Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Economics

Bachelor Thesis

Economic Impact of the Panama Canal Expansion

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Hector Tapiero

Economics and Management

Thesis title

Economic impact of the Panama Canal Expansion

Objectives of thesis

- Evaluate costs and benefits of the Panama Canal Expansion.
- Evaluate the social and economic impact of the Panama Canal expansion in Panama.
- Compare the situation of an expanded Panama Canal among its competitors.

Methodology

Methods of financial evaluation (NPV, IRR, payback period) and cost benefit analysis methods as well as methods appropriate for literature review

The proposed extent of the thesis

40 pages

Keywords

Growth, Ports, Environment, Trade Routes, Cargo, Capacity

Recommended information sources

Aguirre, R. (2010). The Panama Canal. Leiden: Martinus Nijhoff Publishers.
Jervis, Rick. 'U.S. Ports Prepare For Panama Canal Expansion'. USA TODAY. N.p., 2015.
Manfredo, Fernando. 'Los Estudios Sobre La Ampliación Del Canal De Panama'. Revista Tareas 2006.
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Propuesta De Ampliación Del Canal De Panamá. 1st ed. Ciudad de Panamá: N.p., 2006.

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Declaration

I declare that I have worked on my diploma thesis titled "The Economic Impact of the Panama Canal Expansion" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 14.03.16 _____

Acknowledgement

I would like to thank my family for the opportunity offered to me, and my friends for their support and motivation. A would like to offer a special mention to Mr. Petr Procházka for his guidance and patience.

Ekonomický dopad rozšíření Panamského průplavu

Souhrn

Tato bakalářská práce zkoumá ekonomický dopad projektu rozšíření Panamského průplavu.Dále si klade za cíl určit a analyzovat aspekty proveditelnosti, jako náklady a přínosy projektu, jeho vliv na konkurenci a světový obchod, jakož i hospodařský a sociální dopad na panamskou společnost.

Přehled literatury objasňuje relevantnost mezinárodního obchodu a jeho vzniku stejně tak jako roli kterou hraje ve světové ekonomice. Práce představí pojmy jako doprava, obchodní pravidla, lodní doprava, vodní cesty, konkurence a historie Panamského průplavu.

Praktická část se skládá z rozboru nákladů a výnosů na základě údajů publikovaných ACP (Panama Canal Authority) o nákladech na stavbu a o příjmech v průběhu a po dokončení stavebních prací. Jakkoliv tyto údaje jsou čerpány ze spolehlivích studii vypracovaných na vysoké úrovni, vždy se setkáme s opačnými názory na jejich objektivitu. Tato práce si neklade za cíl potvrdit nebo odmítnout objektivitu techo studii, ale spíše je zkoumat a srovnávat je s realitou projektu rozšíření, který je v současnosti dokončen na 98 – 99%.

Klíčová slova: Panamský průplav, Vrata, Přístavy, Vodní cesty, Obchod, Mýtné, Náklady, Mezinárodní obchod, Výhody, Stavba

Economic Impact of the Panama Canal Expansion

Summary

This thesis will examine the economic impact of the Panama Canal expansion project. Furthermore, it will assess and analyze feasibility aspects such as costs and benefits of the project, its effect among competitors and global trade, and the social and economic impact on Panamanian society.

The literature review attempts to shed some light on the relevance of international trade and its origins, as well as the role it plays in today's global economy. It will introduce concepts involving transportation, trade regulations, shipping, waterways, competition and the Panama Canal history.

The practical part will consist of a cost benefit analysis based upon the data published by the ACP (Panama Canal Authority) regarding construction costs and revenues produce during and after the construction period. Even though this data comes from reliable studies performed with the highest of standards, there are always controversial opinions about the objectivity of these studies. This thesis attempts not to refute or argue the objectivity of these studies but rather to analyze and compare them to the reality of the expansion project, which up to date is around 98-99% completed.

Keywords: Panama Canal, Locks, Ports, Waterways, Trade, Tolls, Costs, International Trade, Benefits, Construction

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1. Introduction

Since its opening on August 14th 1914, the Panama Canal has offered to the world a short and inexpensive connective route between the Pacific and Atlantic Oceans. This route has significantly exerted changes to world commerce route patterns by allowing vessels and cargo vessels to save time and money. Due to the significant impact of the Panama Canal on world commerce, all efforts has been made to guarantee the save, efficient, and non-stop operation of the Panama Canal for a little bit over a century now, and also the continual maintenance and upgrading of infrastructure and water way to meet the standards and requirements of the world's merchant fleet.

In recent years, the Panama Canal has developed limiting factors that have impacted its operational capacity that at the present moment is causing a downgrade in service of the Canal. These limiting factors are the increase of daily transits that has gotten beyond its real capacity and water shortage.

On 2005, the Panama Canal had an average operational capacity of 38 vessels daily, with an average of 24 hours spent on its waters. This capacity was reduced to 32 or less vessels per day when repairs or maintenance took place. After these issues were sorted out, the Panama Canal was compelled to increase temporally to 42 vessels daily in order to unburden the water way, consequence of the issues before mentioned.

As it normally happens, the tendency for any human endeavor is growth. This is true also for cargo vessels and overall commerce and trade worldwide. In order for the Panama Canal to keep its status as main commerce route in the world, the government of former president of Panama, Martin Torrijos (2004-2009), presented to the country a plan to expand the Canal on April 24th 2006. Later on October 22nd the plan was approved via national referendum. (*ACP Expansion Proposal*)

The Canal expansion program involves the construction of two new New-Panamax (Post-Panamax) lock complexes, one in the Pacific and one in the Atlantic side of the Canal. Each lock will have three chambers with water-saving basins, a system of lateral filling and emptying, and rolling gates.

The Pacific Post-Panamax lock will have an access channel that requires the excavation of approximately 50 million cubic meters of dry material along 6.1 kilometers.

The expansion also includes the dredging of both entrances (Atlantic and Pacific) and the widening and deepening of the existing navigational channels in Gatun Lake and the deepening of Culebra Cut.

The project requires increasing the maximum operation levels of Gatun Lake to 45 cm, therefore improving water supply and reliability of the dredging.

With the new locks, the expanded canal will be able to handle vessels of up to 1,200 feet (366 meters) length overall, 160 feet (49 meters) beam (width) and 50 feet (15.2 meters) draft (depth) in tropical fresh water. The Panama Canal estimated that, after the expansion, the new canal will double the current capacity reaching 600 million CP/SUAB tons, will handle container vessels of up to 13,000 TEU's and other vessels of up to approximately 170,000 dwt, with some draft restrictions.

The expansion of the Canal will benefit its users, Panama and world trade. In addition to increased capacity, the Canal will boost its services to the maritime industry and global trade flows by facilitating the transportation of goods between different markets. Similarly, the expansion will allow Panama to further settle as the transport and logistics hub of the Americas, enabling the strengthening of maritime routes across the Isthmus.

2. Objectives and Methodology

1.1 Objectives

The main objective is to discuss the costs and benefits of the Panama Canal expansion project. Building upon that premise, evaluate how will it affect global trade, maritime routes, and the socio-economic impact in Panama, all across the board.

The obvious supposition is that the expansion project, considering the Panama Canal as an important trade route for the last hundred years, will have benefits at a global scale. This thesis focuses on quantifying estimates of costs and financial benefits, and compares them with the current situation that is taking place almost upon completion of the project. Other components of the costs and benefits analysis such as environmental impact and externalities are disregarded to a great extent due to its complexity and unpredictable nature.

This thesis is written in order for the reader to understand how important is to satisfy the growing demand for the Panamanian route in international trade, and hence highlight the interest of the global community to improve the capacity to handle cargo required to the Panama Canal.

