UNIVERSIDAD PARA LA COOPERACION INTERNACIONAL
(UCI)

FEASIBILITY STUDY (SEA CUCUMBER AQUACULTURE AS AN ALTERNATIVE TO SHRIMP AQUACULTURE AT BEL-EURO AQUACULTURE LIMITED)

PIA GREGOIRE

FINAL GRADUATION PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
MASTER'S IN PROJECT MANAGEMENT (MPM) DEGREE

Belmopan, Belize

November 2017

UNIVERSIDAD PARA LA COOPERACION INTERNACIONAL
(UCI)

This Final Graduation Project was approved by the University as partial fulfillment of the requirements to opt for the Master in Project Management (MPM) Degree

_____
Carlos Herrera
TUTOR

_____
Eneida del Socorro Góngora Sánchez
REVIEWER No.1

_____
Ruben Alzate
REVIEWER No.2

_____
Pia Gregoire
STUDENT

DEDICATION

I dedicate this project to my mother whose sacrifices, have allowed me to reach this educational milestone. To my brother, for his unconditional love and support during the pivotal years of my educational development.

ACKNOWLEDGMENTS

This project would not have been possible without God who is the source of my strength. I would also like to acknowledge a few individuals and organizations who were instrumental in helping me to bring this project to fruition: My confidant, George Vernon, for always pushing me on the days I lacked motivation. My classmates, Tracey Recinos, Manuel Matus and Keyron Flowers for their support throughout the duration of the program. The University of International Cooperation (UCI), my tutor, Mr. Carlos Herrera, and Academic Assistants, Gabriela Zuniga and Sofia Gomez, for their responsiveness to my inquiries. The University of Belize Environmental Research Institute (UB ERI) and my colleagues at the institute for their unwavering support. I thank Dr. Arlenie Rogers for her guidance, Mr. Kwame Reynolds and Mr. John Sansone for providing information about the aquaculture operations at Bel-Euro Aquaculture Ltd. Lastly, I extend my gratitude to Ms. Ethnelda Paulino for reviewing this document.

INDEX OF CONTENTS

INDEX OF FIGURES

INDEX OF CHARTS

ABBREVIATIONS AND ACRONYMS

BAHA	Belize Agricultural Health Authority
CARICOM	Caribbean Community
CCFS	Calabash Caye Field Station
DOE	Department of the Environment
ECP	Environmental Compliance Plan
EIA	Environmental Impact Assessment
EU	European Union
EVM	Earned Value Management
GDP	Gross Domestic Product
HACCP	Hazard Analysis and Critical Control Points
MMT	Million Metric Tons
MPM	Master in Project Management
NEAC	National Environmental Appraisal Committee
NPV	Net Present Value
PDCA	Plan Do Check Act
PDM	Precedence Diagramming Method
SIB	Statistical Institute of Belize
SMEs	Subject Matter Experts
TOR	Terms of Reference
UB	University of Belize
UB ERI	University of Belize Environmental Research Institute
UCI	Universidad para la Cooperación Internacional/University of International Cooperation
USA	United States of America
WBS	Work Breakdown Structure

EXECUTIVE SUMMARY (ABSTRACT)

Shrimp export contributed over BZ$80million to Belize's economy up until the outbreak of disease in 2015. The disease forced shrimp farmers to empty their ponds and start over. At the same time, the sea cucumber industry grew.

Belize's lead sea cucumber researcher and marine research fellow at the University of Belize Environmental Research Institute (UB ERI) conducted several studies on sea cucumber since her research began in 2011. Her research forms part of UB ERI's mission to build national scientific capacity in Belize for sustainable development. In 2016, Dr. Rogers was able to bridge the gap between her research and the shrimp industry by providing stakeholders in the shrimp industry with an opportunity to explore sea cucumber as an alternative to shrimp.

One local shrimp farm, Bel-Euro Aquaculture Limited, took up the opportunity. Bel-Euro sponsored Dr. Rogers' research at a cost of approximately BZ$25,000 in the hope that her work could successfully rare and harvest sea cucumbers in former shrimp ponds. Though Bel-Euro invested significantly in the exploration of sea cucumber aquaculture, the research project lacked a feasibility study to determine the viability of this alternative.

This project therefore sought to develop a feasibility study to determine the viability of sea cucumber aquaculture as an alternative to shrimp aquaculture by employing the project management methodologies. The methodologies for project integration, scope, quality, communications, risk, time, cost and stakeholder management were applied to successfully plan, execute, monitor and control, and close the project. The findings of the study also served to support stakeholder decision-making for further investment in the exploration of sea cucumber aquaculture.

The general objective of the project was to conduct a feasibility study to determine the viability of sea cucumber aquaculture as an alternative to shrimp at Bel-Euro Aquaculture Ltd. The specific objectives were to develop a project management plan to define the execution, monitoring and control processes for the feasibility study; to conduct a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity; and a legal analysis to determine whether there were any legal requirements for sea cucumber aquaculture. An economic analysis was completed to determine whether sea cucumber provided economic benefits to the country. An assessment of the environmental issues related to this study was to determine whether sea cucumber aquaculture would comply with local environmental policies and a financial analysis to determine whether sea cucumber aquaculture was a viable investment for local shrimp farms. Operations and management analysis to determine whether local shrimp farms possessed the capacity for successful sea cucumber aquaculture were also completed. Risk analysis to identify all the associated risks was completed. Risks that could impact the viability of sea cucumber as an alternative to shrimp were considered. Finally, conclusions and recommendations were made based on insights in the study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.

The analytical, quantitative and qualitative methodologies were the approaches used to gather and analyze information from both primary and secondary sources.

Interviews, peer-reviewed journals, online articles, websites, and organizational reports supported the development of the specific objectives for this study.
The project management processes supported the definition of project and scope and the successful completion of the project within the constraints of its scope, time and cost. The study showed that sea cucumber was not a viable alternative to shrimp aquaculture in the short-term, particularly because the investment costs pose a significant barrier to entry for the already cash-strapped shrimp farm, and length of time required to realize a profit. Several recommendations put forward for Bel-Euro sought to further this study and the sustainable development of aquaculture industry in Belize.

INTRODUCTION

1.1. Background

The University of Belize Environmental Research Institute (UB ERI) is the first nationally owned and managed research institute in Belize (University of Belize Environmental Research Institute, n.d.). In line with its mission, the institute conducts scientific research for the conservation of natural resources and the sustainable development of Belize (University of Belize Environmental Research Institute, n.d.). As a result, the institute's marine research fellow, Dr. Arlenie Rogers, has become widely known locally for her sea cucumber research (University of Belize Environmental Research Institute, n.d.). Dr. Rogers has authored and co-authored the following publications since her research began in 2011 (University of Belize Environmental Research Institute, n.d.). The Socioeconomic study of the sea cucumber fishery in Belize; Density, abundance and distribution of harvested sea cucumbers in Belize (*H. mexicana and I. badionotus*); Reproductive cycle of *H. mexicana* in Belize and Conversion factor study for *H. mexicana* in Belize among others (A. Rogers, personal communication, November 4, 2017). In one of her co-authored publications, Dr. Rogers explained that the sea cucumber fishery officially opened in 2009 (Perez & Garcia, 2012). Fishers catch the species in the wild and take them to suppliers for processing (cooking, salting and drying) before distribution to the local and international market (Perez & Garcia, 2012). Sea cucumber is popular in the Asian market where it is a delicacy and is used in the production of pharmaceuticals and cosmetics (Perez & Garcia, 2012).

1.2. Statement of the problem

In 2015, all shrimp farms in Belize suffered substantial losses due to an outbreak of a shrimp disease called Early Mortality Syndrome (A. Rogers, personal communication, November 18, 2017; 7 News Belize, 2017). The industry contributed millions of dollars to the country's Gross Domestic

Product (GDP), therefore, the decline in shrimp production and export had a significant impact on the economy (7 News Belize, 2016). On the other hand, the demand for sea cucumber grew, particularly in the Asian market (Perez & Garcia, 2012). This growth led to a general decline in the wild species due to overfishing; making it difficult to meet export demand (Rogers, Hamel, Baker, & Mercier, 2018).

In 2016, Dr. Rogers took the opportunity to meet with stakeholders in the shrimp and sea cucumber industry to discuss the sea cucumber fishery (University of Belize Environmental Research Institute, 2016). This resulted in a collaboration with local shrimp farms to explore the potential for sea cucumber aquaculture (A. Rogers, personal communication, November 18, 2017). The collaboration has included visits to aquaculture facilities in Mexico and a partnership with Bel-Euro Aquaculture Limited that allows Dr. Rogers to further her research while Bel-Euro explores this option (University of Belize Environmental Research Institute, 2017; A. Rogers, personal communication, November 18, 2017). Dr. Rogers developed an approximately BZ$25,000 research plan for this purpose; however, there is no supporting feasibility study (A. Rogers, personal communication, November 18, 2017).

This project is therefore vital before any additional investments in sea cucumber aquaculture. The project provides the mechanisms for successfully conducting this study as well as a sound basis for decision-making through the application of project management best practices. The methodology provides structure for the process that will help ensure a timely quality study.

1.3. Purpose

The purpose of this project is to conduct a feasibility study using project management processes to plan, execute, monitor and control, and close the project. It will include the methodologies for project integration, scope, quality, communications, risk, time, cost and stakeholder management to ensure its successful completion.

Bel-Euro's collaboration with Dr. Rogers includes a three-year research plan over the period 2016 to 2019. (A. Rogers, personal communication, November 18, 2017). The goal of the plan is to study the culture of two species of sea cucumber, the *H. mexicana* and *I. badionotus* with the objective to rear and harvest these species in former shrimp ponds (A. Rogers, personal communication, November 18, 2017).

The feasibility study will investigate: whether there is a market for sea cucumber that would allow it to be as profitable as shrimp; whether there are any legal barriers; evaluate the economic benefits, and assess any environmental issues associated with sea cucumber aquaculture. It will also look at the financial capacity of shrimp farms, its operations and management, and assess the risk factors associated with this venture. Finally, conclusions and recommendations based on the various analysis will help to determine the shrimp farm's decision to invest or not.

Given that sea cucumber is a viable alternative, Bel-Euro can circumvent their losses from shrimp diseases and be rest assured that any investments in sea cucumber would be worthwhile. This would also be beneficial to the economy, the furtherance of Dr. Rogers' research, and UB ERI, as it allows the institute to realize its mission to build scientific capacity for the sustainable development of Belize.

1.4. General objective

To conduct a feasibility study to determine the viability of sea cucumber aquaculture as an alternative to shrimp aquaculture at Bel-Euro Aquaculture Limited.

1.5. Specific objectives

1. To develop a project management plan to define the execution, monitoring and control processes for the feasibility study.
2. To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity.
3. To perform a legal analysis to determine whether there are any legal requirements for sea cucumber aquaculture.
4. To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.
5. To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.
6. To perform a financial analysis to determine whether sea cucumber aquaculture would be a viable investment for local shrimp farms.
7. To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.
8. To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an alternative to shrimp.
9. To provide conclusions and recommendations based on insights in the study to support stakeholder’s decision on whether to pursue sea cucumber aquaculture.

THEORETICAL FRAMEWORK

Company/Enterprise framework

Company/Enterprise background

UB ERI is a semi-autonomous department of the University of Belize (UB) (University of Belize Environmental Research Institute, n.d). It operates largely under the policies and procedures set out by the university, and is governed by a steering committee, which includes representatives from UB's upper management (University of Belize Environmental Research Institute, n.d.).

The institute's three (3) core programs include research and monitoring, training and fellowships, and communication and outreach (University of Belize Environmental Research Institute, 2017). Under these programs, UB ERI executes several projects and manages the university's marine field station, the Calabash Caye Field Station (CCFS), all with the financial support of the university, grant funding and partnerships (University of Belize Environmental Research Institute, 2014). Through its programs and projects, UB ERI has produced several peer-reviewed journal publications, an annual marine ecosystem health report, a national research agenda, and a conservation action plan for Belize's Central Belize Corridor among others, which help to inform decision-making at the national level (University of Belize Environmental Research Institute, n.d.). In addition, the institute provides several volunteer, studentship and internship opportunities for both local and international students and offer training to local Non-Governmental Organizations (NGOs) and public-sector personnel in areas relevant to sustainable development (University of Belize Environmental Research Institute, n.d.).

As marine research fellow, Dr. Arlenie Rogers' work falls under the institute's training and fellowships program (University of Belize Environmental Research Institute, 2014). Dr. Rogers is one of two fellows at the institute, the other being Dr. Bart Harmsen whose research focuses on jaguars and their preys (University of Belize Environmental Research Institute, 2014). Dr. Rogers has been able to

bridge the gap between her work and private sector needs, out of which produced the need for this project (A. Rogers, personal communication, November 15, 2017).

Mission and vision statements

Mission statement: “The University of Belize Environmental Research Institute continuously builds national scientific capacity for the effective management, sustainable use and conservation of Belize’s natural resources” (University of Belize Environmental Research Institute, 2014).

The feasibility study that this project seeks to develop is in line with the institute’s mission to build capacity for the conservation of Belize’s natural resources. It achieves this in two ways: Firstly, the transfer of Dr. Rogers’ research and expertise to local shrimp farms to allow them to harvest sea cucumbers; secondly, it fosters the conservation of the species in the wild given its decline due to over-fishing (Rogers et al., 2018).

Vision statement: “As the premiere Environmental Research Institute in Belize and highly respected in the region, UB ERI provides sound science and creates a culture of evidence-based decision–making in the public and private sector in areas relevant to sustainable development” (University of Belize Environmental Research Institute, 2014).

Through a successful feasibility study, the benefits of Dr. Rogers’ research can go beyond the shrimp farms and contribute to Belize’s economy if it is determined that sea cucumber is a viable alternative to shrimp. This will build on Dr. Rogers’ and UB ERI’s credibility and allow the institute to fulfill its vision of becoming highly respected regionally. It will also foster a culture of evidence-based decision-making.

Organizational structure

UB ERI's organizational structure (see Figure 1) shows that the institute is a department of UB and ultimately reports to the university through its steering committee. The institute comprises of twenty-one (21) core staff plus additional staff stationed at the CCFS. There are two (2) directors, one of which also serves as the institute's Administrative Director (University of Belize Environmental Research Institute, 2014). Dr. Rogers' sea cucumber research is under the supervision of the institute's marine science director.

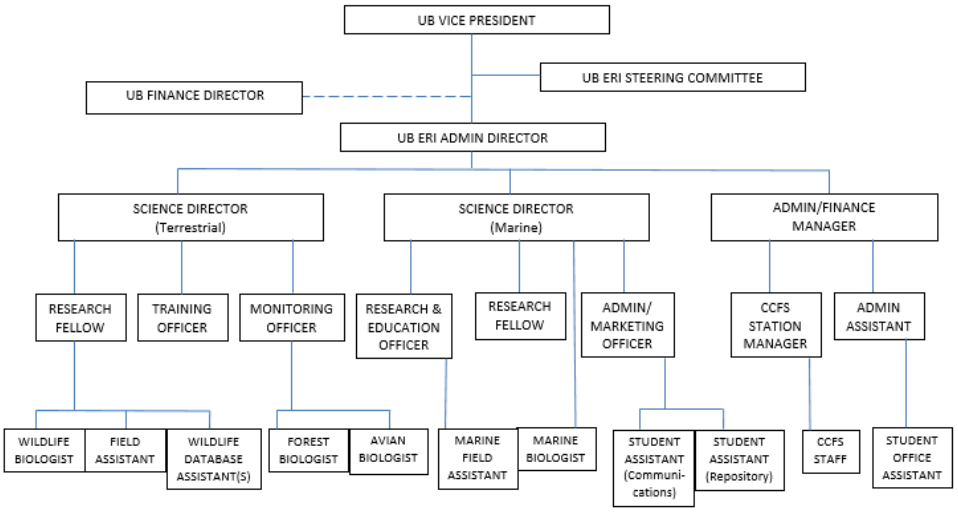


Figure 1 Organizational structure (Source: J. Lopez, personal communication, June 13, 2017; Author 2018)

Products offered

UB ERI, through its research programs and corresponding projects, produces peer-reviewed journal publications, technical reports and graduate projects/thesis (University of Belize Environmental Research Institute, n.d.). The institute also produces trained students through internships, volunteer opportunities, studentships, as well as trained personnel in the natural resource management sector (University of Belize Environmental Research Institute , n.d.).

Project Management concepts

Project

A project is “a temporary endeavor undertaken to create a unique product, service, or result” (Project Management Institute, 2013, p. 1). This project seeks to plan and implement a feasibility study. The study is a project due to its temporary nature; it begins on May 6, 2018 and ends on June 5, 2018. It will produce a unique product in the form of a document analyzing the feasibility of sea cucumber aquaculture as an alternative to shrimp aquaculture at Bel-Euro. The result is the determination of the viability of sea cucumber as an alternative to shrimp. This determination will support decision-making for future investments in sea cucumber aquaculture.

Project management

Project management is “the application of knowledge, skills, tools, and techniques to project activities to meet project requirements” (Project Management Institute, 2013, p. 5). Tools and techniques, and the skills of the project team support the development of each of the knowledge areas. The application of the project management knowledge, skills, tools and techniques to the development of the feasibility study will therefore increase the likelihood that the project will realize its objectives.

Project life cycle

Typically, projects include subdivisions into phases from start to close (Project Management Institute, 2013). These phases can vary from project to project; however, they are generally project initiation, planning, execution and closing (Project Management Institute, 2013). Together, these phases form the project’s life cycle shown in Figure 2 below (Project Management Institute, 2013):

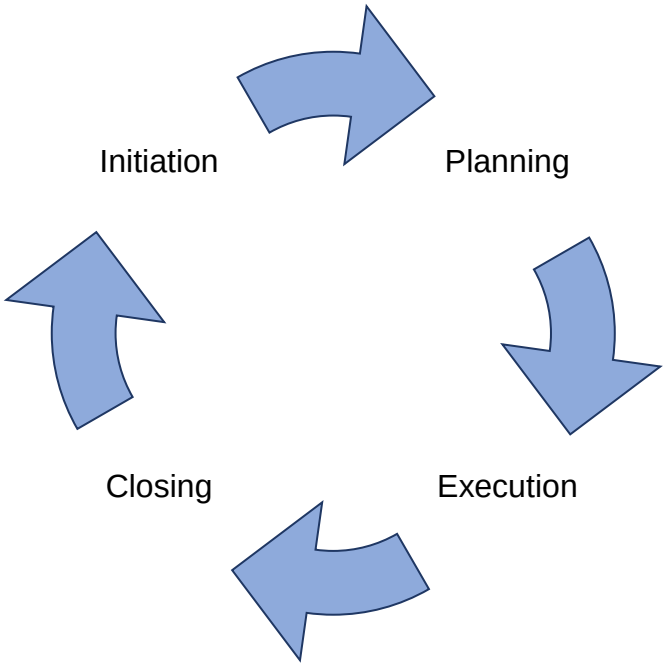


Figure 2 Generic Project Life Cycle (Source: Author, 2017)

Figure 3 shows how each phase is typically developed over time and the expected output. The start or initiation phase is the creation of a project charter. During the planning or preparation phase, a project management plan is developed. The execution phase involves the market, legal, economic, financial, environmental, operational and managerial, and risk factors analysis, followed by conclusions and recommendations. Finally, the project closes with the submission of the final document.

