Practicum On

A Case Study on Addressing Sustainability in DBO Contract for Reconstruction, Expansion and Operation of Pagla STP under Dhaka Sanitation Improvement Project, Dhaka WASA.

By

Mohammad Salim Miah
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A Report submitted to the BRAC Institute of Governance & Development [BIGD] in partial fulfillment of the requirements for the degree of
Masters in Procurement and Supply Management [MPSM].

BRAC Institute of Governance & Development
BRAC University
April, 2025

Declaration

It is hereby declared that

1. The internship report submitted is my own original work while completing degree at BRAC University.
2. The report does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The report does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Letter of Transmittal

Mr. Samir Biswas
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Address: Kha 224, Pragati Saroni
Merul Badda, Dhaka-1212.

Subject: Submission of a Practicum Report on "A Case Study on Addressing Sustainability in DBO Contract for Reconstruction, Expansion and Operation of Pagla STP under Dhaka Sanitation Improvement Project, Dhaka WASA".

Dear Sir,

I am very pleased to submit my Practicum Report titled, "A Case Study on Addressing Sustainability in DBO Contract for Reconstruction, Expansion and Operation of Pagla STP under Dhaka Sanitation Improvement Project, Dhaka WASA". The Report has been prepared as a part of the requirements for the successful completion of my Masters in Procurement and Supply Management at BIGD, BRAC University. This Report presents a comprehensive overview of my practical knowledge gained at Dhaka WASA, along with the insights and analyses conducted during the practicum period.

Throughout the preparation of this report, I have made sincere efforts to ensure its quality and adherence to academic standards. I am grateful for your valuable guidance and feedback during this process, which has greatly contributed to shaping this final submission. I sincerely hope that this report meets your expectations and provides a comprehensive account of my learnings.

Thank you for your time and support.

Sincerely yours,

Mohammad Salim Miah
Student ID -23382005
BRAC Institute of Governance and Development
BRAC University
Date: April 25, 2025.

Non-Disclosure Agreement

This non-disclosure agreement is made and entered into on this 20 day of January, 2025 by and between –

1. Dhaka Water Supply and Sewerage Authority (WASA), an autonomous governmental organization, having its office at 98 Kazi Nazrul Islam Avenue, Kawranbazar, Dhaka-1215 (hereinafter referred to as "The First Party")

and

2. Mohammad Salim Miah, residing at 23 West Nakhalpara, Tejgaon, Dhaka-1215 and currently a student at Brac Institute of Governance & Development, BRAC University (hereinafter referred to as "The Second Party").

Whereas:

- The Second Party desires to access certain confidential and proprietary information of the First Party for the sole purpose of conducting academic research.
- The First Party agrees to disclose such information subject to the terms and conditions set forth herein.

NOW, THEREFORE, in consideration of the mutual promises and covenants contained herein, the parties agree as follows:

1. Definition of Confidential Information: "Confidential Information" refers to any non-public information shared by the First Party with the Second Party, regardless of the format—whether written, verbal, electronic, or otherwise. This includes, but is not limited to, technical data, business strategies, operational procedures, research findings, reports, and any other information explicitly designated as confidential at the time of disclosure.

2. Obligations of the Second Party: The Second Party agrees to:

a) Use the Confidential Information solely for the Academic Purposes.

b) Maintain the confidentiality of the Confidential Information and not disclose it to any third party without the prior written consent of the First Party.

c) Not copy, reproduce any part of the Confidential Information without the First Party's prior written consent.

3. Exclusions from Confidential Information: The obligations of confidentiality shall not apply to information that:

a) Was already known to the Second Party prior to disclosure by the First Party, as evidenced by written records.

b) Becomes publicly available without breach of this Agreement by the Second Party.

4. Term: This Agreement shall remain in effect for a period of 2 (two) years from the date of disclosure of the Confidential Information, unless earlier terminated in writing by the First Party.

5. Return or Destruction of Information: Upon the completion of the Academic Purpose or at the request of the First Party, the Second Party shall immediately return or destroy all copies of the Confidential Information and certify such return or destruction in writing.

6. No License or Ownership: Nothing in this Agreement shall be construed as granting any license or ownership rights to the Second Party in the Confidential Information.

7. Governing Law and Dispute Resolution: This Agreement shall be governed by the laws of Bangladesh. Any disputes arising out of or in connection with this Agreement shall be resolved amicably. If resolution is not possible, disputes shall be submitted to the jurisdiction of the courts of Dhaka.

8. Miscellaneous

a) This Agreement constitutes the entire agreement between the parties with respect to the subject matter hereof and supersedes all prior agreements.

b) Any amendments to this Agreement must be made in writing and signed by both parties.

c) If any provision of this Agreement is held to be invalid or unenforceable, the remaining provisions shall remain in full force and effect.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the date first above written.

On behalf of the First Party,	**On behalf of the Second Party,**
Engr. Quamrun Naher Laily	Mohammad Salim Miah
Addl. Chief Engineer (RP&D)	Student of MPSM
Dhaka WASA.	BIGD, BRAC University.

Acknowledgment

First and foremost, I express my sincere gratitude to the Almighty Allah for granting me the strength, perseverance, and wisdom to complete this Practicum.

I extend my deepest appreciation to Dhaka Water Supply and Sewerage Authority (WASA) for granting me the necessary permission and support to undertake this study. Their cooperation has been invaluable in facilitating access to critical project data and insights.