1.2 Methodology

Conforming to the objectives of this thesis, a cost benefit analysis was implemented in the practical part. This analysis was based on estimates of costs and revenues that the canal would have during and the after the construction period. With the data gathered, the cost benefit analysis will deliver results such as Net Present Value, Internal Rate of Return and Benefit/Cost Ratio. These results were produced under two possible scenarios for the purpose of this thesis. First scenario is taking the revenues constant throughout the construction phase and the project's life span. The second scenario, similarly, takes the same timeline for the period of analysis but considers increasing tolls. These two situations will show the difference in measurable monetary benefits during and after the expansion project.

3. Literature Review

1.3 Transportation and International Trade

Sea transportation (also referred in this thesis as shipping, maritime transportation), globally speaking, is the most widely used approach for international trade, due to its capacity of being the largest carrier of freight throughout recorded history. Containerization revolutionized ship transport starting in the 1970s.

The first ships were created and made out of cedar wood about 1200 years BC by Phoenician sailors who were the first to venture into open sea, and the Vikings, who designed their vessels resembling a human spine. The first steamboat was built in the nineteenth century thanks to the technological development that took place during the Industrial Revolution. The first steamboat was named the Clermont, built by the American inventor Robert Fulton, which first voyage took place in 1807, traveling a distance of 483 km in 62 hours through the Hudson River from New York City to Albany and back. The next upgrade in water transportation was the diesel engine, which replaced the steam propulsion technology due to its economic benefits. ("La Importancia De La Industria Del Transporte Marítimo En El Comercio Internacional")

As shipping evolves, people have created vessels to suit every man's needs either by higher cargo capacity, or for luxury and leisure. In global trade, different types of vessels exist, such as general cargo ship, bulk carriers, and oil tankers, among others.

Historically, navigation has not been only the main form of transportation, but also a communication network for cities, countries, and continents. Nonetheless, the sea has always been considerate a dangerous and harsh environment to work in. In the modern world, sea transport was one of the main industries to implement international regulations and treaties for safety, in order to reduce accidents at sea.

International treaties have existed since the 19th century, establishing common navigational and sailing procedures to avoid collision in the sea. Nowadays, under the responsibility of the IMO (International Maritime Organization) and totally renewed, the treaties and regulations are still the main approach followed regarding maritime safety, which involves fields such as ship design, construction and equipment, subdivision and stability, fire protection, radio communication, navigational safety, cargo transportation, safety management and maritime protection. (Ortiz Abrego)

Gradually, the world is accepting the IMO competence in conflicts and disputes resolutions, derived from national regulations in international trade. The level of ratification and compliance of the treaties, agreements and regulations established by the IMO are very high compared to the international regulations adopted in the industry of road and rail transportation. Globally, treaties and agreements are accepted, such as SOLAS (Safety of Life At Sea), which is the most important agreement about safety in vessels, and the MARPOL (Marine Pollution), which prevents sea pollution. These are a few examples of the tools used to stop any foreign vessel in any port if they don't follow and adjust to the international conventions.

Under the IMO supervision, the shipping and maritime industry has significantly increased the safety and security levels at sea and its environmental performance. Even though political powers, either national or regional criticize international regulations, the IMO assures an agreement upon the complex technical requirements.

Of all the components that take place in global transportation, maritime transportation is probably the one that has the lowest profile; however it is the one which has the most effect in everyone's daily consumption. To the modern world, the shipping industry is of very much importance. It influences on social issues and economic development, by triggering increases in employment rates, as millions of people worldwide work directly or indirectly on sea related activities.

Regarding environmental issues, in comparison to ground transportation, maritime transportation is a way lesser generator of pollution. Despite of the massive increase in global maritime transportation, studies have shown that there has been a substantial decrease in maritime pollution in the last 20 years, especially with regard to the amount of oil spills.

As mention before, maritime transportation is the most efficient way to transport cargo in respect to costs and environment. Nowadays around 90% of global trade is moved by the maritime industry. This industry is just responsible for around 12% of pollution caused by human economical activities. Maritime transportation contributes with an enormous potential to achieve sustainability in today's world by encouraging prosperity through trade and commerce.

To the modern world, the shipping industry is of very much importance. It influences on social issues and economic development, by triggering increases in

employment rates, as millions of people worldwide work directly or indirectly on sea related activities.

The vessels of today are the most technically advanced, the largest and most complex, with most cargo capacity, the safest and environmentally friendly of all history. There are container ships that have the capacity of 10 000 TEU (Twenty-Foot Equivalent Unit) that at the same time cam achieve top speed of 25 knots. By January 1st, 2005, the world merchant fleet accounted for 46 222 vessels which summed up to 597 709 000 DWT (deadweight tonnage). ("Containers | World Shipping Council")

1.3.1 Trade between Continents

It is defined as international or world trade, the movement of goods and services across different countries and markets. It is performed using currencies and is subject to additional regulations established between participants in the exchange and the governments of their home countries. When international trade takes place, the countries involved are mutually benefited from better positioning of their products, and entering into foreign markets. ("La Importancia De La Industria Del Transporte Marítimo En El Comercio Internacional")

The economies involved in foreign trade are called open economies. This process of external opening has essentially begun in the second half of the twentieth century and dramatically increased during the 1990s, when Latin America, Eastern Europe and East Asia joined this movement. The opening of markets has caused a growing interrelationship between what happens in international markets and what happens in the economy of a country. ("What Is Global Trade? - Definition, Advantages & Barriers - Video & Lesson Transcript | Study.Com")

1.3.2 Regulations

Traditionally, trade was regulated through bilateral agreements between two countries. Under the belief in mercantilism for many centuries countries impose high tariffs and other severe restrictions on international trade. In the nineteenth century, especially in Britain, the belief in free trade gained momentum, and this perspective has come to dominate the political thought among Western countries until now. Since the end

of World War II, a number of multilateral treaties have attempted to create a global structure of trade regulation.

Most of communist and socialist countries believe in autarky, which means the complete absence of international trade and the meeting of economic needs through self-reliance. Despite these beliefs, all countries are involved in some kind of international trade, as it is very difficult for one country to meet all their financial needs.

We used several tools to manipulate international trade. These include tariff safeguards, export and import quotas and non-tariff barriers. An essential component of international trade is the international transport of goods. The terms and conditions thereof are regulated by the Incoterms.

ICOTERMS

The Trade Practices Commission of the International Chamber of Commerce developed what has been called Incoterms, acronym from the English words International Commercial Terms. The intention was to that, regardless of the nationality of the parties or the geographical location of its use, those involved could at any time to know what rights and obligations of each in a given contract were.

The Incoterms rules or lack any legal force, and obtain recognition of their daily and constant use worldwide, so, to be applicable to a particular contract, it must specify this.

Incoterms contain a total of thirteen positions, or different types of clauses, which can then, by using certain additions, partially modified. In addition, throughout their existence they have suffered successive changes and modifications to adapt to changes in commercial applications, technical, technological advances, etc. The latest edition for the year 2010, which is still in force:

EXW (ex works): Ex Works

The seller fulfills his obligation once the goods are placed in their establishment (factory, workshop, warehouse, etc.) to the buyer. And is therefore not responsible, nor taking charge duty on the goods in the vehicle provided by the buyer, or any other related to insurance, transportation, offices and customs clearance of goods. The buyer bears all costs since the goods are placed at his disposal at the agreed place. It is important to clarify the buyer loading schedules store, date from which can carry the load, even if the goods or

packaging used, to some degree or need special transportation condition. It is the only Incoterm in which the seller does not ship the office of export, but whether to provide assistance and the necessary documents for it.

There is the possibility of hiring a EXW LOADED mode, in which the seller delivers the goods and cargo in the truck or conveyance sent by the buyer.

FCA (free carrier): Free Carrier

The seller fulfills its obligations when the goods deposited, and cleared for export by the carrier nominated by the buyer at the named place or point to it.

