Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis

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Abstract

This study evaluates the solar photovoltaic (PV) adoption at Pasig Elementary School in an objective and subjective approach through assessing both its economic and financial viability, and the perceived effectiveness of the stakeholders involved. The study utilizes a Cost-Benefit Analysis (CBA), the Consumer Behavior Theory, and viable constructs of the Technology Acceptance Model (TAM), through these, the research applies a mixed-method approach that integrates both financial estimation and stakeholder assessment. The adoption's Net Present Value (NPV) and Internal Rate of Return (IRR) were computed using its capital cost, maintenance costs, and historical electricity cost and consumption records. The results of the study show that the projected NPV and IRR yields negative outcomes, indicating that the investment, under its current conditions, does not indicate economic and financial viability. However, when the project's NPV and IRR were assessed through theoretical estimates through literature-based capital cost assumptions, both the NPV and an IRR yielded positive results, also exceeding the 10% discount rate. Findings from the survey of 100 stakeholders, consisting of students, non-teaching personnel, and teachers, indicate positive perceptions regarding the usefulness and ease of use of the adoption. The findings enable viable policy recommendations that aims to strengthen Republic Act No. 9513.

Keywords: Solar Photovoltaic, Cost-Benefit Analysis, Technology Acceptance Model, Net Present Value, Internal Rate of Return, Perceived Usefulness, Perceived Ease of Use.

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List of Acronyms

Acronym	Meaning
ANEEL	Agência Nacional de Energia Elétrica
AQI	Air Quality Index
CBA	Cost-Benefit Analysis
DOE	Department of Energy
DOF	Department of Finance
FiT	Feed-in Tariff
IPO	Input Process Output
IRR	Internal Rate of Return
kWh	Kilowatt-hour
NDC	Nationally Determined Contribution
NPV	Net Present Value
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
PV	Photovoltaic
RA	Republic Act
RE	Renewable Energy
SDG	Sustainable Development Goals
TAM	Technology Acceptance Model

Chapter 1

Background of the Study

This chapter includes this thesis' introduction, followed by its statement of the problem, objectives of the study, its significance, and lastly, the scope and delimitations are established in order to clarify this study's coverage and limitations.

Introduction

The inherent problem of scarcity gave birth to the study of economics, as limited resources and unlimited human wants coexist. According to Mankiw (2021), the ever-present dilemma with regard to scarcity has shaped how societies allocate, conserve, and innovate, because as to be observed, scarcity forces individuals and nations to make the most rational choices about resource use, prioritization, and long-term sustainability. The history of the global landscape serves as evidence that energy, in particular, has historically been one of the most critically scarce resources, given that it fuels economic growth according to the International Energy Agency (2022). Consequently, as humanity has progressed, innovations have been made in order to address scarcity, among these innovations are sustainable technologies such as solar photovoltaics (PV) which provide a renewable alternative to fossil fuels, which are not merely finite but also major contributors to carbon dioxide emissions and climate change. As per the U.S. Energy Information Administration (2024), solar PV is defined as systems that generate electricity through converting photons from sunlight to electrons by the use of semiconductor materials, which is typically silicon, enabling the production of usable electricity without combustion or emissions. In a study conducted by Thu et al. (2025) it was observed that using solar energy lowers the dangerous emissions of sulfur dioxide and carbon dioxide, which helps to maintain stability in the current atmospheric conditions and create cleaner air.

Thus, solar PV is not merely about answering the problem of scarcity, but concurrently about promoting environmental sustainability and reducing dependence on harmful traditional energy sources. Converting from fossil fuels to renewable energy is a crucial aspect in achieving the preservation of the planet's limited natural resources and preventing the detrimental health effects of climate change towards human life according to Krueger et al. (2024). The United Nations is one of the most prominent international agencies that strongly support solar photovoltaic (PV) adoption given that as emphasized by Azmi et al. (2024), solar PV directly advances the UN Sustainable Development Goals through the provision of clean and reliable energy that reduces dependence on traditional energy sources such as fossil fuels. Further literature substantiates the importance of natural resource management such as the one by Wang & Azam (2023) through illustrating that it is a pressing issue globally and stating that ensuring sustainability over the long-term is a necessity especially with the existence of growing populations, economic development, and demand for natural resources.

However, despite the evident advantages of renewable energy, its high upfront capital cost serves as a significant barrier, consequently discouraging even those capable of adoption, and completely excluding those on the contrary. It is to be observed that costs are the most significant challenges in the adoption of renewable energy in many countries, leading to a hindrance in adoption, as evidenced by existing literature. According to Khalid et al. (2021), the high initial costs for renewable energy adversely affect the consumer's perception of renewable energy, leading to the slow adoption of the aforementioned technologies. Data from a study conducted by Casila (2022), shows the impact of renewable energy's high upfront capital cost with the Philippines still being highly dependent on fossil fuels with 67 percent of its primary energy supply (TPES) in 2019 accounting for fossil fuels.

What is often overlooked is that costs entailed within solar PV's adoption are offset over time through the means of its significant savings on electricity costs and environmental benefits. For this reason, there is a need to empirically evaluate the actual effectiveness of solar PV systems. There must exist concrete proof, supported by data, that solar PV is not merely environmentally sound but also economically viable. This thesis seeks to provide that proof, in order to encourage broader and more confident adoption, especially among public institutions. An opportunity to evaluate the effectiveness of solar PV arises in the case of Pasig Elementary School, a school residing in a location labeled as a "Green City".

According to One Planet Network, as of 2017, Pasig Elementary School, adopted solar PV technology and remains among the earliest publicly documented cases of solar PV installation in a public elementary school in Pasig City. In addition to being the subject of solar PV's evaluation within a public educational institution, Pasig Elementary School's case may also serve as a testament of the long-term benefits of renewable energy by providing data that serves as evidence that could promote solar PV adoption despite its high initial cost, contributing to further adoption extending beyond the aforementioned city and in itself. To determine whether the advantages of Pasig Elementary School's adoption of solar PV outweigh its costs, a Cost-Benefit Analysis (CBA) will be conducted in this thesis. The CBA will incorporate essential financial metrics of both the Internal Rate of Return (IRR) and Net Present Value (NPV).

Moreover, an analysis of the perceived effectiveness of the solar PV adoption will be conducted, through this, the thesis is able to integrate a qualitative component. Both the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) under the Technology Acceptance Model (TAM) will evaluate how stakeholders perceive the system's effectiveness. This thesis provides a more thorough comprehension of effectiveness given its composite analysis, as it utilizes both objective and subjective methods of evaluation through its objective Cost-Benefit Analysis and the TAM constructs of PU and PEOU that also considers subjective user experience.

Although this study does not directly measure the impact of RA 9513 on Pasig Elementary School's adoption of solar PV, results from both analyses of the CBA and perceived effectiveness will provide data that is able to impart understanding of adoption barriers and stakeholder concerns relevant to solar PV adoption within the public education sector. The aforementioned results will serve as a basis for identifying gaps that the current legislation has not yet fully addressed. Therefore, this thesis includes a SOP that aims to propose evidence-based improvements to Republic Act 9513, making certain that the law becomes more accessible and effective especially for the benefit of public educational institutions.

The findings and results of this study will contribute to the decision of institutions that are considering adoption towards renewable energy especially of public schools and will aid policymakers in formulating policies concerning renewable energy, further contributing to the Philippines' alignment with its commitment to greenhouse gases emission reduction and avoidance of 75% in the submitted Nationally Determined Contribution (NDC) in 2021 under the Paris Agreement. Lastly, this study is also parallel to the United Nations Sustainable

Development Goals (SDGs), particularly of SDG 7 "Affordable and Clean Energy" and SDG 13 of "Climate Action".

Statement of the Problem

Given that solar energy is being marketed as an economic and sustainable substitute for traditional electricity yet its adoption remains limited regardless, its financial and economic viability especially for public institutions must be legitimized. Hence, it is of the essence to determine its effectiveness, whether the benefits of the adoption outweigh its significant costs.

Therefore, this study seeks to answer the following questions:

1. What are the demographic and economic characteristics of the respondents from Pasig Elementary School that include teachers, non-teaching personnel, and students in terms of the following, as applicable:
    a. Age
    b. Gender
    c. Monthly household income
    d. Level of education
    e. Monthly electricity bill
2. What is the economic and financial viability of Pasig Elementary School's solar PV adoption based on the metrics of:
    a. Cost-Benefit Analysis (CBA)?
    b. Net Present Value (NPV) and Internal Rate of Return (IRR)?

3. What is the perceived effectiveness of Pasig Elementary School's solar photovoltaic adoption based on a Likert-scale that includes:
    a. Perceived Usefulness (PU)
    b. Perceived Ease of Use (PEOU)
4. Based on the Cost-Benefit Analysis and the perceived effectiveness of Pasig Elementary School's solar photovoltaic adoption, what improvements towards Republic Act 9513 can be proposed to increase the effectiveness and accessibility of solar PV?

Objectives of the Study

In general, this thesis aims to determine if the solar PV adoption at Pasig Elementary School is both financially and economically viable, perceived as effective, and to recommend policy improvements within RA 9513. Hence, to address the research's problems, this study will:

1. Describe the demographic and economic characteristics of the respondents from Pasig Elementary School that include teachers, non-teaching personnel, and students based on applicable variables through a structured survey.
2. Evaluate the economic and financial viability of Pasig Elementary School's adoption of solar photovoltaic (PV) technology through:
    a. Identifying the post-adoption recovered cost of capital through a Cost-Benefit Analysis (CBA);
    b. Analyzing the Net Present Value (NPV) and Internal Rate of Return (IRR).

3. Identify the perceived effectiveness of Pasig Elementary School's solar PV adoption through the Technology Acceptance Model (TAM) constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), based on the responses of teachers, non-teaching personnel, and students using a Likert-scale.
4. Propose improvements towards Republic Act 9513 that can increase the effectiveness and accessibility of solar PV adoption based on the Cost-Benefit Analysis and the perceived effectiveness of Pasig Elementary School's adoption.

Significance of the Study

The objective of this research is to assess the economic, financial, and perceived effectiveness of solar PV adoption at Pasig Elementary School. By integrating both Cost-Benefit Analysis (CBA) and the Technology Acceptance Model (TAM) constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU).

Entire Population

Ultimately, the results and findings of this study will hold substantial value not merely for stakeholders involved, but also to the entire population. It must be acknowledged that according to Holcombe (1997), Paul Samuelson defines air as a public good since it is neither excludable nor competitive, this means that the entire population benefits from environmental improvements resulting from renewable energy.

Educational institutions

Educational institutions, especially public schools, will be able to utilize the results of this study in determining investments toward renewable energy through this research's supply of information regarding the tangible financial and economic benefits of solar PV technology.

Policymakers

Policymakers are to also benefit from this research through the study's provision of information regarding the financial viability of solar PV technology within the context of a public school, especially with the provision of improvements toward Republic Act 9513 in this thesis, this influences the development of policies, government subsidies, and financing towards renewable energy. The improvements for RA 9513 to be supplied by this thesis, changes from a mere benefit, to an exigency when considering the Philippines' unique geographic and environmental context. As an archipelagic nation, the Philippines is highly vulnerable to the impacts of climate change—these are namely: rising sea levels, intensifying typhoons, and increasing temperatures. Hence, it can be concluded that with the current circumstances of the Philippines, it will stand to benefit substantially from the Republic Act being improved upon.

Households

Given that this study also contextualizes adoption of solar PV within the household level, households are to also benefit from this thesis since in its survey, it includes questions that aim to identify the factors influencing their willingness to adopt solar PV. Consequently, this element enables businesses and the government to better cater to the needs of households as they are potential adopters, further creating opportunities for solar PV's increased accessibility.

Long-term Environmental Advantages

Furthermore, despite the study's focus being on the financial and economic viability of the subject, it still emphasizes on the environmental significance of solar PV technology adoption such as reducing dependency on fossil fuels, combatting climate change, and improving air quality. Through the promotion of renewable energy, the study contributes to long-term environmental advantages, which, in turn, supports the health and well-being of the population.

Human Capital Advancement

Given that in a study conducted by Thu et al. (2025), it was found that solar adoption reduces air pollution and enhances public health, it can be argued that solar PV adoption impacts human productivity. This is evidenced by the study of Guo and Xu (2023), which illustrated that China's attraction of more human capital and its promotion of long-term urban economic growth was brought about by tougher air quality regulations that resulted in better environmental conditions. These claims are parallel with a foundational concept in economics, Gary Becker's Human Capital Theory that emphasizes on the correlation between improved health and increased productivity.

Philippines' Contribution to Global Actions

The formulation of this study also indirectly contributes to the Philippines' commitment in reducing greenhouse gas emissions, as aforementioned, in the Nationally Determined Contribution (NDC) of 2021 under the Paris Agreement. This study also aligns with the United Nations Sustainable Development Goals (SDGs), specifically of SDG 7 "Affordable and Clean Energy" and SDG 13 "Climate Action".

Proper Funding Allocation

Lastly, as this research acknowledges the importance of allocating resources to its most optimal use through stating its finite characteristic, the study contributes to proper funding allocations through the utilization of the CBA, and both the NPV and IRR analyses.

Scope and Delimitation of the Study

Given that the main goal of this thesis is to identify the economic and financial viability of solar PV technology adoption at Pasig Elementary School, it will conduct a CBA through both the analyses of NPV and IRR. The analyses will consist of the elements: capital cost, maintenance costs, and the historical records of electricity consumption (kWh) and electricity costs in order to identify the recovered cost of capital. NPV measures the difference between the present value of the school's future electricity savings and the initial cost of installing the solar PV system. A NPV greater than zero states that the savings from solar energy exceed the costs, this proves that the investment is beneficial, on the contrary, a NPV less than zero, will say otherwise. IRR on the other hand, calculates the rate of return the school can expect from its investment. It is the rate at which the total savings over time become equal to the initial cost, therefore if IRR is higher than the cost of capital, it would state that Pasig Elementary School's solar PV technology adoption is profitable, the same applies in reverse.

Moreover, this thesis includes Perceived Effectiveness in its analysis, providing the qualitative aspect of assessing Pasig Elementary School's solar PV adoption. Through the inclusion of Perceived Effectiveness, measured using the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) under the Technology Acceptance Model (TAM), this thesis enhances the traditional Cost-Benefit Analysis by incorporating the subjective experiences and stakeholder perspectives alongside monetary metrics. This approach enables the researcher to provide a more comprehensive understanding of the system's effectiveness in a real-world educational setting.

Additionally, in order to enhance the effectiveness and accessibility of solar PV, this thesis includes propositions of improvements towards Republic Act 9513 (Renewable Energy Act of 2008), based on results derived from the Cost-Benefit Analysis and the Perceived Effectiveness of the solar PV adoption of Pasig Elementary School.

However, the study is limited as it merely looks at Pasig Elementary School alone; it doesn't investigate other educational institutions, both public and private, which could have varying results. Through the establishment of the study's scope and delimitations, the valuable content of the study regarding Pasig Elementary School's solar PV technology adoption is specified and the lapses provided serve as recommendations for possible improvements in further studies.