I am immensely grateful to my academic institution, BIGD, BRAC University, for providing me with the opportunity to pursue my master's degree in Procurement and Supply Management. I sincerely thank my esteemed Academic Supervisor & Adjunct Faculty in MPSM, BIGD, BRAC University & National Trainer on Public Procurement of Bangladesh, **Mr. Samir Biswas,** and Workplace Supervisor & Addl. Chief Engineer (RP&D), Dhaka WASA, **Ms. Quamrun Naher Laily**, for their continuous guidance, constructive feedback, and encouragement throughout the research process. Their insights and expertise have greatly enriched this study. I am also grateful and thankful to **Ms. Tanzina Mizan**, Sr. Academic Co-ordination Officer, BIGD, BRAC University for her relentless co-operation & support in pursuing this MPSM course.

My sincere thanks also go to my colleagues and fellow researchers who have contributed their time, knowledge, and valuable perspectives, helping me refine and enhance my analysis. Additionally, I acknowledge the efforts of all stakeholders, consultants, contractors, and project personnel involved in the Design-Build-Operate (DBO) contract for the Reconstruction, Expansion, and Operation of Pagla Sewage Treatment Plant (STP). Their input and cooperation have been crucial in shaping the findings of this study.

Finally, I am deeply grateful to my family, friends, and colleagues for their unwavering support, patience, and encouragement throughout this academic journey. Their belief in me has been a source of motivation and strength.

This study is a culmination of collective efforts, and I remain responsible for any errors or omissions within this work.

Mohammad Salim Miah
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Executive Summary

Dhaka, the capital city of Bangladesh, faces significant challenges in wastewater management, with existing sewerage facilities covering only 20% of its population. Dhaka Water Supply and Sewerage Authority (WASA) has undertaken an initiative to bring the core city area into a planned sanitation system- the reconstruction and expansion of Pagla STP is a part of that plan.

This practicum report explores the integration of sustainability principles in the Design-Build-Operate (DBO) Contract by assessing the incorporation of environmental, social, and economic sustainability and providing recommendations for improving contract structuring and long-term sustainability in wastewater infrastructure projects. The study also identifies gaps in Pagla STP's existing DBO contract and proposes strategies to enhance efficiency and sustainability throughout the project lifecycle.

The methodology adopted in this study includes a qualitative and analytical approach, with data collected through literature reviews, key informant interviews (KIIs), stakeholder consultations, field observations, and focus group discussions (FGDs). Comparative analysis and SWOT assessments were used to benchmark the sustainability performance of the Pagla STP against similar projects globally.

Key findings highlight the sustainable design and operational features of the Pagla STP, such as:

- **Water Quality Improvement**: The project aims to treat 200 million liters per day (MLD) of sewage, significantly reducing pollution in the Buriganga River and improving aquatic ecosystems.
- **Greenhouse Gases (GHG) Reduction**: The project incorporates anaerobic digestion to capture methane and generate biogas, which will be used for power generation, thereby reducing environmental impact.
- **Energy Efficiency and Renewable Energy Use**: The plant will utilize energy-efficient motors, LED lighting, and solar power for 10% of its total lighting load, enhancing energy sustainability.
- **Sludge Management**: Anaerobic digestion will reduce sludge volume by approximately 30%, lowering disposal costs and promoting circular economy principles.
- **Community Benefits**: The installation of modern odor control systems will improve air quality, while the provision of a septage decanting station will extend sanitation services to hard-to-reach areas.
- **Carbon Footprint Reduction**: The project is expected to result in a net emission reduction of -605,466 tCO_2-eq, aligning with global climate goals.

The study concludes that the DBO contract structure effectively integrates sustainability measures, enhancing environmental protection, social equity, and economic viability. Recommendations include refining contract documents to further incentivize sustainable practices, strengthening stakeholder engagement, and incorporating advanced technologies for enhanced resource recovery. By implementing these measures, the Pagla STP project can serve as a model for future sustainable wastewater infrastructure projects in Bangladesh and beyond.

Keywords: Sustainability; Design-Build-Operate (DBO) Contract; Greenhouse Gas (GHG); Biogas; Energy Efficiency; Circular Economy; Sewage; Pagla Sewage Treatment Plant (STP); Dhaka WASA etc.

List of Acronyms

BOD	Biochemical Oxygen Demand
BS	British Standard
CAS	Conventional Activated Sludge
COD	Chemical Oxygen Demand
DB	Design, Build
DBO	Design, Build and Operate
DPP	Development Project Proforma
EEA	European Environment Agency
ESIA	Environmental and Social Impact Assessment
FGDs	Focused Group Discussions
GHG	Green House Gases
GoB	Government of Bangladesh
IoT	Internet of Things
ISO	International Organization for Standardization
IWA	International Water Association
KIIs	Key Informant Interviews
LCA	Life Cycle Assessment
MBR	Membrane Bioreactor
MLD	Million Liters per Day
OECD	Organization for Economic Co-operation and Development
PAD	Project Appraisal Document
PIM	Project Implementation Manual
PPPs	Public-Private Partnerships
PPSD	Project Procurement Strategy Document
SCADA	Supervisory and Data Acquisitions System
SDG	Sustainable Development Goals
STP	Sewage Treatment Plant
SWOT	Strengths, Weaknesses, Opportunities and Threats
TSS	Total Suspended Solids
UNEP	United Nations Environment Program
UNEP	United Nations Environment Programme
WASA	Water Supply and Sewerage Authority
WEF	Water Environment Federation
WHO	World Health Organization

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CHAPTER ONE: INTRODUCTION

1.1 Context and Background

Dhaka, the capital city of Bangladesh, is the home of about 22 million people. The first pipe-borne sewerage system in Dhaka was constructed in 1923. Dhaka WASA started its journey in 1963 with a mandate for providing water supply and sewerage facilities in Dhaka. A remarkable development of sewerage works in Dhaka City was done under the 1st Project (1966-1979) by the financial assistance of the World Bank where 208 km of sewerage line and 7 (Seven) nos. of Sewage Lifting Stations were constructed. Later on, three projects namely the 2nd Interim Project (1979-1985), the 3rd Interim Project (1985-1993) and Urgent Sewerage Construction & Rehabilitation Project were executed where different sewerage infrastructures were built. However, it is observed that the pace of the development of this sector is always behind the requirement due to many folds of limitations.