FAS (free alongside ship): Free Alongside Ship

The seller fulfills its obligations when the goods have placed alongside the ship on pier or barge (attention to the customs of the port, or the sector, as well as the technical characteristics of the port of loading to avoid cost overruns) in the port of shipment, bearing all the risks and costs until now. In the 2000 version, the seller bears the obligation to clear customs for export. The buyer bears, from this moment with all the costs and risks of the goods. INCOTERM this position can only be used in maritime, river or lake transport. Often accompanied chosen from the loading port, for example FAS CARTAGENA (SPAIN).

FOB (free on board): Free On Board

The seller fulfills its obligations when the commodity has been cleared for export, he has exceeded the designated ship's rail at the port of shipment, to bear all risks and costs until now. The buyer bears, from this moment with all the costs and risks of the goods. INCOTERM this position can only be used in maritime, river or lake transport. Often accompanied chosen from the loading port, for example FOB CARTAGENA (SPAIN). In the 2000 version, on the fob stowed it must be expressly agreed by the parties as is the sharing of costs and risks of stowage and trimming of the goods.

CFR (cost and freight): Cost and Freight

The seller must pay the costs and freight necessary to bring the goods to the port of destination, including all costs of export, including customs clearance. However the risk of loss or damage to the goods as well as any additional expenses occurring after the goods have crossed the ship's rail borne by the buyer. Also borne by this unloading costs at the port of destination, (although there are some exceptions to this rule). Often accompanied

chosen destination port, for example CFR CARTAGENA (SPAIN). INCOTERM this position can only be used in maritime, river or lake transport.

CIF (Cost Insurance and Freight): Cost, Insurance and Freight

The seller has the same obligations as in the previous section, CFR, but includes his charge and the insurance liability and payment of the premium for the transport of goods. It notes that this insurance is only required to be of "minimum coverage" if you want more coverage must be expressly agreed. We must clarify that the risk is still borne by the buyer from the goods cross the ship's rail, but the seller has an obligation to take out insurance to which we have referred. INCOTERM this position can only be used in maritime, river or lake transport. Often accompanied chosen destination port, for example CIF CARTAGENA (SPAIN). In the 2000 version, in the CIF STACKING it must be expressly agreed by the parties as is the sharing of costs and risks of stowage and trimming of the goods. This specification expresses costs and risks to the CIF landed (LANDED) is also required.

CPT (carriage paid to): Carriage Paid To

The seller must pay the costs and freight transport necessary to bring the goods to the point of destination, including all costs and export licenses, including customs clearance. However the risk of loss or damage to the goods as well as any additional expenses occurring after the goods have been delivered to the carrier borne by the buyer. Equally borne by the cost of unloading it, although with some exceptions, at the point of destination.

It can be used with any mode of transport, including multimodal.

CIP (carriage and insurance paid to): Carriage and Insurance Paid to

The seller has the same obligations as in the previous section, CPT, but includes his charge and the insurance liability and payment of the premium for the transport of goods. We must point out that this insurance is only required to be "minimal coverage, if you want more coverage must be expressly agreed. It should also be clear that the risk is still borne by the buyer from which the goods are delivered to the carrier, but the seller is obliged to take out insurance to which we have referred. This position INCOTERM can be used in any type of transport, including multimodal.

DAF (delivered at frontier): Deliver At Frontier

The seller fulfills his obligation to deliver when he has delivered the goods cleared through customs for export, at the point and place the border point that as a general rule defines the Customs Authority of the country, but before the customs border of the adjoining country. The seller bears the costs and risk until delivery, and the buyer from the receipt of the goods. Typically it used for road transport, rail and road, but nothing prevents that can be used with the other. It is very important to verify that the designated Customs is prepared and authorized to dispatch our goods. Is also interesting specify which custom is chosen to avoid any customs that may be between the two countries.

DES (delivered ex ship): Delivered Ex Ship

The seller fulfills his obligation to deliver when the goods placed on board the vessel at the port of destination agreed to the buyer, and cleared through customs for export. The seller bears the costs and risk until delivery (docked ship and ready to download), and the buyer from the receipt of the goods. Only used for maritime, river and lake transport. Often accompanied chosen destination port, for example DES CARTAGENA (SPAIN).

DEQ (Delivered Ex Quay): Delivered Ex Quay

The seller fulfills his obligation to deliver when the goods placed on the dock at the port of destination, to the buyer, Incoterms 2000 .In disappears the obligation to clear customs import by the seller, and it must be agreed the parties expressly. The seller bears the costs and risk until the time of delivery (except express agreement). Only used for maritime, river and lake transport. Usually accompanied chosen destination port, for example DEQ CARTAGENA (SPAIN). They may be excluded by express agreement and so indicating on the INCOTERM, certain concepts, the payment by the seller, going to be paid by the buyer (DEQ CARTAGENA, UNPAID VAT). It is interesting to specify what would happen if for reasons of force majeure could not downloading at the point indicated, for example strike, catastrophe, etc.

DDU (Delivered Duty Unpaid): Delivered Duty Unpaid

The seller fulfills his obligation to deliver when the goods placed at the point of destination, to the buyer, and cleared through customs for export. The seller bears the costs and risk until delivery. It can be used regardless of the means of transport. Often accompanied the chosen destination, for example DDU CARTAGENA (SPAIN). They may be included by express agreement and so indicating on the INCOTERM, certain

concepts within the payments to be made by the seller, then ceasing to be paid by the buyer. DDU, VAT paid, CARTAGENA. (SPAIN).

DDP (delivered duty paid): Delivered Duty Paid

The seller fulfills his obligation to deliver when the goods placed at the point of destination, to the buyer, cleared through customs and import and export, and with all expenses paid. The seller bears the costs and risk until delivery. It can be used regardless of the means of transport. Often accompanied the chosen place of destination, such as "DDP CARTAGENA (SPAIN)". by express agreement can be excluded and indicating this in the Incoterm, certain terms of the payments to be made by the seller, and then cease to be paid for this, and become paid by the buyer: DDP, VAT unpaid, CARTAGENA. ("Incoterms Rules | Incoterms 2010 | Trade Facilitation | Products & Services | ICC - International Chamber Of Commerce")

1.3.3   Relevance

International trade is relevant for its contribution to meeting the various needs of countries. Based on this conviction, free trade has been proposed as a tool to achieve a goal that can be considered universal: improving the conditions of life and work of the world's population, which is closely related to the profit generated and its further distribution. In addition, international trade optimizes flow of resources. Finally, it also affects the formulation of domestic prices, levels of employment, investment and the development of economic policies.

Trade is quantified with various calculation tools, the balance of international payments, and institutions that carry out international trade statistics provide us with data regarding the importance and trends in the commercial relationships of a country with the world.

Trade origins dates back to the late Neolithic, when agriculture was established. At first it was subsistence farming, where the harvested produce was just enough for the population who worked the land. However, as new developments arose, the harvests were increasing thus the surplus provided a local exchange of other goods, which led to metalwork, the wheel, , navigation, writing, new forms of urban settlements, etc..

Throughout the Middle Ages new transcontinental trade routes emerged in order to meet the European high demand for goods and merchandise . Among the most famous routes, the Silk Road was of utter importance, but there were also other important as routes for spices.

From the various important international trade flows, it is considered as outstanding the following:

Hellenism

 When slavery was established and operated in an extraordinary way, economic thinking evolved and began to develop ideas that corresponded to this new mode of production; Plato was one of the first students of society, but Aristotle was the most advanced economic thinker of his time. Plato explains the division of labor as the result of several natural abilities and needs of human beings.

Aristotle laid the foundations for the theory of value to distinguish between use value and exchange value (though not accurately).

Scholasticism

Economic thinking during the middles ages was based upon Aristotelian precepts and doctrines imposed by the Catholic Church.. They regarded the economy as a set of laws, understood as moral precepts whose purpose was the proper administration of economic activities.

The principles for fair pricing were formulated, which depends on the inherent value of goods. Thomas Aquinas highlights the idea that exchange value must be based on the cost of production, coated with ethical character. Initially interest for loans was considered as usury and therefore was condemned. Afterwards loans were considered as and exchange of property and the interest as a tax on labor of the borrower. We can infer that these ideas were an idealistic representation of reality.