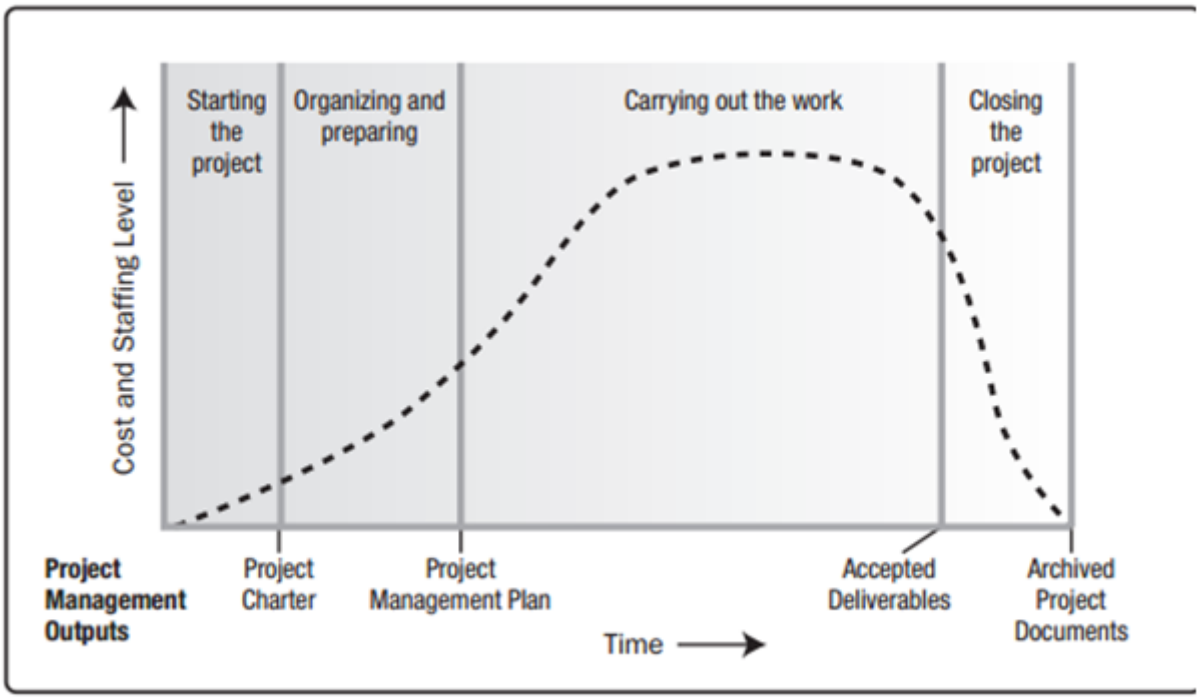


Figure 3 Generic Project Life Cycle Structure (Source: Project Management Institute, 2013)

Project management processes

A process is "a set of interrelated actions and activities performed to create a pre-specified product, service, or result" (Project Management Institute, 2013, p. 47). In the project management discipline, there are 47 processes which span across the five (5) process groups and work together to support the flow of the project throughout its life cycle (Project Management Institute, 2013). Therefore, each phase consists of its own processes. Figure 4 illustrates the typical project management processes:

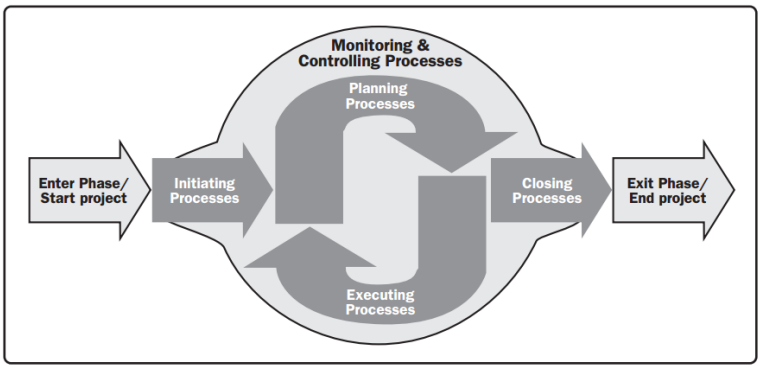


Figure 4 Project management processes (Source: Project Management Institute, 2013)

The feasibility study forms part of the initiation process group, since it helps to determine whether there will be any future sea cucumber aquaculture projects. However, the five (5) process groups and its sub-processes will support the development and implementation of the study.

Project management knowledge areas

According to the Project Management Institute, “a Knowledge Area represents a complete set of concepts, terms, and activities that make up a professional field, project management field, or area of specialization” (Project Management Institute, 2013, p.60). There are ten (10) knowledge areas, namely, Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Project Human Resource Management, Project Communications Management, Project Risk Management, Project Procurement Management and Project Stakeholder Management (Project Management Institute, 2013). These knowledge areas and its processes span across the five (5) project management process groups as shown in the chart below:

Chart 1 Project Management Knowledge Areas (Source: Project Management Institute, 2013)

Knowledge Areas	Project Management Process Groups				
	Initiating Process Group	**Planning Process Group**	**Executing Process Group**	**Monitoring and Controlling Process Group**	**Closing Process Group**
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan	4.3 Direct and Manage Project Work	4.4 Monitor and Control Project Work 4.5 Perform Integrated Change Control	4.6 Close Project or Phase
5. Project Scope Management		5.1 Plan Scope Management 5.2 Collect Requirements 5.3 Define Scope 5.4 Create WBS		5.5 Validate Scope 5.6 Control Scope	
6. Project Time Management		6.1 Plan Schedule Management 6.2 Define Activities 6.3 Sequence Activities 6.4 Estimate Activity Resources 6.5 Estimate Activity Durations 6.6 Develop Schedule		6.7 Control Schedule	
7. Project Cost Management		7.1 Plan Cost Management 7.2 Estimate Costs 7.3 Determine Budget		7.4 Control Costs	
8. Project Quality Management		8.1 Plan Quality Management	8.2 Perform Quality Assurance	8.3 Control Quality	
9. Project Human Resource Management		9.1 Plan Human Resource Management	9.2 Acquire Project Team 9.3 Develop Project Team 9.4 Manage Project Team		
10. Project Communications Management		10.1 Plan Communications Management	10.2 Manage Communications	10.3 Control Communications	
11. Project Risk Management		11.1 Plan Risk Management 11.2 Identify Risks 11.3 Perform Qualitative Risk Analysis 11.4 Perform Quantitative Risk Analysis 11.5 Plan Risk Responses		11.6 Control Risks	
12. Project Procurement Management		12.1 Plan Procurement Management	12.2 Conduct Procurements	12.3 Control Procurements	12.4 Close Procurements
13. Project Stakeholder Management	13.1 Identify Stakeholders	13.2 Plan Stakeholder Management	13.3 Manage Stakeholder Engagement	13.4 Control Stakeholder Engagement	

The application of these knowledge areas is dependent on the project and industry (Project Management Institute, 2013). In the case of this feasibility study, Project Integration Management, Scope Management, Time Management, Cost Management, Quality Management, Stakeholder Management, Communications Management and Risk Management apply. Integration management will ensure the successful management of the project including all its components. Scope management will help ensure that the feasibility study accomplishes what it intends to (Project Management Institute, 2013). Time management ensures a timely project completion; cost management ensures completion within budget; quality management ensures that the study meets stakeholder satisfaction; stakeholder management ensures identification and engagement of all relevant stakeholder; communications management supports the flow of information to stakeholders; and risk management ensures identification and mitigation of project risks (Project Management Institute, 2013).

Other applicable theory/concepts related to the project topic and context

2.3.1 Feasibility Study

A feasibility study refers to the analysis of the viability of an idea (Wollfe, 2017). This is determined by answering the question: “Will the idea work and should one proceed with it?” (Wollfe, 2017). This is the question answered by the feasibility study prior to any investments in developing and implementing a project (Collins, 2014). Therefore, feasibility studies are integral pre-project activities and considered a project in itself (Collins, 2014). This is the case with this project, which analyzes the viability of sea cucumber as an alternative to shrimp aquaculture. The results of the study will provide a basis for a “go” or “no go” decision on whether to invest in sea cucumber aquaculture projects. Given that the study reveals that sea cucumber is a viable alternative, it will support the justification for future projects in the project charter.

METHODOLOGICAL FRAMEWORK

Information sources

Information sources are where we obtain knowledge from (Edinburgh Napier University, n.d.). These sources can be in the form of print, electronic or audio visual and come from books, websites, reports or people (Edinburgh Napier University , n.d.).

For this project, electronic, print and personal communication will be the sources of information. The feasibility study will require the analyses of various factors including the market, legal, economic, environmental, financial, operational and managerial, and risks through information gathered from these sources.

Primary sources

Primary sources are “original sources on which other research is based” (Yale University Library, 2017). This information includes non-reproduced firsthand experiences, original thought and material (Library of Congress, n.d.).

The primary sources for this project are Dr. Rogers’ peer-reviewed journals, technical reports, interviews and emails from stakeholders, proceedings from meetings, websites, surveys, organizational reports and government publications and statistics.

Secondary sources

Secondary sources are “accounts written after the fact with the benefit of hindsight” (Yale University Library, 2017). These sources are generally an analysis and interpretation of primary sources (The Regents of the University of California , 2017).

In the development of this project, secondary sources will include online news articles, books and blogs.

Chart 2 Information sources (Source: Author, 2017)

Objectives	Information sources	
	Primary	Secondary
To develop a project management plan to define the execution, monitoring and control processes for the feasibility study.	Interviews, email, personal communication and organizational reports.	Textbooks, websites, blogs and Master in Project Management (MPM) course notes.
To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity.	Market survey, interviews and email communication.	Textbooks, websites, blogs, news articles and MPM course notes.
To perform a legal analysis to determine whether there are any legal requirements for sea cucumber aquaculture.	Interviews and email communication.	Government reports, organizational reports, textbooks, websites, blogs, news articles and MPM course notes.
To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.	Interviews, email communication and peer-reviewed journals.	Government statistics, substantive and subsidiary legislation, textbooks, websites, blogs, news articles and MPM course notes.

To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.	Interviews, email communication and peer-reviewed journals.	Government reports, substantive and subsidiary legislation, organizational reports, textbooks, websites, blogs, news articles and MPM course notes.
To perform a financial analysis to determine whether sea cucumber aquaculture would be a viable investment for local shrimp farms.	Interviews, email communication and peer-reviewed journals.	Organizational reports, textbooks, websites, blogs, news articles and MPM course notes.
To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.	Interviews, email communication and peer-reviewed journals.	Organizational reports, textbooks, websites, blogs, news articles and MPM course notes.
To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an alternative to shrimp.	Interviews, email communication and peer-reviewed journals.	Textbooks, websites, blogs and organizational reports.
To provide conclusions and recommendations based on insights in the	Interviews and email communication.	Textbooks, websites, blogs

study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.		

Research methods

Research methods is "a particular way of studying something in order to discover new information about it or understand it better" (Cambridge University Press, 2017). For this project, the methods will be analytical, qualitative and quantitative.

Analytical method

The analytical research method involves the analysis of data for translation into meaningful information to answer the research question (California State University, n.d.). It involves critical thinking to determine why events have occurred (California State University, n.d.). The analytical method will assist with the identification of potential problems based on the data collected during the feasibility study.

Qualitative method

The qualitative method involves the exploration and analysis of non-numerical data for discovering problems and answering research questions (O'Neil, 2015). It includes observations, interviews, focus groups and document studies (O'Neil, 2015). Document studies use existing information as the basis for research, and includes public and personal documents such annual reports, blogs, newsletters, census data, journals and personal blogs (O'Neil, 2015).

Quantitative method

According to O'Neil (2015), qualitative research involves the numerical analysis of data through tools such as surveys.

Chart 3 Research methods (Source: Author, 2017)

Objectives	**Research methods**		
	Analytical method	Qualitative method	Quantitative method
To develop a project management plan to define the execution, monitoring and control processes for the feasibility study.		Analysis of textbook content and online articles will be used as the basis for the development of the project management plan.	
To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity.	The analytic method will be applied in the analysis of raw data in relation the market study.	The use of qualitative techniques such as interviews, email and personal communication will be used to conduct a market analysis.	The analysis of existing quantitative data will used to conduct the market analysis for project.
To perform a legal analysis to determine whether there are any legal requirements for	The analytic method will be used to analyze information	The use of online resources, organizational documents	

sea cucumber aquaculture.	gathered to determine whether sea cucumber would meet legal requirements.	interviews will be used to determine the legal requirements for sea cucumber aquaculture.	
To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.	The analytic method will be used to analyze information gathered to determine whether there are economic benefits of sea cucumber.	The analysis of textbook content, email communication and online resources will be used to perform an economic analysis.	The collection and analysis of existing economic statistics will be to perform an economic analysis.
To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.	The analytic method will be applied in the analysis of findings to determine whether sea cucumber aquaculture will comply with environmental policies.	The analysis of organizational documents, textbook content and online resources will be used to perform an environmental assessment of sea cucumber aquaculture.	
To perform a financial analysis to determine whether sea cucumber	The analytical method will be applied in the	The analysis of organizational documents,	The analysis of existing quantitative

aquaculture would be a viable investment for local shrimp farms.	analysis of information gathered to determine whether sea cucumber aquaculture would be a viable investment for local shrimp farms	interviews and online resources will be used to perform a financial analysis.	data will used to perform financial analyses for the project.
To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.	The analytical method will be used to draw meaningful information from the data collected to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.	Qualitative research techniques such as interviews, observation, organizational documents and online resources will be used to perform an operations and management analysis.	
To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an alternative to	The analytical techniques will be used analyze the information gathered to determine	Textbook content, organizational documents and interviews will be to gather information to	

shrimp.	whether there any risks which would impact the viability of sea cucumber aquaculture.	perform a risk analysis.	
To provide conclusions and recommendations based on insights in the study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.	The analytical method will be used to arrive at objective conclusions and recommendations by considering the project's components.	The use of online resources will support the development of the project's conclusions and recommendations.	

Tools

In the project management discipline, a tool refers to "something tangible, such as a template or software program, used in performing an activity to produce a product or result" (Project Management Institute, 2013, p.565). The tools for this project include Microsoft Project, templates, organizational documents, research publications, email and sample reports. The project's specific objectives and corresponding tools are in the chart 4 below:

Chart 4 Tools (Source: Author, 2017)

Objectives	Tools
To develop a project management plan to define the execution, monitoring and control processes for the feasibility	Templates, Microsoft Project 2016, email, organizational documents and sample reports.

study.	
To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity.	Templates, email, research publications, and sample reports.
To perform a legal analysis to determine whether there are any legal requirements for sea cucumber aquaculture.	Templates, email, research publications, and sample reports.
To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.	Templates, email, research publications, and sample reports.
To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.	Templates, email, research publications, organizational documents, and sample reports.
To perform a financial analysis to determine whether sea cucumber aquaculture would be a viable investment for local shrimp farms.	Templates, email, research publications, and sample reports.
To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.	Templates, email, research publications, and sample reports.
To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an	Templates, email, research publications, and sample reports.

alternative to shrimp.	
To provide conclusions and recommendations based on insights in the study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.	Sample feasibility study conclusions and recommendations.

Assumptions and constraints

According to the Project Management Institute (2013), an assumption is "a factor in the planning process that is considered to be true, real, or certain, without proof or demonstration" (p.529).

Project Management Institute (2013) defines a constraint as "a limiting factor that affects the execution of a project, program, portfolio, or process" (p. 533).

The assumptions and constraints related to this project are outlined in chart 5 below:

Chart 5 Assumptions and constraints (Source: Author, 2017)

Objectives	Assumptions	Constraints
To develop a project management plan to define the execution, monitoring and control processes for the feasibility study.	• It is assumed that through the project management plan the project's scope will be completed on time, within budget and to meet stakeholder satisfaction. • It is assumed that the project manager possesses the skills to develop a the project management plan. • It is assumed that the sponsor will commit to meeting project costs • It is assumed that the sources of information for estimating costs will be available.	• There is limited time for the development of the project management plan.
To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable	• It is assumed that there is relevant data available related to sea cucumber	• There is limited time to conduct an extensive market survey and

Objectives	Assumptions	Constraints
commodity.	markets to support this analysis.	corresponding analysis.
To perform a legal analysis to determine whether there are any legal requirements for sea cucumber aquaculture.	• It is assumed that there is relevant information available related to the legal requirements for sea cucumber aquaculture.	• There is limited time to complete a legal analysis for this study.
To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.	• It assumed that relevant economic data is available to perform an economic analysis. • It is assumed that the project manages possesses the necessary skills to perform such an analysis.	• There is limited time to complete an extensive economic analysis for this study.
To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.	• It is assumed that the relevant information will be available to conduct and environmental assessment.	• There is limited time to complete an environmental assessment for this study.
To perform a financial analysis to determine whether sea cucumber aquaculture would be a viable	• It is assumed that relevant information will be available to	• There is limited time to complete a financial analysis

Objectives	Assumptions	Constraints
investment for local shrimp farms.	conduct a financial analysis. • It is assumed that the project manager possesses the necessary skills to perform such an analysis.	for this study.
To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.	• It is assumed that relevant information will be available to perform an operations and management analysis.	• There is limited time to complete an operations and management analysis for this study.
To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an alternative to shrimp.	• It is assumed that the relevant information will be available to support the identification and analysis of related risk. • It is assumed that the project manager possesses the necessary skills to conduct such an analysis.	• There is limited time to complete a risks analysis for this study.
To provide conclusions and	• It is assumed that the	• There is limited

Objectives	Assumptions	Constraints
recommendations based on insights in the study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.	project's conclusion will be based on discoveries made during the project execution. • It is assumed that the recommendations will be objective. • It is assumed that the recommendations will be based on thorough investigation and analysis of the topic covered in this study. • It is assumed that the recommendations will benefit all stakeholders. • It is assumed that the student will have uninterrupted access to technology including internet, laptop and relevant software to complete all components of this study.	time to develop the project conclusion.

Deliverables

According to the Project Management Institute (2013), a deliverable is “any unique and verifiable product, result, or capability to perform a service that is required to be produced to complete a process, phase, or project” (p.537).

The deliverables for this project are outlined in chart 6 below:

Chart 6 Deliverables (Source: Author, 2017)

Objectives	Deliverables
To develop a project management plan to define the execution, monitoring and control processes for the feasibility study.	Project management plan.
To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity.	Market analysis.
To perform a legal analysis to determine whether there are any legal requirements for sea cucumber aquaculture.	Legal analysis
To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.	Economic analysis
To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.	Environmental analysis

To perform a financial analysis to determine whether sea cucumber aquaculture would be a viable investment for local shrimp farms.	Financial analysis.
To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.	Operations and management analysis.
To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an alternative to shrimp.	Risk analysis.
To provide conclusions and recommendations based on insights in the study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.	Conclusions and recommendations report.

RESULTS

4.1. Project Management Plan

The project management plan defines the approach executing, monitoring and controlling this study. It includes subsidiary plans scope, time, cost, quality, stakeholder, communications and risk management.

4.1.1 Scope Management Plan

The Scope Management Plan described in this section documents the project roles and responsibilities, scope definition, project scope statement, WBS and WBS dictionary, scope verification and control measures. The plan provides a framework for the study and thereby ensures that only the work required forms part of project implementation.

4.1.2. Scope Management Approach

The scope statement, Work Breakdown Structure (WBS) and WBS dictionary will define the project scope. The project manager, in consultation with stakeholders, is solely accountable for project scope management. The project manager, sponsor and stakeholders will develop and approve scope management documentation. The initiation of requests to change scope can originate from the project manager, stakeholder or project assistant, and the project manager will seek approval for such change requests through the project sponsor. The project manager will communicate the approval or denial of scope change requests to relevant stakeholders and update the corresponding project documents. The project manager will present the final deliverables to the project sponsor for formal acceptance. See Appendix 6 for the Change Request Form.

4.1.3 Roles and Responsibilities

Key project personnel will ensure project scope management throughout the project life cycle. The chart below defines the role of the project manager, sponsor, assistant and stakeholders in ensuring that work related to the project scope is accomplished:

Chart 7 Roles and Responsibilities (Source: Author, 2018)

Name	Role	Responsibility
Arlenie Rogers (UB ERI)	Sponsor	• Approve or deny change requests • Evaluate basis for scope change requests • Accept project deliverables
Pia Gregoire	Project Manager	• Measure and verify project scope • Facilitate scope change requests • Spearhead analysis of impact of scope change requests • Organize and facilitate schedule meetings to address scope management and control • Communicate approval/denial of scope change requests • Update project documents upon approval of change requests
Ms. Vernon	Project Assistant	• Assist with scope management and control • Evaluate the need for scope

		changes and escalates same to the project manager • Communicate change requests to the project manager
John Sansone	General Manager, Bel-Euro (Key Stakeholder)	• Provide input in the development of the project scope
Kwame Reynolds	Production Manager, Bel-Euro (Key Stakeholder)	• Provide input in the development of the project scope

Scope Definition

A collect requirements process defined the scope for this project to ensure stakeholder satisfaction. These requirements, in conjunction with consultation from Subject Matter Expert (SME), Dr. Arlenie Rogers, and Bel-Euro Managers, Mr. John Sansone and Mr. Kwame Reynolds, resulted in a high-level scope definition. Section 4.1.4 details the project scope.

Project Scope Statement

The project scope statement provides a detailed description of the work required to create the deliverables. It includes the project description, deliverables, exclusions, assumptions and constraints.

Scope Description, Deliverables and Exclusions

The feasibility study will produce a report to determine the viability of sea cucumber as an alternative to shrimp aquaculture at Bel-Euro. The study will build upon existing information related to the sea cucumber and shrimp aquaculture industries.