The existing sewerage facilities in Dhaka cover only 20% of the city dwellers. Presently, Dhaka city has two sewage treatment plants-one at Pagla and another at Dasherkandi. The capacity of the recently constructed Dasherkandi sewage treatment plant (STP) is 500 MLD and that of Pagla STP, which was constructed in 1978, is 120 MLD. Dhaka WASA took an initiative to meet the requirement by implementing its Sewerage Master Plan prepared in 2014 in order to bring the whole city area into a planned sanitation system.

According to the Master Plan, Dhaka Metropolitan Development Plan (DMDP) area (1528 km^2) has been divided into 12 (twelve) sanitation catchments. However, the core city area has been divided into 5 (five) sanitation catchments. These are (i) Pagla catchment, (ii) Dasherkandi catchment, (iii) Rayerbazar catchment, (iv) Uttara catchment and (v) Mirpur catchment.

The existing sewerage system in Pagla catchment is not fully functional due to blockages/damages in the transmission lines (Trunk Mains), inadequate capacity and dilapidated conditions of the collection networks etc. In addition, the growth of the city's sanitation facilities is not like other urban infrastructures development to cope up with the rapidly swelling population.

As a part of the implementation of the sewerage master plan, Dhaka WASA as well as the Government of Bangladesh has taken an initiative for the rehabilitation/reconstruction/ expansion of the sewerage system in Pagla catchment area under the Dhaka Sanitation Improvement Project (DSIP). The following major works are being implemented under DSIP: (i) Reconstruction, Expansion and Operation of Pagla STP (200 MLD) with state-of-the-art technology, (ii) Reconstruction of Eastern Trunk Main (12 km), and (iii) Reconstruction of Western Trunk Main (6 km) (iv) Construction/Reconstruction of sewage collection networks (462 km).

1.2 Statement of the Problem: It is well known that the resources in the world are limited and sustainability means meeting the present demands without compromising the ability of future generations to meet their own needs. The integration of sustainability in **Design-Build-Operate (DBO) contracts** remains a significant challenge in the construction and infrastructure sectors. Despite increasing awareness of environmental, social, and economic sustainability, many DBO projects fail to incorporate sustainable practices effectively. This can lead to inefficient use of resources, increased carbon footprints, and long-term operational inefficiencies. A study is needed to contribute to the development of more sustainable wastewater infrastructure projects by identifying the gaps in the implementation of sustainable practices in DBO contracts.

1.3 Objectives:

(i) The specific objective of the study is to identify the gaps in the implementation of sustainability principles in the DBO Contract of 'Reconstruction, Expansion, and Operation of Pagla STP under Dhaka Sanitation Improvement Project'.

(ii) The study aims to diagnose sustainable design, construction and operational strategies of wastewater infrastructure projects.

(iii) The study also assesses the effectiveness in enhancing economic, social and environmental outcomes and provides recommendations for overcoming the gaps in wastewater infrastructure projects.

1.4 Sustainability: The general concept of sustainability is meeting our present own needs/requirements without compromising the ability of future generations to meet their own needs/requirements. It encompasses a balance among environmental health, social equity, and

economic viability for ensuring long-term well-being and resilience. It is all about maximizing economic viability (Profit), reducing the damage to the environment (Planet), and the well-being of the social issues (People).

1.5 Design-Build-Operate (DBO) Contracts: DBO contracts are an innovative approach to delivering urban infrastructure projects, including sanitation systems. These contracts integrate the design, construction, and operation phases under a single entity, ensuring efficiency and accountability. This type of contract enables a seamless transition from design to operation, ensuring that sustainability goals set during planning are implemented during execution and maintenance. This type of contract also integrates different processes to reduce redundancies and thus promotes the efficient use of resources and sustainability. In this type of contract, the Contractors do get the chances for the preparation of an innovative and efficient design considering the life cycle costs. Some DBO contracts link payments to performance metrics leading to high-quality service delivery and maintenance. Even, some DBO contracts encourage to use of advanced technology for recovering energy, nutrients etc. from the waste, which may promote a circular economy and thus sustainability. Even in some DBO contracts, the Contractors may be incentivized during the operational phases, which can ultimately ensure long-term sustainability. Again, the roles and responsibilities of the Employer as well as the Contractor may be clearly defined in this type of contract. These clearly defined roles and responsibilities in DBO contracts promote transparency, accountability and reduce inefficiencies, and thus enhance sustainability.

1.6 Limitation of the Study: (i) The study has been confined to focusing only on the Contract Agreement signed between VA Tech Wabag Limited (the Contractor) and Dhaka Water Supply and Sewerage Authority (the Employer). On the other hand, as the Contract is in the implementation phase, the actual achievement after the incorporation of different sustainable practices couldn't be verified.

(ii) At the other end of the spectrum, the limited time available for conducting the Study marks the boundaries of the Results.