Mercantilism

Since feudalism, the prevailing conditions that would take place for the next centuries were been conceived, in other words, the foundation for capitalist development. Mercantilism is the economic doctrine that reflects the conditions for commercial capitalism of the sixteenth and seventeenth century.

Physiocratism

The Physiocrat school emerged in the eighteenth century. Scholars believe that this school of thought is the precursor for modern economy. This school sees agriculture as the main really productive activity, because it is the only activity that yields net product, and considers industry, trade and services as ancillary activities. In view of this materialist conception of wealth, both human like the physical world are subject to a natural order, which is often attributed with providential character, therefore the state should limit its intervention.

Classicism and Modernism

In the late eighteenth century a number of changes inspired by the industrial revolution and the boom in the American and Asian markets would shift the prevailing production relations and consequently, the economic doctrines were also altered thus evolving in order to search for explanations to new phenomena.. More efficient production techniques are introduced and thus the supply of goods.

All these ideas behind the evolution of trade gave rise to the continuous interaction between markets, so that after World War I and World War II,, laid the foundations for greater integration and interdependence of markets that countries have been living in since. Today, thanks to e-commerce telemetric tools, things that took months are now achievable in seconds, reducing times and distances. The big challenge is the harmonization of labor and regulatory markets; so that the transferring of social organization, which has brought about welfare in the most technological advanced countries, can be achieved. The relationship between greater economic freedom and development is irrefutable.
("Orígenes E Importancia Del Comercio Internacional")

1.4   History of the Panama Canal

The Isthmus of Panama, which is only 50 miles wide in its narrowest point, is characterized by its mountain ranges, impenetrable jungle, deep swamps, burning sun, torrential rain, debilitating humidity, astounding geological land formations, and pestilence. Most of this was apparent for explorers and surveyors who explored and measured the land. What was unclear was the geological composition of the land, which nowadays still remains an unconquered challenged yet under control. Another apparent aspect was the unsuccessful attempt to build a canal through Panama by one of the largest nations in the world.

Small green mountains emerged before coastal coral formations looked favorable and tempting. However, unlike most of mountain ranges, rather than being formed by bending due to lateral pressure, these mountains were formed by volcanic activity of single ascending movements. Independent formations of different types of hard rock are interspersed between layers, where rocks and softer materials are dispersed over a mixture in an unorderly and
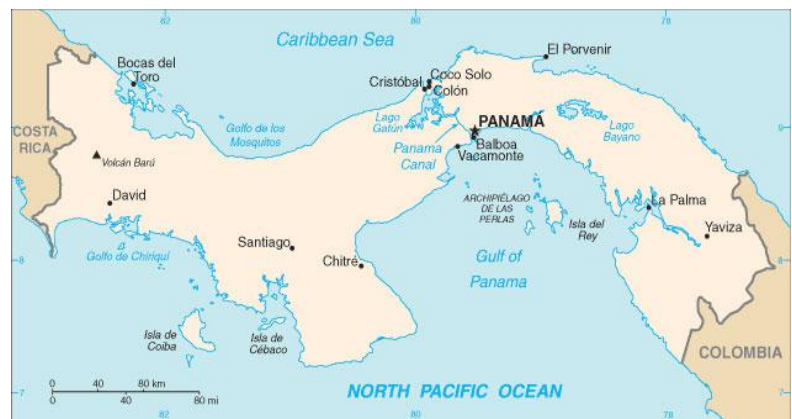
Figure 1-Panama Map

unpredictable fashion. The Isthmus has also been exposed to several periods under water, thus adding layers of marine material to the mixture. This, besides the fact that there are six major faults and five major volcanic centers only in the short stretch between the cities of Colon and Panama, became another challenge in the area. Engineers at the time did not know about the geological complexity of the Isthmus, luckily perhaps, otherwise they would had been appalled by the challenge.

Another difficulty for the land surveyors was the tropical forest that covered the hilly terrain from base to top, consisting of dense vegetation that was almost incomprehensible to the untrained or rookie eye. ("La Tierra En Panamá | Canal De Panamá")

Panama's tropical climate, with an average temperature of 80 degrees and annual rainfall of 105 inches, has the ideal conditions for the preservation and expansion of tropical rainforest, similar to those of the Amazon in Brazil. In fact, Panama's jungle was utilized as a training ground for US troops sent to Vietnam, as well as for survival training by astronauts sent to the moon.

Floods, especially from Chagres River, were another serious threat. Due to the steep terrain, heavy rains accumulate rapidly forming strong currents flowing towards the river, increasing quickly and causing flooding. This phenomena is described by the Climatology and Hydrology Department of the Panama Canal:

"Although most of the country is covered by vegetation, most of which is very dense, the slopes are so steep and the rocks are so superficial that any severe tropical storm turn the steep slopes of Chagres into a series of small streams and waterfalls, making the river grow suddenly, discharging inconceivable amount of water".

For example, on July 19th and 20th, 1903; after two days of heavy rain, the Chagres (usually about forty feet above sea level in Gamboa) rose sixty feet above sea level, drastically increasing its normal rate of discharge from 3,000 cubic feet per second to more than 31,000 cubic feet per second.

French engineers under the leadership of Ferdinand de Lesseps had failed to control flooding from the Chagres. Later on, the American effort was not quite successful either, not until the construction of Madden Dam in Gamboa during the 1930s. From time to time, the French suffered the discouraging sweeping of bridges and equipment due to flooding, causing that tens of thousands tons of dirt, rock and debris refill back into the areas were with such difficulty had been excavated before.

Also, both malaria and yellow fever were endemic diseases in the Isthmus. For several hundred of years, foreigners who visited this "Fever Coast", especially sailors who were just passing through, died of diseases allegedly caused by "miasmal mist" emanating from swamps and bogs.

"When the trade winds die and the hot and humid air of the Isthmus stops blowing, white smoke emanates from the ocean and travels as fog over land and sea. These white

fumes are precursors of fever and disease and those who live in the Isthmus know this fact, thus remaining inside their homes, avoiding halfway encounters with the Ocean Ghost. In those days ... the white vapors emanating from the plagued land of the Isthmus were much more disastrous for their deadly effects than those emanating from the ocean. They exuded from the land as incense from a brazier. They brought up from their underground prison all the poison of putrefaction and wherever they caught their victims, fever and death followed.. " (McCullough)

Although it may seem ridiculous today, at that time there was no other credible explanation. In fact, when it was finally found that insect bites, in this case mosquitoes, transmitted the dreaded diseases - yellow fever and malaria - the idea was also taken as absurd, and whoever supported these concepts, were ridiculed openly. Such was medical knowledge back then. If the Americans would had been in the Isthmus instead of the French, they would had suffered equally.

1.4.1   Construction of the Canal

The idea of digging a water passage across the Isthmus of Panama to connect the Atlantic and Pacific oceans arose in the early 16th century, when Vasco Nunez de Balboa crossed the Isthmus in 1513. Balboa discovered at the time that only a narrow strip of land separated both oceans. Emperor Charles V of the Holy Roman Empire, who also was Charles I of Spain, initiated an undertaking to build a water way through the Isthmus of Panama.

Through a decree issued in 1534, Charles ordered the regional governor of Panama to develop plans to build a route to the Pacific following the Chagres River. This was the first study to build a canal that would allow ships to cross from one ocean to the other through Panama, which path followed more or less the present-day Panama Canal. When the creation of a map was completed, the governor thought it would be impossible for anyone to accomplish such a feat.

The United States interest in a canal connecting the Atlantic and Pacific oceans through the Central American isthmus, not necessarily by Panama, came relatively late. This interest in building a canal increased with the California Gold Rush, which took place

in the Mid-19th century and created a tremendous volume of trade across the Isthmus, mostly through the Panama Railroad.