The project deliverables are:

- A market analysis
- A legal analysis
- An economic analysis
- An environmental analysis
- A financial analysis
- An operations and management analysis
- A risk analysis

The project exclusions are:

- An analysis of shrimp and sea cucumber aquaculture facilities design
- A business case for a sea cucumber aquaculture pilot project

Assumptions

The project assumptions are as follows:

- It is assumed that the planning and implementation of the study can be completed within 34 days commencing May 6, 2018.
- It is assumed that Bel-Euro will support the project and its outcome and therefore provide relevant information for the various analyses.
- It is assumed that the project can be completed within the stipulated budget.
- It is assumed that the project manager and assistant have the relevant experience and soft skills to successfully produce a quality document.
- It is assumed that the study's outcome will be sufficient to develop a business case for or against a sea cucumber aquaculture pilot project.

Constraints

The project has a limited budget and the project's duration is 34 days.

WBS and WBS Dictionary

A decomposition technique subdivides the scope for this project into more manageable work packages in the WBS. The WBS (see figure 5) and all its levels, therefore reflect the entire scope of work for this project. The upper levels reflect the major project deliverables while the lowest levels reflect the planned work to achieve the deliverables. Work in the context of this project refers to the result of efforts by the project manager and the assistant.

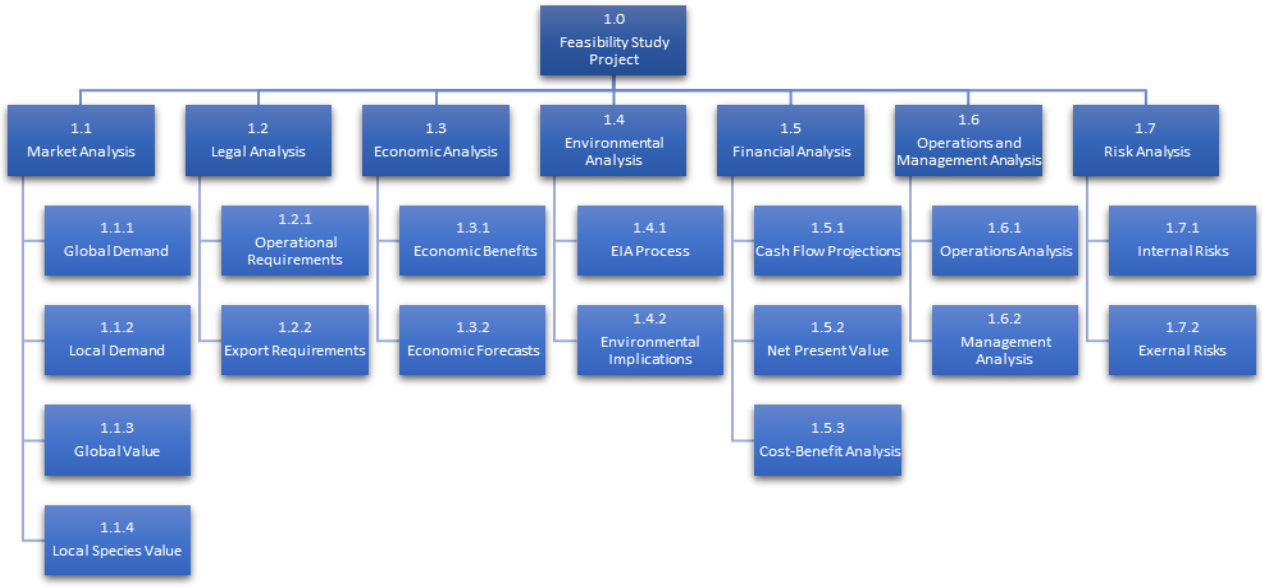


Figure 5 WBS (Source: Author, 2018)

A WBS dictionary supports the WBS by listing detailed information about the deliverables, activities and resources associated with each component. See chart 8 for the WBS dictionary:

Chart 8 WBS Dictionary (Source: Author, 2018)

Level	WBS Code	Element Name	Description	Resources
1	**1.0**	**Feasibility Study Project**	**All the necessary work to complete the feasibility study**	Laptop, internet, relevant literature, phone
2	**1.1**	**Market Analysis**		
3	1.1.1	Global Demand	Research and document global market demand and forecasts for shrimp vs sea cucumber.	Laptop, internet, relevant literature
3	1.1.2	Local Demand	Research and document local market demand for shrimp vs sea cucumbers.	Laptop, internet, relevant literature
3	1.1.3	Global Value	Research and document characteristics, value and customer expectations for shrimp vs sea cucumbers on the global market.	Laptop, internet, relevant literature
3	1.1.4	Local Species Value	Research and document characteristics, value and customer expectations for shrimp vs sea cucumbers on the local market.	Laptop, internet, relevant literature

2	**1.2**	**Legal Analysis**		
3	1.2.1	Operations Requirements	Research and document the legal requirements to operate a shrimp vs sea cucumber aquaculture facility.	Laptop, internet, relevant literature
3	1.2.2	Export Requirements	Research and document the legal requirements to export shrimp vs sea cucumbers.	Laptop, internet, relevant literature
2	**1.3**	**Economic Analysis**		
3	1.3.1	Economic Benefits	Research and document the economic benefits of shrimp vs sea cucumber for Belize.	Laptop, internet, relevant literature
3	1.3.2	Economic Forecasts	Research and document economic forecasts for shrimp vs sea cucumber aquaculture in Belize.	Laptop, internet, relevant literature, telephone
2	**1.4**	**Environmental Analysis**		
3	1.4.1	EIA Process	Research and document process to obtain environmental clearance for shrimp and sea cucumber aquaculture.	Laptop, internet, relevant literature
3	1.4.2	Environmental Implications	Research, analyze and document the environmental impacts of	Laptop, internet, relevant

			shrimp vs sea cucumber aquaculture.	literature
2	**1.5**	**Financial Analysis**		
3	1.5.1	Cash Flow Projections	Estimate interpret and document 5-year cash flow projections for shrimp vs sea cucumber aquaculture operations.	Laptop, internet, relevant data, telephone
3	1.5.2	Net Present Value (NPV)	Calculate, analyze and document NPV for sea cucumber aquaculture operations.	Laptop, internet, relevant data
3	1.5.3	Cost-Benefit Analysis	Calculate, analyze and document cost-benefit analysis for shrimp and sea cucumber aquaculture.	Laptop, internet, relevant data
2	**1.6**	**Operations and Management Analysis**		
3	1.6.1	Operations Analysis	Research and document operational capabilities and requirements for shrimp vs sea cucumber aquaculture.	Laptop, internet, relevant data, telephone, transportation, fuel
3	1.6.2	Management Analysis	Research and document management capabilities and requirements for shrimp vs sea cucumber aquaculture.	Laptop, internet, relevant data, telephone, transportation, fuel

2	**1.7**	**Risk Analysis**		
3	1.7.1	Internal Risks	Research and document internal risks associated with shrimp vs sea cucumber aquaculture.	Laptop, internet, relevant data and literature, telephone
3	1.7.2	External Risks	Research and document external risks associated with shrimp sea cucumber aquaculture.	Laptop, internet, relevant data and literature, telephone

Scope Verification

The project manager is responsible for verifying project deliverables against the project scope baseline (Scope Statement, WBS and WBS Dictionary) throughout the project life cycle. Once the project manager is satisfied that the deliverables meet baseline requirements, the project manager will meet with the project sponsor to present the verified deliverables. The project sponsor's signature on the Deliverable Acceptance Form (see Appendix 5) confirms acceptance of each deliverable.

Scope Control

The project manager and project assistant are responsible for ensuring that the scope does not deviate from its baseline throughout the project. Any changes to the scope must undergo a formal change control process. The project assistant initiates the change request via the Change Request Form (see Appendix 6). The Project Manager reviews the request by evaluating its merit and potential impact on the project's time and resources before escalating it to the project sponsor for approval. The project manager will communicate the project sponsor's decision to

the project assistant and stakeholders. The project manager also updates the scope baseline and related documents.

4.1.4 Time Management

Schedule Management Plan

The schedule management plan outlined in this section is a key component for ensuring timely completion of the feasibility study. The plan establishes the schedule baseline, which serves as a guide for intermittent monitoring. It includes the definition of project activities, sequencing of activities, an estimation of activity resources, estimation of activities duration, schedule development and schedule control.

Activities Definition

The WBS deliverables form the basis for further definition of project activities and its attributes. The decomposition technique and expert judgment supports the definition of activities. Below is the activities list for this study:

Chart 9 Activity List (Source: Author, 2018)

Activity ID	**Activity Name**	**Description of Work**	**Responsibilities**
1.1	**Market Analysis**	**Analyses of the local and global demand and value for shrimp vs sea cucumber.**	**Project Manager, Project Assistant**
1.1.1	Global Demand	Research and document global market demand and forecasts for shrimp vs sea cucumber.	Project Manager, Project Assistant
1.1.2	Local Demand	Research and document	Project Manager,

		local market demand for shrimp vs sea cucumbers.	Project Assistant
1.1.3	Global Value	Research and document characteristics, value and customer expectations for shrimp vs sea cucumbers on the global market.	Project Manager, Project Assistant
1.1.4	Local Value	Research and document characteristics, value and customer expectations for shrimp vs sea cucumbers on the local market.	Project Manager, Project Assistant
1.2	**Legal Analysis**	**Analysis of the operational and export requirements for shrimp vs sea cucumber aquaculture**	**Project Manager, Project Team**
1.2.1	Operations Requirements	Research and document the legal requirements to operate a shrimp vs sea cucumber aquaculture facility.	Project Manager, Project Assistant
1.2.2	Export Requirements	Research and document the legal requirements to export shrimp vs sea cucumbers.	Project Manager, Project Assistant
1.3	**Economic Analysis**	**Analysis of the economic benefits and forecasts for shrimp vs sea cucumber aquaculture.**	**Project Manager, Project Assistant**
1.3.1	Economic Benefits	Research and document	Project Manager,

		the economic benefits of shrimp vs sea cucumber for Belize.	Project Assistant
1.3.2	Economic Forecasts	Research and document economic forecasts for shrimp vs sea cucumber aquaculture in Belize.	Project Manager, Project Assistant
1.4	**Environmental Analysis**	**Analysis of the EIA process and environmental implications of shrimp vs sea cucumber.**	**Project Manager, Project Assistant**
1.4.1	EIA Process	Research and document process to obtain environmental clearance for shrimp and sea cucumber aquaculture.	Project Manager, Project Assistant
1.4.2	Environmental Implications	Research, analyze and document the environmental impacts of shrimp vs sea cucumber aquaculture.	Project Manager, Project Assistant
1.5	**Financial Analysis**	**Use of tools and techniques to for financial analysis of shrimp vs sea cucumber.**	**Project Manager, Project Assistant**
1.5.1	Cash Flow Projections	Estimate interpret and document 5-year cash flow projections for shrimp vs sea cucumber aquaculture operations.	Project Manager, Project Assistant

1.5.2	Net Present Value (NPV)	Calculate, analyze and document NPV for sea cucumber aquaculture operations.	Project Manager, Project Assistant
1.5.3	Cost-Benefit Analysis	Calculate, analyze and document cost-benefit analysis for shrimp and sea cucumber aquaculture.	Project Manager, Project Assistant
1.6	**Operations and Management Analysis**	**Operational and management analysis of the shrimp vs sea cucumber aquaculture operations.**	**Project Manager, Project Assistant**
1.6.1	Operations Analysis	Research and document operational capabilities and requirements for shrimp vs sea cucumber aquaculture.	Project Manager, Project Assistant
1.6.2	Management Analysis	Research and document management capabilities and requirements for shrimp vs sea cucumber aquaculture.	Project Manager, Project Assistant
1.7	**Risk Analysis**	**Internal and external risk analysis of shrimp vs sea cucumber.**	**Project Manager, Project Assistant**
1.7.1	Internal Risks	Research and document internal risks associated with shrimp vs sea cucumber aquaculture.	Project Manager, Project Assistant
1.7.2	External Risks	Research and document external risks associated	Project Manager, Project Assistant

		with shrimp sea cucumber aquaculture.	

Activities Duration, Resources and Sequence

The chart below lists the predecessor activities that support the sequencing of project activities in a Finish-to-Start logical relationship. The project manager and assistant's expert judgment supported the estimation of human resources. In addition to expert judgment, the bottom-up technique supports the estimation of duration (in days) to ensure a high-level of accuracy required to prevent project delays. The project assistant will assist with development of the activities list and attributes, estimation of resources and duration in a session facilitated by the project manager. The activities with a duration of 0 days represent the project milestones.

Chart 10 Activity Sequence, Duration and Resources (Source: Author, 2018)

Activity ID	**Activity Name**	**Duration**	**Predecessor**	**Resources**
1.0	Feasibility Study	34		Project Manager, Project Assistant, Project Sponsor
	Project Start	0		
1.1	**Market Analysis**	**6**	**1.1.1, 1.1.2, 1.1.3, 1.1.4**	**Project Manager, Project Assistant**
1.1.1	Global Demand	2		Project Manager, Project Assistant
1.1.2	Local Demand	1		Project Manager, Project Assistant
1.1.3	Global Value	2		Project Manager, Project Assistant

1.1.4	Local Value	1		Project Manager, Project Assistant
	Market Analysis Complete	0		
1.2	**Legal Analysis**	**4**	**1.2.1, 1.2.2**	**Project Manager, Project Assistant**
1.2.1	Operations Requirements	2		Project Manager, Project Assistant
1.2.2	Export Requirements	2		Project Manager, Project Assistant
	Legal Analysis Complete	0		
1.3	**Economic Analysis**	**4**	**1.3.1, 1.3.2**	**Project Manager, Project Assistant**
1.3.1	Economic Benefits	2		Project Manager, Project Assistant
1.3.2	Economic Forecasts	2		Project Manager, Project Assistant
	Economic Analysis Complete	0		
1.4	**Environmental Analysis**	**4**	**1.4.1, 1.4.2**	**Project Manager, Project Assistant**
1.4.1	EIA Process	2		Project Manager, Project Assistant
1.4.2	Environmental Implications	2		Project Manager, Project Assistant
	Environmental Analysis Complete	0		
1.5	**Financial Analysis**	**4**	**1.5.1, 1.5.2, 1.5.3**	**Project Manager, Project Assistant**
1.5.1	Cash Flow	2		Project Manager,

	Projections			Project Assistant
1.5.2	Net Present Value (NPV)	1		Project Manager, Project Assistant
1.5.3	Cost-Benefit Analysis	1		Project Manager, Project Assistant
	Financial Analysis Complete	0		
1.6	**Operations and Management Analysis**	**6**	**1.6.1, 1.6.2**	**Project Manager, Project Assistant**
1.6.1	Operations Analysis	3		Project Manager, Project Assistant
1.6.2	Management Analysis	3		Project Manager, Project Assistant
	Operations and Management Analysis Complete	0		
1.7	**Risk Analysis**	**6**	**1.7.1, 1.7.2**	**Project Manager, Project Assistant**
1.7.1	Internal Risks	3		Project Manager, Project Assistant
1.7.2	External Risks	3		Project Manager, Project Assistant
	Risks Analysis Complete	0		

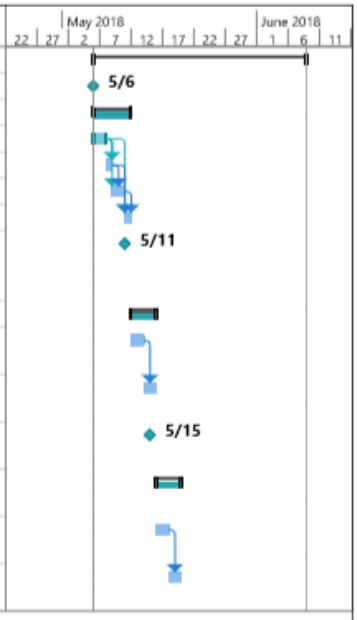
Schedule Development

Microsoft Project 2016 is the tool of choice for developing the project schedule. The project manager is responsible for scheduling a meeting with the project assistant to review the schedule (see Chart 11), assigned resources, duration and

sequence. Following the review, the project manager will submit the schedule to the project sponsor for approval. The approved schedule forms the schedule baseline.

Chart 11 Feasibility Study Schedule (Source: Author, 2018)

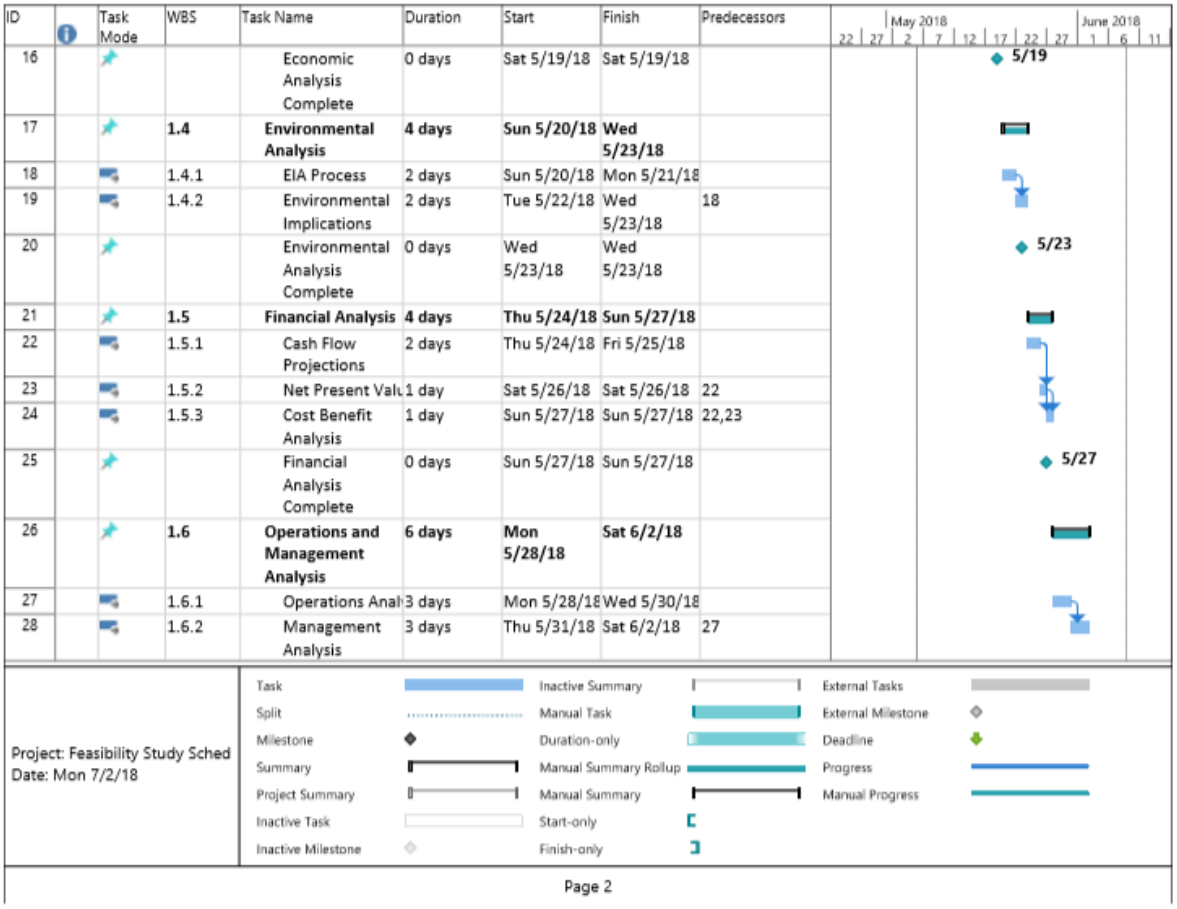
ID	Task Mode	WBS	Task Name	Duration	Start	Finish	Predecessors
1		**1.0**	**Feasibility Study**	**34 days**	**Sun 5/6/18**	**Fri 6/8/18**	
2			Project Start	0 days	Sun 5/6/18	Sun 5/6/18	
3		**1.1**	**Market Analysis**	**6 days**	**Sun 5/6/18**	**Fri 5/11/18**	
4		1.1.1	Global Demand	2 days	Sun 5/6/18	Mon 5/7/18	
5		1.1.2	Local Demand	1 day	Tue 5/8/18	Tue 5/8/18	4
6		1.1.3	Global Value	2 days	Wed 5/9/18	Thu 5/10/18	5,4
7		1.1.4	Local Value	1 day	Fri 5/11/18	Fri 5/11/18	4,5,6
8			Market Analysis Complete	0 days	Fri 5/11/18	Fri 5/11/18	
9		**1.2**	**Legal Analysis**	**4 days**	**Sat 5/12/18**	**Tue 5/15/18**	
10		1.2.1	Operations Requirements	2 days	Sat 5/12/18	Sun 5/13/18	
11		1.2.2	Export Requirements	2 days	Mon 5/14/18	Tue 5/15/18	10
12			Legal Analysis Complete	0 days	Tue 5/15/18	Tue 5/15/18	
13		**1.3**	**Economic Analysis**	**4 days**	**Wed 5/16/18**	**Sat 5/19/18**	
14		1.3.1	Economic Benefits	2 days	Wed 5/16/18	Thu 5/17/18	
15		1.3.2	Economic Forecasts	2 days	Fri 5/18/18	Sat 5/19/18	14