CHAPTER TWO: LITERATURE REVIEW

Design, Build and Operate contracts have become one of the widely used procurement methods in infrastructure development projects. This type of contract integrates the design, construction and operation phases under a single contractual entity. This approach enhances efficiency, and cost-effectiveness and thereby promotes sustainability throughout the project lifecycle. Existing research on addressing the sustainability of DBO contracts in terms of environmental, social, and economic points of view will be examined in this section.

Social sustainability emphasizes engaging stakeholders, benefiting communities, and ensuring worker well-being. It is very important to incorporate social impact assessments into Design, Build, and Operate (DBO) contracts to ensure equitable project outcomes (Anderson, Brown, & Lee, 2019). Besides this, involving communities in decision-making enhances transparency and strengthens public support for infrastructure projects. Furthermore, maintaining fair labor practices and prioritizing occupational health and safety are essential for sustainable project implementation (Kumar, Sharma, Patel, & Gupta, 2020).

Environmental sustainability in DBO contracts focuses on reducing ecological impact, enhancing energy efficiency, and adhering to environmental regulations. Research suggests that incorporating sustainability criteria early in the contract process can enhance environmental outcomes (Zhang, Wu, Shen, & Skitmore, 2018). Life Cycle Assessment (LCA) is recognized as a valuable method for assessing the long-term environmental effects of DBO projects (Gibson & Pullen, 2020) Additionally, adopting green technologies and using sustainable materials can substantially lower carbon emissions and minimize waste production (Chen & Xu, 2021).

Economic sustainability in DBO contracts is associated with financial viability, cost efficiency, and long-term value generation. Research highlights the importance of performance-based incentives in encouraging contractors to adopt sustainable practices (Smith, Williams, & Green, 2021). Additionally, Public-Private Partnerships (PPPs) have been examined as a strategy for enhancing financial stability by balancing risks and responsibilities between public and private stakeholders (Jones & Carter, 2018). Implementing whole-life costing approaches further aids decision-making by assessing cost impacts throughout the project's duration (Harris & White, 2019).

CHAPTER THREE: Approach and Methodology

3.1 General Approach: This case study employed a qualitative and analytical approach focusing on evaluating the sustainability aspects of the Design, Build and Operate contract for the Pagla Sewage Treatment Plant (STP). The study explored how environmental, social and economic sustainability was integrated into the Contract by finding out the gaps in the implementation of DBO Contract for "Reconstruction, Expansion and Operation of Pagla STP"..

In order to do so, the key areas of the Study included the facets, but not limited to, are mentioned below:

- The technical sustainability i.e. the efficiency and long-term functionality of the infrastructure.
- The environmental sustainability i.e. the wastewater treatment efficiency, efficient management of sludge and carbon footprint reduction etc.
- The economic sustainability i.e. the cost-effectiveness, financing mechanisms and long-term viability.
- The social sustainability i.e. community impact, stakeholder engagement and health benefits etc.
- The regulatory and policy compliance i.e. adherence to national and international environmental and sustainability standards etc.
- Find out the gaps in the implementation phase with regard to sustainability and look for ways of strategies to fill up the gaps with recommendations.

3.2 Methodology: The study was conducted in the following structured phases:

3.2.1 Literature Review: The globally used DBO contract models in wastewater treatment were reviewed. The assessment of sustainability criteria in similar wastewater projects was also conducted in the study. The Dhaka WASA policies, DSIP reports and relevant regulatory frameworks were also studied in detail.

3.2.2 Data Collection: To make the data collection more comprehensive, data was collected from two different sources – one is Primary Data Source and another is Secondary Data Sources. The Primary data were collected through Key Informant Interviews (KIIs) i.e. through discussions with different stakeholders including Dhaka WASA Officials, Contractors, Consultants, Social Experts and Environmental Experts etc. with the help of a questionnaire that has been attached herewith as in **Appendix A**. The data were also gathered from field observations. The construction site was also visited to assess ongoing work, and sustainability features. It was not possible to observe the operational challenges as the design-build period was not completed and the operational period will start after that. Some of the data was also collected through Focus Group Discussions (FGDs) by way of community interactions to understand their perceptions of sustainability in the project. Some data was also collected from the project-related documents such as ESIA Reports, PAD, DBO Contract, PPSD, Feasibility Study Report, DPP of the Project, Sustainability reports of similar international projects, related documents of GoB etc. After getting the data, the comparative analysis i.e. benchmarking the sustainability performance of the Pagla STP was done against similar projects globally. Following SWOT analysis, the strengths, weaknesses, opportunities and threats in implementing sustainability measures were identified. At the same time, the potential risks for sustainability were identified and necessary mitigation measures were proposed for those potential risks.

CHAPTER FOUR: Best Practices for Wastewater Treatment.

A comprehensive approach that integrates environmental, economic, and social dimensions is required to ensure sustainability in wastewater infrastructure projects. The following best practices related to wastewater treatment have been derived from global case studies, research reports, and industry guidelines:

4.1 Related to Environmental Sustainability: The adoption of the following measures may promote environmental sustainability:

4.1.1. Energy-Efficient Wastewater Treatment Technologies: The use of low-energy treatment technology such as constructed wetlands, anaerobic digestion and membrane bioreactors (MBR) etc. can contribute a lot in enhancing environmental sustainability. By reducing dependency on fossil fuels i.e. use of renewable energy sources such as solar, biogas, wind etc. can play a vital role in promoting environmental sustainability. The use of fine-bubble diffusers may be used to optimize oxygen transfer which ultimately consumes low energy and thus enhances environmental sustainability **(Water Environment Federation (WEF), 2020)**.