Chapter 2

Review of Related Literature

This chapter includes relevant literature with regard to concepts and frameworks that serve as the foundation of this thesis. It covers a range of studies particularly those parallel with the financial metrics utilized within this study's Cost-Benefit Analysis and the assessment of perceived effectiveness. It also includes studies that give context regarding the adoption of solar PV.

Introduction

In understanding the economic and financial viability of solar photovoltaic adoption, the analysis of related literature is of the essence, making it a crucial aspect in this thesis. This chapter of the thesis serves as the foundation in assessing the economic and financial viability of solar PV adoption at Pasig Elementary School through reviewing preceding literature that includes similar tools that are utilized within this study.

There are four main components in this chapter. First, the function of CBA in renewable energy investments is examined, with the focus being on the economic and financial viability of solar PV adoption, through examining its costs and benefits. Second, the analyses of Net Present Value (NPV) and Internal Rate of Return (IRR), these financial metrics are also part of the main components in this chapter as these metrics assess the risk and profitability of investments. Third, this chapter also discusses the utilization of both Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as tools in evaluating the perceived effectiveness of the solar PV adoption at Pasig Elementary School. Lastly, this chapter examines Republic Act No. 9513 to identify possible improvements in the policy that could increase the effectiveness and accessibility of solar PV adoption.

This chapter starts by providing literature regarding adoption of renewable energy both on a global scale and the Philippines domestically, in order to contextualize the increasing demand and relevance of renewable energy. It elucidates the world's transition towards sustainable energy together with national progress and plans under existing policies.

This chapter of the thesis also includes a discussion regarding the global adoption of solar PV, specifically in the sector of education, illustrating how schools around the globe have also adopted renewable energy. Furthermore, this chapter also gives context regarding the demographic and economic characteristics that influence acceptance, adoption, and perceived effectiveness towards solar PV in order to provide an understanding as to how various circumstances influence how stakeholders would perceive the solar PV adoption.

A brief discussion on Consumer Behavior is also included within this chapter in order to introduce the behavioral factors that influence renewable energy adoption.

The literature utilized in this study are recent and peer-reviewed materials that were published not more than a decade, this validates reliability and relevance which is essential in order for the study to accurately scrutinize domestic and foreign studies.

With the integration of results from both local and international studies, this thesis is able to identify gaps in the body of knowledge. All of the data that are gathered through various literature from credible sources will all collectively serve as the basis for this study's metrics of Cost-Benefit Analysis, particularly both NPV and IRR, as well as the constructs of Perceived

Usefulness (PU) and Perceived Ease of Use (PEOU) in evaluating the perceived effectiveness of the solar PV adoption at Pasig Elementary School. The chapter of literature review ensures that the economic, financial, and experiential viability of solar PV adoption at Pasig Elementary School is investigated from different perspectives.

Global Adoption of Renewable Energy

Khalid et al. (2021) emphasize that the growing reliance on non-renewable energy sources, particularly fossil fuels, has led to alarming levels of environmental consequences, and among them climate change is the most prominent. According to Alam et al. (2021), in response to rising environmental concerns, the world has been progressively shifting towards renewable energy alternatives. With this context, it is to be observed that solar photovoltaic technology is becoming more recognized as a sustainable and environmentally friendly solution.

However, despite the benefits of solar PV, its implementation is impeded by challenges such as financial constraints, regulatory complexities, and technical challenges. Nevertheless, despite the aforementioned challenges faced by the implementation of solar PV, its economic and environmental advantages are still considered to be substantial, given the fact that solar panels continue to generate electricity well beyond the recovery of initial investments.

Data from a study conducted by Khalid et al. (2021) indicates that as of 2019, solar energy accounted for 2% of global electricity generation and its adoption continues to accelerate. Hassan et al. (2024) exhibits that countries within the European Union, especially Denmark and Germany, are leading in renewable energy adoption through strong commitments to wind and solar energy. Rapid growth is also observed in the continent of Asia, wherein nations such as China and India have achieved annual growth rates exceeding 30% in their solar and wind sectors. These upward trends seen across various continents substantiate a strong international movement toward decarbonization and sustainable energy.

In the context of developing countries the adoption of solar PV has also gained traction, according to Ibegbulam et al. (2023), nations across Africa and Asia have also increasingly turned to solar power as an alternative to traditional energy sources. However, it is to be observed that developing countries also face burdens such as high upfront costs and insufficient technical expertise which continue to hamper adoption especially of larger scale. Fortunately, there have been innovative approaches that have been effective in mitigating the aforementioned barriers and among these approaches are microloans and international partnerships that have enabled low-income communities and institutions to access renewable energy in a more affordable manner. These developments are testaments that serve as proof that with proper financial support and policies, developing countries can also successfully adopt renewable energy.

Philippines' Adoption of Renewable Energy

In the Philippine context, interest in renewable energy has significantly increased following the enactment of Republic Act No. 9513, also known as the Renewable Energy Act of 2008. The Department of Finance (2024) notes that, as of March 2024, the Department of Energy (DOE) has awarded 1,327 renewable energy service contracts, demonstrating a strong institutional push for clean energy development. The Philippines' energy sector generated a record high of 23,326 gigawatt-hours in 2018 which marked a major milestone in its renewable energy output.

However, despite the aforementioned gains within the Philippines' energy sector, according to Catubay et al. (2024), the nation still relies heavily on fossil fuels, which makes it highly vulnerable to global price volatility. In response to this vulnerability and to partake in climate action, the 2023–2050 Philippine Energy Plan aims to: increase renewable energy's share in the power generation mix to 35% by 2030 and 50% by 2040. These targets signify the Philippines' commitment to diversify its energy sources and promote a more sustainable future.

Global Adoption of Solar PV in Education

According to Lottu et al. (2023), educational institutions across the globe have been increasingly adopting solar photovoltaic technology; it has been utilized not merely as a means to lower electricity costs but to also improve learning environments and promote sustainability.

In the United States, solar adoption within the context of schools has grown rapidly, data shows that by the end of 2021, an amount totaling to 8,409 K–12 schools, which represent roughly 7% of all U.S. schools, had already adopted solar PV technology. However, despite the progress, solar PV in education also suffers from challenges that include: substantial upfront capital costs, maintenance requirements, and administrative barriers that slow down adoption.

Concurrently, within the sector of education in developing countries, the adoption of solar PV has also been increasing. In a study conducted by Lottu et al. (2023), data show that many rural schools in Africa and Asia have also turned to solar PV as a means to address issues with regard to energy access and to reduce dependence on unreliable power grids. Consequently, the adoption has improved the learning environment of students, but the same issues such as financial barriers and inconsistent support continue to hinder implementation.

Globally, the adoption of solar PV in education serves as a reflection of the growing recognition of renewable energy's benefits, whether economic, environmental, or educational. Despite the evident challenges that are present, there is still consistent evidence that solar PV adoption in educational institutions contributes significantly. These global trends provide the thesis with valuable context for assessing the solar PV adoption at Pasig Elementary School as it highlights the relevance of renewable energy in the sector of education.

Demographic and Economic Characteristics Influencing Solar PV Adoption

A study conducted by Rebuyaco (2023) which is entitled "Analysis of Consumer Acceptance of Solar Photovoltaic Technology in Ramos, Tarlac: Application of the Technology Acceptance Model," the demographic and economic characteristics of respondents consisted of: age, gender, monthly household income, monthly electricity bill, and educational level. The aforementioned characteristics were utilized as control variables to explain the variations in perceptions and adoption of solar PV technology. The findings of the study found that the variables were found to significantly influence acceptance behavior, especially of income and education, which showed a positive relationship with perceived usefulness and willingness of adoption. The author, Rebuyaco (2023), emphasized that demographic and economic factors influence how individuals recognize the benefits and the practicality of solar energy. Therefore, with the inclusion of the similar variables in the present study, the current research is able to make certain that it utilizes established empirical models that provide a comprehensive understanding of how individual characteristics influence perceptions of solar PV effectiveness.

Cost-Benefit Analysis (CBA) in Solar PV Adoption

In a study conducted by Mishan & Quah (2020), Cost-Benefit Analysis (CBA) was referred to as a systematic and analytical approach wherein a project's costs and benefits are compared in order to determine the economic viability of an investment especially within the context of public and social sectors. Moreover, CBA was defined as something that aids institutions and governments in determining an investment's ideal scale, the potential obstacles in its implementation, and its overall value. Saad (2024) noted that CBA is essential in the assessment of solar PV adoption given that it takes into account the elements of installation costs, operational expenses, long-term savings, and external benefits such as environmental sustainability. CBA determines the installation costs and expected electricity savings to accurately identify the break-even point of the said adoption.

Given that solar PV technology requires a significant amount of initial investment, finding out how long it will take to recover the involved costs becomes a crucial aspect in the decision-making process.

The metric of Cost-Benefit Analysis was used in a study conducted by Ogunyemi et al. (2022) at Federal Polytechnic Ilaro, Nigeria, it was utilized to assess the financial effects of a 4kVA solar inverter system within a 20-year period, and was compared to traditional gasoline generators. The findings of the study indicated that while the total expenditure for a generator system would amount to 32.7 million naira, the cost of a solar PV system would only total 11.5 million naira, resulting in potential savings of 21.2 million naira. The study's findings also show that solar PV technology reduced noise pollution and carbon dioxide emissions, which enhanced the socioeconomic and environmental advantages beyond the significant cost reductions.

It can be concluded that CBA is a suitable method in assessing the solar PV adoption at Pasig Elementary School as it helps determine cost-effectiveness, consequently providing information into the potential replicability for other institutions seeking sustainability.

Net Present Value (NPV) and Internal Rate of Return (IRR) in Solar PV Adoption

According to Constantino et al. (2023), Net Present Value (NPV) is a financial statistic used to assess the long-term viability of solar PV projects, it reflects the present value of future savings and the possible returns from the investment, through the comparison of initial installation cost and the anticipated cash flows over time, the metric of NPV is able to assist an investment through determining its financial viability. A negative NPV level or NPV < 0 indicates financial infeasibility, on the other hand, a positive NPV or NPV > 0 indicates that the investment will generate net profit. In addition to NPV, the Internal Rate of Return (IRR) is used to assess the discount rate at which NPV equals zero, representing the break-even point for the investment.

According to Ellabban & Alassi (2019), the larger an IRR is, the more it increases a project's appeal, given that when IRR is higher, it indicates greater profitability, and illustrates lower financial risk. The results from the same study indicated that solar PV investments produced a profitable outcome, with net present values (NPV) ranging from AUD 2,842.39 to AUD 4,419.88. Furthermore, given advantageous tariff arrangements and government incentives, solar PV adoption was shown to be financially feasible, this is evidenced by the project IRRs ranging from 14% to 17%. Despite concentrating on the adoption of solar PV in Australian homes, Ellabban & Alassi (2019) offer a methodology for assessing the financial viability of solar PV adoption and it is particularly useful in this thesis' evaluation of the economic and financial viability of Pasig Elementary School's solar PV adoption through the analyses of NPV and IRR.

Consumer Behavior and Technology Adoption in Renewable Energy

Consumer behavior plays a vital role within the adoption of renewable energy technologies through influencing how people respond to environmental, social, and economic factors. According to Arulmozhi and Deepa (2024), decisions to adopt renewable energy are not driven merely by cost, it was emphasized that environmental awareness, technological accessibility, and evolving social norms are also influencing factors to renewable energy adoption. In the context of public schools like Pasig Elementary School, teachers, staff, and students' perceptions of the usefulness and ease of use of solar PV are influenced by behavioral characteristics. Therefore, understanding these perceptions is essential, as they directly influence the long-term effectiveness and replicability of solar PV adoption within public educational institutions.

Perceived Usefulness and Ease of Use as Constructs for Evaluating Solar PV Effectiveness

Although the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are traditionally utilized under the Technology Acceptance Model (TAM) which was developed by Davis (1989) to predict user adoption of technology, this thesis adapts these constructs in order to evaluate perceived effectiveness in a post-adoption context of solar PV. In this study, PU and PEOU are utilized to assess how stakeholders at Pasig Elementary School perceive the effectiveness of the solar PV.

In this context, Perceived Usefulness is the users' beliefs that the solar PV provides significant benefits such as reducing electricity costs. Perceived Ease of Use, on the other hand pertains to how easily the technology can be understood, operated, and integrated into the school. These constructs under TAM stand as a practical lens in the evaluation of Pasig Elementary School's solar PV from the perspective of its users.

The constructs of PU and PEOU serve as the foundation of this thesis' Likert-scale which will be used to gather responses from teachers, non-teaching personnel, and students. Through anchoring the survey on both PU and PEOU, this study is able to capture both the perceived value and the experience of its users, consequently providing a broader understanding of effectiveness beyond financial measures.

Perceived value, according to Sweeney and Soutar (2001) is a consumer's total evaluation of utility based on what is given versus what is received and according to Khalid et al. (2021), technologies that are perceived as both useful and easy to use are more likely to gain traction in terms of user support. In this context, PU and PEOU function as indicators of value judgment, serving as a bridge that allows stakeholders to express whether the system meets their expectations and justifies what it requires.

The Role of Government Policies (RA 9513) in Solar PV Adoption

According to a study conducted by Hosseini (2019), the initial costs of installing solar panels can be high, and this financial barrier is one of the biggest obstacles to the adoption of solar PV. Therefore, despite the fact that there are long-term savings and environmental advantages entailed within the adoption of solar PV, people become discouraged from switching to renewable energy. Fortunately, governments across the globe have responded to this issue, through the means of formulating and implementing laws that provide financial incentives, governments have been able to increase the accessibility and viability of solar PV investments.

According to Khalid et al. (2021), financial incentives play a critical role in the promotion and adoption of renewable energy around the world. Governments that aim to promote renewable energy adoption in order to boost sustainable growth have been utilizing financial incentives to address the financial barrier hindering the development of renewable energy given that financial incentives help reduce the high initial costs associated with the installation of renewable energy.

The financial effect of tax incentives on the adoption of solar PV in a residential context in Brazil was studied by Drumond et al. (2021), its focus was on how such policies affect the viability of investments. The study evaluated the impact of government incentives on 35 distribution companies through the Net Present Value (NPV) and Payback analysis. Due to the incentives provided by the Brazilian government, specifically through ANEEL's (Agência Nacional de Energia Elétrica) Net Metering policy, often exceeding the total cost of the solar PV system, the results demonstrated that the investment was highly viable. Furthermore, it was also discovered by Drumond et al. (2021), that eliminating incentives substantially lengthens the payback period, this proves the vital role that government assistance plays in promoting the utility of solar energy.

Moreover, relevant literature also illustrates the exigency of alleviating the high upfront capital costs of adopting solar PV for educational institutions. A study conducted by Gao et al. (2025) found that K-12 schools in the United States that received financial aid with regard to upfront cost, were more likely to adopt solar energy within shorter timelines, contrary to those schools with no support. This serves as justification that beyond standard fiscal incentives, help to lower initial upfront costs are highly effective in achieving greater solar adoption in organizational settings such as schools.

