) explain that "Cost Variance is a measure of how much more (or less) the cost is from what was originally planned. Schedule variance is a measure of how much more (or less) work has been accomplished in a certain time frame from what was originally planned."

The program manager determines the SV comparing the budgeted cost of work performed (BCWP) with the budgeted cost of work scheduled (BCWS) as follows:

$$SV = BCWP - BCWS$$

To determine the CV, the program manager compares the budgeted cost of work performed with the actual cost of work performed as follows:

$$CV = BCWP - ACWP$$

As stated by Rendon and Allen (2008), depending on the total of work accomplished and amount of money spent on the tasks, the project might have a negative (unfavorable) variance, no variance, or a positive (favorable) variance.

The EVM method applies other metrics that are sufficient for attending the objective of this thesis: Cost Performance Index (CPI) and Schedule Performance Index (SPI). According to Mislick and Nussbaum (2015), CPI) and SPI are efficiency indices applied to analyze projects of distinct extensions:

> The Cost Performance Index (CPI), and Schedule Performance Index (SPI) are efficiency indices of the cost and schedule performance indicators. These are important because without them, it is difficult to compare projects of different size to one another. …If the CPI is less than 1.0, this implies that the actual cost for a task was greater than the budgeted cost for that task, thus implying a cost overrun for that task. Similarly, when considering the program schedule, SPI calculates whether you are ahead or behind schedule time-wise by using similar principles. (p. 69)

Table 3 shows the meaning of CPI and SPI when these values are greater or less than 1.0.

Table 3. SPI and CPI Earned Value Metrics. Adapted from Mislick and Nussbaum (2015).

Metrics	Description
Schedule Performance Index (SPI) = BCWP/BCWS	Efficiency measure with respect to schedule. If > 1.0, Favorable. If < 1.0, Unfavorable.
Cost Performance Index (CPI) = BCWP/ACWP	Efficiency measure with respect to cost. If > 1, Favorable. If < 1.0, Unfavorable.

C. FORECAST EXCHANGE AND INFLATION RATES (2019–2022)

Considering that exchange and inflation rates from 2019 to 2022 are not available, this thesis forecasted these values based on exponential smoothing as follows:

1. Forecast Exchange Rates (2019–2022)

The exchange rates from 2019 to 2022 are estimates based on exponential smoothing with trend. This approach was applied because of the positive trend in the exchange rate, as seen in Figure 3.

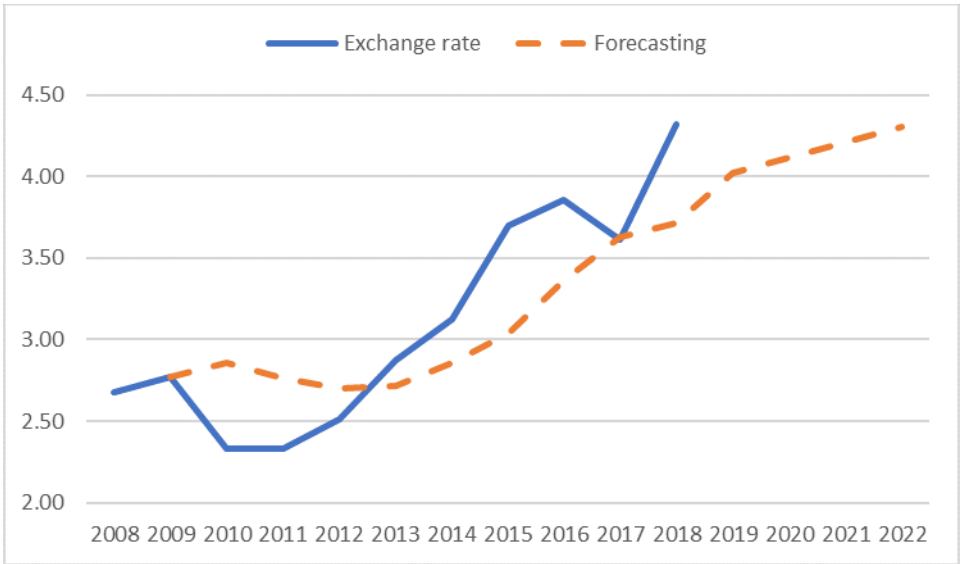

Figure 3. The Average Exchange Rate (2009–2018) and the Exchange Rate Forecast (2019–2022). Adapted from Investing.com (2019).

