Measurement and Managing the Revenue Risks of Toll Roads

Osaid A. A. Alshamleh

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Approval of the Institute of Graduate Studies and Research

Prof. Dr. Ali Hakan Ulusoy
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science in Banking and Finance.

Prof. Dr. Nesrin Özataç
Chair, Department of Banking and Finance

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Banking and Finance.

Assoc. Prof. Dr. Hasan Ulaş Altıok
Supervisor

Examining Committee

1. Prof. Dr. Glenn Jenkins

2. Assoc. Prof. Dr. Hasan Ulaş Altıok

3. Asst. Prof. Dr. Mehrshad Radmehr Hashemipour

ABSTRACT

Transportation infrastructure is considered the engine of countries economic development. Traditionally, implementing and financing such a project has been done by governments through the national budgetary funds. Such projects' benefits attracted the private sector to be involved in these projects, reducing the burden on governments, providing better quality measures, and generating a return that compensates the opportunity cost of their capital and the risk involved. This process was done under public-private partnership agreements.

The revenue generated by these projects is enormous but also surrounded by immense uncertainties. Specifically, forecasting errors resulted from the long-term revenue and expenditure projections to recover the capital expenditure and yield a satisfactory return to equity owners. The study aims to conduct an integrated investment appraisal that assesses the overall potential of the famous Riviera Marcory toll bridge in Ivory Coast using cost-benefit analysis (CBA) approach.

Keywords: Infrastructure, Toll Bridge, Public-Private Partnership, Cost-Benefit Analysis, Ivory Coast.

ÖZ

Ulaştırma altyapısı, ülkelerin ekonomik gelişiminin lokomotifi olarak kabul edildi. Geleneksel olarak, böyle bir projenin uygulanması ve finanse edilmesi hükümetler tarafından ulusal bütçe fonları aracılığıyla yapılırdı. Bu tür projelerin faydaları, özel sektörü bu projelere dahil olmaya çekmiş, böylelikle hükümetler üzerindeki yükü azaltmış, daha kaliteli önlemler sunmuş ve sermayelerinin fırsat maliyetini ve içerdiği riski telafi eden getiri üretmiştir. Bu süreç, kamu özel ortaklık anlaşmaları kapsamında yapıldı.

Bu projelerden elde edilen gelir muazzamdır, ancak aynı zamanda büyük belirsizliklerle çevrilidir. Özellikle, uzun vadeli gelir ve harcama projeksiyonlarından kaynaklanan tahmin hataları nedeniyle sermaye harcamalarını geri kazanmanın yanı sıra öz sermaye sahiplerine tatmin edici bir getiri sağladı. Çalışma, maliyet fayda analizi (CBA) yaklaşımını kullanarak Fildişi Sahili'ndeki ünlü Riviera Marcory ücretli köprüsünün genel potansiyelini değerlendiren entegre bir yatırım değerlendirmesi yapmayı amaçlamaktadır.

Anahtar Kelimeler: Altyapı, Ücretli Köprü, Kamu Özel Ortaklığı, Fayda Maliyet Analizi, Fildişi Sahili.

DEDICATION

To My Family

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LIST OF ABBREVIATIONS

ADSCR	Annual Debt Service Coverage Ratio
AICD	Africa Infrastructure Country Diagnostic
BOO	Build-Own-Operate
BOT	Build-Operate-Transfer
CAPEX	Capital Expenditure
CBA	Cost-Benefit Analysis
CFASDS	Cash Flow Available for Senior Debt Service
CIF	Cost, Insurance, and Freight
DCFM	Discounted Cash Flow Model
DSCR	Debt Service Coverage Ratio
DSRA	Debt Service Reserve Account
EOCK	Economic Opportunity Cost of Capital
EV	Economic Value
FEP	Foreign Exchange Premium
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FV	Financial Value
GDP	Gross Domestic Product
HKB	Henri Konan Bedie Bridge
IIA	Integrated Investment Appraisal
IRR	Internal Rate of Return
LLCR	Loan Life Coverage Ratio
MFIRR	Modified Financial Internal Rate of Return

MIRR	Modified Internal Rate of Return
NCF	Net Cash Flow
NPV	Net Present Value
NTP	Non-Tradable Outlays
OPEX	Operating Expenditure
PV	Present Value
ROR	Rate of Return
SPV	Special Purpose Vehicle
VAT	Value Added Tax
VOC	Vehicle Operating Cost
VOT	Value of Time

Chapter 1

INTRODUCTION

1.1 Introduction

Economic development can be stimulated by many factors, including population, human capital, technology, natural resources, production, and many others. The availability of such factors does not necessarily imply that the economy is expected to grow without the existence of well-functioning public infrastructures such as electricity, energy, health, education, water, etc. The transportation network system is one of the critical infrastructures that facilitate the economic process by connecting various sectors and market segments within the economy. Nowadays, the transportation sector constitutes the fundamental soul of countries' overall development, not only for trade, mobility, and good resource management but also, directly and indirectly, affecting society, environment, and government policies.

Like any other economic unit, the transportation system requires all of its elements (roads, rails, ferries, bridges, etc.) to function efficiently and jointly to meet the overall economic objectives. An efficient transportation system is becoming essential due to increasing traffic counts and to reduce the vehicle’s costs. Also, in certain countries where trade occurs between the mainland and separate islands, it is crucial to have transportation infrastructure such as bridges and ferries that facilitates trade activities. Ultimately, this maximizes the benefits of transportation facilities and reduces travel time and costs.

Historically, the establishment of transportation networks was mainly carried out by governments since the public sector is the primary and ultimate responsible party for public services. However, governments are restricted by several limitations and challenges that might go beyond their primary goal of constructing, operating, and managing with the least cost and most efficient manner. Here the private sector can perform in a more time and cost-effective way. The partnership between public and private sectors in transportation projects is new and showed effectiveness in benefiting both sides if performed reasonably.

The constraints on governments and the public sector paved the way for the private sector to play a role in transportation infrastructure projects through public-private partnerships (PPPs). These constraints incentivize private firms to design, build, operate, maintain and finance the public infrastructure effectively and efficiently, which benefits both the private and public sectors and the constructed facilities' users.

One of the significant problems that the public sector encounters is the high borrowing costs compared to the private sector due to the increasing country’s credit risks and credit rating costs. Therefore, allocating financial tasks to the private sector minimizes the associated risks, and reducing the government's debt burden.

The revenues earned by private firms take two main shapes, either through provisions contracts given by the governments or through direct payments charged to the facilities' users. Revenues generated from these projects are enormous when proper and careful analysis is conducted to identify and then allocate the risks that might endanger the project profitability. To this end, private firms compete to undertake these projects due to their planning, availability of skills that are not available in the public

sectors, and a more flexible and efficient labor force. Besides, private firms perform better at managing specific kinds of major risks (such as construction-delay risk). This is mainly because the private sector is incentivized more than the public sector to keep the observability and measurability of the service's quality most efficiently, which guarantees to generate the highest possible return to the investors and improve the provided service quality.

The success of procured PPP projects depends on the analysis conducted to measure the aspects of the overall performance of the project through the pre-feasibility and feasibility studies, which examine the financial and fiscal sustainability, economic worthiness, identification of the stockholders, and the impact of the project on each of them. Hereafter, the sources and magnitudes of risks are to be assessed to determine the most effective way to reduce and share these risks between the project parties efficiently. This helps to identify the success potentials of the project and the weaknesses that might cause its failure.

The viability of such projects greatly depends on the allocation of project risks to the parties that can efficiently manage the risks. The main risks facing private toll road projects include construction, traffic counts, revenue forecasts, force majeure, and political risks. These risks must be addressed and allocated satisfactorily to the lenders and equity investors before providing the project financing.

Traffic counts and revenue risks are mainly caused by insufficient traffic levels and toll rates that are either too high or too low to generate the forecasted revenues. The PPP for toll projects usually takes BOT form (build -operate -transfer), which requires long-term revenue forecasts. These forecasts are surrounded by immense uncertainty

due to the length of the project duration and other risks that may result in a dramatic change in the estimates, which causes project failure. Particularly, road infrastructure projects are exposed to various kinds of risks, mainly due to high initial costs and long, uncertain revenue streams. Thereby, risk analysis of traffic and revenue forecasts for the toll roads must be conducted to minimize the surrounding uncertainties.

1.2 Background

The Ivory Coast's commercial capital, 'Abidjan', has a major port that serves both the Ivory Coast and several other neighboring countries with no ports that link them to the ocean (such as Burkina Faso and Mali). These countries are thus highly dependent on the Ivorian transportation networks for their trades. It is linked to the rest of the country by an extensive road network and railway. It is also the world's largest producer of cocoa and the fourth-largest producer of coffee. Abidjan city is the location for many international organizations that serve West Africa, including the World Bank and the African Development Bank, beside the location for several industries, including oil refining and power generation. The main industrial and commercial area of Abidjan city is located in the south. The south of Plateau district is Treichville, which is an area of factories and commercial activity. To the east lies the Marcory district, and further south is the port and an extensive industrial area.

Road transportation is the most common transportation mode in Ivory Coast due to the high need for imports and exports, mainly agricultural and industrial sectors. According to (AICD study, 2000), Ivory Coast poses a relatively well-developed transportation infrastructure compared with many other African countries. The results revealed that the primary and secondary road networks provide adequate linkage connecting the major cities, towns, and international borders.

In light of economic development and exponential population rates in major cities such as Abidjan, the roads and transportation networks burden has increased. The country's coastal part contains many isolated islands that require ferries and bridge connections to the mainland. Thus, it is essential to find the most efficient transportation mode that facilitates trade and increases time and cost savings.

Initially, both sides of Ebrie lagoon Plateau and Treichville are connected with two bridges: Felix Houphouet-Boigny and Charles de Gaulle. The increasing commercial and industrial activities on both sides and the island's crucial geographical location (the major connection between the north side of Abidjan city and the industrial area, port, and airport) resulted in traffic congestion. It also caused many other problems that slow down and impede travel, trade, industrial, and commercial activities. To solve these problems, Ivory Coast's government decided to construct a new bridge that connects Riviera-Marcory sides (known as the third bridge of Abidjan '(Henri Konan Bedie Bridge')-). This bridge consists of fast roads. It was anticipated to relieve the traffic congestion and reduce travel time and distance, which will also contribute to the environment by reducing air pollution.

1.3 Aim

This study's primary aim is to conduct a holistic and integrated investment appraisal of the "Riviera-Marcory" toll bridge project constructed in the Ivory Coast. This appraisal is to be conducted using Cost-Benefit Analysis (CBA) to analyze the financial, economic, and stakeholder impacts. This study also aims to identify the critical risk variables that might affect the project outcomes to assure the appropriateness of the project contracts and risk allocation to meet the project's overall objectives and the anticipated rate of return to project investors.

1.4 Structure

The research work has been divided into nine chapters structured as follows:

i. **Chapter 1**: Research field and the main focus of the study.

ii. **Chapter 2**: A Literature review of the current and historical transportation infrastructure in Ivory Coast.

iii. **Chapter 3**: Overview of the proposed Toll bridge project.

iv. **Chapter 4**: Methodology used for the project assessment.

v. **Chapter 5**: In-depth financial analysis to examine the financial viability and sustainability of the bridge project.

vi. **Chapter 6**: In-depth economic analysis to examine the economic worthiness of the bridge project.

vii. **Chapter 7**: In-depth stakeholder analysis to identify, measure, and efficiently allocate the externalities.

viii. **Chapter 8**: Assessment of the toll bridge project using advanced risk software techniques to identify and efficiently allocate the associated risks.

ix. **Chapter 9**: Conclusions and remarks.