Project: Feasibility Study Sched
Date: Mon 7/2/18

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

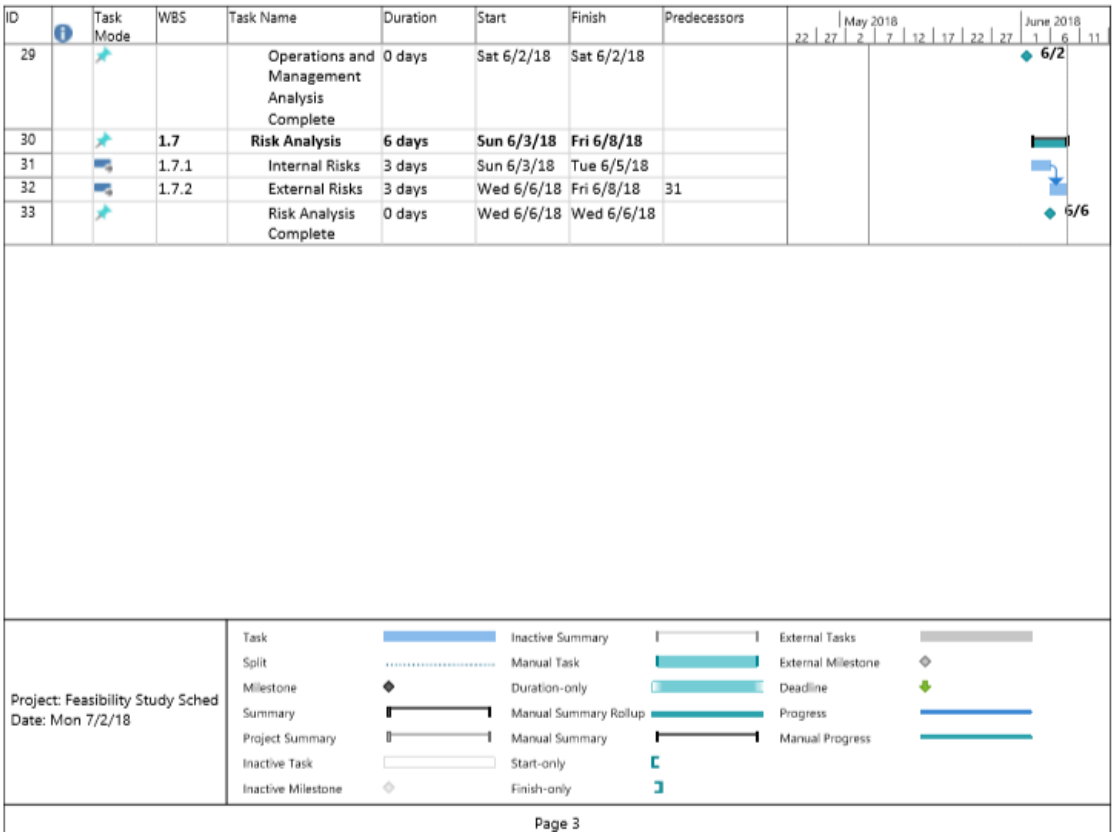
Page 1



ID	Task Mode	WBS	Task Name	Duration	Start	Finish	Predecessors
16			Economic Analysis Complete	0 days	Sat 5/19/18	Sat 5/19/18	
17		**1.4**	**Environmental Analysis**	**4 days**	**Sun 5/20/18**	**Wed 5/23/18**	
18		1.4.1	EIA Process	2 days	Sun 5/20/18	Mon 5/21/18	
19		1.4.2	Environmental Implications	2 days	Tue 5/22/18	Wed 5/23/18	18
20			Environmental Analysis Complete	0 days	Wed 5/23/18	Wed 5/23/18	
21		**1.5**	**Financial Analysis**	**4 days**	**Thu 5/24/18**	**Sun 5/27/18**	
22		1.5.1	Cash Flow Projections	2 days	Thu 5/24/18	Fri 5/25/18	
23		1.5.2	Net Present Valu	1 day	Sat 5/26/18	Sat 5/26/18	22
24		1.5.3	Cost Benefit Analysis	1 day	Sun 5/27/18	Sun 5/27/18	22,23
25			Financial Analysis Complete	0 days	Sun 5/27/18	Sun 5/27/18	
26		**1.6**	**Operations and Management Analysis**	**6 days**	**Mon 5/28/18**	**Sat 6/2/18**	
27		1.6.1	Operations Anal	3 days	Mon 5/28/18	Wed 5/30/18	
28		1.6.2	Management Analysis	3 days	Thu 5/31/18	Sat 6/2/18	27

Project: Feasibility Study Sched
Date: Mon 7/2/18

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress



Schedule Control

The schedule baseline provides a basis for monitoring and controlling the project schedule based on its allotted duration. The project manager will monitor the project schedule against the baseline on a weekly basis with the support of the project assistant. The assistant will initiate corrective or preventative action to address any deviations from the baseline. Only the project sponsor can approve changes to the scope baseline. The project manager will use the Change Request Form (see Appendix 6) to obtain approval from the project sponsor for any such changes and communicate the sponsor's decision to the project assistant and stakeholders. The project manager will also update the schedule and related documents.

4.1.5 Cost Management Plan

Project cost management ensures stakeholder satisfaction through the effective use of project resources. It involves cost planning, budget estimating and control.

The cost management plan outlined in this section ensures the completion of the feasibility study within the stipulated budget. The plan describes the processes for arriving at the project's budget as well as the policies and procedures for the efficient monitoring and control, and management of costs throughout the project life cycle.

The project manager is responsible for ensuring the creation of the cost management plan and for the management and control of costs throughout the project. On a weekly basis, the project manager will provide a brief report via email to stakeholders on cost performance including proposed control measures. Earned Value Management (EVM) will be the technique used to measure cost performance. The project assistant will monitor the project cost performance and bring any deviation from planned cost to the attention of the project manager during twice-weekly project progress meetings. The project manager is accountable for the cost variances and for proposing corrective measures. The project sponsor is responsible for approving the project budget and authorizing changes to cost in excess of budget using the Change Request Form (See Appendix 6). The project manager then communicates cost changes to project stakeholders and updates related project documents.

Cost Management Approach

The project costs are managed at the third level of the WBS using control accounts for tracking expenditure. Microsoft Excel is the tool available for managing these accounts. The project manager and assistant will measure performance and control costs by applying EVM to control accounts. Work will be monitored at the

work package level. At the start of the project 50% of the costs will be allocated to each work package and the remaining 50% on completion. Project costs are rounded to the nearest dollar and the labour to the nearest whole day. A day is equivalent to 8 working hours.

The project manager will take corrective action to get the project back on track where variance in the Schedule Performance Index (SPI) and Cost Performance Index (CPI) is +/-2%. A variance of +/- 1% signals a caution to the project manager, and this is reported in weekly status updates. Only the project sponsor can approve changes to project costs including the use of reserves.

Cost Estimation

The project manager in consultation with the project assistant and key stakeholders will meet to determine estimates of resources. The group will review the project scope baseline and schedule to facilitate this process. During the session, expert judgement and the bottom up technique with consideration for prevailing market prices form the basis for estimating costs associated with each work package.

The administrative costs for the feasibility study is estimated at the going daily rate for local consultancies. Other indirect costs for telephone, internet, electricity, and fuel and transportation is estimated at the local rate. These rates are expected to remain constant during the period of the study.

Chart 12 Feasibility Study Estimated Costs (Source: Author, 2018)

Item	**Quantity**	**Unit Cost Estimate (BZ$)**	**Resources**
Direct Costs			
Administrative Costs:			
Project Manager	1	$300/day	Service

Project Assistant	1	$100/day	Service
Indirect Costs			
Phone Calls	10	$2	Material
Electricity	34	$3.65/day	Utilities
Internet	34	$3.15/day	Utilities
Transportation	2	$50/day	Equipment
Fuel	11	$10.90/gallon	Material

Cost Budgeting

The cost estimate described above supports the development of the project budget. The project manager in consultation with the project assistant and key stakeholders use cost aggregation, expert judgement and reserve analysis to arrive at the budget shown in the chart below:

Chart 13 Feasibility Study Budget (Source: Author, 2018)

Item	**Activity Cost (BZ$)**
Direct Costs	
Administrative Costs:	
Project Manager	$10,200
Project Assistant	$3,400
Indirect Costs	
Phone Calls	$20
Electricity	$124
Internet	$107
Transportation	$100
Fuel	$120
Subtotal	**$14,071**
Contingency Reserve (5%)	$704
Total	**$14,775**

The cost baseline includes a 5% contingency reserve and totals $14,775.00. An estimated $500 management reserve is added to cover any unidentified risks with cost implications. The total budget is $15,275 ($14,775 + $500). The cost baseline is established when the budget is approved by the sponsor.

Cost Control

The project assistant will monitor cost performance against the cost baseline twice weekly. Any variances are reported to the project manager and will include an outline of the triggers. Where variances are beyond the +/- 2 threshold, the project manager will escalate a proposal for corrective action to the project sponsor. The project sponsor will use discretion to approve or deny such change request using the Change Request Form (Appendix 6). The project manager will notify stakeholders of the change request outcome and update the cost baseline and related documents.

4.1.6 Quality Management Plan

The quality management plan outlined in this section ensure that the feasibility study and processes for developing the study meet stakeholder quality requirements. To support this, the project manager and assistant establishes quality policies and objectives, and responsibilities for each area of quality management.

Quality Management Approach and Development

The implementation and continuous monitoring of the plan ensures a quality document. The approach to quality management for this feasibility study will ensure that the project meets customer satisfaction through a “Plan-Do-Check-Act” (PDCA) continuous improvement cycle. The project manager, with the support of the project assistant aims to produce a feasibility study that is applicable to Bel-

Euro and thus forms a basis for investment decisions. The chart below outlines the roles and responsibilities for quality management:

Chart 14 Quality Management Roles and Responsibilities

Name	Role	Responsibilities
Pia Gregoire	Project Manager	Monitors project quality, develop quality policies and procedures, communicates with stakeholders on quality objectives, documents all quality requirements and overall accountability for project quality
Arlenie Rogers	Sponsor	Approve changes to quality requirements
Assistant	Project Assistant	Conducts quality audits, implements quality management plan, assists with the development of quality policies and procedures, and identifies opportunities for improvement
John Sansone	General Manager, Bel-Euro	Provides input at meetings to define quality requirements
Kwame Reynolds	Production Manager, Bel-Euro	Provide input at meetings to define quality requirements

The project manager will facilitate a brainstorming session with the stakeholders outlined in Chart 14 to develop the quality requirements and metrics for this study.

Metrics will be established for this project as a basis for measuring performance during the perform quality assurance process. The following are pertinent metrics for this study:

- Reliability
- Relevance

- Timeliness
- Suitability
- Completeness

Quality Assurance and Control

The project manager and assistant will adopt a rigorous approach for measuring quality to achieve project success. This will include a weekly review of the quality metrics via quality product review and process review via observation. The team will meet to evaluate the performance of processes in terms meeting quality requirements. If deliverables and processes do not conform to quality requirements, the project assistant will brainstorm improvement initiatives. The PDCA approach to continuous improvement will be the means for monitoring quality assurance.

Quality control for this study focuses on the quality of the document, more specifically, the various analyses contained therein. The project manager and project assistant will monitor and control quality on a weekly basis throughout the project life cycle. Where quality falls short of established metrics, the project manager and assistant will identify the source and take corrective action. The quality control log below will be the tool used for this purpose:

Chart 15 Quality Control Log (Source: Author, 2018)

Document/Deliverable	Date	Metrics	Conformance (Y/N)	Product Recommendations	Improve Timeline

The results of this process serve as input into the quality assurance process described above with a view to ensure that associated quality processes achieve the desired result of a quality product. The log sheet below will be the tool used for this purpose:

Chart 16 Quality Assurance Log Sheet

Deliverable/Document Name	Process Area	Observation Technique	Conformance (Y/N)	Recommendations	Improvement Timeline

The project manager will communicate the results of the audit to project stakeholders, and update project documents to reflect any process improvements.

4.1.6 Stakeholder Management

The stakeholder management plan for this study allows the project manager and assistant to identify all individuals or entities that may influence the project. The aim is that the plan will support adequate engagement of these stakeholders, based on their level of influence on project success.

Stakeholder Analysis

Through a brainstorming session, the project manager and assistant identified the project stakeholders. The chart below lists key stakeholder information:

Chart 17 Stakeholder Registry Matrix (Source: Author, 2018)

Project Name: Feasibility Study: Sea Cucumber Aquaculture as an Alternative to Shrimp Aquaculture at Bel-Euro Aquaculture Limited

Project Manager Name: Pia Gregoire

ID	Name of Stakeholder	Role	Contact Information	Main Expectations	Major Requirements	Power (Low-Medium-High)	Interest (Low-Medium-High)
1	Arlenie Rogers	Provide direction for the support of the project	arogers@ub.edu.bz	The thorough feasibility analysis of sea cucumber vs	The study can be used as a basis for research funding	High	High

				shrimp			
2	John Sansone (General Manager, Bel-Euro)	Provide input and guidance for various analyses	jsansone@rainforestseafoods.com	The thorough feasibility analysis of sea cucumber vs shrimp	The study can provide support for investment decisions	High	High
2	Kwame Reynolds (Production Manager, Bel-Euro)	Provide input and guidance for various analyses	kwamerey.beleuro@gmail.com	The thorough feasibility analysis of sea cucumber vs shrimp	The study can provide support for investment decisions	High	High
3	UB ERI	Support the completion and goal of the study	uberiinfo@ub.edu.bz	The thorough feasibility analysis of sea cucumber vs shrimp	The study can help support the institute's credibility and the fulfillment of its mission	High	High
4	Government of Belize	To manage the sea cucumber and shrimp industries and to find viable export products to support economic growth	econdev@btl.net info@agriculture.gov.bz	The study provides support for the management of wild species of sea cucumber and shrimp, and support for investment decisions		Low	High
8	Pia Gregoire	Project Manager	piagregoire@gmail.com	Ensure that the the project is completed and that it meets meet customer requirements	The project management principles are applied	High	High

9	Ms. Vernon	Project Assistant	holmescaye@yahoo.com	The responsibilities of the project assistant will be to support the completion of the project to meet customer requirements	The project management principles are applied	High	High

To further stakeholder analysis, the project team will plot identified stakeholders on a Power/Interest grid (see Appendix 7). Stakeholders with little to no power/interest will require less engagement than those with high power/interest. As dynamics change during the life cycle of the project, the project manager and assistant will update the listing of stakeholders and their power/interest.

Stakeholder Management Plan and Engagement

The project manager with the support of the project assistant is responsible for the development of the stakeholder management plan. The plan outlines the strategies to meet the needs of stakeholders described in the stakeholder register and power/interest grid. Therefore, the project manager and assistant will also engage stakeholders by providing relevant and timely information and feedback as needed. The chart below shows the current and desired engagement level for each stakeholder.

Chart 18 Stakeholder Engagement Matrix (Source: Author, 2018)

Stakeholder	Unaware	Resistant	Neutral	Supportive	Leading
Arlenie Rogers				C	D
John Sansone (Bel-Euro)			C	D	
Kwame Reynolds (Bel-Euro)			C	D	

UB ERI			C	D	
Government of Belize	C			D	
Pia Gregoire					C D
Ms. Vernon				C D	

C = Current level of engagement D = Desired level of engagement

The communications management plan in the subsequent section outlines the communication strategies for each stakeholder. This plan will support the management of engagements with stakeholders. The project assistant will provide updates on the effectiveness of engagement management strategies at project progress meetings.

Control Stakeholder Engagement

The project assistant will monitor and control stakeholder engagement on a twice-weekly basis throughout the project. Where engagement is insufficient or does not meet stakeholder needs, corrective action is required. The project assistant will seek the approval of the project sponsor through the project manager for changes to the stakeholder engagement as the need arises. The stakeholder's register and engagement strategies will reflect approved changes. The project sponsor will approve changes using the Change Request Form (see Appendix 6).

4.1.7 Communications Management Plan

The communications plan outlined in this section defines the approach for communicating with project stakeholders. The successful implementation of the study requires consultation with and input from key stakeholders, namely Dr. Rogers, Mr. Sansone and Mr. Reynolds. The plan, therefore, ensures that these stakeholders have all the relevant information required, and in a timely manner throughout the project life cycle. The plan also identifies their information needs, the frequency and means of distribution, and identifies the individual responsible

for sharing the information. The hope is that through effective communications management, the project manager and assistant can garner support for the project and its deliverables.

Communications Management

The communications matrix shown in chart 19 below, will serve as a guide for managing communications throughout the project:

Chart 19 Communications Matrix (Source: Author, 2018)

Project Name: Feasibility Study: Sea Cucumber Aquaculture as an Alternative to Shrimp Aquaculture at Bel-Euro **Project Manager:** Pia Gregoire			
Stakeholders	**Deliverable**	**Frequency**	**Channel(s)**
Who	*What*	*When*	*How*
Sponsor	Project deliverables and status updates	Once Weekly	Meetings, Email
Bel-Euro	Project deliverables	Every two weeks	Meetings, Email
UB ERI	Project deliverables	Once (on completion)	Oral presentation
Government of Belize	Project outcome	Once (on completion)	Email
Project Manager	Progress report	Weekly	Meetings, Email
Project Assistant	Status updates	Twice Weekly	Email

The project assistant will take minutes at all meetings, highlighting key points therein and distribute to all stakeholders. The twice weekly status update report will include an update on activities completed to date, plans for the rest of the week,

status of quality, risks, time management, stakeholder engagement and any areas identified that requires changes.

It is the responsibility of the project manager to ensure effective communication in compliance with the communications matrix. The project assistant will monitor the implementation of the plan on a twice-weekly basis and recommend changes as needed. The project manager will seek approval from the project sponsor for any proposed changes using the Change Request Form (See Appendix 6). The communications plan will reflect approved changes and the project stakeholders will be apprised.

4.1.8 Risk Management

The uniqueness of this feasibility study brings a certain level of uncertainty that requires project risk management. The management plan for this study defines the processes to identify, analyze and manage associated risks. For purposes of this project, risks are negative events. If they occur, they may or may not affect the objectives of the study. The project manager has sole responsibility for the development and execution of this plan. The project assistant will monitor project risks and provide updates on these risks in status reports.

Risk Identification

It is the project manager's responsibility to identify known project risks. In a meeting facilitated by the project manager, the project assistant and key stakeholders assisted with this process by reviewing the project charter, project schedule, cost, scope, quality, communications and stakeholder management plans to identify risks related to this study. This, in addition to the duo's expert judgement supported the development of the project risk register seen below. See Appendix 9 for supporting Risk Breakdown Structure.

Chart 20 Risk Register (Source: Author, 2018)

ID	Cause	Risk	Category	Consequence	Probability	Impact	PxI	Strategy
1.1.1	Laptop and software malfunction	Delay in executions of project activities	External	Project exceeds scheduled duration				
1.2.1	Natural disasters – hurricanes, freak storms, earthquake	Delay in the execution of activities	External	Project exceeds scheduled duration				
1.3.1	Accuracy and integrity of data and information	Unreliable deliverables	External	Project does not meet stakeholder expectations				
2.1.1	Inadequate scope definition and scope creep	Project does not meet stakeholder expectations	Internal	Project does not meet stakeholder requirements				
2.1.2	Unrealistic project duration	Project exceeds planned duration	Internal	Project exceeds scheduled duration				
2.1.3	Poor communications	Delays in feedback and project execution	Internal	Project exceeds scheduled duration				
2.1.4	Poor cost estimates	Project activities exceed budget	Internal	Project termination				
2.3.1	Inexperienced human resources	Substantial rework and delays	Internal	Project exceeds scheduled duration				
2.3.2	Availability of expert resources	Lack of input for project execution	Internal	Project termination				

4.1.9 Risk Analysis

The project manager, with the support of the project assistant and key stakeholders, will qualitatively analyze each risk identified in the risk register. The

project assistant will use the probability and impact scales shown in chart 18 for this analysis. The project manager, assistant and SMEs will meet to assess the probability and impact of these risks. A weighting of each risk allows the project manager to prioritize them, based on their severity. The prioritization level will range from high, moderate to low. The ability to evaluate and rank these risks allows the project manager and project assistant to plan appropriate risk responses for negative and positive risks. The project assistant will update the risk register with the risk ranking and planned response, as needed. Due to the lack of relevant data and required software, a quantitative analysis does not form part of this project.