The exponential smoothing with trend requires the selection of two parameters (α and β) in the range (0, 1). In practice, a better forecast is obtained when both parameters are in the range (0.01, 0.35). The following equation shows how to calculate the forecast in Table 4:

$$L_t = \alpha \times A_t + (1 - \alpha) \times F_t$$

$$T_t = \beta \times (L_t - L_{t-1}) + (1 - \beta) \times T_{t-1}$$

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

A_t – Actual value of the exchange rate
F_t – Forecast value at time t
L_t – Intrinsic value at time t
T_t – Smoothed trend at time t
α – Smoothing parameter for intrinsic level for trend
β – Smoothing parameter for trend
t – Period

The mean squared error of the forecast is minimized when $\alpha = 0.35$ and $\beta = 0.01$. With these parameters, the forecast is obtained in Table 4.

Table 4. The Forecast of the Exchange Rate (2019–2022) Based on Exponential Smoothing with Trend.

			Alpha =	0.35	
			Beta =	0.01	
Year	Exchange Rate	Forecasting	Level	Trend	Sq Error
2008	2.6785		2.6785	0.0907	
2009	2.7692	2.7692	2.7692	0.0907	0.0000
2010	2.3328	2.8599	2.6754	0.0889	0.2778
2011	2.3279	2.7643	2.6115	0.0873	0.1904
2012	2.5115	2.6989	2.6333	0.0867	0.0351
2013	2.8703	2.7200	2.7726	0.0872	0.0226
2014	3.1221	2.8598	2.9516	0.0881	0.0688
2015	3.6993	3.0397	3.2706	0.0904	0.4351
2016	3.8559	3.3610	3.5342	0.0922	0.2449
2017	3.6088	3.6264	3.6202	0.0921	0.0003
2018	4.3214	3.7123	3.9255	0.0942	0.3710
2019		4.0197			
2020		4.1139			
2021		4.2082			
2022		4.3024		MSE =	0.1646

2. Forecast Inflation Rate (2019–2022)

The inflation rates from 2019 to 2022 are estimates based on exponential smoothing. This approach was applied due to the absence of a trend of the inflation rate, as seen in Figure 4.

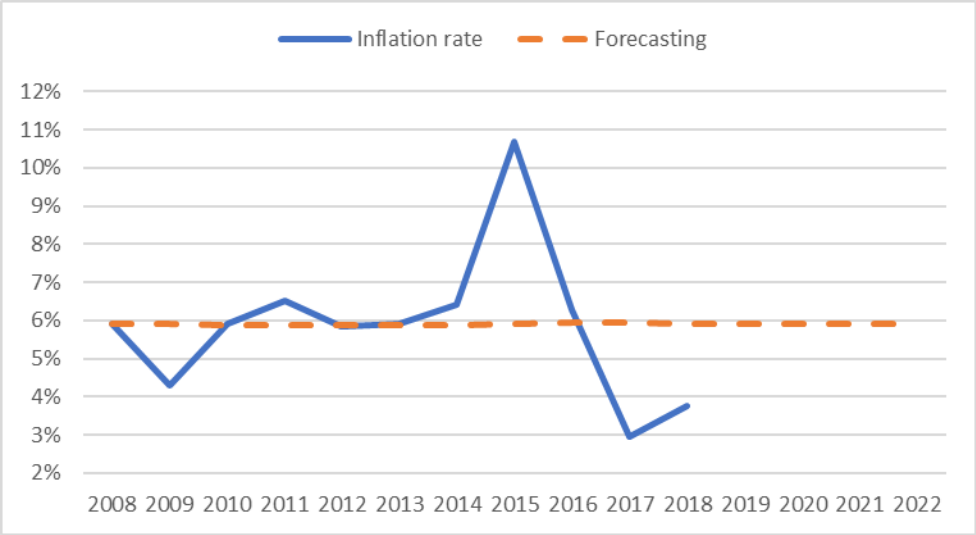

Figure 4. The Average Inflation Rate (2008–2018) and the Inflation Rate Forecast (2019–2022). Adapted from Instituto Brasileiro de Geografia e Estatistica (Brazilian Institute of Geography and Statistics) (2019).

The exponential smoothing requires the selection of the parameter α in the range (0, 1). Indeed, a better forecast is obtained when the parameter is in the range (0.01, 0.35). The following equation shows how to calculate the forecast in Table 5:

$$F_t = \alpha \times A_{t-1} + (1 - \alpha) \times F_{t-1}$$

A_t – Actual value of the inflation rate
F_t – Forecast value at time t
α – Smoothing parameter for intrinsic level. It must be between 0 and 1, recommended smaller than 0.35
t – Period

The Mean Squared Error of the forecast is minimized when $\alpha = 0.01$. With this value of α, the forecast is obtained in Table 5.