4.1.2 Resource Recovery and Circular Economy: The reuse of water, biogas production and nutrient recovery may be three good options for resource recovery and circular economy. The treated wastewater may be reused for irrigation purposes, groundwater recharges and industrial processes etc. The anaerobic digester may be used for arresting biogas produced in the treatment system and this gas can be used for energy generation. The nutrients such as phosphorous, nitrogen may be recovered from wastewater and these nutrients can be used later in agriculture **(UN-Water, 2021)**.

4.1.3 Climate Resilient and Adaptation: The best practice is that the sewage treatment plant should be designed in a way that the treatment plant is capable to withstand extreme weather, droughts and flooding etc. The authority may also conduct climate risk assessment to plan adaptive measures in well ahead of time **(The World Bank, 2019)**.

4.2 Related to Social Sustainability: The following measures may promote social sustainability in a sewage treatment plant:

4.2.1 Stakeholders' Engagement and Public Awareness: The best practice to integrate local knowledge into project planning is to conduct stakeholders' consultation and the public may be educated about the benefits of the wastewater treatment plant and pollution reduction **(UN-Habitat, 2019)**.

4.2.2 Inclusive Employment and Capacity Building: The best practice is to ensure gender inclusivity in workforce hiring and capacity-building programs **(The World Bank, 2018)**.

4.2.3 Public Hygiene and Health Improvement: The best practice is to maintain strict effluent quality standards following the existing laws and regulations of the country **(WHO, 2021)**.

4.3 Related to Economic Sustainability: The following best practices may promote economic sustainability in a sewage treatment plant-

4.3.1 Use of Cost-Effective Design, Build & Operate Contracts: The use of performance-based contracts may contribute to economic sustainability as these types of contracts will ensure long-term efficiency and maintenance. The assessment of life-cycle cost analysis prior to any contracting will ensure the optimization of design and operational costs **(International Water Association (IWA), 2020)**.

4.3.2 Digitization and Smart Monitoring: The use of IoT Sensors and SCADA Systems will contribute to economic sustainability by monitoring the quality of water on a real-time basis and thus reducing costs. The implementation of predictive maintenance by using AI-driven Analytics may be another option that can contribute to economic sustainability **(European Environment Agency (EEA), 2022)**.

4.3.3 Sustainable Financing and Tariff: Contracting through the Public-Private Partnerships (PPP) Model will encourage economic sustainability. The implementation of Polluter-Pays Principles especially for commercial customers will promote economic sustainability. The use of Smart Water Pricing such as progressive tariffs and block tariffs will encourage the rational use of water and thus wastewater. This pricing mechanism will contribute to economic sustainability **(OECD, 2017)**.

4.4 Governance and Policy Best Practices: Strong regulatory frameworks that align with national and international water quality standards such as WHO, ISO etc. will promote sustainable practices. Conducting an Independent Environmental Audit will ensure compliances and thus enhances sustainable practices **(UNEP, 2020)**. The Environment and Social Impact Analysis (ESIA) must be conducted prior to the implementation of any wastewater project. Grievance Redress Mechanism shall be established to address stakeholders' concerns.

CHAPTER FIVE: DATA ANALYSIS AND RESULTS

5.1 Data Analysis: Reconstruction, Expansion and Operation of Pagla STP is one of the major works packages under the Dhaka Sanitation Improvement Project, Dhaka WASA. This Contract is now under implementation stage. The Contract Documents, the Employer's Requirement of the Contract, DPP of the Project, Project Implementation Manual (PIM), Project Appraisal Document (PAD), and Environmental and Social Impact Assessment (ESIA) Report were checked and necessary data related to sustainability were extracted from those reports. As per the proposal submitted by the Contractor, the treatment process of the plant is based on Conventional Activated Sludge with partial nitrification. Further, the sludge to be generated from the treatment plant will be anaerobically digested to generate biogas which in turn will be used for the generation of power using gas engines.

It was found that the treatment plant consists of the following units: Inlet Distribution Chamber, Pre-Treatment Facility, Primary Treatment Facility Secondary Treatment Facility, Disinfection Facility, Treated Effluent Discharge Facility, Sludge Treatment Facility, Gas Processing Facility, and Gas Engine, Odor Control Facility, Chemical Treatment Facility, and Auxiliary Units etc.

Pre-Treatment Facility: The Pre-treatment comprises of units for the removal of solid substances viz. floatables, rags, grit etc. are removed from the wastewater.

Primary Treatment Facility: This section receives the screened and gritted Sewage. In this part of the treatment plant, a substantial amount of influent total suspended solids (TSS) and a portion of influent BOD are removed.

Secondary Treatment Facility: The principle of biological treatment is to convert soluble or dispersed organic wastewater constituents, which cannot be removed from the wastewater by preliminary & primary treatment, into biomass. Thus, the pollutants are converted into a settleable form, which in turn can be removed from the wastewater by a final sedimentation step.

Disinfection Facility: For maintaining fecal coliform effluent discharge limits in the treated sewage, a Disinfection system is provided for the secondary treated sewage.