Chapter 2

LITERATURE REVIEW

2.1 Ivory Coast Economic and Political Overview

After achieving its independence in 1960, Ivory Coast had a steady GDP growth per capita during the 1960s and 1970s with a great flow of foreign investments and expansion of the local agricultural exports. Since 1979, the economic growth became more volatile for over 30 years due to the decline in overall productivity, high population growth, and political instabilities. After the 2010 crisis, the economic and political situations of the Ivory Coast were stabilized and followed by a recovery and economic renaissance (Bavier,2014). Despite the slow political and security reforms, the GDP per capita was expected to continue rising (International Monetary Fund, 2013). The government set out a strategy to improve the major growth sources, including enhancing infrastructure and transport networks. This infrastructure is the primary engine of facilitating economic processes and reducing costs such as construction, handling, transportation costs, and maintenance cost saving. This strategy was anticipated to yield enormous benefits to the economy, especially in the main districts such as Abidjan (Republic of Côte d'Ivoire Ministry of Planning and Development, 2013).

2.2 Road Infrastructure Procurement

Public-private partnerships (PPPs) in Ivory Coast exist for a long time. They were established in different models, including leasing, concession, build-own-operate (BOO), and build-own-transfer (BOT) agreements. During the Ivory Coast economic

boom in the 1960s and 1970s, the government started its reforms to improve road transport and trade activities. A sharp decline followed this in the prices of its primary exports and the political instability during the 1990s. Also, road sector spending fell significantly compared to previous decades. This created the need to catch up with past and recent road maintenance, meet the increasing traffic volumes, and keep pace with population and economic growth. (Africa Infrastructure Country Diagnostic, 2011).

2.3 Road Infrastructure Development Plans

Abidjan city's rapid expansion urged the government to improve the road infrastructure, which led to its second master plan in 1985. The plan was meant to rebalance the activities of Abidjan city, improve traffic flows, expand the port and airport activities and facilities, improve residential activities and create a transportation network that crosses the Ebrie lagoon.

After the resumption of the political stability at the beginning of 2000, an evaluation of the second master plan was conducted, which indicated that the majority of the planned road projects were not implemented. (Republic of Côte d'Ivoire Ministry of construction, housing, sanitation and urban development,2015). This led to a third follow of a master plan to serve the central area. To this end, the government relied extensively on the PPPs to deliver public infrastructure projects aiming to achieve recovery from the recession and political unrest to modernize road networks. This was anticipated to return significant economic and social benefits bringing the country back to international markets.

Chapter 3

PROJECT OVERVIEW

3.1 Introduction

The rapid expansion of the City of Abidjan, especially the Cocody district, prompted the construction of the new North-South link via a toll bridge crossing the Ebrie lagoon and connecting Cocody and Marcory districts. This was part of a public work BOT project tasked by the government to a private operator to build and operate the bridge for 30 years. The proposed Riviera - Marcory Bridge is the eastern bridge of the three shown in figure 1.

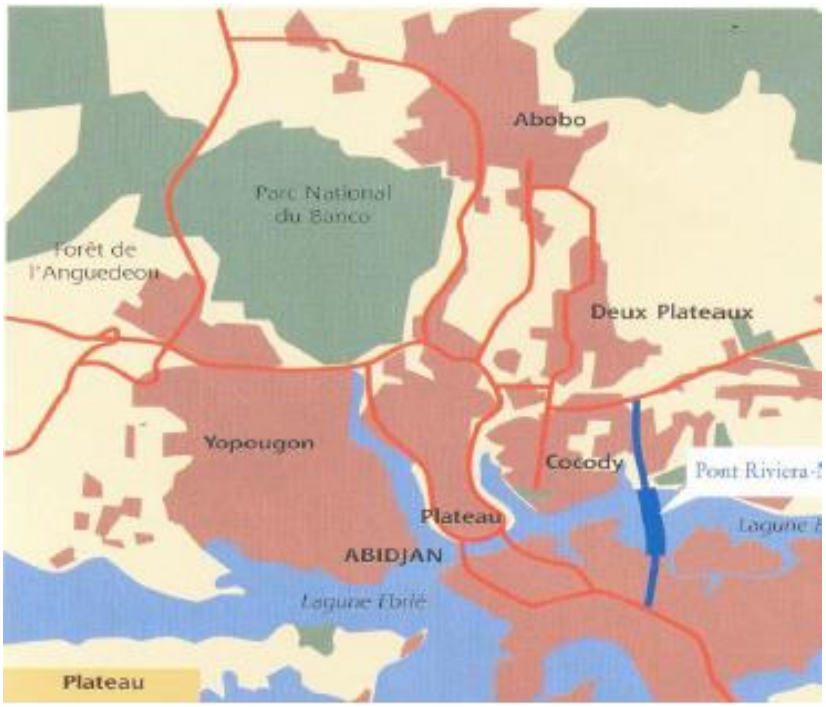


Figure 1: Proposed bridge
Source: Burgeap, 1998

The new bridge was designed to provide extra capacity for drivers crossing the lagoon, as the two existing bridges (Charles de Gaulle and Houphouet-Boigny) were near their practical capacity at the time. Due to its position, the new bridge is also meant to provide a very attractive route for residents of the northern suburbs, Cocody and Deux Plateaux, who wish to cross the lagoon and the industrial area of Marcory. After the new bridge's opening, the existing Houphouet-Boigny Bridge was planned to be shut for extensive maintenance between 2015 and 2017, and Bus lanes were rerouted to Charles de Gaulle bridge in 2018, thus removing one lane of the highway capacity in each direction.

3.2 Background and History

In 1997, Ivory Coast's government outsourced the third Abidjan bridge's execution to a private contractor. The concession holder (SOCOPRIM), a private SPV, and the awarding authority signed a concession agreement to make recourse investments to finance the project from various sources. Due to socio-political unrest, the project was postpended many times. After completing the required studies from the financiers and economic points of view, the project was approved in 2010, and the first part of the work started in September 2011 for the construction of the proposed bridge.

3.3 Current Condition

As a result of increasing economic activities and high population growth rates, the existing two bridges were not able to cope with the rising number of traffic and increased congestion as around 200,000 vehicles were estimated to cross the lagoon every day (Republic of Côte d'Ivoire Ministry of construction, housing, sanitation and urban development,2015).

The military crisis has also contributed to the deterioration of the roads and bridge conditions and the suspension of the allocated funding for road repair and maintenance, which put further pressure on maintenance and enlargement. Thus, additional infrastructure is needed to facilitate the traffic flow crossing the lagoon, allowing for faster traffic flow, especially for goods going from and to the port, considering its position as one of the biggest ports in the western part of Africa.

3.4 Project scope

The Proposed Henri Konan Bedie Bridge (HKB) spans a length of 1.5 viaduct out of 6.6 kilometers of road connections aiming to carry around 10,000 vehicles/day to relieve the congestions of the two other bridges crossing Ebrie lagoon. The project was to be implemented under a BOT concession agreement by a private operator to design, fund, build, operate and maintain the toll facilities for 30 years. This toll bridge was planned to cross the Ebrie lagoon connecting the Riviera district of Cocody to Marcory with access roads and incidental facilities. The HKB toll bridge is the first of its kind in Abidjan city. The concessionaire will be collecting the revenues charged to the users of the bridge during the concession agreement to recover the investment, operating, maintenance costs, and to return a satisfactory return rate to its investors.

Chapter 4

METHODOLOGY

4.1 Cost Benefits Analysis

In the first instance, the judgment of the worthiness of transportation projects can be done from the perspective of project profitability, but that's not the case for the toll facilities that are surrounded by various risks that go beyond the achievement of positive financial net present value (NPV). Hence, the burden on the government requires a careful analysis by conducting an integrated investment appraisal that tries to assess the overall effects of the project. This enables to decide whether the generated benefits are worthy to bear its costs and allows decision-makers to make correct investment choices.

The appraisal of the proposed Riviera-Marcory bridge was done using the CBA methodology. It is based on incorporating the analysis of financial, economic, and stakeholder impacts to examine the project's overall potential from the perspective of its all-related parties. It does so by quantifying the associated costs and benefits throughout the project's life and considering the resources opportunity cost and the time value of the generated revenues and incurred costs. Thus, CBA criteria simplify the process by taking the value of receipts and expenditures in present value terms, as described in the formula below.

$$PV\ of\ Net\ Benefits\ = PV\ of\ Benefits\ -\ PV\ of\ Costs$$

The cost-benefits analysis of the bridge was initiated using discounted cash flow model (DCFM). Microsoft Excel was used to develop the DCFM to derive the net value of the project. The net value was estimated based on the projection of the future inflows and outflows generated and incurred to find the project's net cash flows. Then, net cash flows were discounted by the relative discount rate to derive the NPV of the project.

4.2 Financial Analysis

The first step in conducting the integrated investment appraisal of the proposed bridge was to examine the profitability and the project's ability to recover the investment and operating costs and yield a satisfactory rate of return to equity investors. For this purpose, the financial net present value (FNPV) and internal financial rate of return (FIRR) were used to measure the project's financial viability and sustainability from the concessionaire's point of view.

Investment costs of infrastructure projects are very high, which requires the concessionaire to finance part of the project by debt. Therefore, financial institutions are one of the main interested parties to lend these investors. These institutions need to assert that the project can pay back its debt obligation during the repayment period. Loan Life Coverage Ratios (LLCRs) and Annual Debt Service Coverage Ratios (ADSCRs) were used to examine the project's ability to meet its debt obligation.

4.3 Economic Analysis

The benefits and costs of the toll facilities do not always come in the form of cash receipts and outlays, but also there are non-cash benefits and costs that need to be considered while measuring the impact of the project on the society and economy as a whole, which can be quantified by economic analysis. Before the economic analysis, it is important to establish coherent financial analysis to estimate the monetary values

to be converted to their economic values. This conversion is done using the relative conversion factors in the economic resource statement to see whether the project serves the country's social and economic needs. Here, project costs and benefits were estimated in real terms from the economic perspective. By considering the distortions that deviate the EV from its FV, such as taxes and subsidies, to estimate the ENPV and EIRR.

4.4 Stakeholder Analysis

The decision regarding the implementation of a bridge project necessitates the identification and quantification of the project's interested parties. It is important to identify parties expected to gain and those expected to lose from the project and by how much. This can be achieved by breaking down the costs and benefits and assigning them to their related parties. This enables the parties to make their final decision regarding the approval and implementation of the project.

The distributional analysis (also known as stakeholder analysis) was computed by subtracting the PV of cash flow statement items from the PV of economic resource statement items to derive the PV of externalities (benefits and costs generated by the project). These externalities were then allocated to their affected parties to measure the extent to which the project addressed society's need.

4.5 Risk Analysis

The certainty of the promised benefits differs from an investment to another depending on the project life, scale, capital expenditure, economic conditions, and political stability. The length of the construction and operation phase of the project plays an important role in its viability and profitability. Any delays will undoubtedly affect the stream of the benefits and costs during the project life, leading to its failure, especially

when the project capital expenditures are very high and its revenues require a long period to be realized.

Based on each project's nature, the risk variables that might affect the project the most must be identified, namely, their ranges, scale, magnitude, overall effect on the profitability and the chances of success or failure of the project. Thus, identifying the risk parameters will be substantially helpful in mitigating each kind of the risks that the project is expected to encounter, therefore, using the most suitable contracts that guarantee and secure the investment from the risk of loss.

The bridge's risk analysis was as follows: first, the sensitivity of the project outcomes (FNPV, ENPV, DSCR, and stakeholders gains or losses) to the selected risk variables was examined by conducting sensitivity analysis. Second, to add more accuracy to the model, this analysis was shifted from deterministic models to probabilistic models to enable decision-makers to use the probabilities in making their decisions.