In 1869, President Grant ordered to perform expeditions in Central America. The expeditions were conducted by the Head of the Navigation Bureau, Commodore Daniel Ammen, and were under the command of the Secretary of Navy. The studies were conducted in Tehuantepec, Mexico, led by Captain Robert W. Shufeldt; in Darien, led by Commander Thomas Oliver Selfridge; in Nicaragua, under Commander Chester Hatfield, Commander Edward P. Lull and Chief Civil Engineer Aniceto G. Menocal; and in Panama, along the railway line, by Lull and Menocal. The high quality of these studies are still recognized today. The current Panama Canal route is virtually identical to that proposed in the study by Panama at the time.

President Grant appointed an Interoceanic Canal Commission to assess the findings of these expeditions conducted by the Navy between 1870 and 1875. The Commission prepared a report and, after much consideration, in 1876 the Commission ruled in favor of the Nicaraguan route.

Following the failure of the French to build a canal, the Isthmian Canal Commission of the United States (1899-1901), also known as the second Walker Commission in honor of its president, Admiral John G. Walker, ordered again to study all routes feasible to build a canal between the Atlantic and Pacific oceans. The study was ordered by Grant's successor in office, President William McKinley. This time, the routes through Panama and Nicaragua would receive special consideration. The Nicaraguan route was favored once again, though not for long.

1.4.1.1 American Endeavour

The Panama Canal cost to the US approximately $ 375,000,000, including $ 10,000,000 paid to Panama and $ 40,000,000 paid to the French company. It was considered at the time the most expensive construction project in the history of the United States. The forts cost an additional $ 12,000,000.

Impressively, like no other similar project to date, the American Canal had cost less in dollars than the estimated, with a final cost of about $ 23 million below the estimate made in 1907, despite landslides and changes in design for a wider Canal.

Even more impressive is the fact that this huge and complex project was completed without any scandals of corruption that often undermine these type endeavors, and also none emerged during the subsequent years after the project was concluded.

Of course there were human life costs. According to hospital records, 5,609 lives were lost due to illnesses and accidents during the time the Americans were building the Canal. If we add the deaths during French Canal construction, the total increase to approximately 25,000 deaths, based on an estimate by Gorgas (US Army Physician). However, the real number will never be known, since the French only documented deaths in hospitals.

As for July 1st, 1914, they had excavated a total of 238,845,587 cubic yards of material during the time of the American construction. It summed up to about 30,000,000 cubic yards excavated by the French, that would then reach a total of approximately 268,000,000 cubic yards, more than four times the volume originally estimated for Ferdinand de Lesseps level canal. The construction of the Panama Canal has been largely credited to Roosevelt, who never objected to this assertion. However, of the three presidents whose terms coincided with the construction of the Canal - Roosevelt, Taft and Woodrow Wilson Howard - it was Taft who had the more direct, more active and longer participation. Taft visited Panama five times as Roosevelt's Secretary of War and travelled two more times as president. When Taft replaced Roosevelt at the White House in 1909, the construction of the Canal was just halfway through. Despite this, Theodore is widely recognized as the "real builder of the Panama Canal"

The following words of Theodore Roosevelt are carved in a plaque on the Rotunda of the Administration Building of The Panama Canal. These words, more than anything else, reveal his personal philosophy and spirit of the way in which he conceived the American achievement in Panama. (Sibert and Stevens)

"It is not the critic who counts, not the man who points out how the strong man stumbled, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena; whose face is marred by dust and sweat and blood; who strives valiantly, when errs and comes short again and again; who knows thee great enthusiasm, the great devotions, and spends himself in a worthy cause, who at the best, knows in the end the triumph of high achievement; and who at the worst, if he fails at least fails while daring greatly, so that his place shall never be with those cold and timid souls who know neither victory nor defeat." (McCullough)

In his book "The Path between the Seas" David McCullough wrote: "The creation of a water passage across Panama was one of the supreme human achievements of all time, the culmination of a heroic dream of 400 years and of more than 20 years of phenomenal effort and sacrifice… It is a work of civilization," (McCullough)

1.4.2   Competitors

The main competitors to the Panama Canal are alternative routes that provide options for cargo transportation between the same origin and destination; which are the American Intermodal Network, the Suez Canal, and the Nicaragua Canal; this last still is in the preliminary phase.

According to ACP (Autoridad del Canal de Panama), there is an existing tendency for using Post-Panamax vessels along transcontinental routes to compete against the Panama Canal. Ports and distribution centers along these routes are researching its capacity, maritime location and land infrastructure to make use of these type of vessels and handle the huge cargo volumes. Since 2011, approximately 37% of the world's carrier fleet consists of ships too large to transit across the Panama Canal, thus taking alternative routes which are direct competitors such as the Suez Canal and the Intermodal Network of The United States. ("Mercado Y Competencia | Canal De Panamá")

1.4.2.1 Suez Canal

The Suez Canal, which connects the Mediterranean Sea to the Red Sea, has taken over the past over the past 10 years vessels that use to cross the Panama Canal through the route between Asia and th east coast of the United States. In spite of the shorter and quicker way through the Panama Canal, former users of the aforementioned route prefer the Suez Canal die to its larger capacity, keeping up with the progress and expansion of Asian economies. The Suez Canal can handle ships carrying up to 19,000 containers, whereas the unexpanded Panama Canal is able to handle ships of up to 5,000 containers. An expanded Panama Canal will only be able to handle ships of only up to 10,000 containers.

Aditionally, the Suez Canal has no competition in the maritime route linking Europe and Asia.

Another advantage of the Suez Canal is that it is at sea level, contrarily to the locks system employed in the Panama Canal , which results into a greater handling capacity of cargo because of the open navitional waterway.

Furthermore, the Suez Canal underwent an expansion which cost $8.4 billion. The expansion was opened on August 6th, 2015. ("Panamа No Teme A Competencia Del Ampliado Canal De Suez")

1.4.2.2 Nicaragua Canal

The launching of construction of the Nicaragua Canal is the realization of a project that would compete directly with the Panama Canal. This competition would reduce the Panama Canal transit and impact the logistics center and Colon Free Zone. Despite the environmental and financial feasibility issues, it is still possible that Nicaragua Canal has a geopolitical motive rather than a commercial one. Therefore, ACP must take action with determination and united purpose, regardless of the completion of the Nicaragua Canal project or not. (Tapiero)

1.4.2.3 Intermodal Network US

The U.S intermodal Network is an integrated system; which employs intermodal containment or vehicles using different modes of transportation such as rail, ship, truck to handle freight transported along the Asian- East coast of the United States route.

Some U.S ports along the Pacific coast line, such as Long Beach, Savannah, Oakland, Charleston, and Seattle are able to handle Post-Panamax ships. Despite this fact, the efficiency of these ports is reduced significantly due to congestion caused by road and train rail bottlenecks. ("U.S. Intermodal Network | World Shipping Council")

4. Practical Part

1.5 Initial Costs Estimate

According to the expansion proposal, published in 2006, the third set of locks had had an estimated cost of approximately $ 5,250 million. These estimate included direct and indirect cost in design, managing, construction, testing, environmental mitigation, and commissioning. Furthermore, contingencies were also included in this cost, to cover risks and unforeseen occurrences in the manner of design change, accidents, price increases, delays, etc.; also included the effect of inflation during construction.