The findings from existing literature support the notion of tariff incentives and tax exemptions reducing investment risk and increasing the financial appeal of solar photovoltaic investments.

In the context of the Philippines, Republic Act No. 9513 also known as Renewable Energy Act of 2008, was enacted with the goal of encouraging the development and use of renewable energy sources through offering fiscal incentives. The main features of RA 9513 revolve around lowering investment risks and increasing financial returns for renewable energy adopters, through the means of feed-in tariffs (FiT), net metering, income tax holidays, and duty-free imports of renewable energy equipment. As a result, there has been development and an increase of renewable energy adoption in the Philippines as observed in preceding literature of this thesis.

However, existing literature, such as the one conducted by Rosellon (2017), point out limitations in the implementation of RA 9513, there exist delays in the issuance of implementing rules for fiscal incentives like the zero VAT provision, which has resulted in complications in VAT recovery for renewable energy developers. Moreover, the Feed-in Tariff's (FiT) permitting process has also been deemed overly complex and time-consuming which emphasizes the need for its system to be improved. In addition, Rosellon (2017), also emphasizes that the slow and partial implementation of key mechanisms such as the Renewable Portfolio Standards (RPS), the

Green Energy Option, and the Renewable Energy Market (REM) further limits the law’s full potential.

With the evident success of Brazil’s ANEEL, and the apparent systematic flaws of RA 9513, it must be acknowledged that there is a necessity to refine the public policy of the Philippines to further promote the adoption of renewable energy as the delays and flaws in the implementation of RA 9513 hinder the overall adoption of renewable energy in the Philippines. The systematic flaws of RA 9513 reduce the attractiveness of investments and collaborations in terms of renewable energy, as it creates uncertainty among investors and partners, this consequently results in lesser participation from the private sector which directly affects the extent to which renewable projects are implemented within public institutions.

This thesis includes the systematic shortcomings of RA 9513 and evaluates the solar PV adoption at Pasig Elementary School through the integration of Cost-Benefit Analysis (CBA) and the assessment of Perceived Effectiveness as the study aims to formulate viable policy recommendations that address the gaps in RA 9513 in order to enhance the effectiveness and accessibility of solar PV, especially for public educational institutions.

Research Gap

The topic regarding the economic and financial viability of solar PV adoption has been the subject of a multitude of research, but most of the aforementioned studies have been merely within the context of household and large-scale solar PV adoption, in turn this has overlooked the use of solar PV within public institutions, especially of schools. A study conducted by Drumond et al. (2021) has evaluated the effect of government subsidies on solar PV adoption within Brazil. Moreover, the results of the study pursued by Ellabban & Alassi (2019) have shown that solar PV adoption in the residential sector is financially viable. However, the previously mentioned studies fail to address the economic and financial viability of solar PV technology in the context of educational institutions.

Furthermore, there exist merely a few studies that incorporate metrics such as Cost-Benefit Analysis (CBA), Net Present Value (NPV), and Internal Rate of Return (IRR) in evaluating solar investments within the context of public schools present in the Philippines, despite existing studies emphasizing on its importance. Moreover, there is a lack of research within the body of knowledge that explores how the current provisions of Republic Act No. 9513, or the Renewable Energy Act of 2008 can be improved to better support solar PV adoption in public educational institutions. Despite existing literature discussing the general benefits of laws that promote renewable energy, there are limited existing studies that have examined how these policies can be enhanced within the context of a school, let alone be based on experiences and effectiveness perception. Hence, this thesis addresses this research gap through identifying possible improvements towards RA 9513 that are rooted through the results of its Cost-Benefit Analysis and the perceived effectiveness of solar PV adoption at Pasig Elementary School.

This thesis is also able to fill the aforementioned research gaps through the means of conducting a comprehensive financial analysis of solar PV adoption within the setting of a Philippine public school, particularly Pasig Elementary School, through the tools of CBA, NPV, and IRR in determining its economic and financial viability.

Furthermore, this study will also integrate a qualitative element through providing the non-financial benefits brought about by solar PV adoption into the larger evaluation of the project’s overall impact through assessing perceived effectiveness with the constructs of Perceived Usefulness and Perceived Ease of Use. Lastly, this study examines Republic Act No. 9513 in order to identify potential improvements within the law to enhance solar PV's effectiveness and accessibility especially for public educational institutions, based on the findings from the Cost-Benefit Analysis and stakeholders' effectiveness perceptions.

This study aims to provide empirical data that will contribute vital information for not merely all stakeholders involved, but also for the promotion of transitioning to renewable energy.

Chapter 3

Theoretical Framework

This chapter provides the key theoretical and conceptual framework that guide the cost-benefit analysis of Pasig Elementary School's solar PV adoption. Additionally, this chapter includes this thesis' operational framework, outlines key assumptions, formulates the study's hypotheses, and provides definitions of essential terms that are used all throughout the study.

Theoretical Framework

This study is anchored on the concepts of Consumer Behavior Theory, Cost-Benefit Analysis, and Technology Acceptance Model.

Consumer Behavior Theory

According to Gordon (2022), Consumer Behavior Theory is the study of how individuals make spending decisions based on their preferences and financial constraints. Consumers as rational beings aim to maximize their satisfaction while also taking limited resources and personal priorities into account. Despite the theory traditionally being applied to the spending behavior of individuals, which is contextualized in this thesis, it can also be extended to how individuals evaluate and respond to goods or services they experience, regardless if they are not the direct purchasers.

In this study, the theory helps explain why school stakeholders: teachers, non-teaching personnel, and students, as rational agents, form perceptions about the effectiveness of Pasig Elementary School's solar photovoltaic (PV) adoption.

Cost-Benefit Analysis

According to Mishan & Quah (2020), Cost-Benefit Analysis (CBA) is a systematic method when comparing the benefits and costs of a project in determining its overall desirability, especially in public or social contexts. CBA helps evaluate whether a project is worthwhile, what its optimal scale should be, and what constraints there may be, which makes it a fundamental tool in public decision-making.

In this thesis, CBA is utilized to evaluate the economic and financial viability of Pasig Elementary School's adoption of solar PV. Through the financial metrics of both the Net Present Value (NPV) and Internal Rate of Return (IRR) this study is able to determine if the long-term benefits outweigh the adoption's initial and maintenance costs.

Technology Acceptance Model

Technology Acceptance Model (TAM), according to Portz et al. (2019), explains how users decide to adopt new technologies based on two key perceptions: usefulness (benefit) and ease of use. These perceptions shape a person's intent to use new technology and influences their usage behavior. Factors such as individual differences, system design, and social context all impact these said perceptions. It is more likely that users will adopt technologies that are observed to be usable, useful, and credible.

This study does not entirely adopt TAM but merely focuses on its two core constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) in evaluating stakeholder perceptions of the solar PV adoption. PU refers to the perceived benefits brought about by the adoption such as cost savings, while PEOU refers to how simple the system is to understand and operate within the school. These constructs guide the design of the survey instrument and complements the analysis of this study through providing qualitative data.

Conceptual Framework

The main theoretical foundations and analytical instruments utilized to evaluate the viability of Pasig Elementary School's solar photovoltaic adoption are integrated in this thesis' conceptual framework. This study is based on the three theoretical foundations as aforementioned, these are namely: the Cost-Benefit Analysis, the Technology Acceptance Model, and the Consumer Behavior Theory, each of which adds to a different but interconnected aspect of the analysis.

Consumer Behavior Theory explains why individuals make rational choices, as agents who aim to maximize spending, it serves as the psychological base that explains why individuals behave as they do. In this thesis, the theory serves as the behavioral foundation in understanding why school stakeholders, particularly teachers, non-teaching personnel, and students, all rationally respond to the adoption of solar PV, given that it is a reflection of their reasoning as consumers. The theory is further contextualized through the Technology Acceptance Model (TAM), which supplies both the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). These constructs are utilized in the evaluation of the perceived effectiveness of the solar PV, as experienced by its stakeholders after the adoption. The responses are also analyzed through the lens of the respondents' demographic and economic characteristics, as it explains that despite the existence of rational choices, responses will vary, it will still manifest differently across stakeholder groups and influence their perception of the system's effectiveness given the variance of their circumstances.

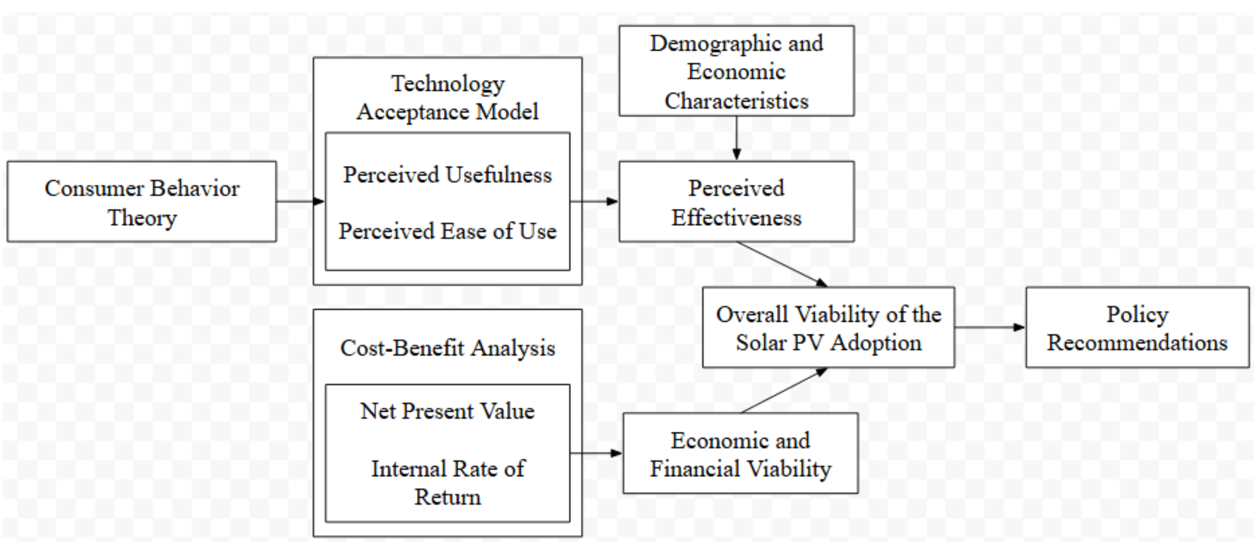
On the other hand, Cost-Benefit Analysis' financial metrics of Internal Rate of Return and Net Present Value is utilized, serving as the objective aspect of this thesis' analysis. These metrics are used to determine the economic and financial viability of the solar PV adoption at Pasig Elementary School.

The results of both the perceived effectiveness and financial and economic analysis are integrated into an overall evaluation of the viability of the solar PV adoption in Pasig Elementary School. This combined assessment enables the study to capture both experiential and objective dimensions of the adoption.

Lastly, the conceptual framework of this thesis ends with policy recommendations based on its overall analysis, its focus revolves around improvements aimed at enhancing Republic Act No. 9513 in order to increase solar PV's effectiveness and accessibility, especially within the context of public educational institutions.

Figure 1

Conceptual Framework of the Study

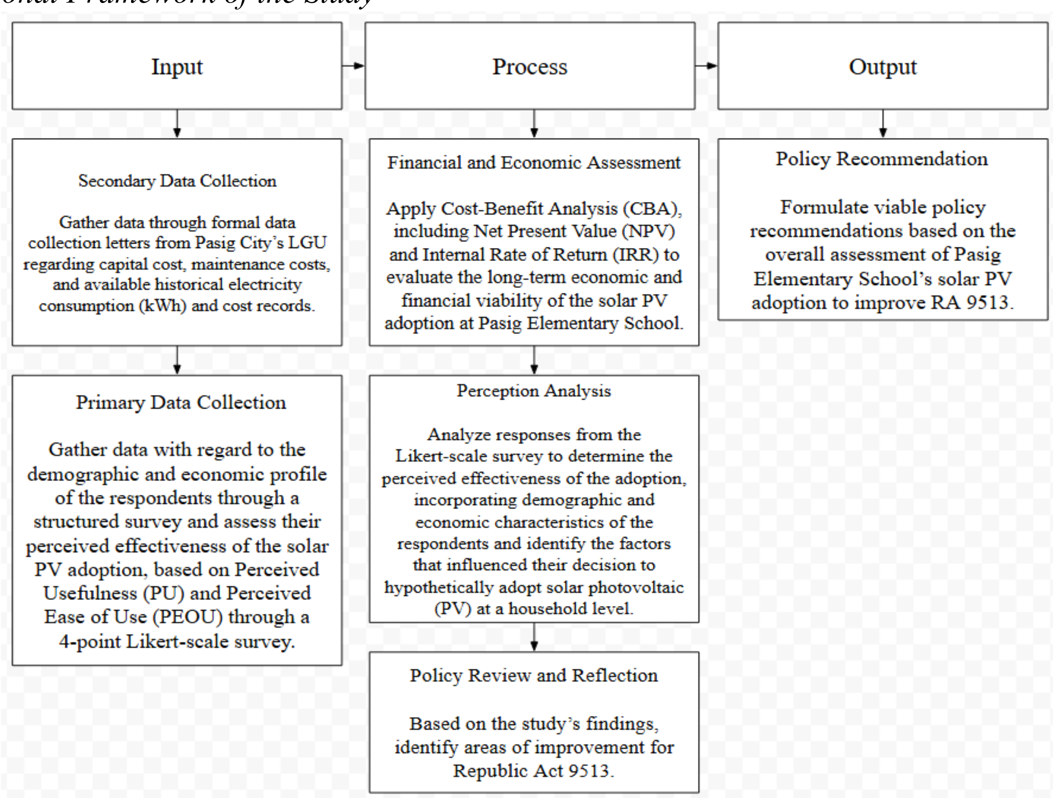


Operational Framework

Through the utilization of a three-phase Input-Process-Output (IPO) framework, this study is able to systematically evaluate the solar PV adoption at Pasig Elementary School. The IPO structure makes certain that there exists a comprehensive assessment through organizing the flow of this thesis: data collection through financial records and stakeholder responses (Input), evaluation of economic and financial viability, perceived effectiveness analysis, policy review (Process), and the formulation of policy recommendations (Output). This structure supports the study's integration of both quantitative and qualitative findings, ultimately guiding the development of proposed improvements to Republic Act No. 9513. The operational framework of this thesis is illustrated in the diagram below.

Figure 2

Operational Framework of the Study



Assumptions

This study is guided by key assumptions to support the validity of this thesis' analysis of the solar PV adoption at Pasig Elementary School:

1. There is consistency with regard to Pasig Elementary School's electricity cost and consumption and there are no major changes in the school's energy usage patterns.
2. The solar panels have a projected lifespan of 25 years and maintain consistent efficiency throughout this period, in line with industry standards.
3. Maintenance costs for the solar PV system are relatively predictable and do not possess volatility wherein there are drastic increases over the system's lifespan.
4. Annual solar PV generation is consistent and can be estimated using the Department of Energy's specific-yield benchmark (kWh/kWp/year), which serves as the standardized basis for computing projected solar output.
5. The analysis begins with the most recent available electricity data.
6. Survey respondents of key stakeholders including: teachers, non-teaching personnel, and students, all understand the basic functions and purpose of the solar PV, enabling them to provide significant, informed, and meaningful feedback on its perceived effectiveness.
7. Respondents will answer the survey items truthfully without the existence of any systematic bias.