Chapter 5

FINANCIAL ANALYSIS

5.1 Introduction

The financial analysis represents the cornerstone of the integrated investment appraisal (IIA), as the information obtained in the financial analysis is necessary to complete the other stages. The financial analysis aims to examine the financial viability and sustainability of the project that is important the most from the owner's and lenders' points of view. The project's forecasted outcomes are not likely to be the same as actual ones due to the uncertainty of future conditions. Thereby, financial analysis needs to forecast these uncertainties to identify the weaknesses and shortfalls and improve them.

The project owners' primary interest is the rate of return that the undertaken project is going to yield in real terms, as they are interested the see how much the investment is earning in terms of today's prices. On the other hand, the lender's primary concern before providing the credit is to figure out whether the project will generate sufficient cash flows to measure its ability to meet its debt service obligation during the loan life.

Starting with the capital expenditure that the toll bridge is going to incur and the operating and maintenance expenditure during its operation phase, the project will also provide a stream of revenues charged to the bridge users. Therefore, the role of the financial analysis is to weigh the cash inflows generated by the project against the cash

outflows incurred to come up with the net cash flows that demonstrate whether the project is going to generate enough cash flows that cover its capital, maintenance, operating and debt service obligations as well as yielding a satisfactory rate of return to its equity holders.

5.2 Inputs Assumptions and Parameters

Parameters and assumptions used in constructing the proposed Riviera - Marcory Bridge's financial model is demonstrated in this section. Some of the parameters and assumptions were modified to simplify the model.

5.2.1 Sources and Uses of Funds

The sources and uses of funds for the proposed bridge are presented in table 1.

Table 1: Sources and uses of funds

Uses (Million EUR)		**sources (Million EUR)**	
Cost of Road Works	196.78	Government Contribution	80
Cost of Bridges and Approaches	17.84	Equity	29
Cost of Installing Lighting	1.24	Subordinated Debt	42
Cost of Installing Traffic Signals	2.32	Senior Debt	127
Cost of Toll Plazas	3.57	AFDB	57
Cost of Weighbridges	5.35	BOAD + BIDC	36
Cost of Truck Stops	2.50	FMO	10
Cost of Construction Labor	40.52	AFC	14
DSRA Prefunding	7.42	BMCE	10
Total	277.54	Total	277.54

5.2.2 Project Timing

The Riviera – Marcory Toll Bridge concession agreement is assumed to last for 34-years, starting from 2012 and ending in 2045. Construction works will take place during the first three years (2012-2014). The bridge is assumed to open for traffics and start its operation in 2015 until 2044. During the 30-years operation period, the

concessioner will collect the toll charges from the users of the bridge and handle its maintenance. The project is assumed to be liquidated in 2045 and transferred to government possession.

5.2.3 Investment Costs

The anticipated capital expenditures for the bridge construction were estimated in the 2012 price level. The total bridge construction costs were estimated to be 265.4 million euros. The construction phase's completion was done within three years starting from 2012 as follows; 58.02%,25.85%, and 16.13%, respectively. Capital cost items and their values are presented in table 2.

Table 2: CAPEX of the bridge project

Cost of Civil Works	EUR 'M	193.37
Cost of Bridges and Approaches	EUR 'M	17.53
Cost of Installing Lighting	EUR 'M	1.21
Cost of Installing Traffic Signals	EUR 'M	2.28
Cost of Toll Plazas	EUR 'M	3.50
Cost of Weighbridges	EUR 'M	5.26
Cost of Truck Stops	EUR 'M	2.45
Cost of Construction Labor	EUR 'M	39.82
Total capital costs	EUR 'M	265.45

5.2.4 Project Financing

The sources of financing used to finance the bridge construction were in three different forms. Senior debt contributed 45.62% of the total capital expenditure, equity/quasi-equity, and government subsidy contributed with 25.67% and 28.71%, respectively. Tables 3 and 4 presents the breakdown of the loans and their interest rates, commitment fees, and upfront fees.

Table 3: Senior Debt Loans

Senior debt loan	% of senior debt	% of total investment coast	Interest rate	Commitment fees	Upfront fees
AFDB	44.68%	20.38%	9.80%	0.75%	1.25%
BOAD + BIDC	28.07%	12.81%	9.80%	1.25%	0.50%
FMO	8.26%	3.77%	9.80%	1.25%	0.75%
AFC	10.73%	4.90%	9.30%	1.50%	0.50%
BMCE	8.26%	3.77%	8.65%	1.50%	2.40%
Total /Average	100%	45.62%	9.65%		

Table 4: Equity/Quasi-equity

Equity/Quasi-equity	% of Total equity	% of total investment coast	Interest rate	Commitment fees	Upfront fees
Subordinated debt	59%	15%	15%	2%	0.50%
Equity invested	41%	11%			

The tenor period for all the loans is 16 years, except the BMCE loan is ten years, starting from 2012 with a grace period of 3 years. The first year of debt repayment begins in 2015.

5.2.5 Operation and Maintenance

User Charges

The bridge users were classified as light vehicles (including cars and taxies) and heavy vehicles (including trucks and buses). The bridge users will be subject to toll payment based on their categories; the base toll charged is 812 FCFA (2012 price level). The toll factor for light vehicles is one and for heavy vehicles is three.

Operating and maintenance costs

To keep the bridge in a good working condition and the quality of the service provided, the bridge is anticipated to undergo light and heavy maintenance, which is forecasted based on the bridge condition. The annual operating costs were assumed to be fixed in

real terms during the project's life with a yearly cost of 6.5 million euros (2012 price level).

Working capital

The bridge was assumed to have account payables of 8% of total annual operating and maintenance costs; cash balance estimated to be 4% of the total yearly toll revenues to meet its operational and maintenance needs. Toll payments are assumed to be on a cash basis; thus, the bridge would not have any account receivables.

5.2.6 Macro-Economic Parameters

The project outputs are greatly affected by macroeconomic factors that can dramatically change the estimation results, especially when trying to estimate the stream of the project cash flows over a long time.

- The domestic inflation rate in Ivory Coast was 3% in 2012, while the Euro inflation rate was also 3%.
- The exchange rate in 2012 was taken as 655.95 FCFA per EURO, and this exchange rate will be subject to inflation rate changes during the life of the project.
- The project will be exempt from paying corporate income tax until 2027, that is the last year of its debt repayments. Starting from 2028, the project will be subject to 25% corporate income tax. The project is also assumed to have 18% VAT on its revenues, operating and maintenance expenditures.
- The required rate of return by the equity owners is set to be 19.42% in real terms due to the high risk involved.

5.2.7 Traffic Forecasts

Traffic forecasts represent the cornerstone of any toll road or bridge projects. Its importance arises due to its crucial role in determining toll rates to be charged, revenue forecasts, determining the project's capital structure (PPIAF, 2016). Economic growth, vehicle utilization, population, and other behavioral factors (such as the value of time and route preferences when other competitive facilities exist) must be taken into account to produce accurate and reliable traffic forecasts.

5.3 Cash Flow Statement

Financial analysis was conducted using the assumptions and parameters provided in the previous sections. Each of the project stakeholders is concerned with their interest; a cash flow statement was constructed to reflect the major stakeholders who have a direct interest in the project. Cash flow statements from the lender's and owners' points of view are presented in table 5 and table 6.

Table 5: Cash flow statement - lenders perspective

		2012	2013	2014	2015	2016	2017	2018	2019	...	2043	2044	2045
Cashflow from the Total Investment Point of View real Euro													
Euro Index	Index	1.000	1.030	1.061	1.093	1.126	1.159	1.194	1.230		2.500	2.575	2.652
Receipts													
Total toll revenue , cars	EUR'000	-	-	-	30,097	33,151	36,063	30,378	32,324		61,643	61,811	-
Total toll revenue , HGV	EUR'000	-	-	-	8,142	8,912	9,692	6,869	7,323		14,598	14,638	-
Total Operating Receipts		-	-	-	38,239	42,063	45,755	37,247	39,647		76,241	76,450	-
OPEX													
Total Operating Expenditure	EUR'000	-	-	-	6,500	6,500	6,500	6,500	6,500		6,500	6,500	-
Net VAT Liability	EUR'000	-	-	-	4,576	5,006	5,664	4,387	4,742		10,280	10,341	-
Total Tax Liability	EUR'000	-	-	-	-	-	-	-	-		13,628	13,731	-
Maintenance Expenditure													
Light Maintenance During Operation	EUR'000	-	-	-	1,741	2,745	2,127	1,988	1,988		1,838	1,838	-
Heavy Maintenance during operation	EUR'000	-	-	-	-	-	-	-	75		510	323	-
Working Capital													
Changes in AP	EUR'000	-	-	-	(659)	(100)	28	(9)	(26)		49	(6)	673
Changes in CB	EUR'000	-	-	-	1,530	198	197	(287)	139		89	97	(2,969)
Total Operating Expenditure	EUR'000	-	-	-	13,687	14,349	14,515	12,579	13,418		32,895	32,824	(2,296)
Net Operating Cash Flow	EUR'000	-	-	-	24,552	27,714	31,240	24,668	26,229		43,346	43,626	2,296
CAPEX													
Total Construction Costs - [excluding Labor]	EUR'000	130,916	58,333	43,380	-	-	-	-	-		-	-	-
Cost of Construction Labor	EUR'000	23,104	10,295	6,422	-	-	-	-	-		-	-	-
Residual Value													
Residual Value	EUR'000	-	-	-	-	-	-	-	-		-	-	49,015
NCF -Total Investment Point of View	EUR'000	(154,021)	(68,627)	(49,802)	24,552	27,714	31,240	24,668	26,229		43,346	43,626	51,311

Table 6: Cash flow statement - owners' perspective

Cashflow - Total Investment Point of View real Euro			2012	2013	2014	2015	2016 ...	2043	2044	2045
Euro Index		Index	1.000	1.030	1.061	1.093	1.126	2.500	2.575	2.652
Receipts										
Total toll revenue , cars		EUR'000	-	-	-	30,097	33,151	61,643	61,811	-
Total toll revenue , HGV		EUR'000	-	-	-	8,142	8,912	14,598	14,638	-
Total Operating Receipts			-	-	-	**38,239**	**42,063**	**76,241**	**76,450**	-
OPEX										
Total Operating Expenditure		EUR'000	-	-	-	6,500	6,500	6,500	6,500	-
Net VAT Liability		EUR'000	-	-	-	4,576	5,006	10,280	10,341	-
Total Tax Liability		EUR'000	-	-	-	-	-	13,628	13,731	-
Maintenance Expenditure										
Light Maintenance During Operation		EUR'000	-	-	-	1,741	2,745	1,838	1,838	-
Heavy Maintenance during operation		EUR'000	-	-	-	-	-	510	323	-
Working Capital										
Changes in AP		EUR'000	-	-	-	(658)	(100)	49	(6)	673
Changes in CB		EUR'000	-	-	-	1,530	198	89	97	(2,963)
Total Operating Expenditure		EUR'000	-	-	-	**13,687**	**14,349**	**32,895**	**32,824**	**(2,296)**
Net Operating Cash Flow		EUR'000	-	-	-	**24,552**	**27,714**	**43,346**	**43,626**	**2,296**
CAPEX										
Total Construction Costs - [excluding Labor]		EUR'000	130,316	58,333	43,380	-	-	-	-	-
Cost of Construction Labor		EUR'000	23,104	10,295	6,422	-	-	-	-	-
Residual Value										
Residual Value		EUR'000	-	-	-	-	-	-	-	49,015
NCF -Total Investment Point of View		EUR'000	**(154,021)**	**(68,627)**	**(49,802)**	**24,552**	**27,714**	**43,346**	**43,626**	**51,311**
Financing of the Project										
Senior Debt Contribution towards Total Investment Costs		EUR'000	70,263	31,307	22,719	-	-	-	-	-
Sub Debt towards Total Investment Costs		EUR'000	23,286	10,376	7,529	-	-	-	-	-
Subsidy Contribution		EUR'000	44,226	19,706	14,300	-	-	-	-	-
Total Debt Repayment		EUR'000	-	-	-	21,372	26,275	-	-	-
NCF After Financing, Real		EUR'000	**(16,246)**	**(7,239)**	**(5,253)**	**2,580**	**1,439**	**43,346**	**43,626**	**51,311**
Real Discount Rate	19.42%									
FNPV	**13,881**	EUR'000								
FIRR	**23.69%**	EUR'000								
MIRR	**20.98%**	EUR'000								

5.3.1 Financial Analysis – Lenders Standpoint

The main concern of financing and lending institution is the borrower's ability to pay back its debt obligation (principal and interest). For the lending decision to be taken, lenders need to ensure the project capability to generate sufficient cash flows that are enough to recover the borrowed amount and earn its expected rate of return during the loan life period.