The obvious and most relevant cost is the construction of the Atlantic locks and Pacific locks. The construction of this set of locks was estimated to be approximately $1,110 million and $1,030 million each, plus another $590 million as provision for any possible contingencies during construction. (*ACP Expansion Proposal*)

Table 1-Cost Estimate for the Panama Canal Expansion Project

Components	Estimate(MILLION)
New Locks	
Atlantic	1,110
Pacific	1030
Contingency for Locks	590
Total	2730
Water Savin Basins	
Atlantic	270
Pacific	210
Contingency for Basins	140
Total	620
Access Channels for New Locks	
Atlantic (dredging)	70
Pacific (dry excavation)	400
Pacific (dredging)	180
Contingency	170
Total	820
Existing Navigational Channel Improvements	
Atlantic	30
Gatun Lake	90
Pacific	120
Contingency	50
Total	290
Water Supply Improvements	
Increase Max. Level of Gatun Lake	30
Deepening of Navigational Channels	150
Contingency	80
Total	260
Inflation During Construction Period	530
TOTAL	5,250

Water reutilization basins will be part of the new locks, which were estimated to cost $270 and $210 million for the Atlantic and Pacific sides, respectively, plus a $140 million provision for potential contingencies. The total estimated cost was, including the

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construction of the new locks, water reutilization basing, and contingencies, summed up to a total amount of $3,350 million.

As part of the new locks, a total cost of about $ 820 million was estimated for the building of the access channels. This total cost included $ 250 million for drilling, blasting and dredging, plus $ 400 million for dry excavation. Possible contingencies were estimated in $ 170 million. Moreover, $ 290 million were directed to the improvement of the existing navigational channels. This included $ 90 million for the widening of Gatun Lake's navigational channels, plus $ 150 million for deepening and widening the Atlantic and Pacific entrances of the Canal. Another $ 50 million were provision for contingencies.

Lastly, improvements costs regarding water supply were estimated in $ 260 million, which included $ 150 million for the deepening of navigational channels, $ 30 million more to increase Gatun Lake's maximum operational level, and an additional $ 80 million directed to contingencies. Another $ 530 million were taken into consideration for inflation during the construction period, representing a grand total of $ 5,250 million for the new third set of locks.

Back then, the cost analysis offered high level of reliability due to the thoroughness and detail in which the study was performed, along with sufficient funds directed into contingencies to compensate for any possible risk, uncertainty or unforeseen eventualities. The probability that the construction would have been performed within the estimated budget was high.

1.6 Predicted Benefits

The third set of locks complex is evidently profitable. According to the expansion proposal, published in 2006, it is to produce 12% internal rate of return. The expansion project will double the Canal's capacity, increase its operational efficiency and provide economic benefits to Panama. This will improve the social well-being of Panamainan society. In order to cope with the growing demand for the Panamanian waterway, an increase in the Canal's operational capacity was required; since it is has been foreseen that international trade will continue to grow during the next 20 years, and possibly surpass the

growth rate of the main world economies. As a result, the expanded Canal will be able to handle during its first 11 years of operation an additional 1,50 million PCUMS19 tons, which will bring about revenues of over $6,000 million around the year 2025. ACP tolls policy implementation for the third set of locks will be targeted toward capturing the added value that the Canal will bring to each segment of its markets. (*ACP Expansion Proposal*)

Tolls will proceed in a manner that will doubled within the following 20 years, in accordance with the expansion proposal from 2006. Hence, the Panama Canal's route will maintain its competiveness, profitability will be true to the amount invested, loans acquired for financing the construction of the third set of locks will be paid quickly, and payments to the National Treasury will increase considerably.

The expansion project is self-financiable, standing on its own without any goverment financial aid. The state is not to guarantee or endorse any loans undertaken by the Panama Canal Authority (ACP) for the expansion execution.

An expanded Panama Canal will produce cash flows which will make up to the investment costs of the expansion in less than 10 years. In the same manner, financing could be repaid in about 8 years.

1.7 Cost Benefit Analysis

A cost benefit analysis was performed in order to measure the feasibility of undertaking the expansion project. It must be mentioned that the data used for the purpose of this exercise was obtained from studies done by private consultants and ACP. The following analysis is going to focus on three economic indicators, which are net present value, internal rate of return, and benefits costs ratio. To evaluate the cost and benefits of the expansion project, several aspects were taken also into consideration. *("Cost-Benefit Analysis Definition | Investopedia")*

Timeline

The costs and benefits were taken since 2007 to 2050. In other words, period analyzed was taken from the starting year of construction, until the estimated useful life of the expansion project.

Benefits

The benefits are considered under to basic scenarios. The first scenario consists in obtaining revenues through constant tolls. On the other hand, the second scenario calculated revenues through increasing tolls.

Costs

The costs of the expansion project will remain constant for both assumptions.

Discount Rate

For the calculation of the NPV, a discount rate of 7.1559% was used. This discount rate was created by URS Holdings Inc. *(du Plessix)*

1.7.1 Financial Assessment

This section will illustrate private profitability that the Panama Canal expansion project will yield taking into consideration the aforementioned economic indicators and under two possible scenarios, taking tolls as constants or tolls as increasing along the timeline. *(du Plessix)*

1.7.1.1 Constant Tolls

This scenario provides results based on a constant toll throughout the entire timeline selected for this study. The timeline includes years 2007-2050, accounting for a total of 43 years. The table below is also provided with a REVENUES column, split into one labeled as with expansion and the other labeled as without expansion. Following REVENUES, comes the FLOW OF BENEFITS column, split into economic benefits and net economic benefits. Lastly to be found is the ECONOMIC COSTS column, split into economic costs with expansion and economic costs without expansion. The present value

from the total sum of economic benefits is labeled as BENEFITS UP TO DATE, which yielded 5078.47 millions of dollars. The present value from the total sum of the difference between the economic costs with expansion and the economic costs without expansion is labeled as COSTS UP TO DATE, which yielded 3624.67 millions of dollars.

The net present value (NPV) provides a total of 1452.99 millions of dollars. This number was calculated by taking the present value from net economic benefits, which is the difference between the revenues from the canal with expansion and the revenues from the canal without expansion.

The discount rate is kept constant throughout the whole timeline. As aforementioned, the discount rate is held at 7.1559%.

The internal rate of return (IRR) yielded a result of 9.07%. The IRR is taken from the net economic benefits. The benefits costs ratio, labeled as B/C rat, resulted in 1.40. This number is provided by dividing BENEFITS UP TO DATE with COSTS UP TO DATE.

Table 2- Constant Tolls (Financial Profitability)

Year		REVENUES		FLOW OF BENEFITS		ECONOMIC COSTS		
		with expansion	without expansion	economic benefits	net economic benefits	with expansion	without expansion	difference
0	2007	392	500	0	-108	234	126	108
1	2008	169	515	0	-346	466	120	346
2	2009	-280	580	0	-860	942	83	859
3	2010	-786	626	0	-1412	1509	97	1412
4	2011	-378	700	0	-1078	1158	80	1078
5	2012	258	739	0	-481	561	80	481
6	2013	460	749	0	-289	369	80	289
7	2014	605	751	0	-146	226	80	146
8	2015	924	762	177	162	95	80	15
9	2016	999	782	232	217	95	80	15
10	2017	1063	794	284	269	95	80	15
11	2018	1126	805	336	321	95	80	15
12	2019	1194	816	393	378	95	80	15
13	2020	1252	823	444	429	95	80	15
14	2021	1314	833	496	481	95	80	15
15	2022	1381	844	552	537	95	80	15
16	2023	1451	854	612	597	95	80	15
17	2024	1524	864	675	660	95	80	15
18	2025	1616	875	756	741	95	80	15
19	2026	1689	891	813	798	95	80	15
20	2027	1765	907	873	858	95	80	15
21	2028	1845	924	936	921	95	80	15
22	2029	1927	939	1003	988	95	80	15
23	2030	2013	956	1072	1057	95	80	15
24	2031	2032	957	1090	1075	95	80	15
25	2032	2033	958	1090	1075	95	80	15
26	2033	2033	958	1090	1075	95	80	15
27	2034	2034	959	1090	1075	95	80	15
28	2035	2035	960	1090	1075	95	80	15
29	2036	2036	961	1090	1075	95	80	15
30	2037	2037	962	1090	1075	95	80	15
31	2038	2038	963	1090	1075	95	80	15
32	2039	2039	964	1090	1075	95	80	15
33	2040	2040	965	1090	1075	95	80	15
34	2041	2042	967	1090	1075	95	80	15
35	2042	2042	967	1090	1075	95	80	15
36	2043	2043	968	1090	1075	95	80	15
37	2044	2044	969	1090	1075	95	80	15
38	2045	2045	970	1090	1075	95	80	15
39	2046	2046	971	1090	1075	95	80	15
40	2047	2046	971	1090	1075	95	80	15
41	2048	2046	971	1090	1075	95	80	15
42	2049	2046	971	1090	1075	95	80	15
43	2050	8193	4611	3597	3582	95	80	15
				$5,078.47	$1,452.99			$3,624.67
				BENEFITS UP TO DATE	NPV			COSTS UP TO DATE