Hypothesis

This thesis formulates null hypotheses that are parallel with the relevant Statement of the Problems in order to guide the economic, financial, and perception-based evaluation of Pasig Elementary School's solar PV adoption:

Hypothesis 1 ($H0_1$): The Cost-Benefit Analysis (CBA) does not indicate that the adoption of solar PV technology at Pasig Elementary School is economically viable.

Hypothesis 2 ($H0_2$): The metrics of Net Present Value (NPV) and Internal Rate of Return (IRR) do not indicate that the adoption of solar PV technology at Pasig Elementary School is financially viable.

Hypothesis 3 ($H0_3$): The perceived usefulness of Pasig Elementary School's solar PV adoption based on its stakeholders is minimal or not significant.

Hypothesis 4 ($H0_4$): The perceived ease of use of Pasig Elementary School's solar PV adoption based on its stakeholders is minimal or not significant.

Definition of Terms

The following terms are specified in order to provide an understanding regarding the variables and concepts utilized in this thesis:

Carbon Dioxide Emission. The release of carbon, a type of greenhouse gas, into the atmosphere over a specific area and period of time (Eurostat, 2017).

Climate Change. Defined as a man-made (anthropogenic) climate issue wherein global temperatures rise as a result of the emissions of greenhouse gases (Eurostat, 2014).

Consumer Behavior Theory. Referred to as the study of how individuals make spending decisions based on their preferences and financial constraints (Gordon, 2022).

Cost-Benefit Analysis (CBA)**.** A systematic approach that evaluates a project's economic viability through weighing its costs and benefits (Mishan & Quah, 2020).

Human Capital Theory. A concept that views health and education as investments that enhance individual productivity and contribute to long-term economic growth (Becker, 1964).

Internal Rate of Return (IRR)**.** A metric used to assess the discount rate at which NPV equals zero, representing the break-even point for the investment (Ellabban & Alassi, 2019).

Net Present Value (NPV)**.** A financial statistic used to assess the long-term viability of projects through a comparison of initial installation cost and the anticipated cash flows over time (Constantino et al., 2023).

Payback Period. Refers to how long it will take a project's net income or savings to recoup its investment (Brizi et al., 2014).

Photovoltaic (PV) **Technology.** Solar photovoltaic (PV) is a silicon made device that converts solar energy into electrical energy (Rahman et al., 2015).

Renewable Energy Act of 2008 (RA 9513)**.** A law in the Philippines that encourages the utilization of renewable energy sources through the government offering fiscal incentives (Congress of the Philippines, 2008).

Sustainable Development. A concept that emphasizes on achieving present needs without compromising the ability of future generations to meet theirs (WCED, 1987).

Technology Acceptance Model (TAM)**.** Explains how people decide to adopt new technologies based on two key perceptions: usefulness (benefit) and ease of use (Portz et al., 2019).

Chapter 4

Methodology

This chapter establishes the thesis' overall research design and strategy, the selection of its participants/respondents, its sampling design, its measurement and instrumentation, the procedure of data collection, its ethical approaches, and the data analysis.

Research Design and Strategy

A mixed-method research design is adopted in this thesis given that it evaluates: the economic and financial viability, and the perceived effectiveness of the solar PV adoption at Pasig Elementary School, which incorporates both quantitative and qualitative approaches. This allows the study to capture not only numerical indicators through its Cost-Benefit Analysis (CBA), Net Present Value (NPV), and Internal Rate of Return (IRR), but also the subjective experiences of stakeholders using constructs such as Perceived Usefulness (PU) and Perceived Ease of Use (PEOU).

Lim (2024) analogized data as "new oil," emphasizing on the relevance of quantitative data in today's world where evidences are of the essence. However, it must be acknowledged that the integration of qualitative insights is equally important given that it ensures the provision of stakeholder perception and direct feedback which is essential for evaluating the effectiveness of projects held by public institutions.

In order to answer the SOPs of this thesis, the following will be conducted:

For SOP 1, descriptive quantitative data on the demographic and economic characteristics of respondents—including teachers, non-teaching personnel, and students—will be collected through a structured survey.

For SOP 2, quantitative secondary data which includes: capital cost, maintenance costs, and available historical electricity consumption (kWh) and cost records, will be formally requested from Pasig City's LGU offices. The data to be provided will serve as the baseline for computing the recovered cost of capital of the adoption through NPV and IRR.

For SOP 3, a Likert-scale will be distributed among stakeholders to assess their perceptions regarding the solar PV adoption. The Likert-scale will be based on the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU).

For SOP 4, the study will use findings from both the CBA and the perceived effectiveness analysis to identify possible improvements towards Republic Act No. 9513 to increase solar PV's accessibility and effectiveness especially within public educational institutions.

This thesis' mixed-method research design makes certain that a comprehensive evaluation of Pasig Elementary School's solar PV adoption is done through systematically assessing both its direct economic and financial viability through CBA, NPV, and IRR, and its perceived effectiveness through feedback from its stakeholders. This approach captures not merely objective economic results but also experiential insights consequently leading to relevant policy recommendations.

Research Participants/Respondents

The data that will be utilized within this study will come from two main sources. First, for the collection of secondary data, the researcher will formally request for data from respective offices of Pasig City's LGU that possess the necessary data needed for the analyses of this study. These aforementioned offices will be asked to supply the necessary information needed for the economic and financial evaluation of this thesis such as the capital cost, maintenance costs, and the historical electricity cost and consumption (kWh) of Pasig Elementary School. However, in order to make certain that there is compliance with Pasig city's ordinance with regard to data collection, the researcher will first prioritize ensuring that the data requests will be endorsed by and will go through Ugnayan sa Pasig, the office responsible for facilitating research-related access to LGU offices.

In evaluating the economic and financial viability of Pasig Elementary School's adoption of solar PV, these data to be requested from Pasig City's offices are essential components in order to pave the way for a Cost-Benefit Analysis (CBA) and to make calculating the Net Present Value (NPV) and Internal Rate of Return (IRR) of the solar PV adoption possible.

Second, for the primary data to be collected in this thesis, a structured survey will be done, respondents will include teachers, non-teaching personnel, and students of Pasig Elementary School and data regarding their demographic and economic characteristics, particularly the following: age, gender, monthly household income, level of education, and monthly electricity bill (as applicable), will be gathered. In addition, the same group of respondents will provide information regarding their perceived effectiveness of the school's solar PV adoption through a Likert-scale based on the constructs of Perceived Usefulness (PU) and

Perceived Ease of Use (PEOU). These respondents were selected as they are the direct stakeholders who interact with and experience the solar PV. For the student respondents, the approval and guidance of the school administration shall serve in lieu of parental consent, as the school acts in loco parentis (in place of parents/guardians) for minimal-risk academic activities such as this survey.

Furthermore, the survey includes additional questions at its latter part in order to assess the respondents' willingness to adopt solar PV in their own households, enabling the analysis of this study to extend beyond perception and help to identify the factors that influence willingness to adopt solar PV, which is useful and relevant for the policy improvements to be proposed, for the betterment of RA 9513.

Within the analysis, the respondents of the survey will be categorized according to their roles in the school, the various groups will consist of teachers, non-teaching personnel, and students. The stratification will pave the way for the researcher to identify differences in perception across the aforementioned groups. Separate descriptive analyses within the discussions are to be conducted for each stakeholder group after the aggregate summary of the overall population.

Sampling Design

For the secondary data collection of this thesis, which is necessary for its Cost-Benefit Analysis, purposive sampling will be utilized through directly approaching both Pasig City's City Engineering Office (CEO) and the Office of General Services (OGS), who both have access to documents such as Pasig Elementary School's historical electricity costs and consumption (kWh) records, the solar PV installation cost, and its maintenance costs. The aforementioned data are all essential for the metrics of Cost-Benefit Analysis (CBA), Net Present Value (NPV) and Internal Rate of Return (IRR). The participation of the aforementioned offices will be limited to supplying objective data required for the study's economic and financial evaluation of their solar PV adoption.

As for the primary data collection of this thesis, one-hundred (100) respondents from Pasig Elementary School including teachers, non-teaching personnel, and students, being all stakeholders, will be selected through purposive sampling. This approach allows maximum efficiency and credibility through the researcher directly targeting the primary stakeholders who engage with and are affected by the school's solar PV adoption on a daily basis. The respondents will provide data regarding their demographic and economic characteristics as well as their perceptions concerning the solar PV's usefulness and ease of use through a Likert-scale. Their participation is essential given that their feedback is a direct reflection of their experience with the technology, consequently contributing in the assessment of the solar PV's perceived effectiveness. Despite the fact that there is no fixed rule that dictates the ideal number of respondents for perception studies of this nature, it is to be observed within existing literature that studies which conducted institutional surveys of similar scale, commonly ranged between 80 and 150 respondents, therefore, the researcher adapted within this range. Another rationale behind selecting one hundred (100) respondents is through the consideration of adequacy to make certain that there exists a proportional and sufficient representation for all the stakeholder groups within Pasig Elementary School.

Measurement and Instrumentation

The NPV and IRR will be computed through Microsoft Excel, an estimation-based projection will be conducted with the available secondary data to be provided serving as the baseline years. The projected electricity savings to be computed will be used to determine the recovered cost of capital of the solar PV adoption at Pasig Elementary School using a 10% discount rate, which is consistent with NEDA ICC's memorandum of 2016.

Equation 1

Net Present Value (NPV)

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

Where: R_t = Net cash flow (benefits minus costs) in year t, i = Discount rate, t = Time period, and n = Number of periods

Equation 2

Internal Rate of Return (IRR)

$$0 = \mathrm{NPV} = \sum_{t=1}^{T} \frac{C_t}{(1+IRR)^t} - C_0$$

Where: C_t = Cash inflow during period t, C_0 = Initial investment cost at time $t = 0$, T = Total number of periods, and IRR = Discount rate at which NPV equals zero

Although this thesis presents both the formulas of Internal Rate of Return (IRR) and Net Present Value (NPV), for accuracy and efficiency purposes, Excel will be utilized in the computation of both, as it also eliminates all possibilities of error in manual computation.

A structured survey instrument will also be utilized in this thesis to gather demographic and economic data (age, gender, monthly household income, level of education, monthly electricity bill) from teachers, non-teaching personnel, and students of Pasig Elementary School, as applicable to each group. In addition, the same survey will contain a Likert-scale based on the constructs of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) to evaluate the perceived effectiveness of the solar PV adoption. The Likert items will be designed to capture the users' assessment of the system’s effectiveness within the school.

The structured survey that will be utilized in this thesis is divided into four sections. The first section consists of the consent form, emphasizing on confidentiality and voluntary participation. As for the second section, it comprises of questions regarding the respondents’ demographic and economic characteristics. Moreover, the survey also asks the respondents to specify their role within the school or what stakeholder group they belong to (teacher, non-teaching personnel, or student). This enables the researcher to organize and analyze the data according to the respondent’s role within Pasig Elementary School.

For the third section, it contains the main measurement instrument of this thesis’ primary data collection, a 4-point Likert-scale that will assess the perceived effectiveness of the respondents regarding the solar PV adoption based on the two constructs of the Technology Acceptance Model (TAM) which are Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). In the Likert-scale, 1 indicates “Strongly Disagree” and 4 indicates “Strongly Agree.

Lastly, the fourth section contains additional questions that contextualizes the solar PV adoption within a household level and identifies the factors that influenced the willingness of the respondents to hypothetically adopt solar PV within their household. These additional questions aim to determine the factors that influence support towards adoption within a household level, which will enable the study to include viable policy recommendations not limited to institutional perception.

In order to ensure accessibility and comprehension among the respondents, the survey was written in both the languages of English and Filipino. Both versions were also utilized within the pre-testing, depending on the respondent's preference, and will remain to be used on the actual data collection.

Given the importance of reliability in making certain that there is accurate and interpretable data, the researcher used Cronbach's Alpha in Microsoft Excel, to test the internal consistency of its Likert-scale. According to Daud et al. (2018) a Cronbach's Alpha value above 0.6 is acceptable, and a value above 0.8 indicates strong reliability. The formula for Cronbach's Alpha is stated below.

Equation 3

Cronbach's Alpha Formula

$$\left(\frac{k}{k-1}\right) * \left(\frac{s_y^2 - \sum s_i^2}{s_y^2}\right)$$

Where: **α** = Alpha, **k** = total number of questions, **sy^2** = variance of total scores, and **Σsy^2** = sum of the variance for individual questions.

The Likert-scale of this study consists of four items for Perceived Usefulness (PU) and four items for Perceived Ease of Use (PEOU). In the reliability test of Cronbach's Alpha for this thesis' survey, the result was 0.883 which indicated a high level of internal consistency, giving confirmation that the survey is reliable for data collection. With the data instrument validated and its reliability confirmed, the researcher is permitted to gather data from respondents at Pasig Elementary School.

Lastly, rather than quantifying the effect of incentives numerically, Republic Act No. 9513 will be analyzed through the results from the CBA and perceived effectiveness assessment as these results will form the basis for proposing viable policy improvements to enhance the effectiveness and accessibility of solar PV implementation especially in public schools.

Research Procedures of Data Collection

Figure 3

Data Collection Procedure

Preparation of Research Instruments

- Draft data collection letters to request secondary data from respective offices of Pasig City's LGU. (SOP 2)
- Draft a permission letter to conduct a survey within Pasig Elementary School.
- Draft a consent form emphasizing on confidentiality, and voluntary participation.
- Design a structured survey to gather: Demographic and economic characteristics (SOP 1) & Perceived Effectiveness using PU and PEOU Likert-scale items (SOP 3).
- Conduct pre-testing and reliability checks.
- Print finalized letters, surveys, and consent forms.

↓

Submission of Letters and Forms

- Submit endorsement / data collection letters to the respective offices.
- Submit the permission letter to the school.

↓

Data Collection

- Secure signature within consent forms before administering surveys.
- Emphasize voluntary and confidential participation.
- Administer structured surveys.
- Collect secondary data from Pasig City offices.

↓

Data Organization and Analysis

- Encode and organize all collected data.
- Analyze demographic and economic characteristics.
- Calculate NPV and IRR.
- Analyze perceived effectiveness based on PU and PEOU.
- Run regression analysis on demographic and economic predictors
- Use findings to formulate recommendations for RA 9513 (SOP 4).

Research Ethics Approaches

This thesis complies with the ethical guidelines of Republic Act No. 10173, also known as the Data Privacy Act of 2012, this safeguards the study's participants against deception, manipulation, or falsification. The respondents of this thesis' surveys are required to read and sign a consent form, this will guarantee that participation is both voluntary and autonomous, protecting the rights of all respondents throughout the process of all data collection methods. All of the data collected from the surveys will be used solely for academic and research purposes. Moreover, no personal information will be disclosed and all answers will be strictly kept confidential. In order to ensure comfort and respect for the respondents' time surveys will be conducted at a time most convenient for them.