The project’s ability to repay its debt obligation was measured on a year-to-year basis. The debt service coverage ratio (DSCR) was used to measure the generated cash flows' adequacy compared to its accrued debt repayment. However, lenders need to have prior knowledge about whether to make bridge financing or not when the project cannot generate enough cash in one or more periods during the loan life. To this end, the loan life coverage ratio LLCR was used.

5.3.1.1 Debt service coverage ratio - DSCR

Arranging project cash inflows and outflows based on their seniority ensures the occurrence of each item at the correct time based on its priority. This enables the project to handle the situation where the generated cash flows are not adequate to meet all project obligations. According to the project's financial structure, the investment was financed by senior debt (which has the priority compared with other debts) and subordinated debt.

DSCR for the senior debt service was computed by dividing the cash flow available annually for senior debt service (CFASDS) over the senior debt service. In contrast, the DSCR for subordinated debt was computed by dividing CFASDS by senior plus subordinate debt service. A ratio of 1.00x means that the annual cash flow available for debt service equals the annual debt service of that period. But that's not the preferred situation as the forecasts, and the estimation of the project items would never be as accurate as of the actual ones, so the project will either do better or worse than expected. Thereby, the higher the ratio, the higher probability to obtain the required debt and the more secure to the lenders. Table 7 presents the annual DSCR results.

Table 7: ADSCR results

Year	ADSCR-senior	ADSCR- subordinated
2015	1.58	1.12
2016	1.43	1.05
2017	1.90	1.35
2018	1.85	1.25
2019	1.66	1.19
2020	1.87	1.33
2021	2.09	1.48
2022	2.47	1.71
2023	2.88	1.96
2024	3.34	2.22
2025	3.81	2.50
2026	5.21	3.16
2027	5.59	4.20

Regarding senior debt obligations, although the ADSCR for the first few years is not as much as the subsequent years, the project's overall performance seems to be attractive. Between 2015 till 2017, the ratios were steadily increasing. As a result of maintaining and reopening the other competitive bridge in 2018, ADSCR was decreased by 0.05 in 2018, while in 2019, it decreased by 0.19 compared with its previous value. Due to increasing traffic counts and the number of vehicles crossing the bridge, the ratio shown an increasing trend from 2020 until the end of the debt life. The lowest value of ADSCR was 1.43x which indicates that the project was able to generate sufficient cash flows that were adequate to meet the value of senior debt service obligations with more than 43% of their values. It is worth noting that the project did not face any difficulties paying its senior debt obligations in its worst situations. The project performance and ability to meet its senior debt obligations were quite satisfactory in the first few years and very attractive in the subsequent years for lenders to lend.

ADSCR for subordinated debt comes at a lower priority than senior debt, so it is apparent that its ratios are expected to be lower than senior debt ratios since the CFASDS will be divided by senior and subordinated debt service. Although the ADSCRs for subordinated debt from 2015 to 2020 was relatively low, which showed that the project faced difficulties during these years, they were all above the total debt service value. The lowest value was 1.05x but other years were much higher than that. On the contrary, from 2021 to 2027, the ratios exhibited an increasing trend that looks very attractive to the subordinated debt lenders. In such situations, where the project is expected to have difficulties, lenders require the borrowers to have a debt service reserve account (DSRA) funded for this project on the last day of the construction face. Besides, some other methods and strategies can be followed to mitigate such kinds of problems, including loan sculpturing, increasing the loan life period, and decreasing the interest rates. Governments are often required to provide guarantees to take the responsibility of payment if the project fails to pay the promised amount.

5.3.1.2 loan life coverage ratio - LLCR

When the project ADSCR is lower than or around the value of debt obligations in one period or more, lenders do not immediately refuse to provide the credit. They need to take into consideration whether the project is qualified to obtain bridge financing or not by looking to the periods before and after to see whether the project is generating enough cash or not to cover the shortfall in a certain period. Thereby, the LLCR criterion is a proper method that guides lenders to make their decisions to provide bridge financing or not.

LLCR is computed as a ratio of present values (PV), using loan interest rate as the discount rate. The PV of the net cash flows is calculated in a specific year as the ratio of the PV of the net cash flow until the end of the loan life over the PV of annual debt repayments computed from the end of the loan back to the same year. Table 8 presents LLCR results.

Table 8: LLCR results

Year	LLCR (senior debt)	LLCR (Sub debt)
2015	2.23	1.66
2016	2.32	1.71
2017	2.49	1.82
2018	2.60	1.88
2019	2.73	1.97
2020	2.96	2.11
2021	3.23	2.28
2022	3.56	2.47
2023	3.91	2.67
2024	4.29	2.90
2025	4.74	3.18
2026	5.39	3.62
2027	5.59	4.20

According to the results of LLCR for both senior and subordinated debt, the project's ability to generate cash that is sufficient to obtain bridge financing in case of any shortfall during any of the debt repayment periods seems to be adequate from the lender's perspective. The lowest value of LLCR for senior debt was 2.23x, while that for subordinated debt was 1.66x. In later years, the project LLCRs recorded very satisfactory results aside from the high expected and promised earnings, making it very attractive for lenders to compete in lending such a project.

Although the analysis results of ADSCRs indicated that the cash generated from the project was fair enough to meet its debt obligations, the LLCRs results provided significant evidence regarding the project's ability to meet its debt obligations at a very low risk to lenders. To sum up, the analysis results of the project's ability to meet its debt obligations (senior and subordinated debts) were satisfactory to its lenders.

5.3.2 Financial Analysis – Owners Standpoint

To accurately analyze the investment potentials, the investment appraisal was done using the direct method by looking at the receipts and expenditures and when they occur rather than revenues and expenses (Jenkins, Kuo, and Harberger, 2019). The implementation of the proposed project seeks several approvals as lenders need to ensure the recovery of the principal loan, and the government wants to ensure the quality and delivery of the service in the most efficient manner, and owners want to generate a profit from their investment.

Equity holders' interest needs to be met to proceed with the project implementation after other related parties' approval. Equity investors expect to generate a rate of return that is equal to or higher than the real opportunity cost of invested capital (net of inflation) and compensate for the various kinds of risk involved with their investment. Thereby, discounting the real net financial cash flows generated during the project's life by the owner's real opportunity cost of capital must be greater than zero to be attractive to the investors.

Looking to the project inflows and outflows based on its occurrence to derive the real net cash flows after financing by adding the debt contributions and subsidies and deducting the debt repayments from the NCF before financing, the FNPV, FIRR, and FMIRR investment criterions were applied to judge the feasibility of the project.

According to the analysis results, the project FNPV was 13.88 million euros in terms of the 2012 price level to be earned by the equity investors if they decided to invest in the proposed project; FIRR was 23.69%, which is above owners required rate of return. Finally, to avoid some of the IRR criterion problems, MIRR was used, and it was 20.98%, which a bit lower than the IRR but still above the rate of return required by the equity holders. To sum up, the project looks attractive from the owner's perspective as it satisfied the returns required by investors.

Based on the detailed financial analysis, the financial cash flow statement was constructed. The project looks attractive for both lenders and owners, as from the lender side, they need to ensure the principal's recovery and earn interest on it. In contrast, owners' objectives were met by generating a rate of return greater than their opportunity cost of capital.

Chapter 6

ECONOMIC ANALYSIS

6.1 Introduction

The benefits and costs associated with the outputs of many public projects such as roads and bridges are not fully captured in the financial analysis. Proceeding with the IIA, the second step is to conduct an economic analysis that captures the project's economic costs and benefits to determine the effect of the project on the country's economic welfare. The economic evaluation is directly linked to the real cash flow statement constructed in the financial analysis that considers the project's effect on a particular group of stakeholders (mainly owners and lenders). The real cash flow statement forms the basis for constructing the economic resource flow statement that measures the project's associated costs and benefits in terms of their economic values. The economic analysis is a part of a consequential and consistent analysis structure.

As the financial values in most of the cases do not reflect their economic values, deriving the economic values starts with finding the related conversion factor ratios that are expressed by dividing the economic value over each item's financial price. These ratios are multiplied by the respective monetary values to derive their economic values. Hereafter, total economic costs accrued from the provided service were subtracted from total economic benefits to find the proposed project's net economic benefits. Finally, discounting net economic benefits using the real economic opportunity cost of capital enables us to measure the project’s economic welfare effect.

6.2 Valuation of Economic Benefits

The benefits of roads and bridge projects do not always come in form of increasing revenues but also comes in terms of cost reduction, such as reducing vehicle operating and maintenance costs and travel time savings. These benefits were considered in the proposed bridge's economic analysis due to its strategic location and urgent necessity to accelerate the trade and economic cycle.

6.2.1 Vehicle Operating Cost Savings

The proposed bridge project was constructed due to the increased congestion on the other two bridges and shortening the length of the travel distance for the users of the bridge facility. Reducing the distance will decrease vehicle operating and maintenance expenses needed to be paid, such as lowering fuel expenditures due to reducing travel distance and faster traffic flow, vehicle repair, and replacement parts expenditures due to the improved quality of the bridge. By comparing these expenditures with and without the bridge construction, the difference will be the cost reduction by using the constructed bridge. Vehicle operating cost estimates were categorized into four categories (Cars-Low Income, Cars-High Income, Taxis, Trucks). Table 9 presents the VOC saving per hour, while table 10 shows the number of kilometers saved per day for the first operational year 2015.

Table 9: VOC savings for 2015

Cars-Low Income	Euro/km	0.595
Cars-High Income	Euro/km	0.579
Taxis	Euro/km	0.579
Trucks	Euro/km	0.579

Table 10: Kilometers saved per day for 2015

Cars-Low Income	Km saved/day	41138
Cars-High Income	Km saved/day	56448
Taxis	Km saved/day	28558
Trucks	Km saved/day	10095

The daily distance savings per category of vehicle and their projected growth rates are estimated for the operation period from 2016 until 2044. Starting with 2015 as a base year.

6.2.2 Travel Time Savings

Time spending on long journeys has an opportunity cost which can be used for productive activities. The quantification of the time saved by shortening these trips can be done in monetary terms. As workers' time can be valued by their hourly wage rate, the time value for cargos that are transiting goods can be quantified in terms of reduced freight and the transited goods opportunity cost. The time value of the project facility users is linked to the value placed on their time. Hence, bringing a project that reduces travel distance and allowing for a higher traffic flow will lower the required time to reach the desired destination. The reduced travel time is quantified in monetary terms to estimate the travel time savings and their value as a result of the implemented project. Table 11 presents the VOT savings per vehicle category in terms of euro per hour. Table 12 shows the number of hours saved in the first year of operation that is the base for the growth rates during the operation period.