Table 5. The Forecast of the Inflation Rate (2019–2022) Based on Single Exponential Smoothing.

Alpha =	0.01		
Annual Inflation (Dec to Dec)	Inflation Rate	Forecasting	Sq Error
2008	5.90%	5.90%	
2009	4.31%	5.90%	0.00025
2010	5.91%	5.88%	0.00000
2011	6.50%	5.88%	0.00004
2012	5.84%	5.89%	0.00000
2013	5.91%	5.89%	0.00000
2014	6.41%	5.89%	0.00003
2015	10.67%	5.90%	0.00228
2016	6.29%	5.94%	0.00001
2017	2.95%	5.95%	0.00090
2018	3.75%	5.92%	0.00047
2019 and beyond		5.89%	
		MSE =	0.00040

D. AVERAGE EXCHANGE RATE AND RAW INDEX BASED ON INFLATION RATE

Considering that the nominal values of the cash flow of the H-XBR Project are on Euro currency, the first step was to convert these values to Brazilian currency, denominated "Real," whose symbol is "R$," based on "Avg exchange rate EUR – BRL," in Table 6. For this MBA project, the symbol of the Brazilian currency adopted is BRL as recognized in the exchange market. Therefore, it was possible to deflate the nominal values in BRL, according to the inflation of each period, regarding 2008 as the base year.

Table 6. The Average Exchange Rate Between the Euro and Brazilian Real (BRL).

Year	Avg Exchange Rate EUR – BRL
2008	2.6785
2009	2.7692
2010	2.3328
2011	2.3279
2012	2.5115
2013	2.8703
2014	3.1221
2015	3.6993
2016	3.8559
2017	3.6088
2018	4.3214
2019	*4.0197
2020	*4.1139
2021	*4.2082
2022	*4.3024

*Estimates forecasted based on exponential smoothing with trend.

Table 7 shows the values of the raw index, which is a cumulative amount of inflation in each year related to the base year. The year 2008 is the base year for calculating the raw index because the FAB awarded the contract of the H-XBR Project in 2008. This thesis applies the raw index for deflating the nominal values of the Brazilian currency (BRL) to calculate the NPV. Considering that the raw index of the base year 2008 is 1.0000 and the inflation of the year 2009 is 4.31%, the raw index 2009 is $1.000 \times (1 + 0.0431) = 1.0431$. To calculate the raw index 2010, whose inflation is 5.91%, the prior raw index must be inflated by the inflation rate of the year 2010. Thus, the raw index 2010 is $1.0431 \times (1 + 0.0591) = 1.1047$. Correspondingly, the raw index 2011 is $1.1047 \times (1 + 0.0650) = 1.1766$. Therefore, the following formula applies for calculating the raw index:

$$R_t = R_{t-1} \times (1 + i_t), \text{being raw index } 2008 = 1.0000$$

R_t – Raw index at time t
i_t – Inflation rate at time t

Table 7. Raw Index Based on Average Inflation Rate Brazil (IPCA) per Year.

Annual Inflation (Dec to Dec)	Inflation Rate	Raw Index
2008	5.90%	1.0000
2009	4.31%	$1 \times (1 + 0.0431) = 1.0431$
2010	5.91%	$1.0431 \times (1 + 0.0591) = 1.1047$
2011	6.50%	$1.1047 \times (1 + 0.0650) = 1.1766$
2012	5.84%	$1.1766 \times (1 + 0.0584) = 1.2453$
2013	5.91%	$1.2453 \times (1 + 0.0591) = 1.3189$
2014	6.41%	$1.3189 \times (1 + 0.0641) = 1.4034$
2015	10.67%	1.5531
2016	6.29%	1.6508
2017	2.95%	1.6995
2018	3.75%	1.7633
2019	*5.89%	1.8671
2020	*5.89%	1.9771
2021	*5.89%	2.0936
2022	*5.89%	2.2169

*Estimates forecasted based on single exponential smoothing.

The next chapter will analyze the data and show the results of this MBA Project. It begins with analysis of the initial cash flow of the H-XBR Project regarding NPV. Then, it compares this parameter to the NPV of the current cash flow of the H-XBR Project and analyzes the result of the IRR. Finally, the chapter discusses the performance of the program based on metrics of EVM.

IV. DATA ANALYSIS

Discussion and analysis of the initial cash flow of the H-XBR Project discounted by inflation, the current cash flow of the H-XBR Project discounted by inflation, and the EVM analysis are essential for comprehending the results of this MBA project.