discount rate:	7.1559%
IRR	9.07%
B/C Rat	1.40

1.7.1.2 Increasing Tolls

This scenario provides results based on increasing tolls throughout the entire timeline selected for this study. The timeline includes years 2007-2050, accounting for a total of 43 years. The table above is providing a REVENUES column, split into one labeled as with expansion and the other labeled as without expansion. Following REVENUES, comes the FLOW OF BENEFITS column, split into economic benefits and net economic benefits. Lastly to be found is the ECONOMIC COSTS column, split into economic costs with expansion and economic costs without expansion. The present value from the total sum of economic benefits is labeled as BENEFITS UP TO DATE, which yielded 8609.96 millions of dollars. The present value from the total sum of the difference between the economic costs with expansion and the economic costs without expansion is labeled as COSTS UP TO DATE, which yielded 3624.67 millions of dollars as in constant toll scenario.

The net present value (NPV) provides a total of 4984.47 millions of dollars. This number was calculated by taking the present value from net economic benefits, which is the difference between the revenues from the canal with expansion and the revenues from the canal without expansion.

The discount rate is kept constant throughout the whole timeline. As aforementioned, the discount rate is held at 7.1559%.

The internal rate of return (IRR) yielded a result of 12.14%. The IRR is taken from the net economic benefits. The benefits costs ratio, labeled as B/C rat, resulted in 2.38. This number is given by dividing BENEFITS UP TO DATE with COSTS UP TO DATE.

Table 3- Increasing Tolls (Financial Profitability)

Year		REVENUES		FLOW OF BENEFITS		ECONOMIC COSTS		
		with expansion	without expansion	economic benefits	net economic benefits	with expansion	without expansion	difference
0	2007	438	546	0	-108	234	126	108
1	2008	246	592	0	-346	466	120	346
2	2009	-166	694	0	-860	942	83	859
3	2010	-644	768	0	-1412	1509	97	1412
4	2011	-200	878	0	-1078	1158	80	1078
5	2012	485	966	0	-481	561	80	481
6	2013	728	1017	0	-289	369	80	289
7	2014	913	1059	0	-146	226	80	146
8	2015	1299	1115	199	184	95	80	15
9	2016	1444	1180	279	264	95	80	15
10	2017	1582	1239	358	343	95	80	15
11	2018	1725	1298	442	427	95	80	15
12	2019	1876	1359	532	517	95	80	15
13	2020	2039	1420	634	619	95	80	15
14	2021	2198	1486	727	712	95	80	15
15	2022	2368	1552	831	816	95	80	15
16	2023	2554	1620	949	934	95	80	15
17	2024	2749	1690	1074	1059	95	80	15
18	2025	2961	1761	1215	1200	95	80	15
19	2026	2026	694	1347	1332	95	80	15
20	2027	3397	1923	1489	1474	95	80	15
21	2028	3636	2007	1644	1629	95	80	15
22	2029	3891	2095	1811	1796	95	80	15
23	2030	4161	2184	1992	1977	95	80	15
24	2031	4262	2185	2092	2077	95	80	15
25	2032	4263	2186	2092	2077	95	80	15
26	2033	4264	2187	2092	2077	95	80	15
27	2034	4265	2188	2092	2077	95	80	15
28	2035	4266	2189	2092	2077	95	80	15
29	2036	4267	2190	2092	2077	95	80	15
30	2037	4268	2191	2092	2077	95	80	15
31	2038	4269	2192	2092	2077	95	80	15
32	2039	4270	2193	2092	2077	95	80	15
33	2040	4271	2194	2092	2077	95	80	15
34	2041	4272	2195	2092	2077	95	80	15
35	2042	4273	2196	2092	2077	95	80	15
36	2043	4274	2197	2092	2077	95	80	15
37	2044	4275	2198	2092	2077	95	80	15
38	2045	4276	2199	2092	2077	95	80	15
39	2046	4277	2200	2092	2077	95	80	15
40	2047	4278	2201	2092	2077	95	80	15
41	2048	4279	2202	2092	2077	95	80	15
42	2049	4280	2203	2092	2077	95	80	15
43	2050	10424	5840	4599	4584	95	80	15
				$8,609.96	$4,984.47			$3,624.67
				BENEFITS UP TO DATE	NPV			COSTS UP TO DATE

discount rate	7.1559%
IRR	12.14%
B/C Rat	2.38

1.7.2 Social Assessment

This section will illustrate social indicators that the Panama Canal expansion project will yield taking into consideration indirect effects. *(du Plessix)*

1.7.2.1 Constant Tolls

This scenario provides results based on a constant toll throughout the entire timeline selected for this study. The timeline includes years 2007-2050, accounting for a total of 43 years. The table below is also provided with columns labeled as Social Benefits, Social Cost, and Net Social Benefit. The Net Social Benefit is to be considered as Net Social Gain. The Social net present value (NPV) provides a total of 2594.44 millions of dollars. This number was calculated by taking the present value from net social benefit, which is the difference between the Social Benefits and Social Cost.

The discount rate is kept constant throughout the whole timeline. As aforementioned, the discount rate is held at 7.1559%.

The internal rate of return (IRR) yielded a result of 11.021%. The IRR is taken from the Net Social Benefit.. The benefits costs ratio, labeled as B/C rat, resulted in 1.71. This number is provided by dividing SOCIAL BENEFITS UP TO DATE, which is 6721.12 millions of dollars, with SOCIAL COSTS UP TO DATE, figuring as 3676.72 millions of dollars.

Table 4-Comstant Tolls (Social Indicators)

Year	Social Benefits	Social Costs	Net Social Benefit
2007	21	110	-89
2008	67	351	-284
2009	211	874	-663
2010	349	1433	-1084
2011	265	1094	-829
2012	114	487	-373
2013	61	292	-231
2014	12	147	-135
2015	192	15	177
2016	252	15	237
2017	308	15	293
2018	364	15	349
2019	425	15	410
2020	480	15	465
2021	536	15	521
2022	596	15	581
2023	660	15	645
2024	728	15	713
2025	814	15	799
2026	875	15	860
2027	938	15	923
2028	1005	15	990
2029	1075	15	1060
2030	1148	15	1133
2031	1167	15	1152
2032	1167	15	1152
2033	1167	15	1152
2034	1167	15	1152
2035	1167	15	1152
2036	1167	15	1152
2037	1167	15	1152
2038	1167	15	1152
2039	1167	15	1152
2040	1167	15	1152
2041	1167	15	1152
2042	1167	15	1152
2043	1167	15	1152
2044	1167	15	1152
2045	1167	15	1152
2046	1167	15	1152
2047	1167	15	1152
2048	1167	15	1152
2049	1167	15	1152
2050	3674	15	3659

$6,271.12	$3,676.72	$2,594.40
SOCIAL BENEFITS UP TO DATE	SOCIAL COSTS UP TO DATE	SOCIAL NPV

discount rate:	7.1559%
IRR	11.021%
B/C Rat	1.71

1.7.2.2 Increasing Tolls

This scenario provides results based on increasing tolls throughout the entire timeline selected for this study. The timeline includes years 2007-2050, accounting for a total of 43 years. The table below is also provided with columns labeled as Social Benefits, Social Cost, and Net Social Benefit. The Net Social Benefit is to be considered as Net Social Gain. The Social net present value (NPV) provides a total of 6287.09 millions of dollars. This number was calculated by taking the present value from net social benefit, which is the difference between the Social Benefits and Social Cost.