Table 11: VOT savings, 2015

Cars-Low Income	EURO/hour	2.96
Cars-High Income	EURO/hour	2.96
Taxis	EURO/hour	2.71
Trucks	EURO/hour	2.71

Table 12: Hours saved per day, 2015

Cars-Low Income	Hours saved/day	5179
Cars-High Income	Hours saved/day	9529
Taxis	Hours saved/day	5252
Trucks	Hours saved/day	1917

6.3 Inputs Assumptions and Parameters

The economic parameters and assumptions, in addition to the financial analysis ones, were all used in the economic analysis of the proposed project, are as follow;

- Foreign exchange premium (FEB): 9.50%
- The premium on Non-tradable Outlays (NTP): 1.50%
- Value Added Tax (VAT): 18.00%
- Effective Tax Rate: 3.00%
- Port handling charges (% of CIF Price): 3.50%
- Domestic transportation cost (% of CIF Price): 3.50%

The abovementioned parameters and assumptions represent the distortions that deviated economic values from their financial values. Hence, using the monetary values derived from the financial cash flow statement and the identified distortions, conversion factors are computed to develop the project's economic resource statement. Table 13 presents a summary of the estimated conversion factors.

Table 13: Summary of Conversion Factors

Toll Revenue (gross of VAT)	0.00
Residual Value	0.85
Bridge Construction	0.85
Labor	0.75
Operating Costs	0.82
Maintenance Costs (2014-2027)	1.03
Maintenance Costs (2027-2044)	0.87
Vehicle Operating Cost	0.88
Value of Time	1.00
Corporate Tax liability	0.00
Change in Accounts Payables	0.87
Change in Cash Balances	1.00

Bridge construction financial costs were mainly composed of equipment, products, and other materials used for civil construction works. The total distortions as a percentage of the financial costs were 15%; thereby, the bridge's economic value and its residuals were 85% of the financial costs after adjusting for the distortions.

Labors employed for the bridge construction were categorized as local (unskilled and semi-skilled labor) and expats (skilled labor). The total distortions are found equal to 25% of the financial value; thus, labor's economic value was 75% of its financial value.

Maintenance costs consist of imported material and labor, while operating costs consist of utilities, transportation, and labor. Distortions were mainly VAT and income taxes. By adjusting these distortions from their financial values, the economic value was 82% of its financial value. Regarding maintenance, after adjusting the distortion and taking into account the tax exemptions until 2027, the economic values for the periods (2014-2027 and 2027-2044) were 1.03x and 87% of their financial values.

VOC mainly includes fuel, tire replacement, maintenance, and repair costs. Total distortions were 12% of the financial cost, primarily caused by various import duties and income taxes. The estimated economic value was 88% of its financial value.

Corporate tax liability and toll revenues have no economic impact, and their conversion factor is zero. VOT was assumed to have no distortions; thus, its economic value is 1.00x. Accounts payables were a percentage of operating and maintenance costs; therefore, the conversion factor was estimated by taking the average of operating and maintenance costs conversion factors, resulting in a conversion factor equals to 87% of its financial value. Cash balances were assumed to have no distortions; thus, the conversion factor was 1.00x.

6.4 Economic Resource Flow Statement

The economic resource flow statement was constructed for the proposed Riviera - Marcory Bridge using the real cash flow statement constructed in the financial analysis along with the conversion factors, as presented in table 14.

Table 14: Economic Resource Flow Statement

			2012	2013	2014	2015	2016	...	2043	2044	2045
Economic Resource Flow Statement (Real EUR'000)											
Benefits	**CF**										
Total toll revenue , cars	0.00		-	-	-	-	-		-	-	-
Total toll revenue , HGV	0.00		-	-	-	-	-		-	-	-
Total Time Savings, Cars	1.00	EUR'000	-	-	-	21,065	36,387		303,313	304,746	-
Total Time Savings, HGV	1.00		-	-	-	1,894	3,590		32,733	32,823	-
Total Operating Cost Savings , cars	0.88	EUR'000	-	-	-	23,584	26,481		71,263	71,459	-
Total Operating Cost Savings , HGV	0.88		-	-	-	1,871	2,225		7,952	7,974	-
Total Operating Benefits			-	-	-	**48,415**	**68,683**		**415,862**	**417,001**	-
OPEX											
Total Operating Expenditure	0.82		-	-	-	5,321	5,321		5,321	5,321	-
Net VAT Liability	0.00		-	-	-	-	-		-	-	-
Total Tax Liability	0.00		-	-	-	-	-		-	-	-
Maintenance Expenditure											
Light Maintenance During Operation	IF		-	-	-	1,790	2,824		1,599	1,599	-
Heavy Maintenance during operation	IF		-	-	-	-	-		444	281	-
Working Capital											
Changes in AP	0.87		-	-	-	(576)	(87)		43	(5)	588
Changes in CB	1.00		-	-	-	1,530	198		83	97	(2,363)
Total Operating Costs			-	-	-	**8,065**	**8,255**		**7,496**	**7,293**	**(2,381)**
Net Operating Benefits			-	-	-	**40,350**	**60,428**		**408,366**	**409,708**	**2,381**
CAPEX											
Total Construction Costs - [excluding Labor]	0.85		111,857	49,840	37,065	-	-		-	-	-
Cost of Construction Labor	0.75		17,435	7,769	4,846	-	-		-	-	-
Residual Value											
Residual Value	0.85		-	-	-	-	-		-	-	41,879
Net Benefits			**(129,292)**	**(57,609)**	**(41,911)**	**40,350**	**60,428**		**408,366**	**409,708**	**44,260**
Real Economic Opportunity Cost of Capital	12.00%										
ENPV	**322,857**	EUR'000									
EIRR	**30.92%**	EUR'000									

6.5 Economic Impact

After converting the financial values to their respective economic values, total economic costs and benefits were estimated to derive the proposed bridge's net economic benefits. Like the financial analysis, the economic analysis relies on the NPV criterion; thus, the discount rate to be used plays a critical role in finding out the present values of the net economic benefits streams. Thereby, the opportunity cost of capital (EOCK) of the country must be used as a discount rate derived by estimating the cost of the funds extracted from the capital market to finance the projects (Jenkins, Kuo, and Harberger, 2019).

By discounting the net economic benefits using EOCK, the estimated bridge's economic net present value was 922.8 million euros, and the internal economic rate of return EIRR was 30.92%, which is much higher than the EOCK. The results indicated that undertaking the proposed project is expected to positively affect the economic welfare of Ivory Coast by 922.8 million euros based on the projected economic costs and benefits of the project. Thereby, from the economic point of view, the project needs to be undertaken as its expected economic return is very high and participates in improving the economic welfare of the whole county.

Chapter 7

STAKEHOLDER ANALYSIS

7.1 Introduction

The previous chapters outlined the project's analysis from different perspectives, mainly owners, lenders, and economic perspectives. However, other parties are affected by implementing the proposed project named the project stakeholders. A stakeholder analysis was used to identify the affected parties and their gains or losses due to the project implementation.

Project externalities were derived by subtracting the present value of the financial cash flow statement items from the present value of the economic resource statement items, as the economic resource statement captures the overall benefits of the project to the whole economy while the cash flow statement capture the net financial benefits to parties that have a financial interest with the project.

The proposed Riviera - Marcory Bridge resulted in a number of externalities that affected the following stakeholders:

- Government of Ivory Coast
- Labor used for the bridge construction and operation.
- Bridge users (Cars, HGV)

7.2 Bridge Externalities

The derivation of the project externalities was done by discounting and computing the present values of the financial and economic values of the project inputs and outputs using the EOCK. Hereafter, taking the difference of both values' PVs will result in the net externalities resulting from the project implementation. PV of total externalities was estimated to equal 969.6 million euros. Tables 15 and 16 presents the total PV of financial, economic, and externalities.

Table 15: PV of externalities

		Econ. PV @ ECOK	Financial PV @ EOCK	Ext. PV @ E0CK
Benefits				
Total toll revenue , cars	EUR'000	-	258,111	(258,111)
Total toll revenue , HGV	EUR'000	-	62,222	(62,222)
Total Time Savings, Cars	EUR'000	800,140	0	800,140
Total Time Savings, HGV	EUR'000	85,234	0	85,234
Total Operating Cost Savings , cars	EUR'000	272,636	0	272,636
Total Operating Cost Savings , HGV	EUR'000	27,031	0	27,031
Total Operating Benefits	EUR'000	**1,185,042**	**320,334**	**864,709**
OPEX				
Total Operating Expenditure	EUR'000	34,167	41,740	(7,573)
Net VAT Liability	EUR'000	-	40,400	(40,400)
Total Tax Liability	EUR'000	-	16,268	(16,268)
Maintenance Expenditure				
Light Maintenance During Operation	EUR'000	12,756	12,770	(14)
Heavy Maintenance during operation	EUR'000	928	978	(50)
Working Capital				
Changes in AP	EUR'000	(516)	(591)	75
Changes in CB	EUR'000	1,706	1,706	-
Total Operating Costs	EUR'000	**49,041**	**113,272**	**(64,231)**
Net Operating Benefits	EUR'000	**1,136,001**	**207,062**	**928,939**
CAPEX				
Total Construction Costs - [excluding Labor	EUR'000	185,905	217,582	(31,677)
Cost of Construction Labor	EUR'000	28,235	37,415	(9,180)
Residual Value				
Residual Value	EUR'000	995	1,164	(170)
Net Externalities	EUR'000	**922,857**	**(46,770)**	**969,627**

Table 16: PV of externalities (Euro'000)

PV EXTERNALITIES @ EOCK	=	PV ECONOMIC FLOW @EOCK	-	PV FINANCIAL FLOW @EOCK
969,627	=	**922,857**	-	**(46,770)**

The distributive analysis was conducted to allocate each of the accrued externalities to their stakeholders. Table 17 presents the allocation of externalities.

Table 17: Bridge Externalities

			Government	Labor	Road Users	
					Cars	HGV
		Ext. PV @E0CK				
Benefits						
Total toll revenue , cars		(258,111)			(258,111)	
Total toll revenue , HGV	EUR'000	(62,222)				(62,222)
Total Time Savings, Cars	EUR'000	800,140			800,140	
Total Time Savings, HGV		85,234				85,234
Total Operating Cost Savings , cars	EUR'000	272,636			272,636	
Total Operating Cost Savings , HGV		27,031				27,031
Total Operating Benefits	EUR'000	**864,709**	-	-	**814,665**	**50,043**
OPEX	EUR'000					
Total Operating Expenditure	EUR'000	(7,573)	(7,573)			
Net VAT Liability	EUR'000	(40,400)	(40,400)			
Total Tax Liability		(16,268)	(16,268)			
Maintenance Expenditure	EUR'000					
Light Maintenance During Operation		(14)	(14)			
Heavy Maintenance during operation		(50)	(50)			
Working Capital						
Changes in AP	EUR'000	75	75			
Changes in CB	EUR'000	-	-			
Total Operating Costs		**(64,231)**	**(64,231)**	-	-	-
	EUR'000					
Net Operating Benefits	EUR'000	**928,939**	**64,231**	-	**814,665**	**50,043**
CAPEX	EUR'000					
Total Construction Costs - [excluding Labor]	EUR'000	(31,677)	(31,677)			
Cost of Construction Labor	EUR'000	(9,180)		(9,180)		
Residual Value	EUR'000					
Residual Value		(170)	(170)			
Net Externalities	EUR'000	**969,627**	**95,738**	**9,180**	**814,665**	**50,043**

7.2.1 Externalities to Ivory Coast Government

Taxes on project inputs and outputs are one of the main distortions for the presence of externalities accrued to the Ivory Coast government. Also, these externalities arise due to gains and losses in the FEP of the country. These distortions can be translated to fiscal impacts derived from the projected tax flows to Ivory Coast's government. According to the bridge distributive analysis, PV of externalities accrued to the Ivorian government were estimated to equal 95.7 million euros, as demonstrated in table 17.