Participants will also be informed that they have the right to skip any survey items they find uncomfortable to answer and they may withdraw from the study at any point without any negative consequence. To maintain complete confidentiality, the identities of the respondents will not be disclosed in the presentation or discussion of the study’s findings.

Furthermore, the formal data collection letters of secondary data from Pasig City’s Office of General Services and City Engineering Office will apply the same ethical standards. The formal data collection letters to be submitted will ask the aforementioned offices of Pasig to voluntarily provide the necessary data with full assurance that all information will be used strictly for academic and research purposes.

Since the study also involves elementary students who are minors, the approval of the school principal, to be gained through the permission letter, is recognized as the institutional consent that permits their participation, consistent with standard academic research practices for minimal-risk surveys conducted in schools.

In all stages of this thesis, it maintains a strong commitment towards transparency as it upholds the value of informed consent and ensures full compliance with data privacy.

Data Analysis

To address the study's objectives, the analysis of both primary and secondary data will utilize both Microsoft Excel and R, wherein a multitude of statistical techniques will be used.

Demographic and Economic Characteristics (for SOP 1):

Descriptive statistics will be used to summarize the demographic and economic profile of the respondents. To ensure analytical clarity, the results will also be categorized by stakeholder group including teachers, non-teaching personnel, and students.

Financial and Economic Analysis (for SOP 2):

For SOP 2, the financial and economic viability of the solar PV adoption will be analyzed using the metrics of both NPV and IRR based on the capital cost, maintenance costs, and the available historical electricity consumption (kWh) and cost data to be provided by Pasig City's LGU. The analysis will treat the secondary data as the basis for estimating the recovered cost of capital of the solar PV adoption through utilizing a 10% discount rate as aforementioned.

Perceived Effectiveness (for SOP 3):

The perceived effectiveness of the respondents will be analyzed using descriptive statistics which are namely mean and standard deviation, based on the PU and PEOU items of the Likert-scale. The results will also be categorized by stakeholder groups to identify observable differences.

Moreover, to determine whether the demographic and economic profile of the respondents influence their perceived effectiveness, a regression analysis will be conducted. An Ordinal logistic regression will be utilized as it is the most suitable regression for data derived from Likert-scales.

Policy Recommendation (for SOP 4):

The results from all the analyses of this study will collectively provide viable policy recommendations for RA 9513, aiming to enhance the effectiveness and accessibility of solar PV, especially for public educational institutions.

Chapter 5

Results and Discussions

This chapter presents the results of the study which includes the respondents' demographic and economic profile, the cost-benefit analysis, the perceived effectiveness of the respondents regarding the solar PV adoption, and lastly, the regression analysis that aims to determine the factors that may influence the respondents' perceptions. Collectively, the results contribute in supporting the formulation of policy recommendations for Republic Act 9513.

Descriptive Statistics of the Respondents

The first part of this chapter presents the demographic and economic profile of the 100 respondents from Pasig Elementary School, who are the stakeholders which consist of teachers, non-teaching personnel, and students. Their demographic and economic characteristics were summarized using frequency and percentage distributions. The characteristics that were summarized include the variables: role, age, gender, monthly household income, monthly electricity bill, and educational level. Table 1 presents the overall demographic and economic profile of the respondents.

Table 1

Demographic and Economic Profile of the Respondents

Variable	N = 100	% of N
Role		
Student	34	34
Non-Teaching Personnel	33	33
Teacher	33	33
Age Bracket		
< 10	27	27

30–39	23	23
40–49	22	22
20–29	14	14
10–14	7	7
> 50	7	7
Gender		
Female	54	54
Male	46	46
Monthly Household Income		
₱10,000–₱20,000	28	28
₱20,001–₱30,000	28	28
> ₱30,000	23	23
< ₱10,000	21	21
Monthly Electricity Bill		
₱1,000–₱2,000	37	37
₱2,001–₱3,000	31	31
> ₱3,000	22	22
< ₱1,000	10	10
Educational Level		
Elementary	34	34
High School	24	24
Graduate Degree	24	24
College	18	18

Note. N = 100; Descriptive statistics by author (2025).

Role of Respondents

As shown in Table 1, the roles of the respondents in the school are evenly distributed across the different stakeholder groups: students comprise 34 percent, non-teaching personnel at 33 percent, and teachers also 33 percent. The balance makes certain that the perceptions of the school's solar PV adoption is a reflection that covers the collective views of different groups within the school; it ensures that there is representation for each stakeholder group in Pasig Elementary School.

Age Bracket

For age, the largest proportion of respondents are those below 10 years old, accounting for 27 percent of the total sample size, followed by those aged 30–39 at 23 percent and 40–49 at 22 percent. Respondents aged 20–29 account for 14 percent, and those who are of ages 10–14 and above 50 both represent merely 7 percent.

Gender

As for gender, female respondents comprise 54 percent of the total sample size and male respondents account for the remaining 46 percent.

Monthly Household Income

In terms of monthly household income, most of the respondents' households earn between ₱10,000–₱20,000 and ₱20,001–₱30,000 both at 28 percent. As for 23 percent of the respondents, they earn above ₱30,000, and the remaining 21 percent earn below ₱10,000.

Monthly Electricity Bill

As for monthly electricity bill, the highest proportion of respondents, at 37 percent, have monthly electricity bills of ₱1,000–₱2,000, followed by those with ₱2,001–₱3,000 at 31 percent and above ₱3,000 at 22 percent. Only 10 percent of the respondents have bills below ₱1,000.

Educational Level

For educational level, 34 percent of the respondents are at the elementary level which roots from the inclusion of students within the sample. For the non-student respondents, 24 percent are high school graduates, 18 percent are college graduates, and 24 percent have graduate degrees.

Categorized Descriptive Statistics of Respondents

In addition to the aggregate demographic and economic descriptive statistics of the respondents, a categorized summary per stakeholder group is also presented. This process of stratification provides a clearer context for the different stakeholders involved, paving the way for interpreting the differences in perceptions with regard to the school's solar PV adoption, the categorized summary will be shown in subsequent tables.

Table 2

Demographic and Economic Profile of Student Respondents

Variable	N = 34	% of N
Role		
Student	34	100
Age Bracket		
< 10	27	79.41
10–14	7	20.59
Gender		
Female	17	50
Male	17	50
Monthly Household Income		
< ₱10,000	20	58.82
₱10,000–₱20,000	12	35.29
₱20,001–₱30,000	2	5.88
Monthly Electricity Bill		
₱1,000–₱2,000	13	38.24
< ₱1,000	9	26.47
₱2,001–₱3,000	7	20.59
> ₱3,000	5	14.71
Educational Level		
Elementary	34	100

Note. Student respondents, N = 34; Descriptive statistics by author (2025).

As shown in Table 2, there are 34 student respondents. For age, 79.41 percent of the students are below 10 years old and the remaining 20.59 percent are aged 10–14 which is consistent with the typical age range of elementary pupils. As for the gender distribution, it is evenly split at 50 percent, with 17 males and 17 females.

A majority of the student population come from households that earn below ₱10,000 monthly, comprising 58.82 percent, which is followed by those who earn ₱10,000–₱20,000 monthly at 35.29 percent, and the remaining 5.88 percent consists of the minority who earn ₱20,001–₱30,000. As for monthly electricity bill, 38.24 percent of the students come from households that spend ₱1,000–₱2,000 per month on electricity, 26.47 percent come from those that spend below ₱1,000, 20.59 percent spend ₱2,001–₱3,000 and 14.71 percent spend above ₱3,000.

Table 3

Demographic and Economic Profile of Non-Teaching Personnel Respondents

Variable	N = 33	% of N
Role		
Non-Teaching Personnel	33	100
Age Bracket		
30–39	12	36.36
40–49	11	33.33
20–29	10	30.30
Gender		
Female	19	57.58
Male	14	42.42
Monthly Household Income		
₱10,000–₱20,000	16	48.48
₱20,001–₱30,000	14	42.42
> ₱30,000	2	6.06
< ₱10,000	1	3.03
Monthly Electricity Bill		
₱1,000–₱2,000	22	66.67

₱2,001–3,000	9	27.27
> ₱3,000	2	6.06
Educational Level		
High School	24	72.73
College	8	24.24
Graduate Degree	1	3.03

Note. Non-teaching personnel respondents, N = 33; Descriptive statistics by author (2025).

It is to be observed in Table 3 that there are 33 non-teaching personnel respondents. Most are aged 30–39 which comprises 36.36 percent, followed by those aged 40–49 at 33.33 percent and those of 20–29 years of age at 30.30 percent, the age bracket of the non-teaching personnel respondents indicates a predominantly middle-aged population. For gender, females comprise 57.58 percent and males account for the remaining 42.42 percent.

For monthly household income, nearly half of the non-teaching personnel respondents, at 48.48 percent, report between ₱10,000–₱20,000, 42.42 percent earn ₱20,001–₱30,000, and only a small portion of the specific respondents earn above ₱30,000 at 6.06 percent or merely below ₱10,000, which comprises 3.03 percent. As for monthly electricity bill, two-thirds of the non-teaching personnel, specifically 66.67 percent, have monthly bills of ₱1,000–₱2,000, 27.27 percent pay ₱2,001–₱3,000 and the remaining 6.06 percent exceed paying bills above ₱3,000.

For the specific respondents' educational level, 72.73 percent are high-school graduates, 24.24 percent hold college degrees, and 3.03 percent possess graduate degrees.

Table 4

Demographic and Economic Profile of Teacher Respondents

Variable	N = 33	% of N
Role		
Teacher	33	100
Age Bracket		

30–39	11	33.33
40–49	11	33.33
> 50	7	21.21
20–29	4	12.12
Gender		
Female	18	54.55
Male	15	45.45
Monthly Household Income		
> ₱30,000	21	63.64
₱20,001–₱30,000	12	36.36
Monthly Electricity Bill		
> ₱3,000	15	45.45
₱2,001–3,000	15	45.45
₱1,000–1,000	2	6.06
< ₱1,000	1	3.03
Educational Level		
Graduate Degree	23	69.70
College	10	30.30

Note. Teacher respondents, N = 33; Descriptive statistics by author (2025).

As shown in Table 4, there are 33 teacher respondents. Most of the teachers are aged 30–39 and 40–49 both at 33.33 percent each, followed by those above 50 years of age at 21.21 percent and 20–29 at 12.12 percent. For gender, similar with the other stakeholder populations, there is a slight female majority, with females comprising 54.55 percent and males comprising the remaining 45.45 percent.

The majority of teachers earn more than ₱30,000 monthly comprising 63.64 percent and the remaining 36.36 percent earn ₱20,001–₱30,000. For monthly electricity bill, 45.45 percent of the teacher population pay monthly electricity bills of ₱2,001–₱3,000, 45.45 percent exceed paying ₱3,000 monthly, 6.06 percent pay ₱1,000–₱2,000 and 3.03 percent pay below ₱1,000.

For the variable of educational level, 69.7 percent of teachers possess graduate degrees and 30.3 percent have college degrees, the results for this particular variable is consistent with the professional requirements in the education sector.

Cost-Benefit Analysis Results (NPV and IRR)`

Due to data scarcity regarding the maintenance costs of Pasig Elementary School's solar PV adoption, a detailed and specific maintenance cost based on a credible institutional source, which is applicable for the context of the adoption, is utilized. The study adopted an estimated maintenance cost that is sourced from the Department of Energy, specifically ₱900 per kWp per year, which resulted in a cost of ₱14,175 for the 15.75 kWp solar PV of Pasig Elementary School. Moreover, the estimated annual energy generation was also sourced from the DOE, which stated a specific yield of approximately 1,402.1 kWh per kWp per year for Metro Manila, resulting in an estimated annual energy generation of 22,083.08 kWh for the solar PV adoption of Pasig Elementary School. The data regarding the historical electricity cost and consumption of Pasig Elementary School, which were provided by Pasig City's Office of General Services, were used to determine the average cost per kWh, together with the estimated annual energy generation, this formed the basis for valuing the system's annual savings. Table 5 summarizes the results of the Cost-Benefit Analysis.

Table 5

Cost–Benefit Analysis Results (NPV and IRR)

Parameter	Value
Capital Cost (₱)	53,468,718.75
Maintenance Cost (₱/year)	14,175
Discount Rate	10%
System Size (kWp)	15.75
Estimated PV Generation (kWh/year)	22,083.08
Average Cost per kWh (₱)	14.95
Annual Savings (₱/year)	330,149.76
Lifespan (years)	25

NPV (₱)	-50,600,603.23
IRR	-11%
Simple Payback Period (years)	169.22

Note. The CBA is based on the gathered capital cost and DOE-estimated maintenance cost of ₱900 per kWp. Calculations assume a 25-year lifespan, 10% discount rate, and consistent annual savings from the 15.75 kWp system.

The results of the Cost-Benefit Analysis indicates that the solar PV adoption of Pasig Elementary School, when evaluated using the provided capital cost, yields a negative NPV of -₱50,600,603.23, and a IRR of -11%. The negative NPV states that over the assumed 25-year lifespan of the adoption at a 10% discount rate it is not expected to generate sufficient financial returns that will recover the initial investment. Furthermore, the IRR which is substantially below the discount rate is an indication that the financial returns do not meet the minimum threshold that is required for financial viability. The results of the CBA is collective proof that the adoption does not produce a favorable financial return.

Furthermore, the result of the exceptionally long simple payback period of approximately 169 years far exceeds the assumed and expected lifespan of the solar PV adoption.

Based on the aforementioned results, the study does not reject H01 and H02 given that the Cost-Benefit Analysis, through the metrics of both the Net Present Value and Internal Rate of Return, does not indicate economic or financial viability.

However, despite the negative results of the CBA, it must be acknowledged that the outcome is largely influenced by the relatively high capital cost that was reported for Pasig Elementary School's solar PV adoption, the value appears to be considerably higher relative to typical solar PV systems that possess the similar capacity. This is an indication that the findings may be a reflection of the specific cost of the adoption rather than an inherent limitation of solar PV adoption in educational institutions.

Therefore, to contextualize the financial results and evaluate Pasig Elementary School's solar PV adoption under a capital cost that is more realistic, a second computation was conducted by the researcher through utilizing a benchmark capital cost of approximately ₱1.55 million. The estimated value for the capital cost was derived from a literature by Pacudan (2018), which indicated prices of about USD 1.75 per watt-peak for small solar PV systems in the Philippines, this is an equivalent to roughly ₱78,750 per kWp through using a ₱45 per 1 US Dollar exchange rate at the time of the adoption, which is the year 2014. For a 15.75 kWp solar PV system, this amounts to an estimated cost of ₱1.24 million, which is then increased to ₱1.55 million when accounting for the typical 20% cost share of battery components within hybrid solar PV as stated by Thakor (2017). Table 6 presents the results of the Cost-Benefit Analysis using a literature-based benchmark for the capital cost.