A. INITIAL CASH FLOW OF THE H-XBR PROJECT CONVERTED BY EXCHANGE RATE AND DEFLATED TO 2008

Table 8 shows the initial cash flow of the H-XBR Project converted from Euro to Brazilian Real in a million. The values in the "BRL" column are the result of multiplying the nominal values of the "EUR" by the "Exchange rate EUR/BRL." They represent the values of the H-XBR Project in Brazilian Real per year, which consider the effects of the Brazilian inflation. From 2009 to 2016, each value in the "BRL" column is "planned payments." For instance, in the year 2009, the payment of BRL 767.35M is EUR 277.10M times the exchange rate of 2.7692. As the nominal values in the "BRL" column include inflation, to calculate the constant value related to the base year 2008, it is necessary to deflate these values by the raw index of each year, as shown in Table 9.

Table 8. The Initial Cash Flow of the H-XBR Project Converted from Euro to Brazilian Currency in a Million.

Year	*EUR (1,000,000)	Exchange Rate EUR/BRL	*BRL (1,000,000)
2008	**1,847.35		
2009	(277.10)	2.7692	(767.35)
2010	(97.18)	2.3328	(226.70)
2011	(361.32)	2.3279	(841.12)
2012	(310.64)	2.5115	(780.17)
2013	(331.66)	2.8703	(951.96)
2014	(257.55)	3.1221	(804.10)
2015	(149.70)	3.6993	(553.79)
2016	(62.21)	3.8559	(239.88)

*Nominal value.
**Initial investment.

1. Net Present Value of the Initial Cash Flow of the H-XBR Project

Table 9 shows the initial cash flow of the H-XBR Project deflated by inflation. The constant values in the "2008 BRL" column represent the amount planned to undertake the program, regarding 2008 as the base year. The constant value does not include inflation and corresponds to the present value of the amount required to pay the entire H-XBR Project in 2008. The values in the "2008 BRL" column are the result of dividing the values in the "BRL" column by those in the "Raw index" column. For example, the amount of payment of BRL 205.21M in 2010 is the result of dividing the nominal value of BRL 226.70M by the raw index of 1.1047. Table 9 also shows the NPV of the initial cash flow of the H-XBR Project regarding the base year 2008. Considering that the H-XBR Project is a financing program, the payments are negative outcomes. The negative result of the NPV of BRL 4,078.89M could imply that the H-XBR Project created value for the institution that is financing the program. In other words, based on the data above, the program could not have been accepted by the FAB, according to Brealey et al. (2013), Lapponi (2007), and Carvalho (2014). Considering the limitations of this MBA project, which did not include social and economic benefits or political and market benefits, this result of the NPV is only reasonable for understanding the impact of the budgetary constraints over the program and not for making assumptions related to the acceptance of the H-XBR Project.

Table 9. NPV of the Initial Cash Flow of the Project H-XBR in the Base Year 2008.

Year	*BRL (1,000,000)	Raw Index	**2008 BRL (1,000,000)
2008		1.0000	***
2009	(767.35)	1.0431	(735.64)
2010	(226.70)	1.1047	(205.21)
2011	(841.12)	1.1766	(714.90)
2012	(780.17)	1.2453	(626.51)
2013	(951.96)	1.3189	(721.81)
2014	(804.10)	1.4034	(572.96)
2015	(553.79)	1.5531	(356.56)
2016	(239.88)	1.6508	(145.31)
		NPV (2008) =	(4,078.89)

*Nominal value.
**Constant value.
***Only the disbursed amounts considered in the NPV calculation.

B. CURRENT CASH FLOW OF THE H-XBR PROJECT CONVERTED BY EXCHANGE RATE AND DEFLATED TO 2008

Table 10 shows the current cash flow of the H-XBR Project converted from Euro to Brazilian Real in a million. The nominal values in the "BRL" column are the result of multiplying the amounts in the "EUR" by the "Exchange rate EUR/BRL." In the "BRL" column, the negative values are the payments planned of the H-XBR Project converted by the exchange rate. As noted in Table 10, the current cash flow of the H-XBR Project goes up to year 22 because the initial cash flow of the H-XBR Project suffered modifications in function of significant budgetary constraints, which impose limitations on commitment and payment of budget appropriations.

