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Green Investment Appraisal: A Comprehensive Framework for Evaluating Environmental and Financial Returns

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Abstract

This article presents a comprehensive framework for evaluating green investments, considering environmental impacts and financial outcomes. This framework is designed to assist decision-makers in identifying projects that provide high financial returns while considering positive environmental impacts. The proposed green investment evaluation methods include net present value (NPV), internal rate of return (IRR), and cost-benefit analysis, which considers the economic value of environmental impacts. The proposed green investment evaluation method includes Net Present Value (NPV) and Internal Rate of Return (IRR), tools commonly used in financial assessment. This framework also considers a cost-benefit analysis that includes the economic value of environmental impacts. These results allow stakeholders to consider energy savings, carbon emission reduction, and the social impact of green investment projects.

Keywords: Green Investment, Environmental Impact, Financial Results, Investment Evaluation, Framework.

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Introduction

The world is facing unprecedented environmental and sustainability challenges, and the increasingly pronounced climate change caused by human activities such as burning fossil fuels and deforestation has produced a chain effect that threatens the survival of our planet. Rising global temperatures, more frequent natural disasters, and rising sea levels are some of the many consequences of this phenomenon (Li & Umair, 2023; Mohsin et al., 2023). Rapid population growth and widespread industrialization have also increasingly triggered an unsustainable increase in natural resource consumption. Excessive use of fossil resources, such as oil and coal, has caused destructive air and water pollution and destruction of natural habitats. Awareness of the destructive impact of these practices is increasing among global society, and calls for more sustainable action are growing louder, with demands surfacing for policy changes and more environmentally friendly business practices (Hsu & Chao, 2020). Many governments around the world are starting to take steps to implement regulations that promote green investment and sustainability. Several tools are used to drive change towards a

more sustainable future, such as fiscal incentives, carbon taxes, and emissions targets (Alattyih et al., 2020; Zheng et al., 2021).

Companies are also starting to realize that environmentally friendly business practices are not only a moral imperative but also an investment in a more sustainable future. Businesses prioritizing these practices can experience long-term benefits, including increased operational efficiency and strong brand differentiation. Global cooperation is also crucial in responding to complex and transboundary environmental challenges (Singh & Sharma, 2022; Wan & Sheng, 2022). Green investment and sustainability are becoming increasingly important in response to global environmental challenges. These investments provide long-term environmental benefits and can improve economic and social resilience in the longer term, and the need for green and sustainable investments is increasingly urgent in today's world (Almeida et al., 2023; Chang et al., 2021).

The COP27 Summit highlighted the difficulties in mobilizing the trillions of dollars needed for climate change adaptation and mitigation in developing countries, which contribute the least to global warming but suffer the most from its consequences. To meet this need, innovative mechanisms and various types of capital will be needed; some of this capital comes from the public sector, but most comes from the private sector; the following data explains the above in more detail:

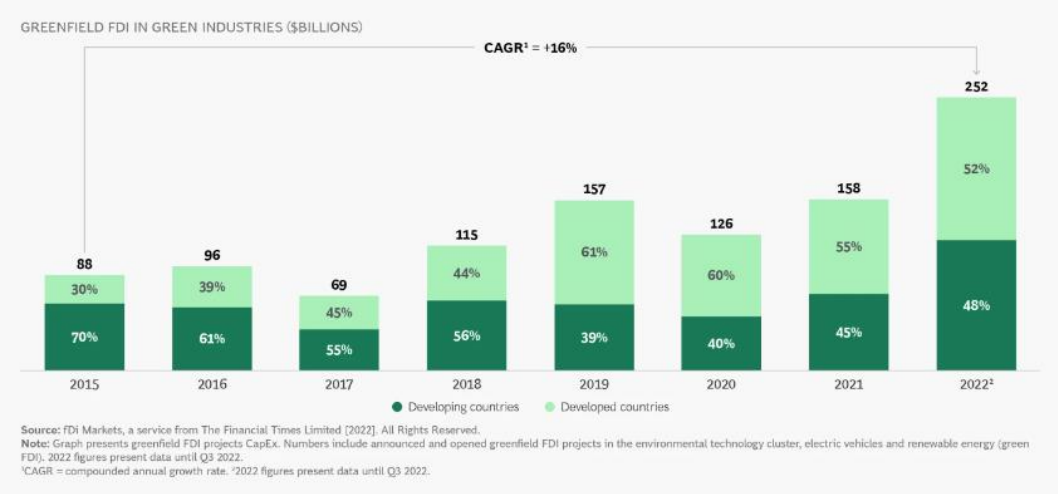

Figure 1. Green FDI Flow, most ti Developed Countries
Source: BCG (2023)

Foreign direct investment in sectors that affect (or are affected by) climate change—so-called "green foreign direct investment"—is the most critical segment of this much-needed private capital flow. With sectors ranging from agriculture and forestry to energy and infrastructure, it is not easy to comprehensively track green foreign direct investment flows. Using a simplified definition focused on renewable energy, transportation, and environmental technologies and services, data from FDi Markets shows that green foreign direct investment has tripled in the last ten years and is now the largest category of foreign direct investment.