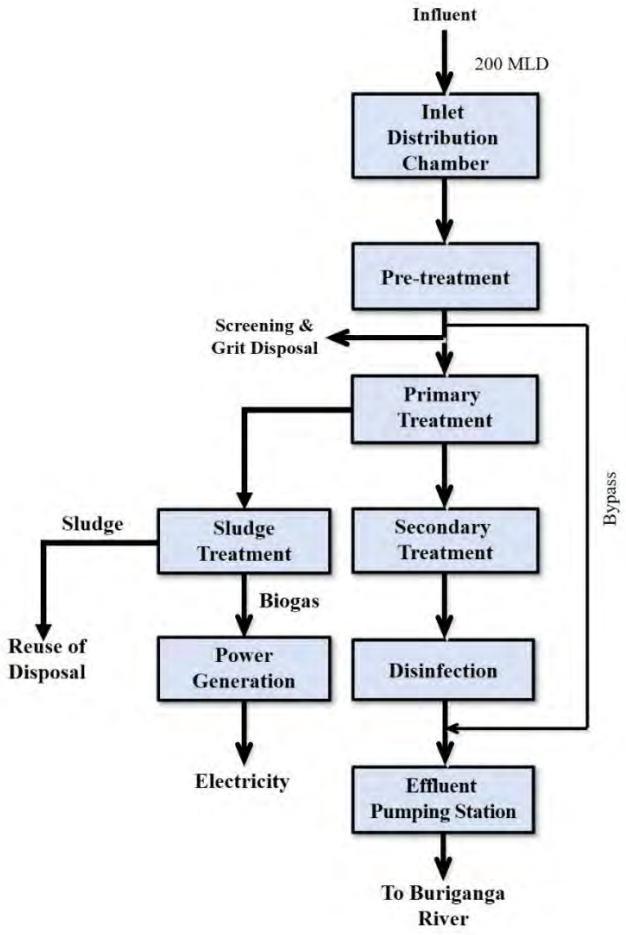

Figure 1: Process Flow Diagram

Design Capacity: The design capacity of the treatment plant is 200 MLD i.e. 200,000 m^3/day. Considering the factor of safety as 1.5, the treatment plant will be able to treat a peak flow of 12.5 x 1000 m^3 per hour. Considering the equity, a provision in the treatment plant has been kept for treating an amount of 30 m^3 of septage/fecal sludge per day.

Influent Sewage Characteristics: The Treatment Plant will be designed considering the following influent wastewater characteristics:

Table 1: Influent Sewage Characteristics:

Parameter	Unit	Sewage	Septage
BOD	mg/l	350	800

COD	mg/l	750	4000
TSS	mg/l	400	6600
TKN-N	mg/l	60	-
pH	--	6.5 to 8	-
Fecal Coliform	MPN/100 ml	10^7	-
Minimum Sewage Temperature	Deg C	20	20
Maximum Sewage Temperature	Deg C	31	31

Effluent Characteristics: The effluent quality requirements to be met at the Chlorine Contact Tank outlet are listed below:

Table 2: Effluent Characteristics

Parameter	Unit	Values
pH		6.5-8
BOD_5	mg/L	$\leq$ 30
TSS	mg/L	$\leq$ 30
COD	mg/L	$\leq$ 120
TAN = NH_3-N + NH_4-N	mg/L	$\leq$ 15
Fecal Coliform	MPN/100 ml	$\leq$1000

Salient Features of the Treatment Plant: The Salient Features of the Pagla sewage treatment plant that enhance or promote sustainability have been summarized below:

e) Improving the water quality of the Buriganga river: About 200 MLD of sewage flowing to the Buriganga river will be treated by the sewage treatment plant and thereby the pollution of the river water will be reduced. As a result, "Life below Water" will be improved which is fully aligned with the SDG-2030.

f) Improving the Livability index of the area nearby: Raw sewage which is one of the sources of odor emissions creates a nuisance to the public nearby. However, in the Employer's Requirement of this design, build, and operate contract, it was found that the Contractor will install a modern odor control system that will improve air emission quality surrounding the STP and increase the livability index of the region. This also indicates the enhancement of the sustainability practices.

g) GHG Reduction: The treatment process of the sewage treatment plant normally generates greenhouse gases such as methane, siloxane etc. which are detrimental to the environment. However, it was found from the Employer's Requirement that these greenhouse gases produced in the anaerobic digester will be arrested and further utilized for power generation which ultimately enhances sustainability.

d) Sludge Disposal: It was found from the Contract that there is an anaerobic digester in the treatment process. Because of the utilization of an anaerobic digester, the volume of the sludge will be reduced by approximately 30% leading to lower disposal costs i.e. lower operational costs. These lower operational costs enhance the sustainability of the treatment plant.

e) Power Generation from Biogas: There is a provision in the Contract that the biogas that will be produced in the anaerobic digester will be utilized for power generation. The plant has been designed in a way that a total electricity amounting to 0.284 kWh will be consumed per m^3 of wastewater inflow treated and out of this 0.1 kWh per m^3 will be generated from the biogas engine. The produced electric power shall be used directly at Pagla STP. In addition, a system will be installed to warm the Anaerobic Digester using the waste heat generated from the gas generator. This system of energy recovery from waste promotes green energy and thus sustainability.

f) Solar Power Generation: As per the Contract, 10% of the total lighting loads in the Plant will be met from solar power generation. This will encourage the use of renewable energy and thus ultimately sustainability.

g) Usage of Energy Efficient Motors and LED Lighting Fixtures: As per the Contract, the Contractor will have to use Energy Efficient Motors, Pumps, and lighting fixtures to reduce energy consumption. The Contractor will have to use a Variable Frequency Drive (VFD) for high-capacity motors based on the process requirements, which helps in reducing overall power consumption. The minimum efficiency of the pump will be 80%, and that of the motor will be 95%. These energy-efficient equipment and Variable Frequency Drive will promote the sustainability of the treatment plant.

h) Septage Decanting Station: In pursuit of an equitable society, there is a provision in the Contract for the construction of a septage decanting station in the treatment plant for co-treatment of the septage. This Decanting Station will be able to receive and treat an amount of 30 m^3 of septage per day. This septage will be collected from the hard-to-reach area where the construction of the sewerage network may not be technically feasible. This provision shall contribute to the equitable society which ultimately promotes the sustainability of the treatment plant.

i) Reduced Carbon Footprint: As per the Project Appraisal Document (PAD) of Dhaka Sanitation Improvement Project published by the World Bank (Page 28 of 78), "The net emission reductions because of wastewater collection and treatment for Component 2 are greater than the net emission increases under Component 3, leading to estimated net emissions of −605,466 tCO_2-eq for the project overall. Thus, the project is expected to result in an overall net emissions reduction. The combined gross emissions are 2,589,325 tCO_2-eq and the combined average annual net emissions are −15,137 tCO_2-eq." The above data clearly indicate that the treatment plant reduces the Carbon Footprint and thus promotes the sustainability of the treatment plant.