Chart 21 Impact Scales by Category (Source: Author, 2018)

Defined Conditions for Impact Scales (for negative risks)					
Project Objective	Very Low/1	Low/2	Medium/3	High/4	Very High/5
Communications	Insignificant engagement decrease	less than 2% engagement decrease	2-4% engagement decrease	4-8% engagement decrease	more than 8% engagement decrease
Schedule	Insignificant schedule increase	less than 2% schedule increase	2-4% schedule increase	4-8% schedule increase	more than 8% schedule increase
Scope	Insignificant scope increase	Scope increase to only one activity	Scope increase to more than two activities	Scope increase to more than three project activities	Significant scope increase to more than four project areas
Quality	Quality degradation barely noticeable	Quality degradation noticeable but relatively insignificant	Quality reduction requires sponsor approval	Quality reduction unacceptable to sponsor	Project end item is effectively useless
Cost	Negligible increase in costs above budget	Less than $10 increase in costs above budget	Less than $20-$30 increase in costs budget	Less than $30-$40 increase in costs above budget	Less than $40 -$50 increase in costs above budget

Chart 22 Probability Scales (Source: Author, 2018)

Probability Scales (for negative risks)	
Rating	**Interpretation**
Very High - 5	It is almost certain that the risk will occur. If it does not it would be a surprise.
High - 4	The risk is more likely to occur than it is not to, however, there is no certainty
Medium - 3	There is a chance that the risk may or may not occur. It is 50-50
Low - 2	The risk is more likely not to occur than it is to occur. If it does occur, it would be a surprise.
Very Low -1	It is almost certain that the risk will not occur. The likelihood is so small that it is almost impossible.

The probability impact matrix (see Chart 23) for this study allows for the determination of the probability and impact (PxI) for each risk. The severity of each risk determines prioritization for corrective action. The lowest point on the matrix is 1, where the risk has a very low likelihood of occurring and low impact. The highest point is 25, where the risk has a very high likelihood of occurring and the impact is high. Risks in the red area require attention before risks in the yellow area of the matrix.

Chart 23 Probability Impact Matrix (Source: Author, 2018)

	Probability Impact Matrix				
	Impact				
Probability	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)
Most likely to occur (5)	5	10	15	20	25
Likely to occur (4)	4	8	12	16	20
Moderate chance to occur (3)	3	6	9	12	15
Unlikely to occur (2)	2	4	6	8	10
Very unlikely to occur (1)	1	2	3	4	5

Category	Scores
Low risks	1 to 4
Moderate risks	5 to 10
High risks	11 to 25

Low risks (scores 1 to 4): Pose very little to no potential of overrun costs, delay in schedule, or poor performance and quality. Risks that fall within this category require less attention and resources.

Moderate risks (scores 5 to 10): Risks identified in this range can pose some threat to the project and could potentially increase costs, affect the schedule, performance and its quality. Corrective action may be required to ensure that these risks pose minimal risks to the feasibility study.

High risk (scores 11 to 25): High risks are severe threats to the project. They pose risks for very high cost, significant schedule disturbance, poor performance and quality. They require urgent corrective action by the project manager and assistant.

Risk Management

The project assistant will address all major risks (red and yellow blocks) with the support of the project manager. One of the following strategies will be used to address each risk:

- **Avoidance** – the project assistant eliminates the threat by eliminating the cause or protect the project from the impact
- **Mitigation** – the project assistant identifies means of reducing the probability of occurrence of the impact on the project
- **Acceptance** – the project assistant does nothing to address the risk, in cases where there is no other option
- **Transference** – the project assistant makes another party responsible for the risk by outsourcing it.

The project assistant will monitor the risk register for changes in levels of severity and update it, as new risks arise. The assistant will also provide updates on risks in twice-weekly status reports. The project manager will notify stakeholders, accordingly.

4.2 Market Analysis

Global Demand - Shrimp

According to the World Wildlife Fund approximately 55% of shrimp on the global market is produced via aquaculture (World Wildlife Fund , n.d.). In 1990 shrimp aquaculture accounted for 26% of world supplies, 28% in 2000, rapidly increased to 49% in 2006 and 54% in 2014 (Anderson, Valderrama, & Jory, 2016).

Anderson et al. (2016) found that shrimp production grew steadily from 1995 with a few fluctuations between 2011 and 2015. Production decreased from 3.87 million metric tons (MMT) in 2012 to 3.47MMT in 2013, rose to 4.30MMT in 2014 and fell again in 2015 to 3.99MMT primarily due to disease (Anderson, Valderrama, & Jory, 2017). According to Anderson et al. (2017), production projections show a slow increase, which will reach 4.82MMT by 2019.

Anderson et al. (2017) also found Latin America, Ecuador, Mexico, Brazil, Honduras, Nicaragua and Venezuela to be major shrimp producers with Ecuador producing more than 400MMT per annum. In minor producing countries such as Panama, Costa Rica, Belize, El Salvador and Colombia production ranges between 1 to 9 thousand metric tons per annum (Anderson et al, 2016).

Major 2017 importers included China, Vietnam, USA, Japan and the Republic of Korea (Food and Agricultural Organisation of the United Nations, 2018). The survey published by Global Aquaculture Alliance also revealed that the most important issues and challenges affecting the industry are diseases, production costs, seed stock quality and availability, and access to disease-free brood stock (Anderson et al., 2016). In Latin America, feed costs are expected to continue to be a major challenge in 2018.

Global Demand – Sea Cucumber

Internationally, sea cucumbers trade across more than 70 countries with the Asian market being the most lucrative (Purcell, Samyn, & Conand, Commercially Important Sea Cucumbers of the World, 2012). The high demand for the species on the Asian market is forcasted to continue on this upward trend (Purcell, Williamson, & Ngaluafe, 2018). According to Perez and Brown (n.d.), this trend is due to a health-conscious movement among ethnic populations and fast growing populations such as China's. Additionally, forecasts indicate that China's economy will grow by 6.5% and 6.4% in 2018 and 2019, respectively (Reuters, 2017). The country is also reportedly the world's largest seafood market with most of its products imported from around the world (Fabinyi, Liu, Song, & Li, 2016). Purcell et al (2018) surmises that aquaculture provides a sustainable means for meeting this increasing demand.

Between 2013 and 2014, Hong Kong imported 8,995,571 and 7,797,873 tons of sea cucumber, respectively, from more than 30 countries worldwide including neighboring Mexico (Conand, 2017). In the Latin America and the Caribbean region, there are few emerging exporters including Belize, Panama, Trinidad and Tobago, and Venezuela (Josupeit, 2014). Mexico leads exports in the region, exporting an estimated 650 tons or 1,433,004 pounds in 2013 (Josupeit, 2014).

The sea cucumber aquaculture industry is relatively young, with China being the major producer of more than 180,000 tons (Robinson & Lovatelli, 2015). According to Robinson & Lovatelli (2015), China's sea cucumber aquaculture industry preceded more than two decades of research resulting in the successful aquaculture of the highest value species, sandfish (*H.sacbra*). Countries such as Madagascar and Fiji also engage in small-scale sea cucumber aquaculture as a source of supplementary livelihoods for members of their coastal communities (Robinson & Lovatelli, 2015). Other countries engaged in the industry, include Tanzania, Papua New Guinea, Australia, Philippines, Indonesia (Sicuro & Levine, 2011) and Mexico (A. Rogers., personal communication, October 31, 2016).

There is little information on the sea cucumber fishery in the Caribbean and the region's aquaculture industry is underdeveloped (Robinson & Lovatelli, 2015). However, Robinson and Lovatelli (2015) states that there is potential for the aquaculture of the Caribbean's high value species, *I. badionotus*. Mexico has successfully reared this species in hatcheries while Bermuda has conducted successful spawning trials (Robinson & Lovatelli, 2015).

Chart 24 Global Demand Summary (Source: Author, 2018)

Global Demand		
Factor	Shrimp	Sea Cucumber
Largest Import Market	Asia	Asia
Market Forecasts	Increase	Increase
Major importers	China, Vietnam, USA, Japan and the Republic of Korea	China and Hong Kong
Production	Millions of metric tons globally and thousands of metric tons in the regionally	Thousands of tons in China
Challenges	Diseases, production costs, seed stock quality and availability, and access to disease-free broodstock	Lack of research
Major importers	China, Vietnam, USA, Japan and the Republic of Korea	China and Hong Kong

Local Demand - Shrimp

Most local shrimp farms in Belize export all their produce to the United States of America (USA), Canada, Asia, Europe, Mexico, Guatemala and the Caribbean

Community (CARICOM) (Beltraide, n.d.), Mexico being the largest buyer of Belizean shrimp (CTV News , 2014). The CARICOM market is the final destination for all shrimp produced by Bel-Euro (J. Sansone, personal communication, June 1, 2018). Three local shrimp farms supply the local market but export most of their product (CTV News, 2014). The proximity of the market for Belizean shrimp allows for a competitive advantage (Beltraide , n.d.).

In 2013 and 2014, Belize exported more than 14 million pounds of shrimp. By 2017, production declined to a little over 1 million pounds (L. Cruz, personal communication, April 13, 2018). The country's shrimp importation grew from 43 pounds to 10,039 pounds in 2010 and 2011, respectively, to over 81,000 pounds in 2014 (L. Cruz, personal communication, April 13, 2018).

Less than 5% of shrimp produced is available on the local market and consumed mainly by the tourism sector (Food and Agriculture Organization of the United Nations , n.d.). To support the local demand, shrimp farms offer concessionary prices during times of shortages and price hikes (CTV News , 2014).

Local Demand – Sea Cucumber

Locally, there is a small market for sea cucumber in Belize, with the Asian population being the largest consumers (Perez & Garcia, 2012). There is one supplier in the north of the country who purchases sea cucumbers at BZ$1.50 to BZ$2.50 per individual from local fishers (Perez & Garcia, 2012).

Major export markets for the species include the USA, Hong Kong and Guatemala (Perez & Garcia, 2012). Belize exported approximately 31,000 pounds of wild caught sea cucumbers in 2016 (L. Cruz, personal communication, April 13, 2018). There is no record of importation over the past ten years (L. Cruz, personal communication, April 13, 2018).

Chart 25 Local Demand Summary (Source: Author, 2018)

Local Demand		
Factor	Shrimp	Sea Cucumber
Largest Export Market	Mexico	USA, Hong Kong, Guatemala
Local Demand	Low	Low
Imports	Low	No record of importation
Production	Millions of pounds via aquaculture	Thousands of pounds from the wild

Global Value - Shrimp

There are more than 2,000 species of shrimp around the world (Ambergis Caye Belize, n.d.). According to Anderson et al. (2016), the most important species produced via aquaculture is the *P. vannamei* followed by the *P. monodon* and *M. rosenbergil*.

The final product can take various forms including green/head-on, green/head-off, peeled, cooked and breaded among others. However, there is increasing demand for green/head-on shrimp on the global market (Anderson et al, 2016). In 2016, the global shrimp market was valued at US$37 billion and by 2027, it is projected to value US$39 billion (Future Market Insights, 2017).

Global Value - Sea Cucumber

Globally, sea cucumber wild populations are depleting, and exporters are unable to meet demand (Purcell, Samyn, & Conand, Commercially Important Sea Cucumbers of the World, 2012). In Belize, populations declined significantly and as a result the fishery remained closed in 2017 (Belize Fisheries Department, n.d.).

On the Asian market, valuable and expensive species include *A. japonicas*, *H. scabra*, *H. lesson*, *H. fuscogilva, H. nobilis* and *H. whitmaei* which retail between US$25-130 per kilogram or more than US$450, depending on size and quality

(Fabinyi, Barclay and Eriksson, 2017). Fabinyi et al. (2017) also found that the *I. badionotus,* a lower value species, ranges from about US$20-$110 per kilogram. According to Sicuro & Levine (2011), these lower value species are becoming more popular in the global market. Purcell et al (2018) found that between 2011 and 2016 retail prices for 20 species, including those of low value, increased by an average of 16%. This increase was greater than China's annual Consumer Price Index (CPI) during the same period.

Purcell et al (2018) also found that in Hong Kong, sea cucumber retails at up to US$3,583 per kg depending on size and quality. Larger size beche-de-mer (dried sea cucumber) translates into increased revenue due to their premium prices, as well as increased production cost related to the time required for grow-out of larger species. According to Josupeit (2014), the total export value of sea cucumber is estimated at USD$412 million.

Chart 26 Global Value Summary (Source: Author, 2018)

Global Value		
Factor	Shrimp	Sea Cucumber
Most valuable species	*P. vannamei*	*H. Sacbra*
High value characteristics	Large and green/head-on	Large and dried
Industry value	US$37 billion	US$412 million

Local Value - Shrimp

The major species of culture in Belize and at Bel-Euro is the *L. vanamei* (Beltraide, n.d.; J. Sasone, personal communication, June 1, 2018). The export price is estimated at BZ$6.00 to BZ$8.00 per pound between 2014 and 2017 (L. Cruz, personal communication, April 13, 2018). In 2014, the export value peaked at BZ$88,466,472.00. Export forms include peeled and deveined, peeled and undeveined, butterflied, individually quick frozen, head-on and shell-on or as tails

(Food and Agriculture Organization of the United Nations , n.d.). Bel-Euro exports mainly tails (J. Sasone, personal communication, June 1, 2018).

There is a great demand from the international market for large to medium size shrimp; therefore, shrimp farmers provide smaller sized shrimp for local consumption (CTV News, 2014). In a 2014 report, shrimp retailed on the local market between BZ$7.00 and BZ$9.00 per pound (CTV News , 2014).

Local Value – Sea Cucumber

There are eight (8) species of sea cucumbers found in Belize, *Astichopus multifidus, H. mexicana, Actinopyga agassizi, Isostichopus badionotus, Holothuria impatiens, Pseudothyone belli, Euapta lappa* and the *Holothuria thomasi* (Perez & Garcia, 2012). Of these, the most abundant and thus exported species is the *H. Mexicana* (Perez & Garcia, 2012). Belize's wild caught and processed (dried) sea cucumber sells on the export market directly to Hong Kong, USA and Guatemala at prices ranging from US$12 to US$50 per pound, depending on the market (Perez & Garcia, 2012). 2016 selling price is estimated at BZ$10-BZ$11 (L. Cruz, personal communication, April 13, 2018).

Within the span of one year, from 2015 to 2016, local sea cucumber export tripled, generating BZ$318,527 by the end this period while shrimp export declined (L. Cruz, personal communication, April 13, 2018). As of 2016, there were three (3) individual sea cucumber exporters and one (1) fishing cooperative (A. Rogers, personal communication, June 28, 2016).

Chart 27 Local Value Summary (Source: Author, 2018)

Local Value		
Factor	Shrimp	Sea Cucumber
Species commonly produced	*L. vannamei* - farmed	*H. Mexicana* – from the wild
Processed form	Peeled and deveined,	Dried

	peeled and undeveined, butterflied, individually quick frozen, head-on and shell-on or tails	
Selling price	BZ$6-BZ$8 per pound	BZ$10-BZ$11

4.3 Legal Analysis

Operational Requirements

The laws of Belize require that new companies obtain a Memorandum of Association and Articles of Association as part of the formal registration process (Beltraide, n.d.). Additionally, companies must obtain a trade license, register for income and general sales tax, register with the Social Security Board and obtain intellectual property rights (Beltraide, n.d.).

In compliance with Belize's Environmental Protection Act, environmental clearance is required for new projects such as sea cucumber aquaculture to assess the impacts on the environment (Department of the Environment, n.d.). The farming of non-native species requires approval from the Department of the Environment (DOE), the Fisheries Department and the Belize Agricultural Health Authority (BAHA) (A. Rogers, personal communication, November 18, 2017). Fishers also require a fishing license to harvest sea cucumber from the wild for aquaculture purposes (Perez & Garcia, 2012).

Export Requirements

To export, shrimp farms require an export license, customs declaration, commercial invoices, a certificate of the product's origin and a certification of sanitary/health inspection of the facilities and products by BAHA (Beltraide, n.d.). BAHA also issues the Hazard Analysis and Critical Control Points (HACCP) Certification, which demonstrates the farm's commitment to food safety and allows

for trade on the European Union (EU) market (Food and Agriculture Organization of the United Nations , n.d.; General Society of Surveillance, n.d.).

Under Belize's Export Processing Act 2000, a Certificate of Compliance is required to establish an export processing zone business on a company's premises. Further, the Export Processing Act 2000 allows the business to operate solely under the conditions for which it obtained certification.

4.4 Economic Analysis

Economic Benefits

The shrimp industry provides employment for hundreds of Belizeans, particularly from the rural communities (Food and Agriculture Organization of the United Nations , n.d.) and generates millions of dollars for the economy (L. Cruz, personal communication, April 13, 2018). The industry contributes to a variety of sectors including customs brokerage, mechanical and electrical repair and maintenance services, refrigeration installation and maintenance services, trucking, shipping and airfreight services, as well as processing, packaging and marketing services.

Sea cucumber provides significant economic benefit for fishers, their families and thus the economy (Perez & Garcia, 2012). Through local sale of the product, fishers have been able to generate up to BZD$4,500 per month (Perez & Garcia, 2012). There is relatively no local competition, with only one (1) large-scale exporter of sea cucumber in Belize (Perez & Garcia, 2012). The table below shows the Statistical Institute of Belize's (SIB) recorded contribution of sea cucumber (wild caught) and shrimp (farmed) to the economy over the past five (5) years:

Chart 28 Economic Contribution of Sea Cucumber and Shrimp (Source: L. Cruz, personal communication, April 13, 2018)

	2013	2014	2015	2016	2017
Shrimp	14,597,764	14,388,893	9,283,812	1,460,833	1,160,680

Export Net Mass (lbs.)					
Shrimp Export Value (BZ$)	84,069,898	88,466,472	59,672,634	12,682,622	9,137,635
Sea Cucumber Net Mass (lbs.)	-	-	10,158	31,487	-
Sea Cucumber Export Value (BZ$)	-	-	118,655	318,527	-

Economic Forecasts

The Central Bank of Belize (2018) forecasts an increase in shrimp production in 2018, following the recent decline due to disease. Belize's Minister of Agriculture is also optimistic about the revitalization of shrimp industry with the support of stakeholders and improved technology (Channel 5 Belize News, 2018).

The Belize Fisheries Department has not determined whether the sea cucumber fishing season will be open in 2019 (G. Ortiz, personal communication, May 31, 2018).

4.5 Environmental Analysis

EIA Process

Under the Environmental Protection Act of Belize, environmental clearance is required for new projects that may pose environmental risk (Department of the

Environment, n.d.). The environmental clearance or environmental impact assessment (EIA) process is as follows:

- Screening – at this initial stage, the DOE determines whether an EIA is required. The project can obtain clearance or move to the next phase (Department of the Environment, n.d.).
- Scoping - at this stage, the scope of the environmental issues is determined during meetings with DOE and other key stakeholders and outlined in a Terms of Reference (TOR) (Department of the Environment, n.d.).
- Develop EIA – here, the project developer and stakeholders develop and submit the EIA. The National Environmental Appraisal Committee (NEAC) and DOE come to a decision within 60 days (Department of the Environment, n.d.).
- Public Consultation – during this phase, the NEAC considers the public's views (Department of the Environment, n.d.).
- Decision-making – at this stage, the DOE makes a decision and communicates this to the project developer (Department of the Environment, n.d.).
- Monitoring and Compliance – the DOE continuously monitors projects against the Environmental Compliance Plan (ECP) in the EIA. Noncompliance is subject to penalties (Department of the Environment, n.d.).

For sea cucumber aquaculture projects, the establishments of sea cucumber farms, construction of a laboratory, staff quarters, office building, rearing ponds and effluent treatment ponds requires environmental clearance (A. Rogers, personal communication, November 18, 2017).

Environmental Implications

The environmental implications for shrimp aquaculture include the contamination of water resources (surface and ground) and soil due to flooding, habitat destruction

due to land clearing and the introduction of shrimp into the wild in the event they escape from the pond (Jacobs & Wright, 2015).