7.2.2 Externalities to Labor

One of the main beneficiaries of the bridge's implementation was the employed human capital to construct, operate and maintain the bridge facility. The PV of externalities

accrued to labors employed as a result of this project was estimated to equal 9.18 million euros.

7.2.3 Externalities to Bridge Users

Users of the bridge project are considered the main beneficiaries of its presence. The bridge's main aim is to serve its users in the most efficient, convenient, and least costly way, thus reducing the accrued costs associated with their trips compared with its previous values before the project implementation. As a result of using the bridge, the user's main savings were the VOCs and travel time savings. The results of distributive analysis have shown that the bridge positively affected its users. The PV of the net benefits to its users was as follows: benefits to cars were 814.6 million euro while HVG net benefits were 50.0 million euro as shown in table 17.

Chapter 8

RISK ANALYSIS

8.1 Introduction

The proceeding modules (Financial, economic, and stakeholder analysis) are closely related, as the information obtained at one stage was essential for completing the next phase of an IIA. The results of these modules were based on the deterministic values of project parameters. However, due to uncertain future conditions, the project's key parameters' certainty is unlikely to be the same as projected, such as prices, quantities, exchange, and inflation rates throughout the project's life. Thereby, the measures and investment criterions used to evaluate the project are subject to forecasting errors and uncertainties. To this end, the question of (what if) takes place to examine the situations when project variables deviate from the base values in both directions.

The key pillar in conducting a risk analysis is to identify the critical risk variables that lead to dramatic changes in the project outcomes. Sensitivity analysis was adopted to determine the proposed bridge's risk variables and the scale and magnitude of their impact on the outcomes. Unlike sensitivity analysis, probabilistic analysis allows for simulating an enormous number of variables at one time. The probabilistic analysis was conducted using RiskEase software to identify the risk posed by the selected variables, its scale, magnitude, and probability of occurrence on the project viability and sustainability from different perspectives.

8.2 Sensitivity Analysis

The critical risk variables that significantly affect the final outcomes were identified to examine the uncertainties surrounding each of these variables and their effect on the financial, economic, and stakeholder results. Risk variables were capital cost overrun, traffic overruns, base toll charged, exchange rate (EUR/FCFA), and euro inflation rate. Table 18 presents the results of sensitivity analysis.

Table 18: Sensitivity analysis results

Risk Variables	Base case of risk variables	Sensitivity test range	% change in FNPV	% change in ADSCR	% change in ENPV	% change in PV. Ext road users
Capital cost overrun	0.00%	(-20%)-(20%)	(132%) - (-132%)	(24%) - (-16%)	(4%) - (-4%)	N/A
Traffic overruns	0.00%	(-20%)-(20%)	(-192%) - (97%)	(-25%) - (18%)	(0.04%) - (-0.03%)	(7%) - (-5%)
Base toll charged	700	500-950	(-247%) - (343%)	(-36%) - (45%)	(0.05%) - (-0.07%)	(10%) - (-13%)
Exchange rate	656	469-890	(384%) - (-252%)	(51%) - (-33%)	(-0.07%) - (0.05%)	(15%) - (-10%)
Inflation rate -Euro	3.00%	(0%)-(6%)	(-87%) - (69%)	(-9%) - (10%)	(0.2%) - (-0.09%)	N/A

8.2.1 Capital cost overrun

Capital cost overrun is considered one of the main reasons that endanger the project's profitability, and in some cases, it goes beyond the implementation of projects. Delays in the construction phase, accrued interest during construction, and the increase in price levels are the main reasons that lead to investment cost overrun (Jenkins et al., 2019). Besides, the scale of the investment and the accountability are found to be contributing factors to investment cost escalations (Flyvbjerg et al., 2004). Capital expenditures for transportation infrastructure are very high; thus, any changes in these expenditures will significantly affect the project outcomes, such as increased capital costs which decreases the concessionaire returns. Table 18 shown that a rise in capital costs by 20% will decrease the FNPV by 132%, while reducing capital costs by 20% would increase the FNPV by the same percentage.

The contribution of equity owners for such PPPs is not enough for its implementation due to the high investment costs; thus, part of these costs must be financed by debt. Thereby, the impact of changing capital costs extends to affect the project's ability to meet its debt obligations and increase the required debt to be raised to meet the capital expenditures; thus, the project's ability to pay its obligation will decline. In the case of the proposed bridge, an increase in investment costs by 20% would decrease the minimum ADSCR by 16% to become 1.20x, while the decrease of costs by 20% would appreciate the minimum ADSCR by 24%.

Capital cost escalation will also increase the resources used to construct the bridge, which negatively affects the economy. The increase in capital costs by 20% will decrease the ENPV by 4%. In comparison, the reduction in these costs with the same percentage would increase the ENPV by 4%, thus positively affecting economic welfare by reducing the resources needed for the construction. Investment cost overrun does not affect the bridge users unless the toll charges increased to recover the increased capital costs.

8.2.2 Traffic overruns

The projection of traffic counts is not accurate as of the actual ones, which refers to several reasons, including the consumer's preferences, development of other competitive roads and bridges, and force majeure risks. (Skamris and Flyvbjerg,1997) found that 20%-60% of the traffic forecasts of transportation infrastructures tend to be overestimated, which leads decision-makers to take over-optimistic decisions. Also, the revenues generated from such projects are mainly dependent on the facility's traffics; thus, any deviation from the forecasted counts would dramatically affect the project outcomes.

Concessionaires are the main party affected by the changing traffic counts, the decrease in traffics would significantly affect returns accrued to project investors. The decline in the traffic counts by 20% would decrease the FNPV by 192%, while the increase in the number of counts by 20% would raise the FNPV by 97%.

As traffic counts decrease, the available net cash flow generated by the project to meet its debt will also decline; thus, the project's ability to meet its debt obligation will erode. When traffics decreases by 20%, the minimum ADSCR will fall by 25% to become 1.06x, and the increase of counts by 20% will increase the minimum ADSCR by 18%. The economy will not be affected by traffic counts as these traffics will exist either with the new bridge or other roads and bridges. However, the road users will benefit from the decrease traffic counts mainly due to increased traffic flows, thus time-saving and vehicle operating cost saving will also increase. When the traffic counts decrease by 20%, the PV of externalities will increase by 7%, while the increase of 20% will reduce the road users' benefits by 5%.

8.2.3 Base Toll Charged

The toll charged to bridge users poses a significant impact on the project outcomes, especially on the investor's returns. Tolls are the main sources of revenues to recover the capital, operating, and maintenance costs and yield a satisfactory ROR to project investors. Also, due to the correlation between tolls and traffic counts, any changes in tolls level will significantly affect the consumer's route choices. Therefore, any changes in tolls level will drastically affect the project stakeholders.

The highest impact resulting from tolls changes was on the project concessionaries, as reducing the toll charged by 200 FCFA would reduce the FNPV by 247% while increasing it by 250 will appreciate the FNPV 343%. Similarly, a positive relationship exists between the toll level and the minimum ADSCR. Decreasing the tolls by 200 FCFA would decrease the minimum ADSCR by 36% to become 0.91x, whereas increasing the tolls by 250 will increase the minimum ADSCR by 45%. The ENPV will increase by 0.05% when tolls are reduced by 200 FCFA, and it will decrease by 0.07% In the case of increasing tolls by 250 FCFA. Lastly, for our project's case, the PV of externalities accrued to bridge users and the toll charges are negatively correlated. The decrease of tolls by 200 will increase the PV of bridge users' externalities by 10%, while increasing it by 250 will decrease the bridge users' benefits by 13%.

8.2.4 Exchange Rate

A French SPV constructed the bridge project; thus, equity and debt contribution towards the investment costs were mainly obtained in euro currency. Additionally, materials used for the construction were imported from French-based companies. Thereby, the Euro/FCFA exchange rate changes will significantly affect the benefits to be realized by the project stakeholders. The decline in exchange rate by 187 FCFA/Euro would increase the FNPV by 348%, minimum ADSCR by 51%, and PV of externalities for road users by 15% while decreasing the ENPV 0.07%. On the contrary, increasing the exchange rate by 243 FCFA/Euro will reduce FNPV by 252%, minimum ADSCR by 33% to become 0.95x, PV of road users benefits by 10%, while increasing the ENPV by 0.05%.

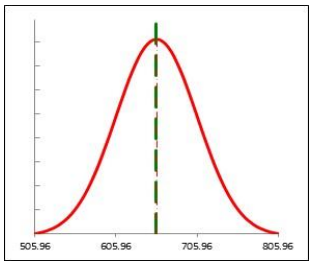
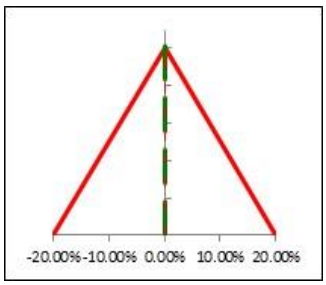
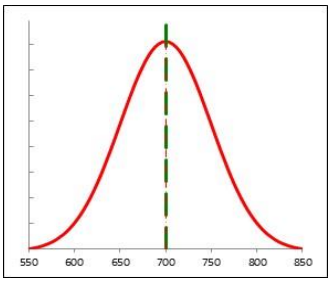
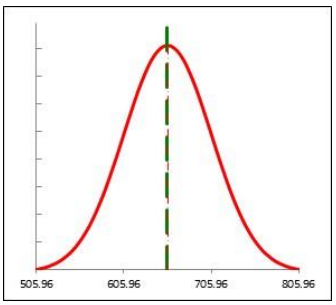
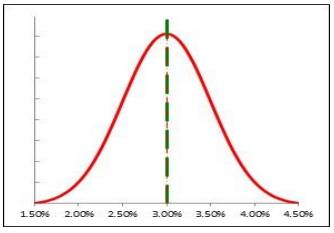
8.2.5 Euro inflation rate

Inflation is considered one of the crucial variables that need to be considered while estimating the costs and benefits during the project's life. The prices of imported material, labor wages, interest rates, revenues and operating and maintenance costs, etc., must all accounts for the inflation while estimating the net cashflows and benefits of the project. As the inflation rates decline by 3%, the FNPV will decrease by 87% and the minimum ADSCR by 9% to become 1.29, while the ENPV will increase by 0.2%. Conversely, when the inflation rate rises by 3%, the FNPV will increase by 69% and minimum ADSCR by 10%, while the ENPV will decline by 0.09%.

8.3 Results of the Risk Analysis

A RiskEase simulation was conducted consisting of 5000 trials on risk variables identified in the sensitivity analysis. The probability distributions of risk variables are presented in Table 19.

Table 19: Risk variables used in RiskEase simulation

Risk Variable	Type of distribution		Probability distribution range
Capital cost overrun	Normal		Min -50% Mean 0% Max 50%
Traffic overruns	Triangular		Min -20% Mean 0 Max 20%
Base toll charged	Normal		Min 550 Mean 700 Max 850
Exchange rate (EUR/FCFA)	Normal		Min 505.96 Mean 655.96 Max 805.96
Euro inflation rate	Normal		Min 1.5% Mean 3% Max 4.5%

8.3.1 Financial outcomes - concessionaire perspective

Figures 2 and 3 presents the cumulative distribution and frequency distribution for the concessionaire returns. The base case of FNPV was 13.8-million-euro, the cumulative distribution of FNPV shown that the average expected value of the FNPV was 14.2 million euros. The probability of obtaining a positive outcome was 74.5%, with a maximum value of 98.2 million euros, while the likelihood of negative outcomes was 25.5% with a minimum value of (-54.4) million euros.