Again, the questionnaire developed to evaluate sustainability is based on three key dimensions: Environmental, Social, and Economic, along with their respective indicators. This assessment tool was then reviewed by project personnel from DSIP, who are directly involved in project implementation. The evaluation employed a three-tiered rating system: highly sustainable, moderately sustainable, and least sustainable. A numerical scale from 1 to 3 was used, where 3 signifies the highest sustainability level, 2 represents moderate sustainability, and 1 indicates the lowest sustainability level.

The Environmental dimension assessment included the following factors: (a) Land utilization, (b) Energy consumption, (c) Air pollution, (d) Odor emissions, (e) Noise and other disturbances, (f) Chemical usage, (g) Sludge generation, (h) Pollutant removal efficiency, and (i) Presence of toxic substances.

The Social dimension assessment focused on: (a) Public safety, (b) Cultural acceptability, (c) Employment generation, (d) Local development, and (e) Required skill levels.

The Economic dimension assessment considered: (a) Construction costs, (b) Operation and maintenance costs, (c) Land acquisition costs, (d) Salaries and wages, (e) Health and safety

expenditures, (f) Resource utilization costs, and (g) Financial viability of production and waste management.

Table 3 presents the nine environmental sustainability indicators concerning the studied treatment technique.

Table 4 provides the five social sustainability indicators concerning the studied treatment technique.

Table 5 summarizes the six economic sustainability indicators reflecting the studied treatment technique.

Table 3: Indicators of the Environmental Dimension of Sustainability -

Sl. No.	**Indicator**
1	Land utilization
2	Energy consumption
3	Air Pollution
4	Odor emission
5	Noise and other disturbances
6	Chemical usage
7	Sludge generation
8	Pollutant removal efficiency
9	Presence of toxic substances

Table 4: Indicators of the Social Dimension of Sustainability -

Sl. No.	**Indicator**
1	Public safety
2	Cultural acceptability

Sl. No.	Indicator
3	Employment generation
4	Local Development
5	Required skills level.

Table 5: Indicators of the Economic Dimension of Sustainability -

Sl. No.	Indicator
1	Construction costs
2	Operation & maintenance costs
3	Land acquisition costs
4	Salaries and wages
5	Health and safety expenditures
6	Resource utilization costs
7	Financial viability of production and waste management

5.2 Result Discussion**:** After the scrutiny of different data, it was found that the indicators of Environmental Dimension were awarded 41% points, the indicators of Social Dimension were awarded 28% points out of , and the indicators of Economic Dimension were awarded 31% points. Therefore, it is evident that the environmental dimension had the highest impact on overall sustainability, while the social dimension contributed the least. As a result, the ranking of sustainability contributions follows this order:

Environmental Dimension > Economic Dimension > Social Dimension.

Figure-2 presents a Pie Chart illustrating the percentage contribution of each of the three dimensions to overall sustainability.

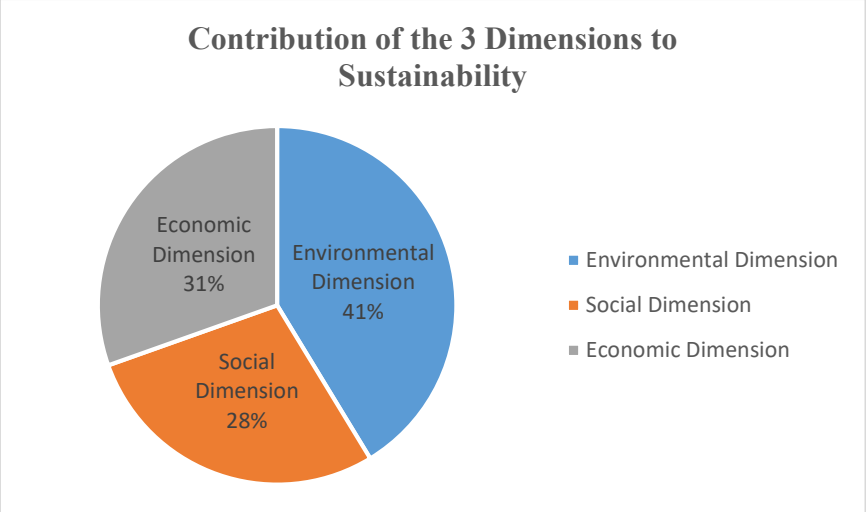

Figure 2: Contributions of the 3 Dimensions to Sustainability

It is to be noted here that some gaps found in the DBO Contract regarding sustainability are enumerated below:

(i) The Contractor is responsible for the years of operation of the STP. About 200 metric tons of sludge will be produced per day as a by-product from the treatment plant. The Contractor is responsible for disposing of the said sludge for the 2nd and 4th years of operation of the treatment plant. However, in the 1st, 3rd and 5th years of operation of the treatment plant, the Contractor will dispose of by dumping of the sludge upon the approval from the Employer in the available existing vacant lagoon situated at the Pagla premises. This type of disposing of sludge indicates a clear lack of sustainability for the proper management of the sludge of the treatment plant.