Sea cucumber aquaculture environmental implications include a reduction in the genetic diversity of the species (Liu, 2016), the clearing of land and thus destruction of natural habitats for the construction of ponds and other facilities (Eriksson, Robinson, Slater, & Troell, 2011), contamination of water resources, surface water bodies and the soil (A. Rogers, personal communication, November 18, 2017). Erosion and flooding could lead to further contamination of water resources by waste associated with the aquaculture process (A. Rogers, personal communication, November 18, 2017).

The following are potential mitigation measures for shrimp and sea cucumber environmental impacts:

- Monitoring of ponds on a weekly basis to assess contamination (A. Rogers, personal communication, November 18, 2017).
- Placing screens on ponds to prevent entry of pathogens and quarantine of any detected (A. Rogers, personal communication, November 18, 2017).
- Obtaining a permit from the Forest Department for the clearing for land as needed (A. Rogers, personal communication, November 18, 2017).
- Ensuring a 66 ft reserve above the pong water mark to mitigate flood impacts (A. Rogers, personal communication, November 18, 2017).
- Repurposing excavated material for use as fill (A. Rogers, personal communication, November 18, 2017).
- Planting trees near canals and developing a slope to prevent erosion (A. Rogers, personal communication, November 18, 2017).
- Ensuring consulation with the Central Building Authority prior to construction of any buildings (A. Rogers, personal communication, November 18, 2017).
- Conducting water quality tests on a quarterly basis (A. Rogers, personal communication, November 18, 2017).

- Ensuring treatment of effluents before discharge (A. Rogers, personal communication, November 18, 2017).

4.6 Financial Analysis

According to the Eriksson et al. (2011), the cost of running a sea cucumber farm is high and its profitability uncertain. Aquaculture farmers reported feed as the costliest expense (Nadkami, 2017). Madagascan aquaculture company, Indian Ocean Trepang received a $2.75 million investment from Aqua Spark in support of its sustainable farming operations (Towers, 2017). Nadkami (2017) cites that the operation employees up to 170 persons and produces 5 metric tons of dried sea cucumber per annum.

The charts below summarize the projected cash flow for shrimp and sea cucumber aquaculture at Bel Euro over the next 5 years, if Bel-Euro successfully manages shrimp disease by 2019:

Chart 29 Cash Flow Projection for Shrimp Aquaculture at Bel Euro (Source: Author, 2018; A. Rogers, personal communication, November 18, 2017; K. Reynolds, personal communication, June 1, 2018; J. Sansone, personal communication, June 1, 2018)

Shrimp					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenue	$ 2,080,000.00	$ 2,184,000.00	$ 2,293,200.00	$ 2,407,860.00	$ 2,528,253.00
Expenses:					
Capital Costs (ponds, equipment, p	$ 800,000.00	$ -	$ -	$ -	$ -
Maintenance	$ 5,800.00	$ 5,916.00	$ 6,034.32	$ 6,155.01	$ 6,278.11
Labour	$ 657,000.00	$ 670,140.00	$ 683,542.80	$ 697,213.66	$ 711,157.93
Feed	$ 278,265.00	$ 283,830.30	$ 289,506.91	$ 295,297.04	$ 301,202.99
Gas, Fuel, Oil	$ 2,600.00	$ 2,652.00	$ 2,705.04	$ 2,759.14	$ 2,814.32
Office Supplies	$ 1,320.00	$ 1,346.40	$ 1,373.33	$ 1,400.79	$ 1,428.81
Insurance	$ 1,000,000.00	$ 1,020,000.00	$ 1,040,400.00	$ 1,061,208.00	$ 1,082,432.16
Legal	$ 2,000.00	$ 2,040.00	$ 2,080.80	$ 2,122.42	$ 2,164.86
Electricity	$ 8,400.00	$ 8,568.00	$ 8,739.36	$ 8,914.15	$ 9,092.43
Water	$ 12,000.00	$ 12,240.00	$ 12,484.80	$ 12,734.50	$ 12,989.19
Internet	$ 900.00	$ 900.00	$ 900.00	$ 900.00	$ 900.00
Other costs	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00
Total Cash Outflow	$ 1,968,785.00	$ 2,008,132.70	$ 2,048,267.35	$ 2,089,204.70	$ 2,130,960.80
Net Cash Flow	**$ 111,215.00**	**$ 175,867.30**	**$ 244,932.65**	**$ 318,655.30**	**$ 397,292.20**

Chart 30 Cash Flow Projection for Sea Cucumber Aquaculture at Bel Euro (Source: Author, 2018; A. Rogers, personal communication, November 18, 2017; K. Reynolds, personal communication, June 1, 2018; J. Sansone, personal communication, June 1, 2018)

Sea Cucumber					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Revenue	$ -	$ -	$ 1,500,000.00	$ 1,725,000.00	$ 1,983,750.00
Expenses:					
Capital Costs (ponds, pipes etc.)	$ 2,700,000.00	$ -	$ -	$ -	$ -
Maintenance	$ 5,800.00	$ 5,916.00	$ 6,034.32	$ 6,155.01	$ 6,278.11
Labour	$ 225,300.00	$ 229,806.00	$ 234,402.12	$ 239,090.16	$ 243,871.97
Feed	$ 186,000.00	$ 189,720.00	$ 193,514.40	$ 197,384.69	$ 201,332.38
Gas, Fuel, Oil	$ 2,600.00	$ 2,652.00	$ 2,705.04	$ 2,759.14	$ 2,814.32
Office Supplies	$ 1,250.00	$ 1,275.00	$ 1,300.50	$ 1,326.51	$ 1,353.04
Insurance	$ 1,000,000.00	$ 1,020,000.00	$ 1,040,400.00	$ 1,061,208.00	$ 1,082,432.16
Legal	$ 2,000.00	$ 2,040.00	$ 2,080.80	$ 2,122.42	$ 2,164.86
Electricity	$ 9,200.00	$ 9,384.00	$ 9,571.68	$ 9,763.11	$ 9,958.38
Water	$ 15,000.00	$ 15,300.00	$ 15,606.00	$ 15,918.12	$ 16,236.48
Internet	$ 900.00	$ 900.00	$ 900.00	$ 900.00	$ 900.00
Other costs	$ 500.00	$ 500.00	$ 500.00	$ 500.00	$ 500.00
Total Cash Outflow	$ 1,448,550.00	$ 1,477,493.00	$ 1,507,014.86	$ 1,537,127.16	$ 1,567,841.70
Net Cash Flow	**$ (1,448,550.00)**	**$ (1,477,493.00)**	**$ (7,014.86)**	**$ 187,872.84**	**$ 415,908.30**

Net Present Value

At a discount rate of 5% the Net Present Value (NPV) for shrimp aquaculture at Bel-Euro at the end of year 5 is $250,464.87. The NPV for sea cucumber is ($4,945,322.35).

Cost-Benefit Analysis

The cost benefit ratio for shrimp aquaculture is .31 ($250,464.87/$800,000). The cost benefit ratio for sea cucumber is -1.8 (-$4,945,322.35/$2,700,000).

4.7 Operations and Management Analysis

The chart below summarizes the operational and managerial factors applicable to shrimp and sea cucumber aquaculture:

Chart 31 Shrimp and Sea Cucumber Aquaculture Operations and Management Analysis (Source: Author, 2018; K. Reynolds, personal

communication, June 1, 2018; J. Sansone, personal communication, June 1, 2018)

	Shrimp	**Sea Cucumber**
Production	• Reared in ponds on land • Approximately 2-3 months to juvenile • Approximately four months to grow-out	• Reared in ponds on land • Approximately 5 days for *H. Mexicana* and 28 days for *I. badionotus* to juvenile • Approximately two years to grow-out
Required Conditions	• Salinity of 5-35 parts per thousand • Mildly sensitive to temperature	• Salinity of 32-35 parts per thousand • Highly sensitive to temperature
Facilities	• Hatchery • Small (semi-intensive), medium (intensive) and large (extensive) ponds	• Hatchery • Large ponds, twice as deep to regulate temperature
Processing	• Processing is not	• Processing will not

	conducted by Bel-Euro	be conducted by Bel-Euro
Supply	• Transported of fresh produce to processing plant on a weekly basis	• To be transported semi-processed to processing plant
Management	• Requires 30 staff	• Requires 8 staff

4.8 Risk Analysis

Disease poses a major threat to both the shrimp (Towers, 2015) and sea cucumber (Han, Keesing, & Liu, 2016) aquaculture industries. Liu (2016) found that sea cucumber is susceptible to more than 15 diseases at various stages of development. However, there are several preventative measures to curb diseases in both industries (Towers, Disease Prevention in Shrimp Farming, 2015; Han, Keesing, & Liu, 2016). The charts below outline the major risks assocaited with shrimp and sea cucumber aquaculture:

Chart 32 Sea Cucumber Aquaculture Risks (Source: Eriksson et al, 2011; Towers L., 2015; Purcell et al., 2012; J. Sasone, personal communication, June 1, 2018; SPC Aquaculture, n.d.; Anderson et. al, 2016)

Shrimp
Diseases
Decrease in market prices
High production costs
Low quality and lack of availability of seedstock
Decrease in growth rate
Lack of availability of food

Natural disasters
Sea Cucumber
Profitability or return on investment uncertainty.
Intensified production can lead to greater environmental impacts.
Disease.
The Sandfish is the only species extensively farmed. There is a lack of scientific research related to the farming of local species.
High mortality rate following settlement due to sensitivity to temperature and salinity.
Floods and hurricanes can destroy facilities and lead to death of species due to low salinity.

CONCLUSIONS

The development of this project management plan and feasibility study led to the following conclusions:

1. The development of this study brought several factors to the surface. Firstly, there is an abundance of available relevant information online about shrimp and sea cucumbers. Therefore, focusing on and narrowing the scope of this project was critical in preventing scope creep and allowing its timely completion. The scope management played an important project management process. It provided a systematic process for defining roles and responsibilities, scope, scope statement, WBS and WBS dictionary, scope verification and control measures allowed for a more accurate scope definition. It forced the project manager to thoroughly analyze the boundaries of the project and thus, it resulted in a more defined scope which could be completed within the project time constraint.
2. Time management supported the definition of project activities and estimated durations, and the visualization of the project schedule. The scheduled allowed for monitoring of the project activities on a weekly basis and in timely completion within the 34 days duration, despite the extensive research involved in the study.
3. The cost management plan provided a systematic process for estimating project resources and arriving at the budget of $15,275. The budget includes a contingency reserve of 5% for known risk and a management reserve for unknown risks. The cost baseline is the basis for the monitoring cost performance using the EVM method.
4. The quality management plan evaluated stakeholder requirements and quality metrics. The metrics critical to ensuring quality included reliability, timeliness, suitability, completeness of this study. The project requirements were managed through the effective application of the quality assurance and control process.
5. The stakeholder management plan supported the identification of relevant stakeholders and their level of power or interest in the project. The busy

schedules of key stakeholders prevented planned participation in areas outlined in the plan. Nonetheless, the plan supported the timely communication that allowed for some degree of movement from the current to desired level outlined in the stakeholder matrix.

6. The communication management plan outlined a strategy for efficient communications with stakeholders identified in the stakeholder management plan. The communications matrix contained therein defined who, what, when and how information would be communicated. It provided further support for the engagement, as required by stakeholders.
7. The risk management allowed the project manager to manage project risks by providing the mechanism for identifying, analyzing, prioritizing and controlling risks. The greatest risk realized throughout the project was the lack of availability of the key stakeholder at Bel-Euro. This risk was accepted and the abundance of information available online supported a reliable study.
8. The market analysis revealed that there is a high demand for shrimp and sea cucumber on the Asian market and this upward trend is expected to continue into the near future. Sea cucumber was found to be a rare and higher value species than shrimp. So much so that the suppliers are unable to meet this demand, thus resulting in the overexploitation in wild species. On the local market there is low demand for both species and it is consumed only by a small fraction of the society. Therefore, the export market is the only means of earning substantial profits via commercialization of these species. Local shrimp farmers and Bel-Euro remain competitive by harvesting highest value shrimp species on the market. The highest value species of sea cucumbers are not native to Belize. However, research has found that lower value species are becoming more popular and now fetch higher prices. Among the most abundant species found in Belize, is the *I. badionotus.* Shrimp has been farmed in the region for many years, however, only Mexico has had success with sea cucumber.

9. The establishment of a sea cucumber or shrimp aquaculture farm is subject to the laws of Belize. These legal requirements are the same. The already established Bel-Euro's shrimp farm eliminates the need for business registration or the establishment of an export processing zone; however, an EIA is required.
10. The economic benefits of shrimp aquaculture are undeniable. It contributes substantially, over $88 million to the economy during period of peak production and provides jobs for Belizeans in various fields. Despite the decline from 2015 due to disease, the Central Bank forecasts an increase in production in 2018. The contribution of wild caught sea cucumbers is minimal with less than $500,000 generated between over the past years.
11. Both sea cucumber and shrimp aquaculture project require approval from the DOE. Approval from the DOE is meant to ensure ongoing compliance to prevent or mitigate impacts. These impacts are similar in nature.
12. The financial analysis revealed that Bel-Euro requires significant investment of approximately BZ$800,000 in technology to recover from the shrimp disease. The cash flow statement shows a slow growth in revenue over the next 5 years. The positive NPV shows that the investment in recovery is worthwhile. On the other hand, the commercialization of sea cucumber requires a substantial investment of over BZ$2 million. Given the time required for sea cucumber to reach maturity, cash flow remains negative up until year 4. Further, the NPV is negative, which indicates the investment is not financially viable over the next 5 years. In both scenarios the cost benefit ratio is less than 1, an indication that both options are unattractive as they exceed the benefits of implementation. This is far greater sea cucumber, given the negative ratio.
13. The management of a sea cucumber farm is less labor intensive than shrimp and thus requires less than half the staff. However, staff would be required to closely monitor sea cucumbers during the juvenile to maturity stage due to their sensitivity to the elements like temperature and salinity. They would also engage in semi-processing, and use new technology or

skills given the depth of the ponds. The study found that shrimp reach the juvenile stage within 2-3 month while the sea cucumber species *H. Mexciana* and *I. badionotus* take, 5 and 28 days, respectively. Shrimp reaches maturity within 4 months while sea cucumber can take up to 2 years.

14. There are several risks associated with shrimp and sea cucumber aquaculture. Diseases and natural disasters are common to both industries. Other risks related to the shrimp industry include the high costs production, low quality and lack of availability of seedstock and food, and a decrease in the species growth rate and market prices, which could all affect profitability. The risks involved in sea cucumber aquaculture include the uncertainty of returns on investment, the high mortality rate of species, lack of related scientific knowledge and the increase in potential environmental impacts due to large-scale production.
15. Finally, the study revealed that the large-scale aquaculture of sea cucumber is not a viable alternative to shrimp aquaculture in the short-term. This is particularly due to the high risk and high investment required from already cash-strapped company combating the outbreak of shrimp disease, as well as the length of time required to realize a profit.

RECOMMENDATIONS

Having completed this feasibility study, the project manager makes the following recommendations:

1. Bel-Euro should investigate low cost technology to increase its cash flow and realize a positive cost-benefit ratio to revitalize its shrimp production.
2. The company should document lessons learnt from the outbreak of shrimp disease to support preventative measures in the future.
3. Given that it took two decades of research for China to successfully rare sea cucumbers, Bel-Euro should seek investments to continue its sea cucumber research with Dr. Rogers.
4. Research should focus on the highest value native species, *I. badionotus*. This will increase future earning potential and value of the research.
5. Bel-Euro should investigate the feasibility of the community-based approach to sea cucumber aquaculture currently being developed in Madagascar (Nagai, 2013). Through a similar initiative, *I. badionotus* can be cultured to the juvenile stage, raised to the desired size in the ocean by local stakeholders, and sold back to Bel-Euro for processing. This reduces the risk of mortality from juvenile to maturity as temperature and salinity are regulated at the ocean floor, based on required depth.

BIBLIOGRAPHY

7 News Belize . (2015 , November 13). *Shrimp Situation Dire*. Retrieved from http://www.7newsbelize.com/sstory.php?nid=34323&frmsrch=1

7 News Belize. (2016, November 30). *Deep Dip For Exports In October*. Retrieved from http://www.7newsbelize.com/sstory.php?nid=38563&frmsrch=1

7 News Belize. (2017, May 9). *Shrimp Industry Unperturbed By Industry Newsletter Headline*. Retrieved from http://www.7newsbelize.com/sstory.php?nid=40269&frmsrch=1

Ambergis Caye Belize. (n.d.). *All About Shrimp* . Retrieved from the Ambergis Caye Belize website : https://ambergriscaye.com/reefbriefs/briefs70.html

Anderson, J. D., Valderrama, D., & Jory, D. (2017, October 16). *GOAL 2017: Global shrimp production review and forecast*. Retrieved from the Global Aquaculture Alliance website : https://www.aquaculturealliance.org/advocate/goal-2017-shrimp-production-survey/

Anderson, J. L., Valderrama, D., & Jory, D. (2016). Retrieved from https://www.aquaculturealliance.org/wp-content/uploads/2017/06/Day1_JimAnderson.pdf

Belize Fisheries Department. (n.d.). *Press Release: Sea Cucumber Fishing Season Notice.* Retrieved from Belize Fisheries Department website: http://fisheries.gov.bz/wp-content/uploads/2017/03/Closure-Sea-Cucumber-Fishery-Press-Release-2017-1.pdf

Beltraide . (n.d.). *Fisheries & Aquaculture*. Retrieved from the Beltraide website : https://www.belizeinvest.org.bz/fisheries--aquaculture.html

Beltraide. (n.d.). *Company Registration*. Retrieved from the Beltraide website : https://www.belizeinvest.org.bz/company-incorporation.html

Beltraide. (n.d.). *Establishing a Business*. Retrieved from the Beltraide website : https://www.belizeinvest.org.bz/establishing-a-business.html

Beltraide. (n.d.). *Export Process*. Retrieved from the Beltraide website : https://www.belizeinvest.org.bz/export-process.html

California State University. (n.d.). *Chapter 1 Basic Concepts of Research in Economics*. Retrieved from the California State University, Sacramento website: http://www.csus.edu/indiv/y/yangy/145ch1.htm

Channel 5 Belize News . (2018, April 12). *Shrimp Industry Fights On*. Retrieved from the Channel 5 Belize News website : http://edition.channel5belize.com/archives/163616

Collins, V. S. (2014, February 3). *Project Management Feasibility Studies*. Retrieved from http://www.velopi.com/news/project-management-feasibility-studies

Conand, C. (2017). *Expansion of Global Sea Cucumber Fisheries Buoys Exports. Revista de Biologia Tropical, 65, 1-1*. Retrieved from https://revistas.ucr.ac.cr/index.php/rbt/article/download/31661/31304

Council, A. S. (2018). *Aquaculture Stewardship Council*. Retrieved from https://www.asc-aqua.org/news/latest-news/belize-shrimp-growers-achieve-asc-certification/

CTV News . (2014, January 9). *Price Of Shrimp Increases, Local Vendors Feel The Pinch*. Retrieved from the CTV News website : http://www.ctv3belizenews.com/index.php?option=com_content&view=article&id=4107:price-of-shrimp-increases-local-vendors-feel-the-pinch&catid=46:featured-news&Itemid=102

Department of the Environment. (n.d.). *Department of the Environment.* Retrieved from Environmental Clearance Process Brochure: http://www.doe.gov.bz/index.php/services/category/7-environmental-clearance-process-brochure

Department of the Environment. (n.d.). *Land Development.* Retrieved from Department of the Environment: http://www.doe.gov.bz/index.php/services/category/9-land-development

Edinburgh Napier University . (n.d.). *Understanding Information Sources* . Retrieved from https://staff.napier.ac.uk/services/hr/Documents/CLandD%20documents/Learning%20Resources/UnderstandingInfoSources-07.11.11.pdf

Eriksson, H., Robinson, G., Slater, M. J., & Troell, M. (2011). *Sea Cucumber Aquaculture in the Western Indian Ocean: Challenges for Sustainable Livelihood and Stock Improvement.* Retrieved from National Center for Biotechnology Information, U.S. National Library of Medicine website: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3357833/

Export Processing Zone Act 2000 (Bze.). (n.d.). Retrieved from the Organisation of American States Foreign Information System: http://www.sice.oas.org/Investment/NatLeg/BEL/Export_ProcsZone_e.pdf

Fabinyi, M., Barclay, K., & Eriksson, H. (2017). *Chinese Trader Perceptions on Sourcing and Consumption of Endangered Seafood.* Retrieved from Frontiers website: https://www.frontiersin.org/articles/10.3389/fmars.2017.00181/full