Table 10. The Current Cash Flow of the H-XBR Project Converted from Euro to Brazilian Real in a Million

Year	*EUR (1,000,000)	Exchange Rate EUR/BRL	*BRL (1,000,000)
2008	**1,891.38		
2009	(83.33)	2.7692	(230.77)
2010	(248.98)	2.3328	(580.82)
2011	(42.35)	2.3279	(98.58)
2012	(330.04)	2.5115	(828.90)
2013	(196.96)	2.8703	(565.34)
2014	(114.02)	3.1221	(355.99)
2015	(81.19)	3.6993	(300.34)
2016	(106.57)	3.8559	(410.91)
2017	(113.86)	3.6088	(410.90)
2018	(119.03)	4.3214	(514.40)
2019	(234.36)	***4.0197	(942.07)
2020	(123.73)	***4.1139	(509.01)
2021	(64.94)	***4.2082	(273.30)
2022	(32.01)	***4.3024	(137.72)

*Nominal values.
**Initial investment.
***Estimates forecasted based on exponential smoothing with trend approach.

1. Net Present Value of the Current Cash Flow of the H-XBR Project

Table 11 shows the current cash flow of the H-XBR Project deflated to 2008 using the raw index. The constant values in the "2008 BRL" column represent the amount planned to undertake the program, using 2008 as the base year. The values in the "2008 BRL" column are the result of dividing the nominal values in the "BRL" column by those in the "Raw Index" column. In doing so, the amount of planned payments of the H-XBR Project related to the base year 2008 is BRL 4,109.19M, which is the NPV of the current cash flow of the H-XBR Project. When comparing the NPV of the initial cash flow, Table 9, to the current cash flow of the H-XBR Project, Table 11, the NPV of the current cash flow increases by BRL 30.31M, or 0.74%, as shown in Table 12. Thus, due to the federal government's budgetary constraints, which compelled it to extend the program to 2022, the Brazilian government is paying an additional BRL 30.3M.

Table 11. NPV of the Current Cash Flow of the H-XBR Project.

Year	*BRL (1,000,000)	Raw Index	**2008 BRL (1,000,000)
2008		1.0000	***
2009	(230.77)	1.0431	(221.23)
2010	(580.82)	1.1047	(525.75)
2011	(98.58)	1.1766	(83.78)
2012	(828.90)	1.2453	(665.64)
2013	(565.34)	1.3189	(428.66)
2014	(355.99)	1.4034	(253.66)
2015	(300.34)	1.5531	(193.38)
2016	(410.91)	1.6508	(248.91)
2017	(410.90)	1.6995	(241.77)
2018	(514.40)	1.7633	(291.73)
2019	(942.07)	1.8671	(504.56)
2020	(509.01)	1.9771	(257.46)
2021	(273.30)	2.0936	(130.54)
2022	(137.72)	2.2169	(62.13)
		NPV (2008) =	(4,109.19)

*Nominal value.
**Constant value.
***Only the disbursed amounts considered in the NPV calculation.

Table 12. Difference between the NPV of the Initial and Current Cash Flows of the H-XBR Project.

Difference between NPV	
NPV (2008)	*2008 BRL (1,000,000)
Updated plan (a)	(4,109.19)
Initial planned outlays (b)	(4,078.89)
Difference (a-b)	(30.31)
Increment (a-b)/b	0.74%

*Constant value.

2. Internal Rate of Return of the Cash Flow of the H-XBR Project due to Budgetary Constraints

Figure 5 shows the IRR vs. NPV chart of the H-XBR Project based on the sum of the difference of the payments in nominal values in the “EUR” column, Table 8, and those

in the "EUR" column, Table 10, divided by the factor $(1 + \text{IRR})^t$. The negative values of the IRR (-1.578, and -1.743) are discarded because it is unusual to apply negative IRR to compare to the cost of opportunity in the market. Also, "Analysts should disregard negative IRRs when preparing IRR averages, or weighted average IRRs for multiple actions" (Schmidt, 2019).