The discount rate is kept constant throughout the whole timeline. As aforementioned, the discount rate is held at 7.1559%.

The internal rate of return (IRR) yielded a result of 14.165%. The IRR is taken from the Net Social Benefit.. The benefits costs ratio, labeled as B/C rat, resulted in 2.71. This number is provided by dividing SOCIAL BENEFITS UP TO DATE, which is 9963.81 millions of dollars, with SOCIAL COSTS UP TO DATE, figuring as 3676.72 millions of dollars.

Table 5- Increasing Tolls (Social Indicators)

Year	Social Benefits	Social Costs	Net Social Benefit
2007	19	110	-91
2008	64	351	-287
2009	203	874	-671
2010	341	1433	-1092
2011	271	1094	-823
2012	123	487	-364
2013	63	292	-229
2014	14	147	-133
2015	215	15	200
2016	301	15	286
2017	385	15	370
2018	474	15	459
2019	571	15	556
2020	679	15	664
2021	778	15	763
2022	888	15	873
2023	1013	15	998
2024	1146	15	1131
2025	1296	15	1281
2026	1434	15	1419
2027	1584	15	1569
2028	1746	15	1731
2029	1921	15	1906
2030	2110	15	2095
2031	2216	15	2201
2032	2216	15	2201
2033	2216	15	2201
2034	2216	15	2201
2035	2216	15	2201
2036	2216	15	2201
2037	2216	15	2201
2038	2216	15	2201
2039	2216	15	2201
2040	2216	15	2201
2041	2216	15	2201
2042	2216	15	2201
2043	2216	15	2201
2044	2216	15	2201
2045	2216	15	2201
2046	2216	15	2201
2047	2216	15	2201
2048	2216	15	2201
2049	2216	15	2201
2050	4723	15	4708

$9,963.81	$3,676.72	$6,287.09
SOCIAL BENEFITS UP TO DATE	SOCIAL COSTS UP TO DATE	SOCIAL NPV

discount rate:	7.1559%
IRR	14.165%
B/C Rat	2.71

41

1.7.3 Observations

Regarding the first scenario of financial assessment, which considers the tolls as constant, it can be seen that the NPV yielded 1452.99 millions of dollars. According to the decision rule, anything greater than one is a positive result. By means of constant toll, we could say that is an acceptable result. The second indicator, the IRR, has shown that the project can tolerate a discount of 9.07% without yielding any losses. The third indicator, B/C rat, has shown that for every dollar invested in the Panama Canal expansion project, 40 cents will be recaptured.

The second scenario, which has increasing tolls, has an NVP of 4984.47 millions of dollars. This NVP is about three times greater than the previous scenario. The IRR suggests that even a greater discount rate can be withstood without generating losses. The benefits costs ratio points out that for every dollar invested in the Panama Canal expansion project, 1.38 dollars will be recovered.

The social indicators first scenario shows a clear positive result, as the result for Social NVP, which is of 2594.44 millions of dollars, is consistent with the financial assessment.

The IRR shows that society can accept a discount 11.01% before losses. The benefits cost ratio shows that for every dollar invested, 71 cents are recovered.

The increasing tolls scenario shows a greater social NVP than its counterpart, counting as a even more positive result. The IRR points out the discount rate society can experience before generating loses, which of 14.165%. The benefit cost ratio, resulting in 2.71, indicates that or every dollar invested , 1.71 dollar is recovered.

5. Results and Discussion

1.8 Cost Overruns

The ACP has had to acknowledge cost overruns for over 233 million dollars. This is half the quantity GUPC (Grupo Unidos por el Canal), which is the partnership undertaking the project for the expansion of the Panama Canal. The claimed amount was 463 million dollars.

According to ACP, these overruns refer to unforeseen expenses suffered due to the low quality of basalt that is dug out from a nearby mine and later on use as construction material. ("ACP Reconocerá $233 Millones En Sobrecostos A GUPC")

According to GUPC, ACP was notified about the low quality of these mines back in February 2011. In the contractual documents, it was pointed that the quality of basalt coming from these mines were of higher standards. (S.A.)

The claims are founded around the additional costs that the contractor incurred in to adjust the processing plant and finding a new supplier of basalt. These changes affected logistics and time and investments of the project at the time.

The expanded Panama Canal scheduled beginning of operations has around 2 years of delay due to several other costs overruns claims and strikes that took place along several phases of the construction period. *("ACP Reconocerá $233 Millones En Sobrecostos A GUPC")*

1.9 Economic Impact

The Panama Canal expansion is a colossal project that in the next few years will be an even more vital part of the Panamanian economy. In the next few it will represent a bigger part of the public investments that will in return, increase Panama's GDP. Most importantly is the fact that it will attract foreign investment and industrial development around the maritime sector. The benefits of the canal will be recognizable more in its indirect effect than on the revenues it produces due to infrastructure. The indirect benefits

will come over the shipping business, ports, shipbuilding, etc All this activity complementary to the Canal will have big impact.

Even before the construction phase, the idea of an expanded canal brought into the Panamanian economy large construction and infrastructure groups that wanted to participate in the project.

According to ACP, during the construction period, the Panama Canal expansion project created 40000 new jobs, 7000 jobs directly related to construction work.

When third set of locks is operational, between 150000 and 250000 new jobs will be attached to the benefit of the expansion, not only in Panama but all over Latin-American, attracting and feeding the trade industry in the region.

The negative aspect of the expansion project is the environmental impact. Numerous of the studies concerning this issues has endorsed its viability. Naturally, any project as big as the third set of locks will have an environmental impact because its modifying the landscape. This modification of the natural landscape, nonetheless has been reported to be minimal in comparison to the benefits the expanded canal will yield. ("La Ampliación Del Canal De Panamá Abre Sus Compuertas A Un Nuevo Desarrollo Económico - Universia Knowledge@Wharton")

6. Conclusion

Since its opening in 1914, the Panama Canal has proven to be of vital importance to trade and commerce. Advancements in shipping and vessesl technologies have taken toll in the efficiency of handling cargo across the isthmus. This has resulted in the undertaking of the Panama Canal expansion project. This will increase the Panama Canal capacity. As a result fulfilling the demand for the route, consequently increasing its revenues.

The result of the cost benefit analysis points out that the Canal either with tolls kept constant or as increasing tolls, will have a positive impact in the economy. All economic and social indicators shows positive results. Ilustrating better results are the increasing tolls which is a better approach to confront reality. Everything points out to a signficant GDP growth due to the expansion project as early as in 2025, and meaningful effect in employment rates, poverly levels and population well being.

Practically speaking, the analysis undertaken in this thesis strongly suggests the financial solidity of the expansion project, having positive effects all across the board, particularly among Panamanian society.

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8. Appendices

APPENDIX A: Formulas

NPV

$$NPV = \sum_{t=0}^{N} \frac{Bt - Ct}{(1 + r)^t}$$

Where:

Bt – benefit for year t of the project

Ct – cost for year t of the project

t – year corresponding to project life from 0 to n

0 – initial year of project, in which investment begins

r – discount rate or minimum acceptable discount rate (MADR)

IRR

$$0 = \sum_{t=0}^{N} \frac{Bt - Ct}{(1 + r)^t}$$

BCR

$$B/C R = \frac{\sum_{t=0}^{N} \frac{Bt}{(1 + r)^t}}{\sum_{t=0}^{N} \frac{Ct}{(1 + r)^t}}$$

APPENDIX B: Definitions

Net present value (NVP): Value measured in today's currency.

Internal rate of return (IRR): discount rate that will make the NVP of a project equal to 0.

Benefit/Cost ratio (B/C): compares benefits discounted to r with costs discounted as well to r.