Fabinyi, M., Liu, N., Song, Q., & Li, R. (2016). Aquatic Product Consumption Patterns and Perceptions Among the Chinese Middle Class. *Science Direct, 7, 1-9.* Abstract retrieved from https://www.sciencedirect.com/science/article/pii/S2352485516300135

Food and Agricultural Organisation of the United Nations . (2018, March 14). *GLOBEFISH - Analysis and information on world fish trade*. Retrieved from Food and Agricultural Organisation of the United Nations : http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/1107034/

Food and Agriculture Organization of the United Nations . (n.d.). *National Aquaculture Overview: Belize*. Retrieved from the Food and Agriculture Organization of the United Nations: http://www.fao.org/fishery/countrysector/naso_belize/en

Future Market Insights. (2017, 08 17). *Shrimp Market: Farmed Whiteleg Shrimps Species Type to Hold High Market Share Throughout the Forecast Period: Global Industry Analysis (2012-2016) and Opportunity Assessment (2017-2027)*. Retrieved from https://www.futuremarketinsights.com/reports/shrimp-market

General Society of Surveillance. (n.d.). *HACCP Certification*. Retrieved from the General Society of Surveillance website https://www.sgs.com/en/agriculture-food/commodities/audit-certification-and-verification/certification/haccp-certification

Han, Q., Keesing, J. K., & Liu, D. (2016). A Review of Sea Cucumber Aquaculture, Ranching, and Stock Enhancement in China. *Taylor & Francis Online, 24, 326-341*. Abstract retrieved from: https://www.tandfonline.com/doi/abs/10.1080/23308249.2016.1193472?src=recsys&journalCode=brfs21

Josupeit, H. (2014). *Sea Cucumber Trade* . Retrieved from the Infopesca website: http://www.infopesca.org/sites/default/files/complemento/actividadesregionales/adjuntos/1215//3%20-%20Sea%20cucumber%20trade%20-%20Helga%20Josupeit.pdf

Library of Congress . (n.d.). *Using Primary Resources*. Retrieved from http://www.loc.gov/teachers/usingprimarysources/

Liu, D. (2016). *A Review of Sea Cucumber Aquaculture, Ranching, and Stock Enhancement in China*. Retrieved from the Research Gate website: https://www.researchgate.net/publication/304216481_A_Review_of_Sea_Cucumber_Aquaculture_Ranching_and_Stock_Enhancement_in_China

Research Method. (n.d.). *In Cambridge online dictionary*. Retrieved from https://dictionary.cambridge.org/dictionary/english/research-method

Nadkami, A. (2017, January 18). *Farm Focus: An Asian Delicacy Raised Feed Free*. Retrieved from http://www.intrafish.com/aquaculture/1205464/farm-focus-an-asian-delicacy-raised-feed-free

Nagai, A. (2013, August 7). RE: Investing Under the Sea: Shrimp and Sea Cucumber Farms Offer Models for Aquaculture Investments [Blog post]. Retrieved from https://nextbillion.net/under-the-sea/

O'Neil, A. (2015, December 17). RE: Qualitative Research Methods [Blog post]. Retrieved from https://blog.optimalworkshop.com/qualitative-research-methods

Perez, A., & Garcia, O. (2012). *Socioeconomic Assessment of the Sea Cucumber Fishery in Belize.* Retrieved from University of Belize Environmental Research Institute website: http://eprints.uberibz.org/1335/

Perez, M. L., & Borwn, E. O. (n.d.). *Market Potential and Challenges for Expanding the Production of Sea Cucumber.* Retrieved from http://pubs.iclarm.net/resource_centre/WF_3034.pdf

Project Management Institute. (2013). *A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fifth Edition.* Newtown Square, Pennsylvania: Project Management Institute, Inc.

Purcell, S. W., Hair, C. A., & Mills, D. J. (2012). Sea cucumber culture, farming and sea ranching in the tropics: Progress, problems and opportunities. *Science Direct 368-369, 68-81.* Abstract retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0044848612005340

Purcell, S. W., Samyn, Y., & Conand, C. (2012). *Commercially Important Sea Cucumbers of the World.* Retrieved from the Food and Agricultural Organisation of the United Nations website : http://www.fao.org/docrep/017/i1918e/i1918e.pdf

Purcell, S. W., Williamson, D. H., & Ngaluafe, P. (2018). *Chinese market prices of beche-de-mer: Implications for fisheries and aquaculture.* Retrieved from the Science Direct website http://www.sciencedirect.com/science/article/pii/S0308597X17308035

Reuters. (2017). *World Bank raises China 2017 growth forecast, maintains 2018 outlook.* Retrieved from https://www.reuters.com/article/us-worldbank-china/world-bank-raises-china-2017-growth-forecast-maintains-2018-outlook-idUSKBN1ED035

Robinson, G., & Lovatelli, A. (2015). *Global sea cucumber fisheries and aquaculture FAO's inputs over the past few years* (Report No. FAN 53). Retrieved from the Research Gate website https://www.researchgate.net/publication/276328588_Global_sea_cucumber_fisheries_and_aquaculture_FAO's_inputs_over_the_past_few_years

Rogers, A., Hamel, J.-F., Baker, S., & Mercier, A. (2018). *The 2009–2016 Belize sea cucumber fishery: Resource use patterns, management strategies and socioeconomic impacts.* Retrieved from the Research Gate website : https://www.researchgate.net/publication/325289457_The_2009-2016_Belize_sea_cucumber_fishery_Resource_use_patterns_management_strategies_and_socioeconomic_impacts

Sicuro, B., & Levine, J. (2011). *Sea Cucumber in the Mediterranean: A Potential Species for Aquaculture in the Mediterranean.* Retrieved from the Academia website : http://www.academia.edu/2556464/Sicuro_B._Levine_J._2012._Sea_cucumber_a_new_candidate_species_for_aquaculture_in_Mediterranean_Sea._Reviews_in_Fisheries_Science_19_3_299_304

SPC Aquaculture . (n.d.). *Commodities: Sea Cucumber* . Retrieved from the SPC Aquaculture website : http://aquaculture.spc.int/index.php?option=com_commodities&view=commodity&id=23

Towers, L. (2015). *Disease Prevention in Shrimp Farming*. Retrieved from The Fish Site website: https://thefishsite.com/articles/disease-prevention-in-shrimp-farming

Towers, L. (2017). *Sustainable Sea Cucumber Farming Operation Receives $2.75 million Investment*. Retrieved from The Fish Site website: https://thefishsite.com/articles/sustainable-sea-cucumber-farming-operation-receives-275-million-investment

University of Belize Environmental Research Institute . (n.d.). *Annual Report 2014-2015.* Retrieved from http://docs.wixstatic.com/ugd/c09ab2_b4b1a2fd03fd4be1807f4ea2940ca481.pdf

University of Belize Environmental Research Institute . (n.d.). *Recent Publications* . Retrieved from http://www.uberibz.org/publications

University of Belize Environmental Research Institute. (2016, July 7). *UB ERI, UWI and Stakeholders Examine Sea Cucumber as a Viable Option for Belize Aquaculture*. Retrieved from http://www.uberibz.org/single-post/2016/07/07/UB-ERI-UWI-and-Stakeholders-Examine-Sea-Cucumber-as-a-Viable-Option-for-Belize-Aquaculture

University of Belize Environmental Research Institute. (2017, January 30). *Sea Cucumber Mariculture Grow-out.* Retrieved from http://www.uberibz.org/single-post/2017/01/27/Sea-Cucumber-Mariculture-Grow-out

University of Belize Environmental Research Institute. (n.d). *Background*. Retrieved from the University of Belize Environmental Research Institute website: http://www.uberibz.org/about-us

University of Belize Environmental Research Institute. (n.d.). *Arlenie Rogers, Ph.D. Marine Research Fellow*. Retrieved from http://docs.wixstatic.com/ugd/c09ab2_2d4a044d21754fb8ae38871eabb5c622.pdf

University of California Irvine Libraries . (n.d.). *Secondary Sources*. Retrieved from https://www.lib.uci.edu/secondary-sources

Wollfe, L. (2017, October 14). RE: How to Write a Feasibility Study Step by Step [Blog post]. Retrieved from https://www.thebalance.com/what-is-a-feasibility-study-3514853

World Wildlife Fund. (n.d.). *Overview*. Retrieved from the World Wildlife Fund website: https://www.worldwildlife.org/industries/farmed-shrimp

Yale University Library. (2017). *Comparative Literature: Primary, secondary & tertiary sources*. Retrieved from the Yale University Library website: https://guides.library.yale.edu/c.php?g=295913&p=1975839

APPENDICES

Appendix 1: FGP Charter

PROJECT CHARTER	
Date	**Project Name:**
November 19, 2017	Feasibility Study: Sea Cucumber Aquaculture as an alternative to shrimp aquaculture at Bel-Euro Aquaculture Limited.
Knowledge Areas / Processes	**Application Area (Sector / Activity)**
Knowledge areas: Integration, Scope, Time, Cost, Quality, Communications, Risk and Stakeholders **Process groups:** Initiation, Planning, Executing, Monitoring and Controlling, Closing	Shrimp Industry, Export
Start date	**Finish date**
November 13, 2017	July 13, 2018

Project Objectives (general and specific)

General objective:
To conduct a feasibility study to determine the viability of sea cucumber aquaculture as an alternative to shrimp at Bel-Euro Aquaculture Limited.

Specific objectives:

1. To develop a project management plan to define the execution, monitoring and control processes for the feasibility study.
2. To perform a market analysis to determine whether there is a market for sea cucumber produced via aquaculture to be a profitable commodity.
3. To perform a legal analysis to determine whether there are any legal requirements for sea cucumber aquaculture.
4. To perform an economic analysis to determine whether sea cucumber provides economic benefits to country.
5. To assess the environmental issues related to this study to determine whether sea cucumber aquaculture would comply with local environmental policies.
6. To perform a financial analysis to determine whether sea cucumber aquaculture would be a viable investment for local shrimp farms
7. To perform an operations and management analysis to determine whether local shrimp farms possess the capacity for successful sea cucumber aquaculture.
8. To perform a risk analysis to identify all the associated risks which could impact the viability of sea cucumber as an alternative to shrimp.
9. To provide conclusions and recommendations based on insights in the study to support stakeholder's decision on whether to pursue sea cucumber aquaculture.

Project purpose or justification (merit and expected results)

All shrimp farms in Belize, which all happen to be privately owned and operated in southern Belize have suffered sustainable losses due to the onset of a shrimp disease called Early Mortality Syndrome since 2015. The industry contributed millions to the country's Gross Domestic Product, therefore, the decline in shrimp production and export has also had a significant impact on the economy. On the other hand, the demand for sea cucumber has grown particularly in the Asian market where it is eaten as a delicacy and used in the production of pharmaceuticals and cosmetics. This growth has led to a general decline in the species due to overfishing, making it difficult to meet export demand. These factors have led stakeholders in shrimp industry to explore sea cucumber an alternate export through large scale production by way of aquaculture.

The idea is that through this project, a feasibility study can be conducted to determine whether sea cucumber aquaculture can be a viable alternative to shrimp. The study will include a market, legal, economic, financial, operations and management and risk analysis which will support an objective recommendation for or against the pursuit of sea cucumber aquaculture. This

project will therefore prove beneficial to the shrimp farms in Belize who would have a sound basis for determining whether to pursue this alternative.

Description of Product or Service to be generated by the Project – Project final deliverables

The project's final deliverable is a document outlining the project management plan which will serve as a guide for implementation of a feasibility study, and a feasibility study that will determine if sea cucumber aquaculture can be viable alternative to shrimp.

The document will include the following deliverables:

1. A project management plan
2. A market analysis
3. A legal analysis
4. An economic analysis
5. An environmental analysis
6. A financial analysis
7. An operations and management analysis
8. A risk analysis
9. Conclusions and recommendations report

Assumptions

It is assumed that the planning and implementation of the study can be completed within three (3) months.
It is assumed that the knowledge gained during the Master in Project Management is sufficient to plan and implement this project.
It is assumed that the necessary resources will be readily available, including scientific research and statistical information to support an objective analysis.
It is assumed that the student has the relevant experience and soft skills to successfully produce a quality document.
It is assumed that the student will have uninterrupted access to technology including internet, laptop and relevant software.

Constraints

Time: The project is to be completed within the allotted time frame of three (3) months.
Cost: The project has a limited budget allocated for the research required for this study.

Preliminary risks

If timely feedback on deliverables is not received, there will be limited time to carefully and accurately address all amendments, resulting in a poor-quality document.
If stakeholders are not willing or able to provide relevant data, this will hinder a thorough analysis and thus compromise the quality and reliability of the recommendations.

Budget

The project budget is $15,275

Milestones and dates

Milestone	Start date	End date
Graduation Seminar Approval	December 11, 2017	December 15, 2017
Tutor Assignment	February 19, 2018	February 19, 2018
Adjustment of previous chapters	February 22, 2018	February 28, 2018
Chapter IV Development (Analysis)	March 1, 2018	May 4, 2018
Chapter V Conclusion	May 7, 2018	May 11, 2018
Chapter VI Recommendations	May 14, 2018	May 18, 2018
Assignment of two reviewers	May 21, 2018	May 22, 2018
Reader 1 & 2 Reports	June 8, 2018	June 8, 2018
Adjustments	June 11, 2018	July 6, 2018
Presentation to Board of Examiners	July 9, 2018	July 13, 2018

Relevant historical information

The University of Belize Environmental Research Institute (UB ERI) was established in 2010 to address the large gap in local capacity for research and monitoring in Belize. As such, the institute's mission is to continuously build national scientific capacity for the effective management, sustainable use and conservation of Belize's natural resources. In 2011, Dr. Arleine Rogers joined the Institute as the Marine Research Fellow and began investing sea cucumbers in Belize. As Belize's lead sea cucumber researcher, Dr. Rogers, has authored and co-authored several publications since her research began in 2011. These include the Socioeconomic study of the sea cucumber fishery in Belize; Density, abundance and distribution of harvested sea cucumbers in Belize (*H. mexicana and I. badionotus*); Reproductive cycle of *H.* mexicana in Belize and Conversion factor study for *H. mexicana* in Belize among others. In 2016, Dr. Rogers met with stakeholders to discuss the fishery which resulted in a collaboration with local shrimp farms to explore the potential for sea cucumber aquaculture. This collaboration has included visits to aquaculture facilities in Mexico and a partnership with Bel-Euro Aquaculture Limited that allows Dr. Rogers to further her research while Bel-Euro explores this option. A research plan has been developed for this purpose, however, a feasibility study has not been conducted.

Stakeholders

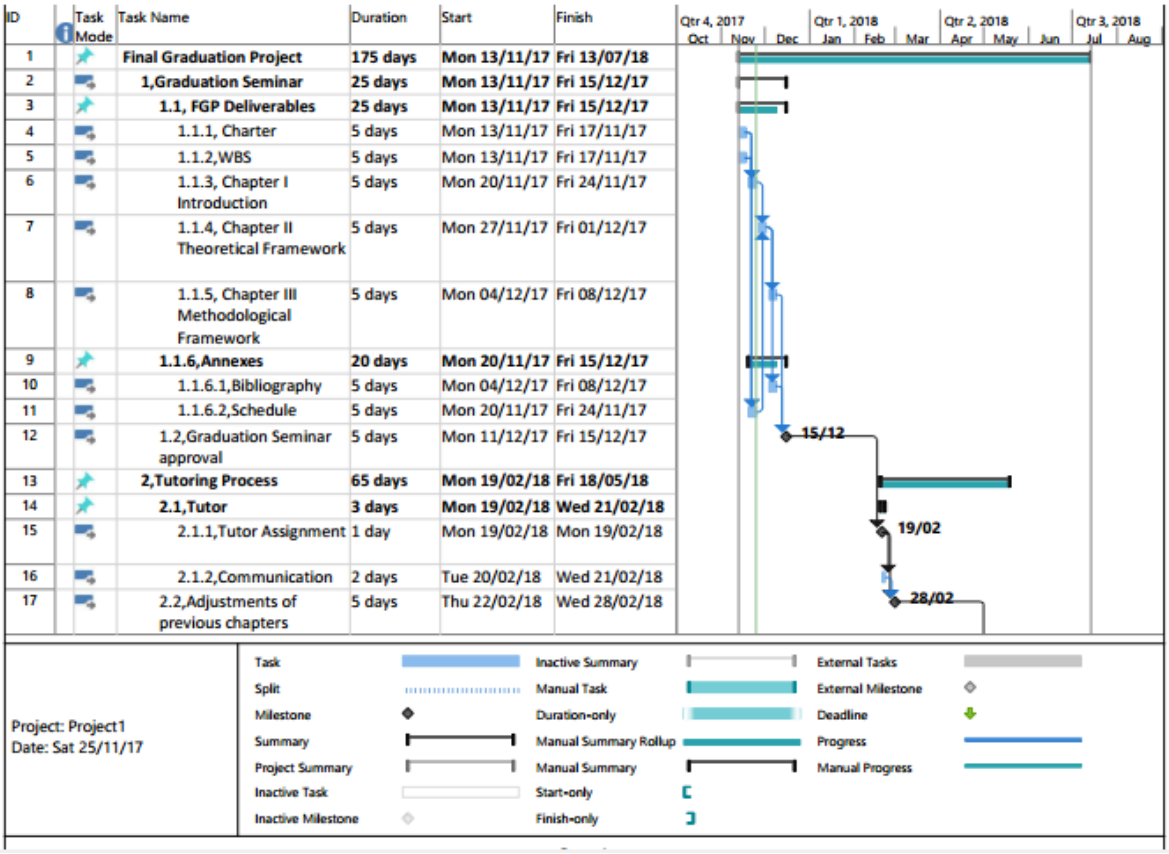
Direct stakeholders:
Global School of Project Management, University of International Cooperation
Student
Course facilitator
Tutor
Academic Assistant
Reviewers
Board of Examiners
Shrimp farms
Belize's lead sea cucumber researcher

Indirect stakeholders:
University of Belize Environmental Research Institute
Classmates
Government and people of Belize
Student's family

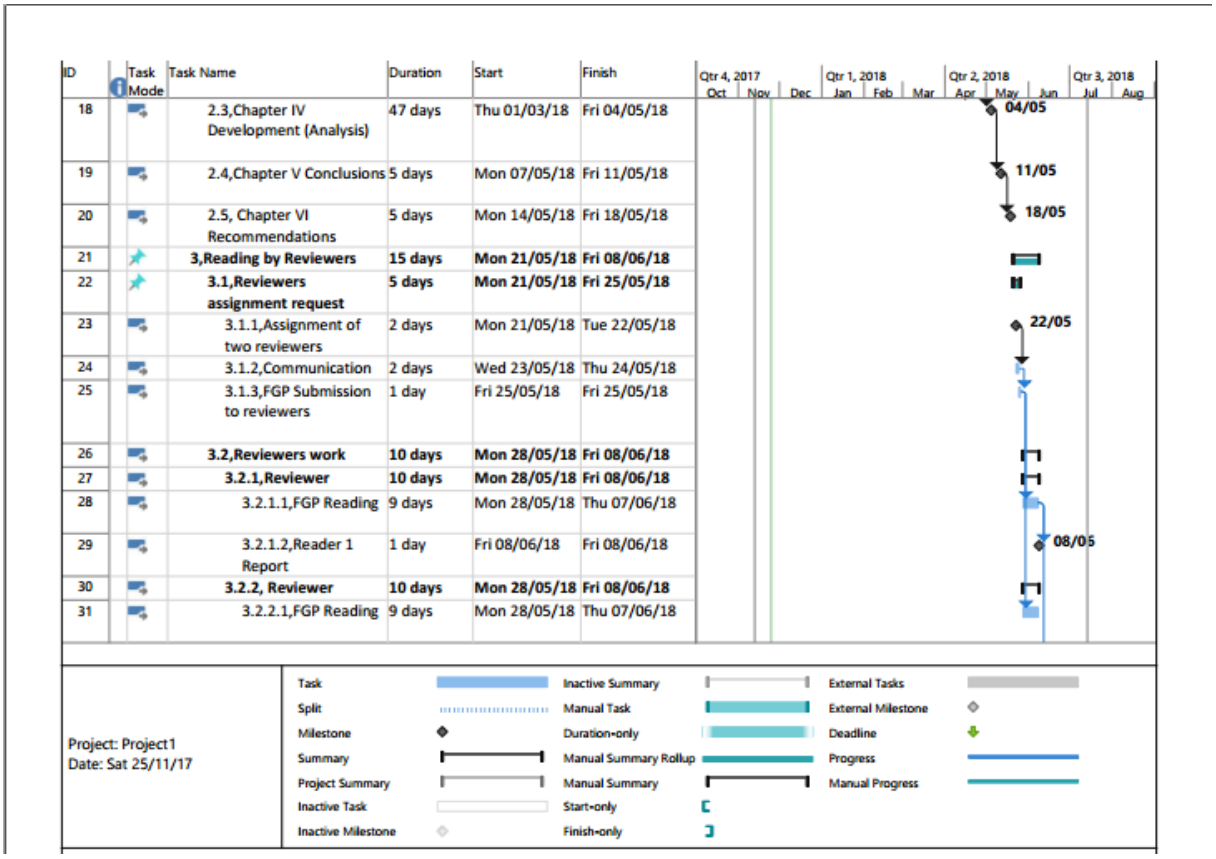
Project Manager: **Pia Gregoire**	**Signature:** 
Authorized by:	**Signature:**