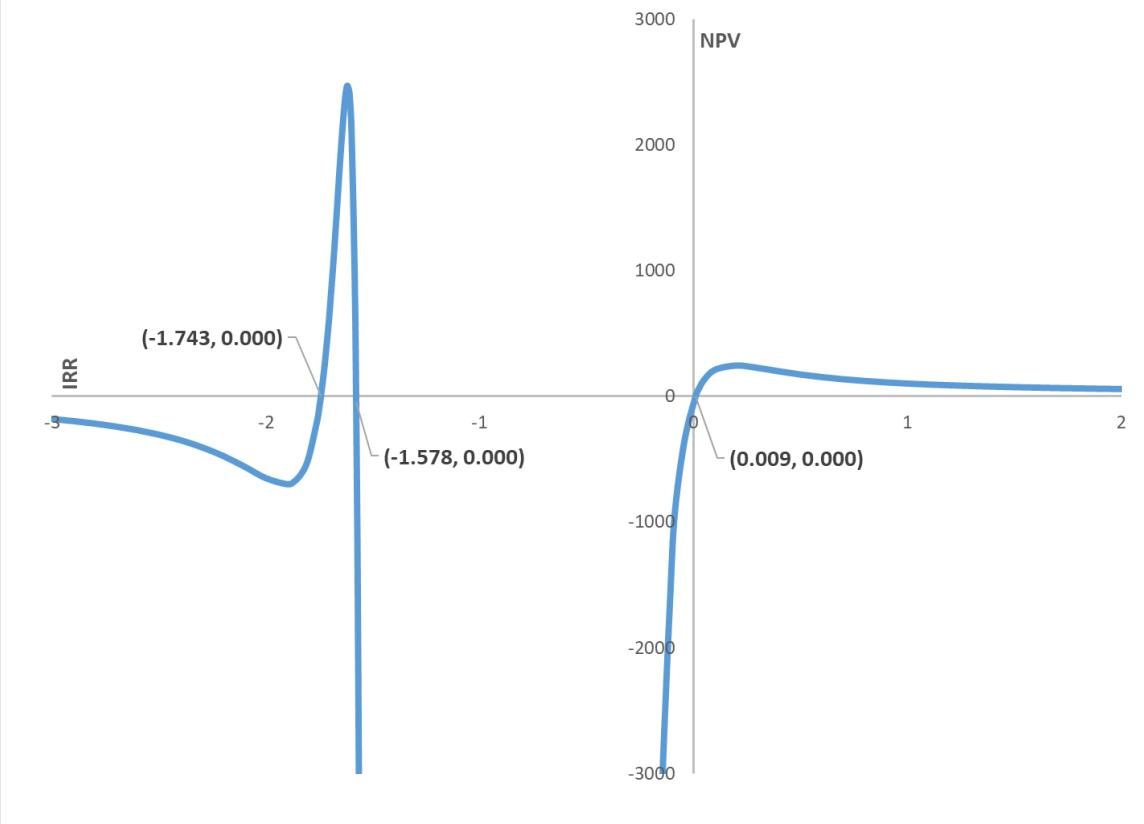

Figure 5. IRR versus NPV Chart Based on Nominal Values (Euro in a Million) of the Initial and Current Cash Flows of the H-XBR Project.

Table 13 shows the result of the IRR for the initial and current cash flows of the H-XBR Project. IRR = 0.9% represents the interest rate of return in which both the cash flows have the same NPV. Thus, the IRR of 0.9% is the rate of indifference between the initial and current cash flows of the H-XBR Project. Therefore, if the H-XBR Project were

refinanced with the opportunity cost of 0.9%, there would be no financial gain or loss for the Brazilian government.

Table 13. IRR of the Initial and Current Cash Flows of the H-XBR Project Based on EUR (Nominal Value).

Current Cash Flow	
*IRR	0.9%

*Value of IRR, in which the NPV of the initial and current cash flow of the H-XBR Project is zero.

Table 14 shows the comparison between the IRR of the initial and current cash flows of the H-XBR Project. In the "Initial Cash Flow" column, calculating the values in the "PV (2008) EUR," each value in the "EUR" was discounted by the factor $(1 + \text{IRR})^{t}$, where IRR $= 3\%$. This rate was selected because it was the interest rate of the European Central Bank in December 2008 (ECB, 2019), when FAB awarded the H-XBR Project's contract. The sum of the present values (PVs) is equal to EUR 1,639.91M. In the "Current Cash Flow" column, IRR = 2.20% is selected because it is the discount rate that gives the same sum of PV = EUR 1,639.91M. In other words, if the institution that financed the H-XBR Project accepted the IRR of 3% for the initial financing of the program, the NPV of the initial cash flow would be EUR 1,639.91M. When considering this value of NPV $=$ EUR 1,639.91M for the current cash flow of the H-XBR Project, the IRR used for refinancing was 2.20%. Thus, the institution that financed the H-XBR Project accepted a lower opportunity cost than before $(2.20\% < 3\%)$ in the initial investment. Therefore, the Brazilian government obtained a financial benefit of 0.8% due to its budgetary constraints.

Table 14. Comparison between the IRR of the Initial and Current Cash Flows of the H-XBR Project at the Same NPV.