Table 6

Cost–Benefit Analysis Results Literature Based Capital Cost Estimate

Parameter	Value
Capital Cost (₱)	1,550,390.63
Maintenance Cost (₱/year)	14,175
Discount Rate	10%
System Size (kWp)	15.75
Estimated PV Generation (kWh/year)	22,083.08
Average Cost per kWh (₱)	14.95
Annual Savings (₱/year)	330,149.76
Lifespan (years)	25
NPV (₱)	1,317,724.89
IRR	20%

Simple Payback Period (years)	4.91

Note. Capital cost is based on a literature derived benchmark for a 15.75 kWp hybrid solar PV system (Pacudan, 2018; Thakor, 2017); all other parameters mirror those used in the initial CBA.

The results presented in Table 6 illustrates a notably stronger financial outcome, with an estimated capital cost of ₱1.55 million, the adoption would yield a positive Net Present Value amounting to ₱1,317,724.89 and a 20% Internal Rate of Return, these results both indicate that the financial benefits of Pasig Elementary School's solar PV adoption would substantially exceed its discounted costs over its 25-year lifespan. Furthermore, its short simple payback period of about 4.9 years is also a strong indication that the system could begin generating net savings early in its implementation.

The results of Table 6 substantiate that if the adoption was implemented at a cost that is reported in existing literature, the installation would be economically and financially viable, and would have been capable of providing substantial long-term savings.

Survey Results of Perceived Effectiveness

Table 7

Perceived Effectiveness of the Solar PV adoption at Pasig Elementary School

Question	Mean	Standard Deviation
Q6: PU1	3.52	0.50
Q7: PU2	3.70	0.46
Q8: PU3	3.68	0.49
Q9: PU4	3.64	0.58
Q10: PEOU1	3.69	0.49
Q11: PEOU2	3.70	0.50
Q12: PEOU3	3.76	0.45
Q13: PEOU4	3.67	0.51

Note. Overall PU = 3.64; overall PEOU = 3.71; overall PE = 3.67.

As shown in Table 7, the solar PV adoption at Pasig Elementary School obtained an overall mean of 3.67 which is interpreted as “Agree” under the 4-point Likert-scale. The value of the overall mean is an indication that the respondents view the system as both useful and easy to use. The constructs of both Perceived Usefulness and Perceived Ease of Use under the Technology Acceptance Model recorded means of 3.64 and 3.71 respectively, which is also a reflection of the consistent positive perceptions across all of the stakeholder groups.

The highest-rated PU Question was 7: “The solar PV contributes to a better school environment” with a recorded mean of 3.70. As for PEOU, the highest-rated was Question 12: “The school has adapted well to the solar PV system” at 3.76. Although theoretically, PU1 was expected to yield the highest mean, it gathered the lowest among its category. In the context of Pasig Elementary School, the respondents may not directly observe or manage expenditures regarding electricity, which makes financial savings less noticeable compared to environmental or institutional benefits experienced by the school. Existing research conducted by Venkatesh & Davis (2000) states that perceived usefulness is vitally shaped by role relevance and outcome visibility. Furthermore, the uniformly high means across all of the PU items is an indication of a high ceiling rather than conceptual inconsistency.

The results in terms of perceived effectiveness indicates a positive collective perception of the solar PV adoption, supporting the rejection of both H03 and H04.

Categorized Survey Results of Perceived Effectiveness

Table 8

Perceived Effectiveness of Student Respondents

Question	Mean	Standard Deviation
Q6: PU1	3.50	0.51
Q7: PU2	3.62	0.49
Q8: PU3	3.59	0.56
Q9: PU4	3.53	0.75
Q10: PEOU1	3.50	0.56
Q11: PEOU2	3.56	0.56
Q12: PEOU3	3.68	0.47
Q13: PEOU4	3.59	0.50

Note. Student PU = 3.56; student PEOU = 3.58; student PE = 3.57.

As shown in Table 8, student respondents had an overall perceived effectiveness mean of 3.57 which is under "Agree" in the 4-point Liker-scale, the students also had PU and PEOU means of 3.56 and 3.58, respectively. The results are indications that students collectively view the solar PV adoption at Pasig Elementary School as useful and easy to use. Similar to the aggregate results of perceived effectiveness, for the context of students, the highest rated means were also PU Question 7 with a mean of 3.62, and PEOU Question 12 with a mean of 3.68.

Majority of the PU and PEOU questions showed low standard deviations, illustrating consistency in the responses of students. However, Question 9: "Using solar energy is better for the environment in the long term" resulted in a standard deviation of .75 which is relatively higher among the other questions, a representation of variation in how students understood the statement on long-term environmental benefits. Overall, the student respondents hold a favorable view of the solar PV adoption in their school.

Table 9

Perceived Effectiveness of Non-Teaching Personnel Respondents

Question	Mean	Standard Deviation
Q6: PU1	3.48	0.51
Q7: PU2	3.70	0.47
Q8: PU3	3.73	0.45

Q9: PU4	3.61	0.50
Q10: PEOU1	3.85	0.36
Q11: PEOU2	3.79	0.42
Q12: PEOU3	3.79	0.42
Q13: PEOU4	3.61	0.56

Note. Non-teaching personnel PU = 3.63; PEOU = 3.76; PE = 3.69.

As shown in Table 9, non-teaching personnel respondents had an overall perceived effectiveness mean of 3.69, which falls under "Agree" in the 4-point Likert-scale. The questions under the construct of PU resulted in a mean of 3.63, as for PEOU, it resulted higher with a mean score of 3.76, both indicators illustrate that non-teaching personnel within the school perceive the solar PV adoption as both beneficial and easy to operate. The highest PU rating was for Question 8: "The solar PV system benefits both the school and its students" at 3.73 mean, which reflects a strong recognition of the adoption's benefits to both the school and its students. For PEOU, Question 10: "The solar PV system works without disrupting school operations" received the highest mean with a score of 3.85, which is an indicator that the non-teaching personnel of the school majorly agrees that the solar PV adoption operates in a smooth manner without disrupting operations in the school.

Standard deviations across all questions were low showing consistent perceptions among the specific respondents. Question 10 combined a high mean with one of the lowest standard deviations, which provides proof that there exists strong consensus regarding the adoption's operational stability and minimal disruption.

The non-teaching personnel of Pasig Elementary school shows a positive perception of the solar PV adoption; their perception is further enhanced with credibility given their operational roles within the school. The consistent agreement that exists between these respondents shows a collective view that the adoption benefits the school.

Table 10

Perceived Effectiveness of Teacher Respondents

Question	Mean	Standard Deviation
Q6: PU1	3.58	0.50
Q7: PU2	3.79	0.42
Q8: PU3	3.73	0.45
Q9: PU4	3.79	0.42
Q10: PEOU1	3.73	0.45
Q11: PEOU2	3.76	0.50
Q12: PEOU3	3.82	0.46
Q13: PEOU4	3.82	0.46

Note. Teacher PU = 3.72; Teacher PEOU = 3.78; Teacher PE = 3.75.

As shown in Table 10, teacher respondents had the highest overall perceived effectiveness among all of the stakeholder groups at Pasig Elementary School, their mean score is 3.75, which falls under “Agree” in the 4-point Likert-scale. As for both the PU and PEOU questions, the teacher respondents recorded mean scores of 3.72 and 3.78, respectively, which indicates a strong agreement that the solar PV adoption is both beneficial and easy to use in the school. The highest PU rated questions were both Question 7: “The solar PV contributes to a better school environment” and Question 9: “Using solar energy is better for the environment in the long term” both with 3.79 mean scores, a reflection of the teachers’ strong recognition of the adoption’s environmental and institutional benefits. For PEOU, Question 12: “The school has adapted well to the solar PV system” and Question 13: “I understand the function and purpose of the solar PV system” both scored the highest mean at 3.82, substantiating that the teachers find Pasig Elementary School to have integrated the adoption well and understand its purpose within the school.

Standard deviations across the perceived effectiveness questions were generally low which indicates consistent perceptions among the teachers of Pasig Elementary School. The aforementioned questions with high mean scores also showed minimal variability as indicated in their standard deviation levels; this illustrates that there is uniform agreement on the adoption's usefulness and ease of use among teachers.

The teacher respondents showed the strongest support towards the solar PV adoption at Pasig Elementary School.

Regression Analysis on the Predictors of Perceived Effectiveness

To determine whether the demographic and economic characteristics of the respondents influenced their perception, a regression analysis was conducted in R. Initially, the researcher attempted an ordinal logistic regression given that it is appropriate for the categories of the Likert-scale, however the model could not be estimated due to the responses being overwhelmingly concentrated at the higher categories of the Likert-scale, consequently leaving insufficient variation. Therefore, a binary logistic regression was performed instead, using the binary-coded perceived effectiveness variable as the dependent variable (0 = Agree; 1 = Strongly Agree) and the variables role, age, gender, monthly household income, monthly electricity bill, and educational level entered as predictors. The results of this analysis are presented in Table 11.

Table 11

Binary Logistic Regression Results on the Predictors of High Perceived Effectiveness

Predictor	Estimate	Std. Error	z-value	p-value
(Intercept)	38.37027	8900.64048	0.004	0.997
Role (Student)	-34.94425	8900.60436	-0.004	0.997
Role (Teacher)	-15.56727	7116.67163	-0.002	0.998

Age ≥ 50	17.31059	9022.63950	0.002	0.998
Age 10–14	.90626	1.55046	0.585	0.559
Age 20–29	18.10910	6476.76797	0.003	0.998
Age 30–39	-0.69896	1.51639	-0.461	0.645
Age 40–49	NA	NA	NA	NA
Gender (Male)	-1.24459	1.31210	-1.099	0.272
Income > ₱30,000	-4.58794	3.29026	-1.394	0.163
Income ₱10,000–₱20,000	-2.28949	1.44136	-1.588	0.112
Income ₱20,001–₱30,000	-2.12080	1.97221	-1.075	0.282
Electricity Bill > ₱3000	19.47840	5196.66956	0.004	0.997
Electricity Bill ₱1000–₱2000	0.03311	1.39523	0.024	0.981
Electricity Bill ₱2001-₱3000	1.55376	1.69286	0.918	0.359
Education (Elementary)	NA	NA	NA	NA
Education (Graduate Degree)	-16.59570	5345.50124	-0.003	0.998
Education (High School)	-33.04400	8900.64029	-0.004	0.997

Note. Data analysis by author (2025).

The binary logistic regression which examines the predictors of high perceived effectiveness resulted in indicating no statistically significant effects from any demographic or economic variable from Pasig Elementary School's respondents. The intercept resulted in an estimate of 38.37 with a p-value of 0.997 which is a reflection of the model's instability due to complete separation. For the roles, students had an estimate of -34.94 at a p-value of 0.997 and teachers had -15.57 at a p-value of 0.998, which are both statistically insignificant and states that the model was unable to detect meaningful variation within these categories.

The variable of age also showed no significant influence. Respondents that are aged 50 and above had an estimate of 17.31 at a p-value of 0.998, those aged 10-14 had .90626 at a p-value of 0.559, those aged 20-29 had 18.1 at a p-value of 0.998, and the 30-39 group had -0.69896 at a p-value of 0.645. The age bracket 40-49 produced no estimate due to perfect prediction which resulted in values listed as NA.

For the variable of gender, male resulted in an estimate of -1.24 with a p-value of 0.272, which also signifies no statistical significance.

For the categories under monthly household income, it also yielded no statistical significance. Respondents that earn above ₱30,000 showed an estimate of -4.58 at a p-value of 0.163. Those earning ₱10,000–₱20,000 had an estimate of -2.28 at a p-value of 0.112, and the ₱20,001–₱30,000 category showed -2.12 with a p-value of 0.282, none reached statistical significance.

Monthly electricity bills also did not produce significant results. Respondents that paid more than ₱3,000 had an estimate of 19.47 at a p-value of 0.997. Those who paid ₱1,000–₱2,000 had an estimate of 0.033 at a p-value of 0.981, and those paying below ₱2001-₱3000 had an estimate of 1.55 at a p-value of 0.359, all being statistically non-significant.

Lastly, educational level also produced non-significant estimates. Elementary-level respondents were assigned NA values due to separation, while graduate degree holders had an estimate of -16.59 at a p-value of 0.998. As for High school graduates, the model showed an estimate of -33.04 at a p-value of 0.997.

None of the predictors reached statistical significance and many showed extremely large standard errors which indicates that there exists unstable coefficient estimates due to the uniformly high ratings across all of the respondents. The model lacked sufficient variation to determine any meaningful relationships; this is a confirmation that no demographic or economic characteristic statistically predicted high perceived effectiveness of the solar PV adoption at Pasig Elementary School.

A histogram of the respondents' Perceived Effectiveness was coded in R, and the scores show a positively skewed distribution, given that nearly all responses concentrated in the upper range of the 4-point Likert scale (Refer to the appendix B10). The results produced a sharply peaked distribution with a heavy right-side concentration and minimal spread.

The uniform and high ratings across all of the respondents resulted in very low variability, this is an indication that all demographic and economic groups perceived the solar PV adoption at Pasig Elementary School as effective. The histogram supports the outcome of the regression, as it shows almost no differentiation in responses.

To ensure that the pattern was not due to methodological error, the researcher reviewed existing literature. It was found that preceding studies also report overwhelmingly positive perceptions of solar PV systems, a study conducted by Alrashoud and Tokimatsu (2019) found that 97% of 1,498 respondents in Saudi Arabia strongly and positively view solar PV and showed no significant regional differences, as for Ahmad et al. (2017) the authors observed strong acceptance in Malaysia due to perceived environmental and economic benefits.

The findings with regard to similar literature validate the regression results of this thesis, illustrating that highly positive and uniform perceptions are common in solar PV research. Therefore, the non-significant predictors found in this study are aligned with established literature and explains why there exists a strong and positive sentiment among Pasig Elementary School respondents.

Results of Additional Questions

To contextualize solar PV adoption beyond the school, there were additional questions included at the end of the survey which examined the respondents' behavior towards solar PV adoption at a household level. The items were formulated to something that will capture not merely their support for the school's solar PV adoption, but also their willingness to adopt solar PV in their own homes, which co-exists along questions that aim to identify the factors that influence their decision regarding hypothetical household adoption.

Table 12

Summary of Responses to Additional Questions

Variable	N = 100	% of N
Importance of Solar PV (Q14)		
Yes	97	97
No	3	3
Support for Continued Use (Q15)		
Yes	99	99
No	1	1
Willingness to Adopt at Home (Q16)		
Yes	99	99
No	1	1
Factors Influencing Adoption (Q17)		
Potential savings on electricity bills	92	92
Government support (subsidies, incentives, net metering)	87	87
Environmental benefits	53	53
Long-term investment and return on cost	52	52
Influence of other institutions	17	17

Other	0	0
Willingness to Invest (Q18)		
Below ₱50,000	56	56
₱50,000–₱100,000	11	11
₱100,001–₱150,000	11	11
Above ₱150,000	22	22
Adoption with Flexible Options (Q19)		
Yes	96	96
No	4	4

Note. N = 100.

As shown in Table 12, the results of the additional questions indicate a consistent and positive behavior among the respondents. Nearly all of the stakeholders at Pasig Elementary School think that solar PV is important in public schools at 97 percent, a majority of them also support its continued use, at 99 percent, a reflection of a strong institutional acceptance.