(ii) As per the Contract, the Contractor will discharge the effluent directly to the nearby river Buriganga, during its operational contract period. From the effluent parameters, it is clear that the quality of effluent is much better than that of water in the Buriganga and may be used for industrial purposes. This effluent may also be used for domestic purposes with a further slight treatment. The recycling of water may be a good promotion for the enhancement of sustainability in a sewage treatment plant.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions:

This practicum report explored the integration of sustainability principles in the Design-Build-Operate (DBO) contract model for the reconstruction and expansion of Pagla STP under the Dhaka Sanitation Improvement Project (DSIP). The findings reveal that while the DBO contract framework provides a promising avenue for long-term infrastructure efficiency, actual sustainability outcomes depend heavily on effective contract structuring.

It is evident from the Practicum report that all the key sustainability aspects such as environmental protection, resource recovery, energy optimization, and social inclusivity have been partially addressed through the design considerations. It was also found that during the selection of the Contractor, fifteen years' life-cycle costs were also considered, though only five years' operational responsibility lies with the Contractor. However, some gaps remain in some areas such as sludge management innovation, the reuse of treated wastewater, community engagement and nutrients recovery.

The Pagla STP contract also demonstrates how sustainability can be embedded within urban sanitation infrastructure development when guided by international standards such as ISO, BS etc., clear contractual obligations, and strategic planning.

6.2 Recommendations:

i. The inclusion of sustainability clauses i.e. sustainability performance indicators such as carbon footprint, energy recovery within the DBO contract, and ensuring their linkages with payment milestones.

ii. Promotion of circular economy practices i.e. inclusion of mechanisms for power generation, nutrient recovery, and water recycling to enhance the environmental and economic sustainability of the STP.

iii. Capacity enhancement of Dhaka WASA personnel in life-cycle costing assessment, sustainability assessment and contract management to ensure efficient monitoring and enforcement of sustainability commitments.

iv. Foster stakeholders' involvement through awareness campaigns, grievance redressal mechanisms, and FGDs to build ownership and transparency.

v. Inclusion of climate resilience-related clauses in the contract so that the infrastructures are designed with future climate risks such as extreme rainfall and flooding.

vi. Encouraging the contractors to propose and implement innovative sustainability solutions by offering performance-based incentives.

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Appendix A

Sustainability Assessment Questionnaire

BRAC Institute of Governance and Development (BIGD)
BRAC University

Topic: Addressing Sustainability in DBO Contract for Reconstruction, Expansion and Operation of Pagla STP under Dhaka Sanitation Improvement Project, Dhaka WASA.

Instructions: This is a sustainability assessment questionnaire for conducting a case study on Addressing Sustainability in DBO Contract for Reconstruction, Expansion and Operation of Pagla STP under Dhaka Sanitation Improvement Project, Dhaka WASA. The objective of this study is to evaluate the contribution of the different indications of environmental, social and economic dimensions to Sustainability. This study is a part of the fulfillment of the requirements for the degree of Masters in Procurement and Supply Management at BRAC Institute of Governance and Developments, BRAC University.

The information provided by the Respondents will be kept confidential and will be used for academic purposes only. Please evaluate each criterion by selecting the most appropriate rating based on your assessment. Use the following scale:
3: Highly Sustainable
2: Moderately Sustainable
1: Least Sustainable

Section 1: Environmental Dimension:

Sl. No.	Description of the Indicators	Scale 1 to 3		
1	To what extent is land utilization optimized for sustainability?	1	2	3
2	How efficient is energy consumption in the project?	1	2	3
3	How effectively is air pollution controlled?	1	2	3
4	How well are odor emissions managed?	1	2	3
5	What is the level of noise and other disturbances caused by the project?	1	2	3
6	What is the level of noise and other disturbances caused by the project?	1	2	3
7	How effectively is sludge generation controlled and disposed of?	1	2	3
8	How efficient is the pollutant removal process?	1	2	3
9	How effective is the removal of toxic substances in the project operations?	1	2	3

Section 2: Social Dimension:

Sl. No.	Description of the Indicators	Scale 1 to 3		
10	How well does the project ensure public safety?	1	2	3
11	To what extent is the project culturally acceptable to the local community?	1	2	3

Sl. No.	Description of the Indicators	Scale 1 to 3		
12	How significantly does the project contribute to employment generation?	1	2	3
13	How effectively does the project support local development?	1	2	3
14	What is the skill level required for employment in the project?	1	2	3

Section 3: Economic Dimension:

Sl. No.	Description of the Indicators	Scale 1 to 3		
15	How cost-effective are the construction expenses?	1	2	3
16	How well are operation and maintenance costs managed?	1	2	3
17	How feasible are the land acquisition costs?	1	2	3
18	How well are salaries and wages structured in the project?	1	2	3
19	How effectively are health and safety expenditures planned and utilized?	1	2	3
20	How efficiently are resources utilized in the project?	1	2	3
21	How financially viable is the project's production and waste management process?	1	2	3

Additional Questions:

22. Are there any specific challenges faced in maintaining environmental sustainability?

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23. How does the project ensure long-term economic viability?

Additional Comments:
(Please provide any relevant feedback or observations regarding the sustainability aspects of the project.)

We appreciate your time and valuable insights in contributing to this sustainability assessment!

Signature of the Respondent (Optional)