	Initial Cash Flow		Current Cash Flow	
Year	*EUR (1,000,000)	PV (2008) EUR (IRR=3%)[3]	*EUR (1,000,000)	PV (2008) EUR (IRR=2.2%)[4]
2008			(83.33)	(81.54)
2009	(277.10)	(269.03)	(248.98)	(238.38)
2010	(97.18)	(91.60)	(42.35)	(39.67)
2011	(361.32)	(330.66)	(330.04)	(302.54)
2012	(310.64)	(276.00)	(196.96)	(176.67)
2013	(331.66)	(286.09)	(114.02)	(100.07)
2014	(257.55)	(215.69)	(81.19)	(69.72)
2015	(149.70)	(121.72)	(106.57)	(89.55)
2016	(62.21)	(49.11)	(113.86)	(93.62)
2017			(119.03)	(95.77)
2018			(234.36)	(184.50)
2019			(123.73)	(95.31)
2020			(64.94)	(48.95)
2021			(32.01)	(23.61)
2022				
		NPV = (1,639.91)		NPV = (1,639.91)

*Nominal value.

C. EARNED VALUE MANAGEMENT ANALYSIS

Table 15 demonstrates the current cash flow of the H-XBR, including effective payments from 2009 to 2018 and scheduled payments from 2009 to 2022. The total of EUR 1,436.07M, in the "Effective Payments EUR" column, is the actual cost of work performed (ACWP) by the program. Because EVM considers the cumulative values, the ACWP means that the project has paid, up to 2018, the amount of EUR 1,436.07M for the execution of the planned phases of the project. The total of EUR 1,891.38M represents the BCWS by the program. This parameter indicates that the amount of EUR 1,891.38M, achieved after the delay of phases due to the federal government's budgetary constraints, is what the program planned to spend to undertake the whole H-XBR Project. Considering that the program was executed up to 2018, the BCWP is EUR 1,436.33M, which means

[3] Interest rate level in percentage per annum of the European Central Bank (ECB) on December 2008 (ECB, 2019).

[4] Interest rate of return calculated based on the $\mathrm{NPV} = 1{,}639.91$.

the amount planned and executed by the H-XBR Project based on the data collected. Table 16 summarizes these parameters, including SV and CV.

Table 15. The Current Cash Flow of the H-XBR Project, including Effective and Scheduled Payments in Nominal Values.

Year	*Effective Payments EUR (1,000,000)	*Scheduled Payments EUR (1,000,000)
2008		
2009	83.33	83.33
2010	248.98	248.98
2011	42.35	42.35
2012	330.04	330.04
2013	196.96	196.96
2014	114.02	114.02
2015	81.19	81.19
2016	106.57	106.57
2017	113.86	113.86
2018	118.77	119.03
2019		234.36
2020		123.73
2021		64.94
2022		32.01
TOTAL	1,436.07	1,891.38

*Nominal value.

As shown in Table 16, the SV, which is the difference between the BCWP and BCWS, has a negative result. This negative amount means that the H-XBR Project is behind schedule in EUR 455.05M. In other words, there is a delay in the program because the work performed is less than the work planned. On the other hand, the CV, which is the difference between the BCWP and ACWP, has a positive result. This positive amount means that the H-XBR Project has spent EUR 0.26M less than planned on the program. Based on CV and SV parameters it is reasonable to assume that the federal government's budgetary constraints influenced the H-XBR Project, impacting the progress of tasks due to the limitation of funding.

Table 16. EVM Metrics of the H-XBR Project.

EVM Metrics	*EUR (1,000,000)
BCWS	1,891.38
BCWP	1,436.33
ACWP	1,436.07
SV=BCWP-BCWS	(455.05)
CV=BCWP-ACWP	0.26

*Nominal value.

Table 17 shows the EVM metrics of efficiency of the H-XBR Project, which measure the performance of the program regarding cost efficiency and schedule efficiency. Related to the SPI, the result of 0.7594 means that the program is unfavorable regarding schedule during the execution of the tasks. It means that the program is behind schedule. On the other hand, the CPI of 1.0002 indicates that the program is slightly favorable related to the cost spent on the project. The H-XBR Project has spent less than planned on the program. The SPI and CPI corroborate the results of CV and SV parameters. Therefore, the federal government's budgetary constraints influenced the performance of the program. Without the limitation of the necessary resources, the project could have progressed more to accomplish its tasks.

Table 17. EVM Metrics of Efficiency of the H-XBR Project.