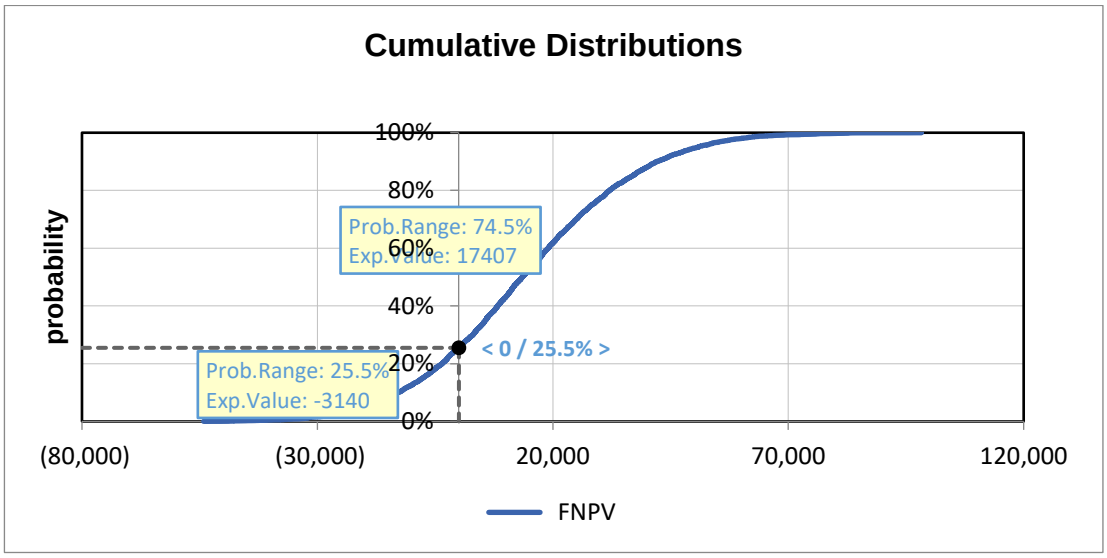


Figure 2: FNPV Cumulative Distribution

Figure 3 shows the frequency distribution of FIRR; the base case was 23.69%. The lowest possible value according to the simulations was 9.12%, and the highest was 66.20%. The expected mean value of FIRR probability distribution was 24.95%, which is above the projected base case of the deterministic analysis and the minimum required rate of return. The financial outcomes simulation showed that the mean values of the financial outcome were higher than its base case.

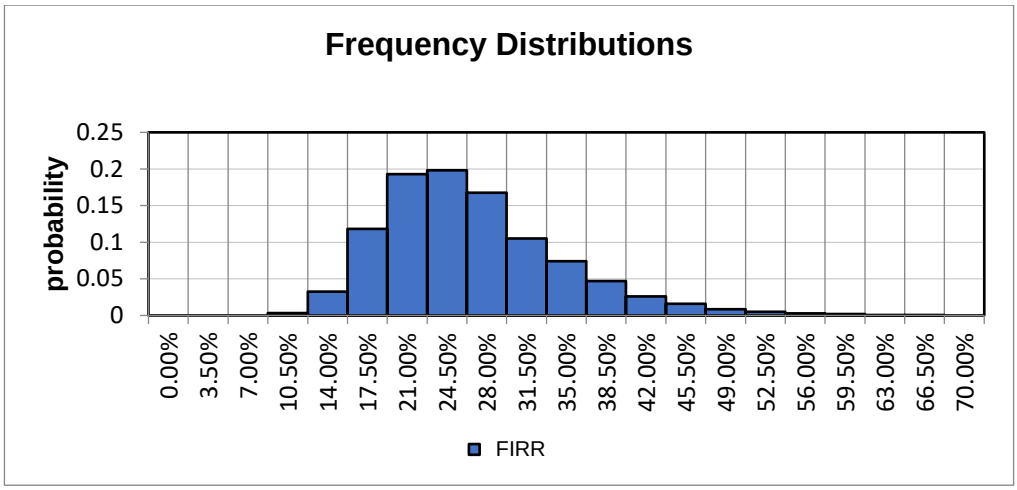


Figure 3: FIRR Frequency Distribution

8.3.2 Financial outcomes - Lenders perspective

Figure 4 presents the confidence range plot of the senior DSCRs, and the base case scenario showed that the project was able to meet its debt obligation. During the third and sixth year of operation, the ADSCR was fallen to 1.43x and 1.66x due to reopening the other comitative bridge. However, these values were quite satisfactory; the simulations showed the same pattern, as ADSCR for the third period was 1.47x and for the sixth period was 1.72x. Also, the average DSCR was 2.75x compared with the base case of 2.74x. The simulation results were above the base case seniors.

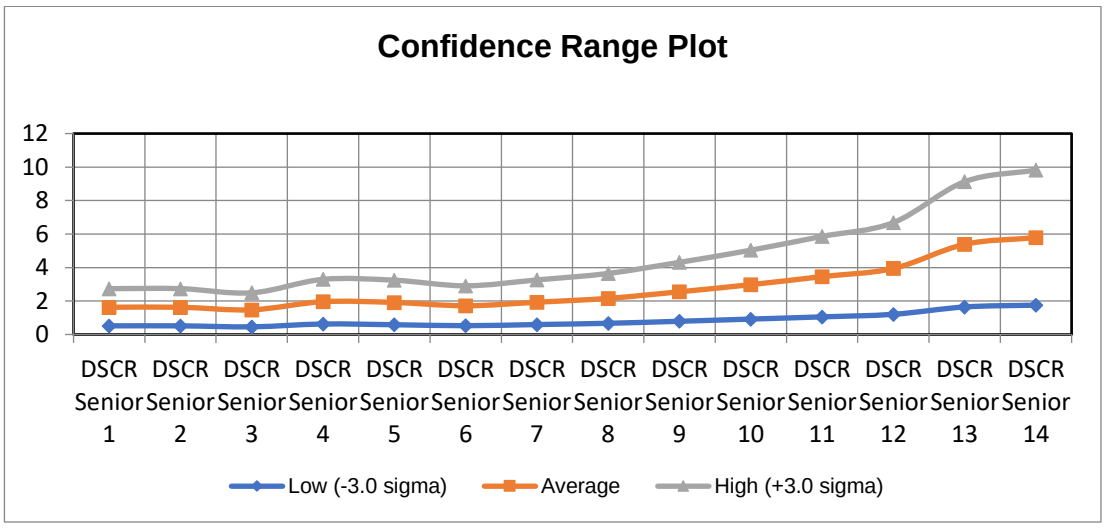


Figure 4: Senior ADSCR Plots

The ADSCR for subordinated debt exhibited a lower value based on its priority. The base case scenario indicated that the project was expected to face difficulties during the first few years of operation, with the lowest value of 1.05x in the third period. The simulations in figure 5 showed that the lowest value for ADSCR was for the third year of 1.09x and an average of 1.51, which is lower than the base case value of 1.89x. Although the results are very low, it is acceptable since the project generates enough cash flows in the previous and later years.

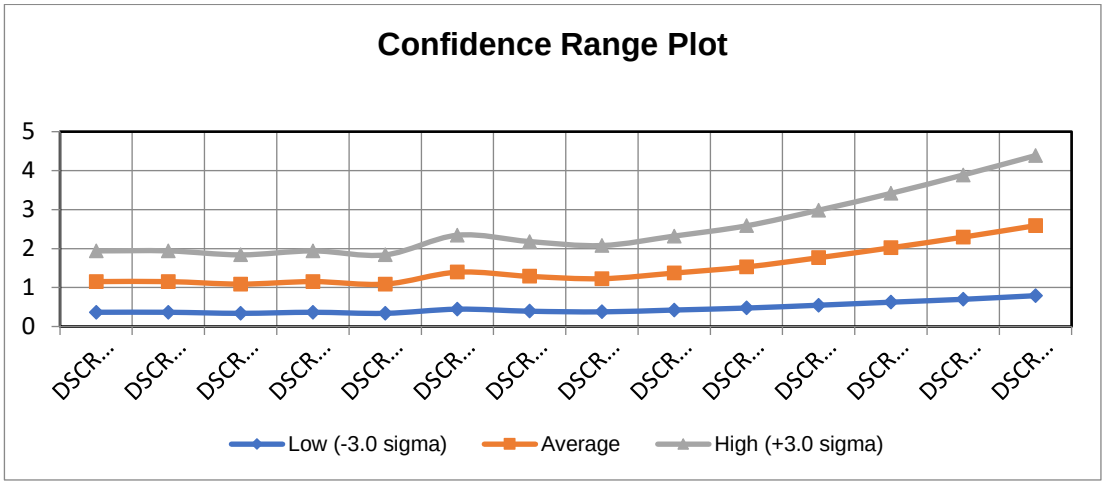


Figure 5: Subordinated ADSCR Plots

8.3.3 Economic outcomes

Figure 6 presents the cumulative distribution of the ENPV of the proposed bridge. The base case of the projected benefits accrued to the economy was 922.8 million euros. Interestingly, the risk analysis results show that the probability of negative outcome was zero in all of the cases; the ENPV is expected to be positive with an average expected value of 922.7 million euro and ranges between the minimum value of 821.5 million euro and a maximum of 1.02 billion euro. Thereby, in its worst situation, the Ivorian coast's economy will benefit from implementing the proposed bridge.

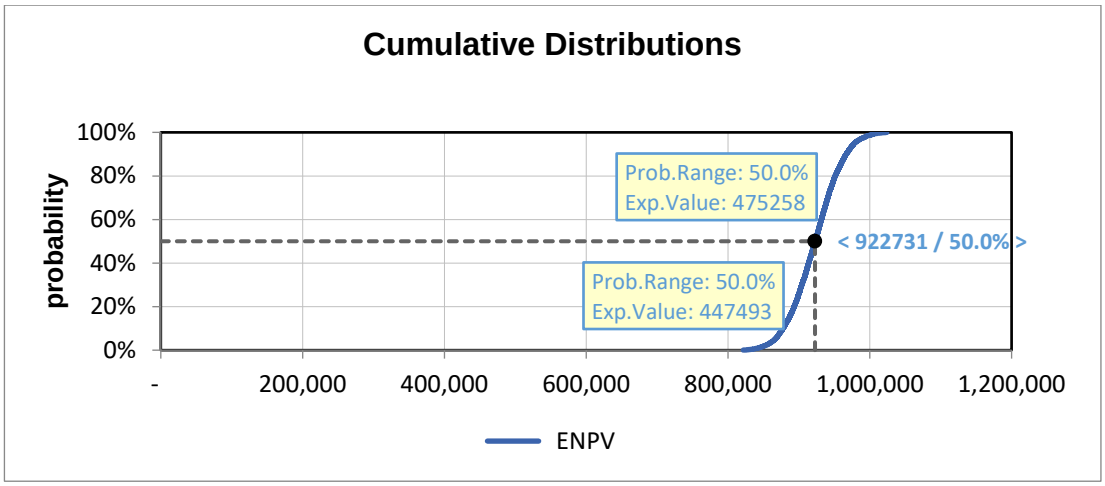


Figure 6: ENPV Cumulative Distribution

According to the frequency distribution of the EIIR presented in figure 7, the average expected mean value of EIRR was 31.22, which above the base case scenario of 30.92%. The simulation results also shown that the minimum value of 25.21% was above the EOCK, while the maximum value was 42.96%. Thereby, as indicated by the cumulative distribution of ENPV, the economy will benefit from implementing the project in all situations.