The respondents' willingness to adopt solar PV at a household level was also high, with 99 percent showing willingness towards adoption if given the opportunity, a spillover effect occurred, where the school's adoption of solar PV also encouraged its stakeholders in household adoption.

As for the factors that influenced their hypothetical adoption, financial and policy-related factors were the most vital motivators. The most cited factor for adoption was potential savings on electricity bills at 92 percent, which is then followed by government support at 87 percent. The factors of both environmental benefits at 53 percent and long-term investment value at 52 percent were also relevant factors that affected the decision of hypothetical adoption, despite being less influential than the aforementioned factors. Merely 17 percent cited the influence of other institutions.

56 percent, were willing to invest merely below ₱50,000 which is the lowest among the options, while only 22 percent were willing to invest above ₱150,000, the highest among the options. 96 percent of the respondents would adopt solar PV if flexible payment options exist. These are things such as government subsidies or installment plans, serving as proof of the importance of accessible financing mechanisms.

Chapter 6

Conclusions and Recommendations

The final chapter of this thesis summarizes the key findings of the study regarding the effectiveness of the solar photovoltaic technology adoption at Pasig Elementary School. It shows the results of both the Cost-Benefit Analysis and the perceived effectiveness of the stakeholders involved in the study, which is then followed by conclusions that are drawn from the study's hypotheses. Lastly, this chapter provides viable recommendations that are based on the study's results, in order to improve the accessibility and the effectiveness of solar PV, especially within public educational institutions.

Conclusions

This thesis determined the effectiveness of Pasig Elementary School's solar PV adoption through utilizing economic and financial metrics, as well as identifying its stakeholders' perceptions. The Cost-Benefit Analysis, with the gathered data regarding its capital cost of ₱53.47 million resulted in a negative NPV, a negative IRR, together with an impractically long payback period of 169 years, when the system's lifespan is assumed to only last for 25 years, these results illustrate that the investment is not economically or financially viable under its actual capital cost.

However, the researcher found that when a literature-aligned benchmark capital cost of approximately ₱1.55 million was applied, the system then became both economically and financially viable, with the results producing a positive NPV, an IRR of 20%, and a payback period of merely 4.9 years specifically. This is an indication that the lack of viability of Pasig

Elementary School's solar PV adoption is largely due to the unusually high reported capital cost rather than any inherent weakness of solar PV technology.

As for the results regarding the perceived effectiveness of the stakeholders, they were overwhelmingly positive, this is illustrated by the high PU and PEOU scores across all respondent groups. Teachers, non-teaching personnel, and students all agreed that the system is useful, environmentally beneficial, and easy for the school to integrate.

The regression results showed no significant demographic or economic predictors of perceived effectiveness due to the uniformly and clustered high ratings, this means that the support for solar PV within Pasig Elementary School is universally shared regardless of variables such as age, gender, monthly household income, monthly electricity bill, educational level, and role within the school.

The additional questions provided in this thesis' survey further enhanced the fact that there exists a strong support from its stakeholders, given their willingness to adopt solar PV at their own household, if the opportunity presents itself, especially with the availability of financial support or flexible payment mechanisms.

Despite the positive perceptions found in this study, the effectiveness of adopting solar PV is hindered by limitations, in which cost barriers serve as the major contributor of hindering adoption. This indicates that RA 9513 remains insufficiently effective for enabling affordable renewable energy adoption, especially in public schools. The study found that solar PV is strongly supported and is perceived as highly effective, however, it is constrained by cost irregularities and policy gaps.

Hypothesis Results

The findings of this study dictate the outcomes of its hypotheses. Given that the Cost-Benefit Analysis resulted in a negative NPV and IRR, the study does not reject H01, which states that the CBA does not indicate economic viability, and does not reject H02, which states that the NPV and IRR do not indicate financial viability. These results are substantiated by empirical data, which shows that the adoption, at its actual recorded capital cost, cannot recover its investment.

As for the stakeholders' perceptions, it showed consistently high mean scores for both Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), thus, a strong agreement that the solar PV is both beneficial and easy to use, exists. Therefore, the study rejects H03 and rejects H04, since both hypotheses assumed minimal or insignificant perceptions of usefulness and ease of use. The aggregate results, especially with the existence of a uniform and strong support across economic and demographic groups, provides clear evidence that enables the study to contradict these null hypotheses.

Recommendations

Based on the findings regarding the effectiveness of Pasig Elementary School's solar PV adoption, recommendations are proposed.

For Policymakers

The procurement processes involving solar PV for public schools must be made more transparent and cost-efficient, these are both achievable through the existence of benchmark-based costing and validation of prices through the intervention of third parties. This is of the essence given that the study gathered an unusually high capital cost relative to other solar PV systems with similar capacities, signaling the potential of misallocating scarce public resources.

Improvements towards RA 9513 also remain to become necessary, particularly in the context of expanding subsidies, simplifying access to tax incentives and net metering, and institutionalizing flexible financing such as zero-interest loans or installment plans. Moreover, there should exist an established national cost ceiling for government-funded solar projects, this will further strengthen accountability and promote accessibility and more efficient adoption. Lastly, monitoring systems must be improved upon in order to avoid data scarcity for future researchers and to efficiently monitor solar PV's effectiveness.

For Households

Within this thesis, the stakeholders showed a high willingness to adopt solar PV within their households, especially with the presence of flexible payment options and government support. Hence, families are encouraged to explore solar PV systems of smaller scale that will match their budget, it must be noted that quotations must be compared in order to verify quality and to make certain that it is cost-efficient. Participation in net metering will also further maximize electricity savings. With meticulous cost management, households can benefit from solar PV both financially and environmentally.

For Educational Institutions

With this study, schools are able to recognize that solar PV becomes financially viable when the capital costs are aligned with existing market benchmarks. Therefore, educational institutions are encouraged to promote and apply transparent procurement practices and use benchmarks as reference points for costing in order to avoid overspending. Given that there are strong and positive perceptions among teachers, staff, and students, schools should also implement topics regarding solar PV into environmental education to further promote renewable energy literacy.

Proper Resource Allocation

This thesis emphasizes the importance of allocating scarce resources efficiently. Solar PV has a strong potential for economic and financial viability, but properly managed costs must co-exist. Regardless of context, whether for schools or households, renewable energy investments must prioritize transparency and cost discipline for long-term returns to be present.

Areas for Further Research

Future research should expand this study through examining solar PV adoption across multiple schools in order to determine whether financial outcomes, cost structures, and perceived effectiveness will vary across different educational institutions. A wider study would enable the identification, as to whether the cost irregularities observed in Pasig Elementary School's solar PV adoption is isolated. Future studies must also include stakeholder interviews and institutional procurement records to further deepen understanding regarding financial, operational, and policy-related challenges affecting solar PV adoption.

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Appendix A

A1: Request of Endorsement from Ugnayan sa Pasig Office

Request for Endorsement to the Office of General Services and City Engineering Office

Dear Ugnayan sa Pasig Office,

Good day! I am John Peter German, an undergraduate student from San Beda University, currently conducting my thesis titled *"Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis."*

In line with this, I am respectfully requesting your kind assistance in endorsing my data request to the Office of General Services (OGS) and the City Engineering Office (CEO). The purpose of this request is to obtain the following data necessary for my study:

From the Office of General Services (OGS):

1. The available historical records of annual electricity consumption of Pasig Elementary School, expressed in kilowatt-hours (kWh), covering both pre-adoption and post-adoption periods of the solar photovoltaic (PV) system; and

2. The available historical records of annual electricity cost (in Philippine pesos) of the same school for the same corresponding periods.

From the City Engineering Office (CEO):

1. The total capital cost of the solar photovoltaic (PV) installation at Pasig Elementary School; and

2. The maintenance costs of the solar PV system.

All requested data will be used solely for academic purposes and treated with full confidentiality.

I would greatly appreciate your endorsement to the respective offices so I may formally coordinate with them regarding the data collection needed for my thesis.

Thank you very much for your time and assistance.

Respectfully yours,

John Peter German
BS Economics and Public Policy
San Beda University – Manila

A2: Data Collection Letter to Pasig's City Engineering Office (CEO)

Data Collection Letter to Pasig's City Engineering Office (CEO)

John Peter German
Department of Economics and Public Policy
San Beda University – Manila
jpdmgerman@gmail.com | +63 966 992 6927

To:
Engr. Artaxerxes V. Geronimo
City Engineer
City Engineering Office (CEO)
2/F Temporary Pasig City Hall
Pasig City

Subject: Formal Request for Data on Solar Photovoltaic (PV) Project Implementation

Dear Engr. Geronimo,

I am John Peter German, a fourth-year BS Economics and Public Policy student at San Beda University – Manila, currently conducting my thesis titled "Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis."

In connection with this, I respectfully request your assistance in providing secondary data related to the solar photovoltaic (PV) project at Pasig Elementary School, specifically the following:
- Capital cost of the solar PV installation
- Maintenance costs

These data are essential to determine the financial and economic viability of the project through the financial metrics of both the Net Present Value (NPV), and Internal Rate of Return (IRR). All information will be used strictly for academic purposes and handled in accordance with the Data Privacy Act of 2012 (RA 10173).

Your cooperation will significantly contribute to the completion of this research.

Respectfully yours,

John Peter German
BS Economics and Public Policy
San Beda University – Manila

Approved by:
Michael O. Sinocruz – Thesis Adviser
Aris Zoleta – Thesis Statistician

A3: Data Collection Letter to Pasig's Office of General Services (OGS)

Data Collection Letter to Pasig's Office of General Services (OGS)

John Peter German
Department of Economics and Public Policy
San Beda University – Manila
jpdmgerman@gmail.com | +63 966 992 6927

To:
Ms. Ruth F. Romano
Head, Office of General Services (OGS)
2/F Temporary Pasig City Hall
Pasig City

Subject: Formal Request for Historical Electricity Cost and Consumption Data

Dear Ms. Romano,

I am John Peter German, a fourth-year BS Economics and Public Policy student from San Beda University – Manila, currently conducting my thesis entitled "Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis."

I would like to formally request your assistance in obtaining available historical records of electricity consumption and cost (in kWh and peso value) for Pasig Elementary School, covering both the pre-adoption and post-adoption periods of the solar photovoltaic (PV) system.

While it is understood that the school's solar PV adoption began around 2017, this request intentionally does not specify an exact timeframe to allow your office to provide all available and accessible data, ensuring the completeness and accuracy of the cost-benefit analysis.

The information will be used exclusively for academic research purposes and will remain confidential, in full compliance with the Data Privacy Act of 2012 (RA 10173). These data are vital for the study's Cost-Benefit Analysis (CBA) and the computation of Net Present Value (NPV) and Internal Rate of Return (IRR).

Your office's assistance will greatly contribute to a better understanding of Pasig City's sustainability initiatives and their measurable impacts.

Respectfully yours,

John Peter German
BS Economics and Public Policy
San Beda University – Manila

Approved by:
Michael O. Sinocruz – Thesis Adviser
Aris Zoleta – Thesis Statistician

Appendix B

B1: Permission Letter to Conduct a Survey at Pasig Elementary School

Permission Letter to Conduct a Survey at Pasig Elementary School

John Peter German
Department of Economics and Public Policy
San Beda University – Manila
jpdmgerman@gmail.com | +63 966 992 6927

To:
Ms. Marife V. Villadiego
The Principal
Pasig Elementary School
Pasig City

Subject: Request for Permission to Conduct Survey

Dear Madam,

I am John Peter German, a fourth-year Economics student from San Beda University – Manila, currently conducting my thesis titled "Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis."

In line with this, I respectfully request your permission to conduct a short, structured survey among Pasig Elementary School's teachers, non-teaching personnel, and selected students regarding their perception of the solar photovoltaic system implemented in your school. Participation will be voluntary, confidential, and in full compliance with the Data Privacy Act of 2012 (RA 10173). For student respondents, the survey will be conducted with the approval and guidance of the school administration.

Please note that the secondary data needed for this research—such as installation costs, maintenance costs, and electricity consumption—will instead be formally requested from the Pasig City Engineering Office and the Office of General Services. This letter therefore seeks permission only to conduct the primary survey among your school's respondents.

All collected data will be treated with strict confidentiality and used solely for academic and research purposes.

Respectfully yours,

John Peter German
BS Economics and Public Policy – San Beda University – Manila

Approved by:
Michael O. Sinocruz – Thesis Adviser
Aris Zoleta – Thesis Statistician

B2: Consent Form for Respondents

Consent to Act as a Participant
Research Title:
"Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis"

Researcher:
John Peter German
Department of Economics and Public Policy
San Beda University – Manila

1. My participation in this research project is voluntary. I understand that I will not be paid for my participation. If I decline to participate or withdraw from the study, it will be confidential.

2. I may withdraw and discontinue participation at any time without penalty. If I feel uncomfortable at any point, I may skip any question(s) or end the survey.

3. Participation involves answering a structured survey questionnaire by the researcher from San Beda University. The survey will last approximately 5–10 minutes and will be conducted at a time convenient to me.

4. I understand that the researcher will not identify me by name in any reports. My confidentiality will be protected in accordance with Republic Act No. 10173 (Data Privacy Act of 2012). All information will be used solely for academic and research purposes.

5. I understand that this research study has been reviewed and approved by the Department of Economics at San Beda University. I also understand that the administration of Pasig Elementary School has approved the conduct of this survey within the school and among its students, teachers, and personnel.

6. I have read and understood the explanation provided. I have had the opportunity to ask questions, and all were answered to my satisfaction. I voluntarily agree to participate in this study.

7. I have been given a copy of this consent form.

Signature of the Respondent *(If applicable)*: _______________

B3: Filipino version of Consent Form for Respondents

Pahintulot sa Paglahok sa Pananaliksik
Pamagat ng Pananaliksik:
"Effectiveness of Utilizing Solar Photovoltaic at Pasig Elementary School: Cost-Benefit Analysis"

Mananaliksik:
John Peter German
Departamento ng Ekonomiks at Pampublikong Patakaran
San Beda University – Manila

1. Ang aking pagsali sa pananaliksik na ito ay kusang-loob. Nauunawaan ko na wala akong matatanggap na bayad. Kung ako ay tumanggi o umatras sa paglahok, ito ay mananatiling kumpidensyal.

2. Maaari akong umatras o huminto sa paglahok anumang oras nang walang parusa. Kung ako ay makaramdam ng hindi pagiging komportable, may karapatan akong laktawan ang anumang tanong o tapusin ang survey.

3. Ang pagsali ay nangangahulugang pagsagot ng survey na ibibigay ng mananaliksik mula sa San Beda University. Tinatayang tatagal ito ng 5–10 minuto at isasagawa sa oras na pinaka-maginhawa para sa akin.

4. Nauunawaan kong hindi babanggitin ang aking pangalan sa anumang ulat. Ayon sa Republic Act No. 10173 (Data Privacy Act of 2012), ang lahat ng impormasyon ay mananatiling kumpidensyal at gagamitin lamang para sa layuning pang-akademiko. Nauunawaan ko rin na inaprubahan ng pamunuan ng Pasig Elementary School ang pagsasagawa ng survey na ito sa loob ng paaralan at sa mga mag-aaral, guro, at kawani nito.