Metrics of Efficiency	
SPI=BCWP/BCWS	0.7594
CPI=BCWP/ACWP	1.0002

To summarize, the budgetary constraints of the Brazilian federal government influenced the creation of value and performance of the H-XBR Project. The NPV of the current cash of the program increased by 0.74%. Thus, the Brazilian government is paying an additional BRL 30.3M. Also, if the institution that financed the H-XBR Project refinanced it with lower opportunity cost than before ($2.20\% < 3\%$) in the initial investment, the Brazilian government obtained a financial benefit of

0.8% due to its budgetary constraints. Finally, the performance of the project is unfavorable regarding scheduling and slightly favorable considering cost because the program could progress further if it had received the necessary amount of resources without limitation of funding.

The next section provides the conclusion of this thesis, as well as suggestions and recommendations for future research related to the results of this MBA project.

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V. CONCLUSION, RECOMMENDATIONS, AND FUTURE RESEARCH

A. CONCLUSION

To fulfill its constitutional mission for ensuring national defense, FAB awards commercial and financing contracts to acquire defense projects, in coordination with the Ministry of Defense and in accordance with the END.

The viability of these projects requires a continuous flow of financial resources, in compliance with the agreed-upon disbursement schedule. Because of Brazilian Federal Government Decree, however, limitations on the commitment and payment of budget appropriations, known as budgetary constraints, affect the viability of awarded projects.

The H-XBR Project, a helicopter program undertaken by the COPAC, has its PFS extended due to budgetary constraints, which directly influence the program. This thesis analyzed how the federal government's budgetary constraints, which impose limitations on the commitment and payment of budget appropriations, have influenced the creation of value and performance of the H-XBR Project in the FAB. The following are responses to the assumptions that guided this research:

- The federal government's budgetary constraints have not influenced the H-XBR Project by creating more value for the institution that is financing the program. On the contrary, although the Brazilian government is paying an additional BRL 30.3M (0.74%), it obtained a financial benefit of 0.8% in EUR if the refinancing of the H-XBR Project occurred with an opportunity cost of 2.20%, lower than that assumed in the initial financing (3%). Thus, budget constraints influenced the project, generating financial benefits for the Brazilian government.

- The federal government's budgetary constraints have influenced the performance of the H-XBR Project. Although the program is unfavorable regarding schedule, it is slightly favorable related to the amount of money spent on the project. Thus, the program is behind schedule and has spent

less than planned. Therefore, the H-XBR Project could progress further if it had received the resources without limitation of funding.

To achieve the purpose of this MBA project, bibliographic research based on the Brazilian Federal Constitution and the END was fundamental for understanding the constitutional mission of the FAB to guarantee national defense, focusing on the acquisition of defense projects, as well as for understanding the federal budgetary constraints. Also, the review of renowned authors, in conjunction with an investigation of documents kept inside of the COPAC, was essential for the adoption of H-XBR Project's criteria for the creation of value and performance. Finally, the consolidation of data in tables, related to the initial and current cash flow of the H-XBR Project, facilitated the calculation of NPV, IRR, and EVM metrics, such as BCWS, BCWP, ACWP, SPI, and CPI, which were crucial for obtaining the mentioned results of this thesis.

B. RESEARCH RECOMMENDATIONS

As for recommendations, this MBA Project suggests the following:

- Applying the value creation analysis model, based on NPV and IRR, as an instrument of decision making for choosing viable projects within the scope of FAB.
- Establishing an incremental range, based on NPV, as a practical tool for changing the schedule of the FAB's program due to the federal government's budgetary constraints.
- Monitoring projects altered because of the federal government's budgetary constraints based on EVM techniques. By doing this, it is possible to simulate the impact on the program's performance because of the resource's limitations.

Of all these recommendations, the most crucial is that the Brazilian Federal Government does not constrain defense project budgets. The best alternative is to carry out

the project according to the initial plan. Otherwise, Brazil could be subject to interest rate changes in the future and may suffer large financial losses.

C. FUTURE RESEARCH

Based on this study, this thesis recommends future research and exploration in the following areas:

- Applying the socioeconomic benefits of the H-XBR Project, such as the generation of direct and indirect jobs, and technology transfer, as probable positive cash flow returns.
- Analyzing the political and market benefits of the H-XBR Project that result from the external and commercial relations between the stakeholders involved in the program.
- Evaluating the H-XBR Project interest rates on contractual adjustments and monetary corrections due to late payments.

This MBA Project provided a set of tools to measure the creation of value and performance of the H-XBR Project within the scope of the FAB when the federal government compels budgetary constraints. In an environment of limited resources, the application of models that contribute to measuring the value yielded by projects is fundamental for benefiting the organization. In doing so, the decision makers will prioritize limited resources for the most viable programs. Therefore, by applying the resources on the most viable projects, the FAB will always increase its capabilities to undertake its crucial role: Defend the Brazilian nation.

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