Appendix 2: FGP WBS

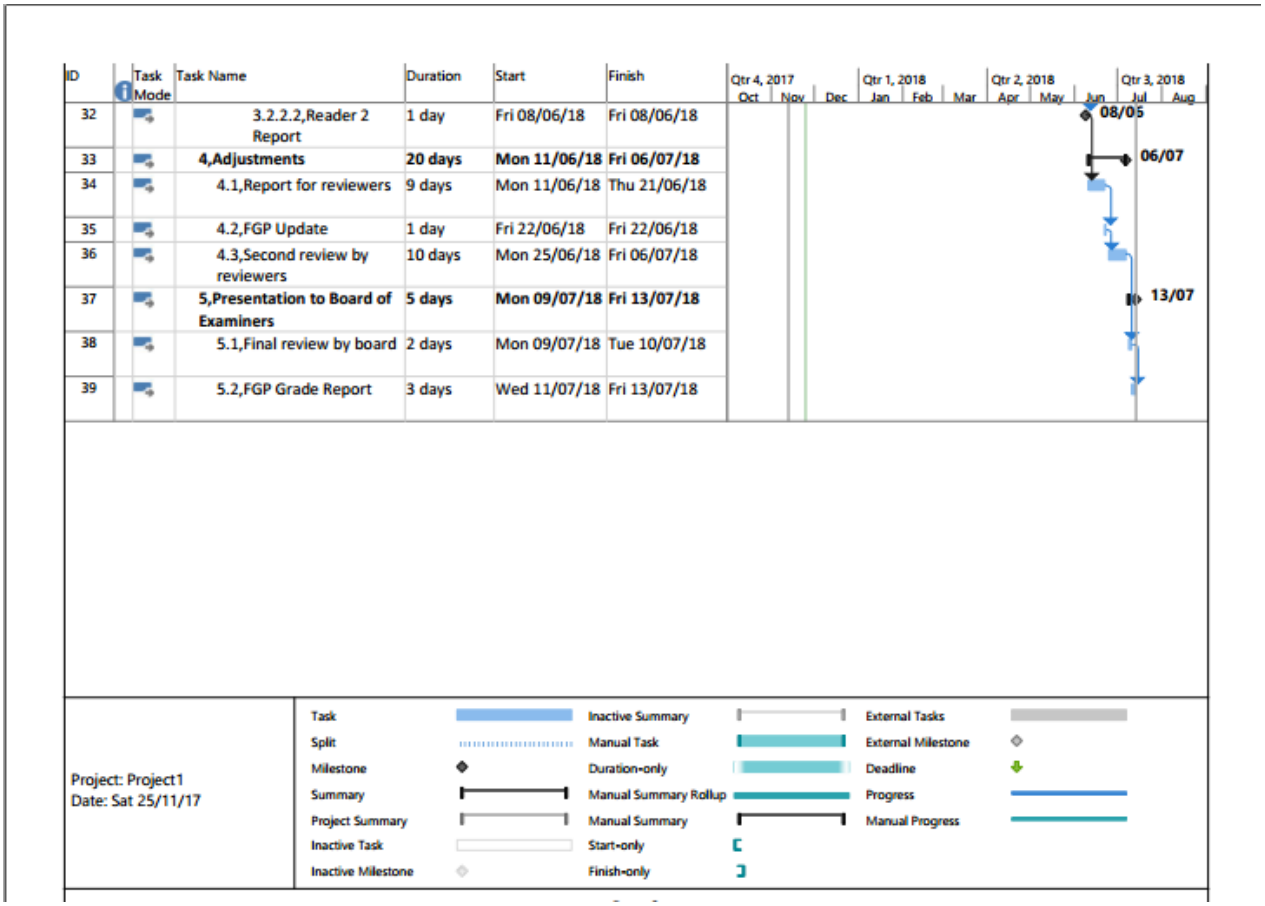
Appendix 3: FGP Schedule



ID	Task Mode	Task Name	Duration	Start	Finish
1		**Final Graduation Project**	**175 days**	**Mon 13/11/17**	**Fri 13/07/18**
2		**1,Graduation Seminar**	**25 days**	**Mon 13/11/17**	**Fri 15/12/17**
3		**1.1, FGP Deliverables**	**25 days**	**Mon 13/11/17**	**Fri 15/12/17**
4		1.1.1, Charter	5 days	Mon 13/11/17	Fri 17/11/17
5		1.1.2,WBS	5 days	Mon 13/11/17	Fri 17/11/17
6		1.1.3, Chapter I Introduction	5 days	Mon 20/11/17	Fri 24/11/17
7		1.1.4, Chapter II Theoretical Framework	5 days	Mon 27/11/17	Fri 01/12/17
8		1.1.5, Chapter III Methodological Framework	5 days	Mon 04/12/17	Fri 08/12/17
9		**1.1.6,Annexes**	**20 days**	**Mon 20/11/17**	**Fri 15/12/17**
10		1.1.6.1,Bibliography	5 days	Mon 04/12/17	Fri 08/12/17
11		1.1.6.2,Schedule	5 days	Mon 20/11/17	Fri 24/11/17
12		1.2,Graduation Seminar approval	5 days	Mon 11/12/17	Fri 15/12/17
13		**2,Tutoring Process**	**65 days**	**Mon 19/02/18**	**Fri 18/05/18**
14		**2.1,Tutor**	**3 days**	**Mon 19/02/18**	**Wed 21/02/18**
15		2.1.1,Tutor Assignment	1 day	Mon 19/02/18	Mon 19/02/18
16		2.1.2,Communication	2 days	Tue 20/02/18	Wed 21/02/18
17		2.2,Adjustments of previous chapters	5 days	Thu 22/02/18	Wed 28/02/18



ID	Task Mode	Task Name	Duration	Start	Finish
18		2.3,Chapter IV Development (Analysis)	47 days	Thu 01/03/18	Fri 04/05/18
19		2.4,Chapter V Conclusions	5 days	Mon 07/05/18	Fri 11/05/18
20		2.5, Chapter VI Recommendations	5 days	Mon 14/05/18	Fri 18/05/18
21		**3,Reading by Reviewers**	**15 days**	**Mon 21/05/18**	**Fri 08/06/18**
22		**3.1,Reviewers assignment request**	**5 days**	**Mon 21/05/18**	**Fri 25/05/18**
23		3.1.1,Assignment of two reviewers	2 days	Mon 21/05/18	Tue 22/05/18
24		3.1.2,Communication	2 days	Wed 23/05/18	Thu 24/05/18
25		3.1.3,FGP Submission to reviewers	1 day	Fri 25/05/18	Fri 25/05/18
26		**3.2,Reviewers work**	**10 days**	**Mon 28/05/18**	**Fri 08/06/18**
27		**3.2.1,Reviewer**	**10 days**	**Mon 28/05/18**	**Fri 08/06/18**
28		3.2.1.1,FGP Reading	9 days	Mon 28/05/18	Thu 07/06/18
29		3.2.1.2,Reader 1 Report	1 day	Fri 08/06/18	Fri 08/06/18
30		**3.2.2, Reviewer**	**10 days**	**Mon 28/05/18**	**Fri 08/06/18**
31		3.2.2.1,FGP Reading	9 days	Mon 28/05/18	Thu 07/06/18



ID	Task Mode	Task Name	Duration	Start	Finish
32		3.2.2.2,Reader 2 Report	1 day	Fri 08/06/18	Fri 08/06/18
33		**4,Adjustments**	**20 days**	**Mon 11/06/18**	**Fri 06/07/18**
34		4.1,Report for reviewers	9 days	Mon 11/06/18	Thu 21/06/18
35		4.2,FGP Update	1 day	Fri 22/06/18	Fri 22/06/18
36		4.3,Second review by reviewers	10 days	Mon 25/06/18	Fri 06/07/18
37		**5,Presentation to Board of Examiners**	**5 days**	**Mon 09/07/18**	**Fri 13/07/18**
38		5.1,Final review by board	2 days	Mon 09/07/18	Tue 10/07/18
39		5.2,FGP Grade Report	3 days	Wed 11/07/18	Fri 13/07/18

Project: Project1
Date: Sat 25/11/17

Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress

Appendix 4: Deliverable Acceptance Form

Project Title: Feasibility Study: Sea Cucumber as an alternative to shrimp in Belize

Deliverable Name: _____

Acceptance Criteria: _____

Verification Method: _____

Approved ( ) Denied ( )

Verified by:

_____ _____

Project Manager Date

Accepted by:

_____ _____

Project Sponsor Date

Appendix 5: Change Request Form

Change Request Number: _____

Project Name: _____

Requester's Name: _____ Email:_____ Phone#:_____

Change Description:

_____
_____
_____

Justification:

_____
_____
_____

Impact:

_____
_____
_____

Areas affected:
( ) Scope
( ) Time
( ) Stakeholders
( ) Quality
( ) Cost
( ) Project Charter

Recommendation:

_____
_____
_____

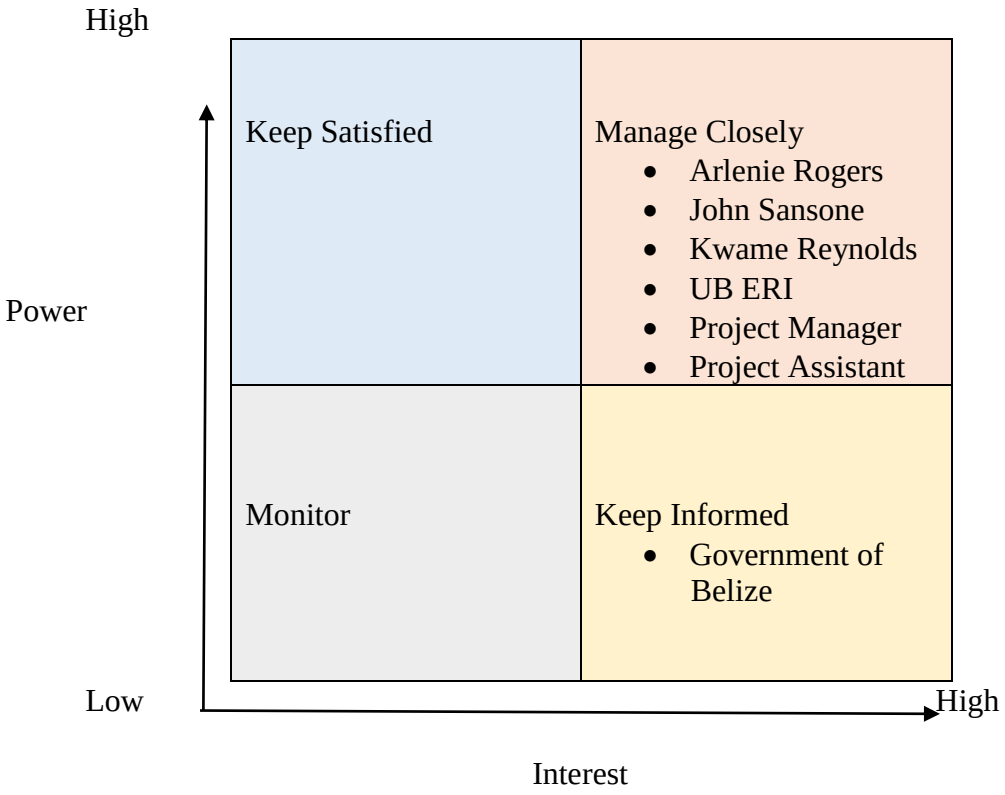
Alternative:

_____
_____
_____

Approved by:

_____ _____
Project Sponsor Date

Appendix 6: Stakeholder Power Interest Grid



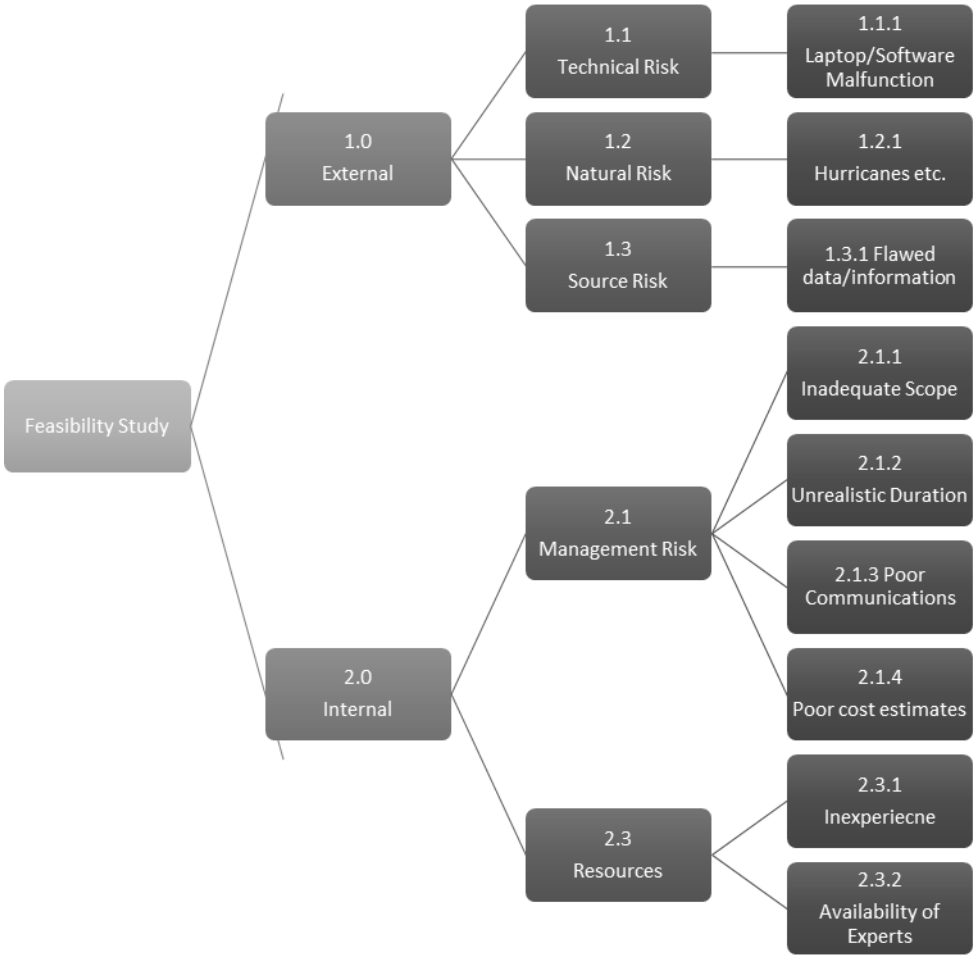
Appendix 7: Stakeholder Register

Project Name:

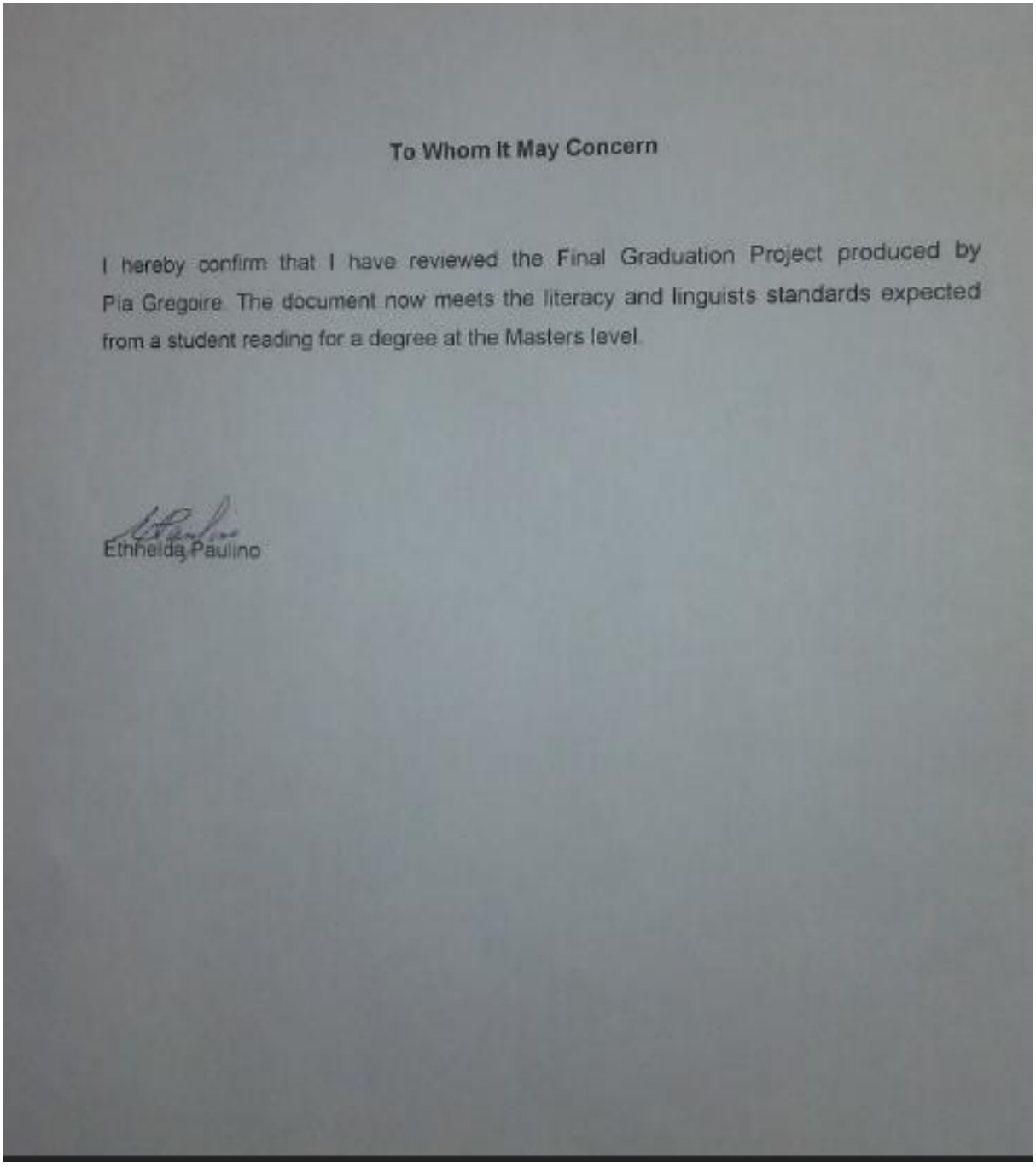
Project Manager Name:

ID	Name of Stakeholder	Role	Main Expectations	Major Requirements	Influence/Impact (Low-Medium-High)	Additional Comments

Appendix 8: Risk Breakdown Structure



Appendix 9: FGP Philology Letter



To Whom It May Concern

I hereby confirm that I have reviewed the Final Graduation Project produced by Pia Gregoire. The document now meets the literacy and linguists standards expected from a student reading for a degree at the Masters level.

Ethnelda Paulino

Appendix 11: Philologist Qualification

Ethnelda Paulino

Email: ethneldabz@yahoo.com

Tel: 501-601-8081; 501-822-2283

Full License: CY 2000-00426

Education

University of the West Indies, 2011	Master of Education- Teacher Education
Connecticut, USA, 2005 -2006	Diploma in Children's Literature
University of the West Indies, 1988	Certificate in Humanities
University of the West Indies, 1989 -1983	Bachelor of Education: Concentration: English Education and Literature
Belize Teachers' College, 1969 -1972	Diploma in Primary Education
General Certificates of Examination, Ordinary Level, London, 1966	English, Sociology
Ministry of Education, Belize,1968	First Class Teachers' Certificate
High School Diploma, Claver College, Punta Gorda, Belize, 1962 -1966	High School Diploma