5. Ang pananaliksik na ito ay aprubado ng Department of Economics sa San Beda University.

6. Nabasa at naintindihan ko ang mga paliwanag. Ako ay boluntaryong pumapayag na lumahok sa pag-aaral na ito.

7. Ako ay binigyan ng kopya ng form na ito.

Signatura ng Sumagot *(Kung naaangkop)*: ___________________________

B4: Structured Data Collection Survey & Perceived Effectiveness Likert-Scale

Structured Survey Questionnaire

Before proceeding to the survey, please check the category that best describes your role in Pasig Elementary School:

☐ Teacher ☐ Non-Teaching Personnel ☐ Student

PART 1: Demographic and Economic Profile of the Respondents

Q1. Age:

☐ Below 10 ☐ 10–14 ☐ 15–19 ☐ 20–29

☐ 30–39 ☐ 40–49 ☐ 50 and above

Q2. Gender:

☐ Male ☐ Female ☐ Prefer not to say

Q3. Estimated Monthly Household Income:

☐ Below ₱10,000 ☐ ₱10,000–₱20,000 ☐ ₱20,001–₱30,000 ☐ Above ₱30,000

Q4. Monthly Electricity Bill:

☐ Below ₱1,000 ☐ ₱1,000–₱2,000 ☐ ₱2,001–₱3,000 ☐ Above ₱3,000

Q5. Educational Level:

☐ Elementary ☐ High School ☐ College/University ☐ Graduate Degree

PART 2: Perceived Effectiveness of the Solar Photovoltaic (PV) System

Scale: 1 – Strongly Disagree 2 – Disagree 3 – Agree 4 – Strongly Agree

Perceived Usefulness (PU):

Q6. The solar PV system helps reduce the school's electricity expenses. [1] [2] [3] [4]

Q7. I believe the solar PV contributes to a better school environment. [1] [2] [3] [4]

Q8. The solar PV system benefits both the school and its students. [1] [2] [3] [4]

Q9. Using solar energy is better for the environment in the long term. [1] [2] [3] [4]

Perceived Ease of Use (PEOU):

Q10. The solar PV system works without disrupting school operations. [1] [2] [3] [4]

Q11. The system is easy to understand. [1] [2] [3] [4]

Q12. The school has adapted well to the solar PV system. [1] [2] [3] [4]

Q13. I understand the function and purpose of the solar PV system. [1] [2] [3] [4]

Additional Questions:

Q14. Do you believe solar PV technology is important in public schools?
☐ Yes ☐ No

Q15. If given the chance, would you support continued use of solar PV in the school?
☐ Yes ☐ No

Q16. If your household had the opportunity, would you be willing to adopt (install) a solar PV system?
☐ Yes ☐ No

If No → End of Survey.
If Yes → Proceed to Q17–Q19.

Q17. What factors influenced your willingness to adopt solar PV? (Check all that apply)
☐ Potential savings on electricity bills
☐ Environmental benefits (reduced emissions, sustainability)
☐ Long-term investment and return on cost
☐ Influence of seeing solar PV in schools or other institutions
☐ Government support (subsidy, incentives, net metering)
☐ Other: ___________

Q18. How much are you willing to invest in a household solar PV system (if affordable financing options are available)?
☐ Below ₱50,000
☐ ₱50,000–₱100,000
☐ ₱100,001–₱150,000
☐ Above ₱150,000

Q19. Would you consider adopting solar PV if there were flexible payment options (e.g., installment, government subsidy, or loan assistance)?
☐ Yes ☐ No

B5: Filipino version of Structured Data Collection Survey & Perceived Effectiveness Likert-Scale

Istrakturadong Kwestyonaryo ng Sarbey

Bago ipagpatuloy ang pagsagot sa sarbey, pakilagyan ng tsek ang kategoryang pinakaangkop sa iyong tungkulin sa Pasig Elementary School:
☐ Guro ☐ Di-Guro na Kawani ☐ Mag-aaral

BAHAGI 1: Demograpikong Impormasyon ng mga Sumusagot

Q1. Edad:
☐ Mas mababa sa 10 ☐ 10–14 ☐ 15–19 ☐ 20–29

☐ 30–39 ☐ 40–49 ☐ 50 pataas

Q2. Kasarian:
☐ Lalaki ☐ Babae ☐ Mas pinipiling huwag sabihin

Q3. Tinatayang Buwanang Kita ng Buong Pamilya:
☐ Mas mababa sa ₱10,000 ☐ ₱10,000–₱20,000 ☐ ₱20,001–₱30,000 ☐ Higit sa ₱30,000

Q4. Buwanang Halaga ng Bill sa Kuryente:
☐ Mas mababa sa ₱1,000 ☐ ₱1,000–₱2,000 ☐ ₱2,001–₱3,000 ☐ Higit sa ₱3,000

Q5. Taon ng Edukasyon:
☐ Elementarya ☐ High School ☐ Kolehiyo/Unibersidad ☐ Graduate Degree

BAHAGI 2: Pananaw sa Bisa ng Solar Photovoltaic (PV) System

Scale: 1 – Lubos na Hindi Sumasang-ayon 2 – Hindi Sumasang-ayon 3 – Sumasang-ayon 4 – Lubos na Sumasang-ayon

Perceived Usefulness (Kabuluhang Nakikita):

Q6. Ang solar PV ay nakatutulong sa pagbawas ng gastos sa kuryente ng paaralan. [1] [2] [3] [4]

Q7. Ang solar PV ay nakatutulong sa kapaligiran ng paaralan. [1] [2] [3] [4]

Q8. Kapaki-pakinabang ang solar PV para sa paaralan at mga mag-aaral. [1] [2] [3] [4]

Q9. Ang paggamit ng solar energy ay makabubuti sa kalikasan sa hinaharap. [1] [2] [3] [4]

Perceived Ease of Use (Dali ng Paggamit):

Q10. Ang solar PV ay gumagana nang hindi nakakaabala sa operasyon ng paaralan. [1] [2] [3][4]

Q11. Madaling maintindihan ang sistemang ito. [1] [2] [3] [4]

Q12. Madaling nakaangkop ang paaralan sa paggamit ng solar PV. [1] [2] [3] [4]

Q13. Nauunawaan ko ang layunin at gamit ng solar PV system. [1] [2] [3] [4]

Karagdagang Tanong:

Q14. Sa iyong pananaw, mahalaga ba ang teknolohiyang ito sa pampublikong paaralan?
☐ Oo ☐ Hindi

Q15. Kung may pagkakataon, susuportahan mo ba ang paggamit ng solar PV sa paaralan?
☐ Oo ☐ Hindi

Q16. Kung magkakaroon ng pagkakataon, nais ba ng inyong sambahayan na mag-adopt (magpakabit) ng solar PV system?
☐ Oo ☐ Hindi

Kung Hindi → Wakas ng Survey.

Kung Oo → Magpatuloy sa Q17–Q19.

Q17. Ano ang mga salik na nakaimpluwensya sa inyong kagustuhan na mag-adopt ng solar PV? (Maaari pumili ng higit sa isa)
☐ Posibleng makatipid sa bayarin sa kuryente
☐ Mga benepisyong pangkalikasan (pagbawas ng polusyon, pagpapanatili ng kalikasan)
☐ Pangmatagalang pamumuhunan at pagbabalik ng puhunan
☐ Impluwensya mula sa pagkakita ng solar PV sa paaralan o ibang institusyon
☐ Suporta mula sa pamahalaan (subsidyo, insentibo, net metering)
☐ Iba pa: ____________

Q18. Magkano ang handa ninyong ipuhunan para sa isang household solar PV system (kung may abot-kayang opsyon sa pagbabayad)?
☐ Mas mababa sa ₱50,000
☐ ₱50,000–₱100,000
☐ ₱100,001–₱150,000
☐ Higit sa ₱150,000

Q19. Ikokonsidera ba ninyong mag-adopt ng solar PV kung may flexible payment options (hal. hulugan, subsidiya ng gobyerno, o pautang)?
☐ Oo ☐ Hindi

B6: Likert-Scale Cronbach's Alpha

Perceived Usefulness				Perceived Ease of Use				
Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Total Score
2	4	4	4	4	2	4	3	27
4	3	4	4	4	4	4	4	31
3	4	3	4	4	4	4	4	30
4	4	4	4	4	4	4	4	32
4	4	4	4	4	4	4	4	32
4	4	4	4	4	4	4	4	32
4	3	4	4	4	4	4	4	31
3	4	4	4	4	4	4	4	31
4	4	4	4	4	4	4	3	31
4	4	4	4	4	4	4	4	32
4	4	4	4	4	4	4	4	32
3	1	2	1	4	2	4	4	21
4	4	4	4	4	4	4	4	32
4	4	4	4	4	4	4	4	32
4	3	4	4	4	4	4	4	31
4	4	4	4	4	3	4	4	31
3	4	4	4	4	4	4	4	31
4	4	3	4	4	4	4	4	31
4	2	1	1	4	2	1	2	17
4	4	4	4	4	4	4	4	32
3	4	4	4	4	4	4	3	30
4	4	4	4	4	4	4	4	32
4	4	4	4	4	4	4	4	32
4	4	4	4	4	4	4	4	32
3	3	2	1	3	1	3	3	19
3	4	4	4	4	4	4	4	31
4	4	4	4	4	3	4	4	31
4	3	4	4	4	4	4	4	31
4	4	4	4	4	3	4	4	31
4	4	4	4	4	4	4	4	32
0.2766666667	0.4888888889	0.5433333333	0.81	0.03222222222	0.64	0.3155555556	0.2266666667	

n=30

Description	Values
# of Variables	*8*
Sum of Q*n* Variances	*3.333333333*
Variance of Total Scores	*14.66666667*
Cronbach Alpha	***0.8831168831***

B7: Cost-Benefit Analysis (NPV and IRR) Excel Computation

Parameter	Value
Capital Cost	53468718.75
Maintenance Cost	14175
Discount Rate	0.1
2023 Cost	619669.03
2023 Consumption	45029
2024 Cost	543566.6
2024 Consumption	33680
DOE Specific Yield (kWh/kWp/year)	1402.1
System Size (kWp)	15.75
Lifespan (years)	25
2023 Cost per kWh	13.76155433
2024 Cost per kWh	16.13915083
Average Cost per kWh	14.95035258
Estimated PV Generation (kWh/year)	22083.075
Annual Savings (PhP)	330149.7573
Year	**Cash Flow**
0	-53468718.75
1	315974.7573
2	315974.7573
3	315974.7573
4	315974.7573
5	315974.7573
6	315974.7573
7	315974.7573
8	315974.7573
9	315974.7573
10	315974.7573
11	315974.7573
12	315974.7573
13	315974.7573
14	315974.7573
15	315974.7573
16	315974.7573
17	315974.7573
18	315974.7573
19	315974.7573
20	315974.7573
21	315974.7573
22	315974.7573
23	315974.7573
24	315974.7573
25	315974.7573
NPV	-₱50,600,603.23
IRR	-11%
Simple Payback Period	169.2183236

B8: Cost-Benefit Analysis (NPV and IRR) Literature Based Capital Cost Estimate Excel Computation

Parameter	Value
Capital Cost	1550390.625
Maintenance Cost	14175
Discount Rate	0.1
2023 Cost	619669.03
2023 Consumption	45029
2024 Cost	543566.6
2024 Consumption	33680
DOE Specific Yield (kWh/kWp/year)	1402.1
System Size (kWp)	15.75
Lifespan (years)	25
2023 Cost per kWh	13.76155433
2024 Cost per kWh	16.13915083
Average Cost per kWh	14.95035258
Estimated PV Generation (kWh/year)	22083.075
Annual Savings (PhP)	330149.7573
Year	**Cash Flow**
0	-1550390.625
1	315974.7573
2	315974.7573
3	315974.7573
4	315974.7573
5	315974.7573
6	315974.7573
7	315974.7573
8	315974.7573
9	315974.7573
10	315974.7573
11	315974.7573
12	315974.7573
13	315974.7573
14	315974.7573
15	315974.7573
16	315974.7573
17	315974.7573
18	315974.7573
19	315974.7573
20	315974.7573
21	315974.7573
22	315974.7573
23	315974.7573
24	315974.7573
25	315974.7573
NPV	₱1,317,724.89
IRR	20%
Simple Payback Period	4.906691402

B9: R output of Binary Logistic Regression

```
model_logit <- glm(
  High_Effectiveness ~ Role + `Age Bracket` + Gender +
    `Monthly Household Income` + `Monthly Electricity Bill` +
    `Educational Level`,
  data = df,
  family = binomial(link = "logit")
)

summary(model_logit)
```

```
Warning message:
“glm.fit: fitted probabilities numerically 0 or 1 occurred”

Call:
glm(formula = High_Effectiveness ~ Role + `Age Bracket` + Gender +
    `Monthly Household Income` + `Monthly Electricity Bill` +
    `Educational Level`, family = binomial(link = "logit"), data = df)

Coefficients: (2 not defined because of singularities)
                                        Estimate Std. Error z value Pr(>|z|)
(Intercept)                             38.37027 8900.64048   0.004    0.997
RoleStudent                            -34.94425 8900.64036  -0.004    0.997
RoleTeacher                            -15.56727 7116.67163  -0.002    0.998
`Age Bracket`> 50                       17.31059 9022.63950   0.002    0.998
`Age Bracket`10-14                       0.90626    1.55046   0.585    0.559
`Age Bracket`20-29                      18.10910 6476.76797   0.003    0.998
`Age Bracket`30-39                      -0.69896    1.51639  -0.461    0.645
`Age Bracket`40-49                            NA         NA      NA       NA
GenderMale                              -1.24459    1.13210  -1.099    0.272
`Monthly Household Income`> 30000       -4.58794    3.29026  -1.394    0.163
`Monthly Household Income`10000-20000   -2.28949    1.44136  -1.588    0.112
`Monthly Household Income`20001-30000   -2.12080    1.97221  -1.075    0.282
`Monthly Electricity Bill`> 3000        19.47840 5196.66956   0.004    0.997
`Monthly Electricity Bill`1000-2000      0.03311    1.39523   0.024    0.981
`Monthly Electricity Bill`2001-3000      1.55376    1.69286   0.918    0.359
`Educational Level`Elementary                 NA         NA      NA       NA
`Educational Level`Graduate Degree     -16.59570 5345.50124  -0.003    0.998
`Educational Level`High School         -33.04400 8900.64029  -0.004    0.997

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 50.728  on 99  degrees of freedom
Residual deviance: 35.601  on 84  degrees of freedom
AIC: 67.601

Number of Fisher Scoring iterations: 20
```

B10: Histogram of Perceived Effectiveness Scores

```
hist(
  data$PE_score,
  breaks = seq(1, 4, by = 0.25),
  main = "Histogram of Perceived Effectiveness Scores",
  xlab = "Perceived Effectiveness (1 = Strongly Disagree, 4 = Strongly Agree)",
  ylab = "Frequency"
)
```