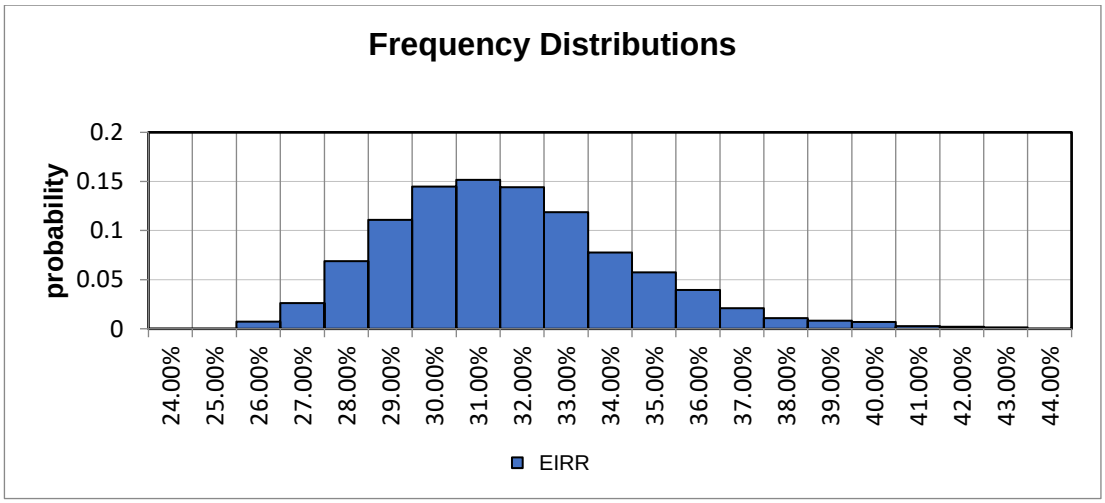


Figure 7: EIRR Frequency Distribution

8.3.4 Externalities outcomes

Figures 8 and 9 present the cumulative distribution of the externalities accrued by the government and project labor. The base case for government externalities was 95.7 million euros, close to the simulated average expected value of 96.04 million euros ranging between 66.3 and 128.4 million euros. Similarly, the base case for labor was 9.18 million euros with an average expected value of 9.19 million euros and ranged between the minimum and maximum values of 4.73 and 13.66 million euros.

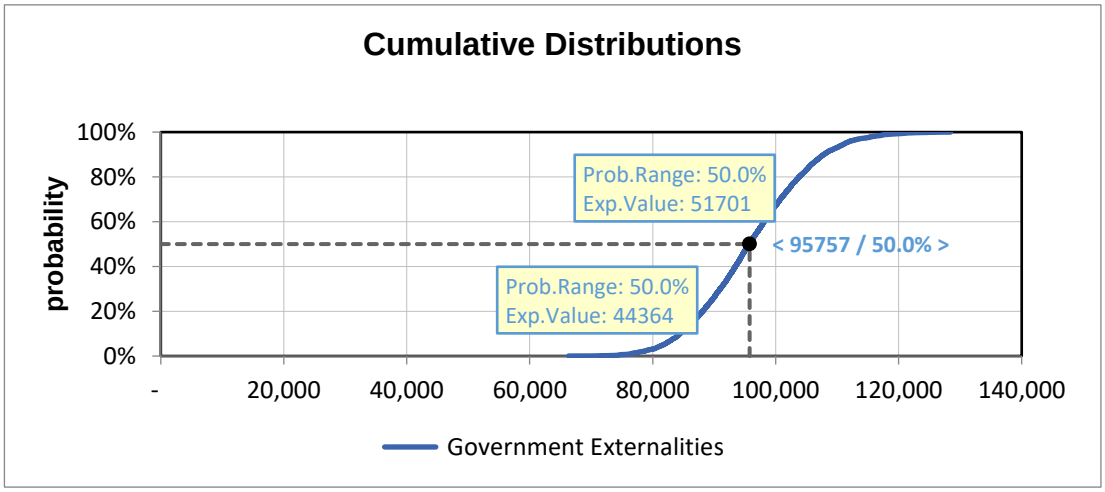


Figure 8: Cumulative Distribution- Government externalities

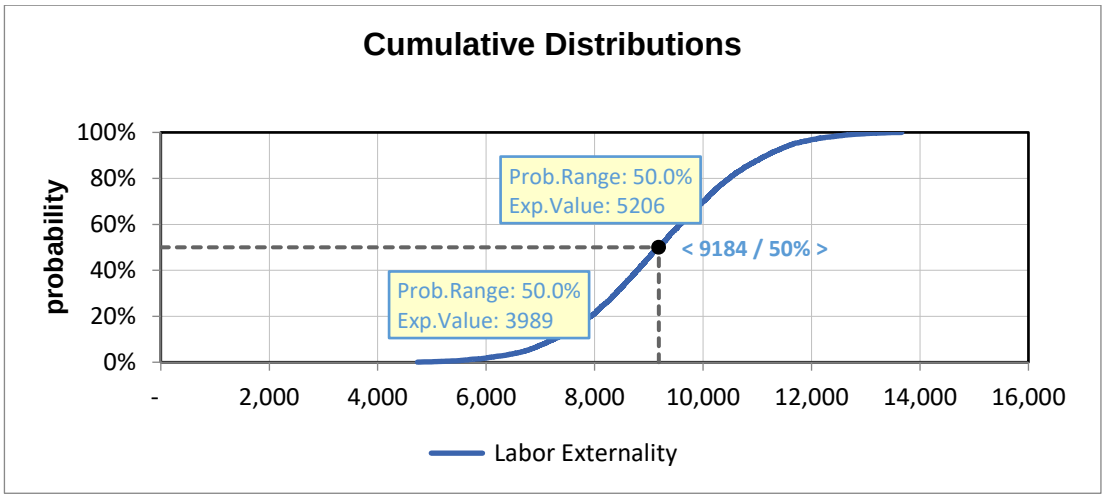


Figure 9: Cumulative Distribution - Labor externalities

Road users are the main beneficiaries who benefited from the project implementation; figures 10 and 11 present the frequency distribution for each category. The base value for cars 814.6 million euro while the simulated mean value was 813.64 and ranged between the minimum and maximum values of 697.3 and 890.8 million euro. On the other hand, the HGV base value was 50.04 million euros, and its expected mean value of 49.7 million euros and ranging between 21.7 and 68.4 million euros.

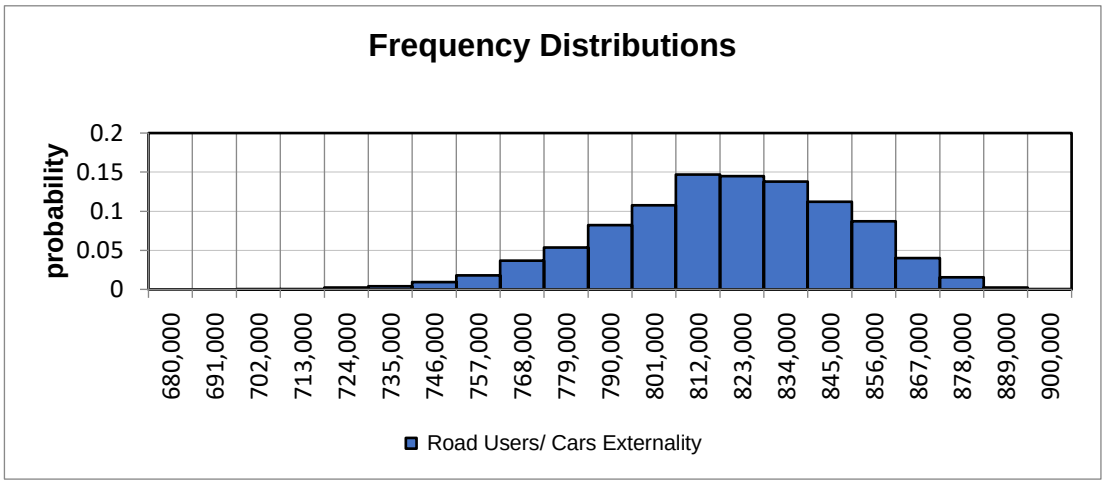


Figure 10: Frequency Distribution-Cars

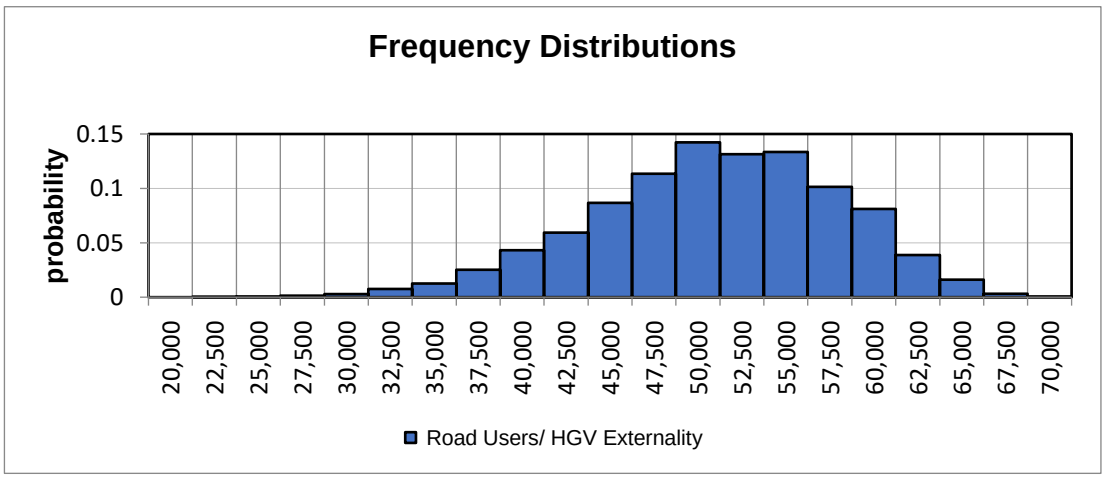


Figure 11: Frequency Distribution - HGV

Chapter 9

CONCLUSIONS

The analysis of the proposed Riviera - Marcory Bridge was conducted using the IIA approach, which enabled us to examine the project's overall potential from all related parties' perspectives, mainly (owners, lenders, the economy, and the users of the constructed facility). Hereafter, deterministic and probabilistic analyses were conducted and identified the different scenarios that may occur. Analysis Conclusions were as follow:

- According to the financial analysis, although the required ROR was very high, the results were quite satisfactory. The project is worthwhile from the concessionaire's point of view as the project ROR was above the required one with a positive NPV.
- As part of the project was financed by debt, the debt ratios revealed that although the project is expected to face difficulties paying its subordinated debts during the first few years, the project was able to generate sufficient cash flows that can cover the gap in case of any shortages.
- The economy of Ivory Coast was the major beneficiary from the project implementation, the economic analysis results have shown that the NPV of the benefits were enormous to the country as a whole
- After allocating the project externalities, the bridge users tend to benefit from the project from various aspects, thereby reducing the costs associated with their previous routes.

- According to the risk analysis results, the riskiest position was for the concessionaries with a 25% probability of loss. Lenders posed the second riskiest position, but the results showed that the project was able to meet its debt service obligation in all of the cases. The economy and users of the facility were the major beneficiaries, with 0% of getting negative outcomes.

The project seems to be attractive to all of its stakeholders, and the concessionaires were the highest risk-takers among all of the stakeholders, which explained by charging a high return to take the associated risk as the project seems attractive the most to the economy and its users due to the benefits generated.

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