Worsening climate change has become a real threat to the global environment and economy. As global temperatures increase, extreme weather patterns are becoming more frequent, including stronger storms, frequent floods, and longer forest fire seasons. The

impact is not only felt in the natural environment but also has an impact on human life; for example, increasing temperatures cause ice to melt at the North and South Poles, resulting in rising sea levels and threats to tens of millions of people living in coastal areas. Climate change also affects security. Food and the availability of clean water increase the risk of hunger and social conflict in various parts of the world (Del Giudice et al., 2021; Rizvi et al., 2022).

The impacts of climate change can be very detrimental in economic terms. More frequent and extreme natural disasters can significantly damage infrastructure, including homes, roads, and other public facilities, requiring enormous costs to repair and restore. Economic sectors vulnerable to climate change, such as agriculture, fishing, and tourism, may also experience significant economic losses due to changes in weather patterns and the availability of natural resources. Climate change can also disrupt global supply chains, increase business risks, and disrupt overall economic growth (S. Li et al., 2022; Wang & Wang, 2023). The escalation of climate change is not only an environmental problem but also an economic and social problem that urgently needs to be resolved. Coordinative and targeted action from governments, companies, and civil society is needed to reduce greenhouse gas emissions, increase adaptation to climate change, and build a more sustainable and disaster-resilient economy.

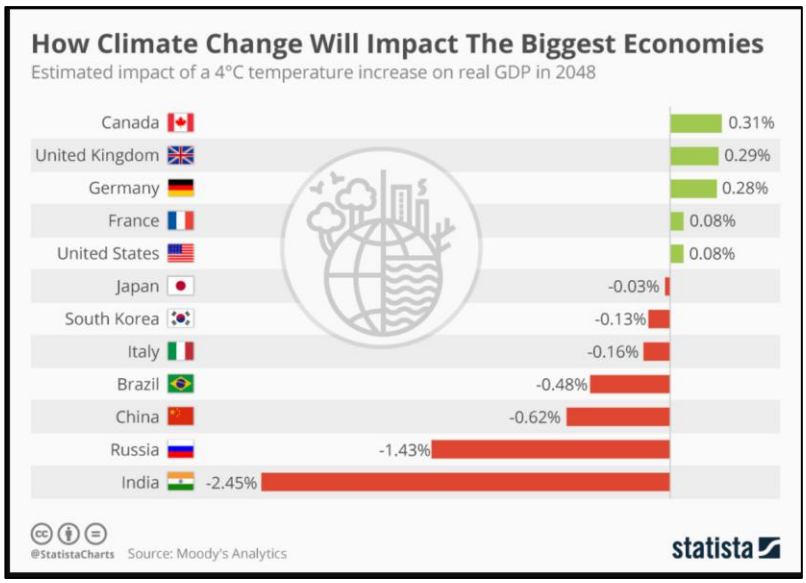

Figure 2. How Climate Change Will Impact the Biggest Economies
Source: Statista (2023)

A recent analysis of Moody's Analytics highlights the economic impacts of climate change. Four scenarios were considered, involving variations in temperature increases of 1, 1.9, 2.4, and 4.1°C by 2100. Global economic damage projections estimate $54 trillion by 2100 in a 1.5°C warming scenario, while two °C of warming would cost $69 trillion. In the most worrying condition, namely an increase in temperature of 4°C, a dynamic of victory and defeat occurs. If this scenario becomes a reality, it is estimated that India will experience the most significant impact on Gross Domestic Product (GDP) in 2048 compared to all other developed countries, with a contraction rate of 2.45 percent. This is mainly due to the

composition of India's employment sector, which has a lower proportion of the services sector, making it vulnerable to the impacts of heat stress. Although China is also negatively impacted by heat stress, the impact is not as significant as India's because the country benefits from the tourism and agricultural sectors. While Canada, the UK, Germany, France, and the United States are expected to see only minimal increases in their GDPs in that worst-case scenario, Moody's noted that the study did not take into account several other climate change metrics that would also likely impact the economy, such as increased likelihood of costly natural disasters.

The growing awareness of the need for sustainable and environmentally friendly investments has become increasingly prominent in the modern era. The global community is increasingly aware of the destructive impacts of unsustainable economic practices, such as the overuse of natural resources, pollution, and the generation of greenhouse gas emissions. This awareness has driven calls for more responsible action from governments, companies, and individuals to address global environmental challenges (Gu et al., 2021a; Hang, 2022). Governments are starting to implement policies and regulations that support sustainable investment, including fiscal incentives for renewable energy and ambitious emissions targets; many companies are starting to adopt more environmentally friendly practices on the business side, both to meet the demands of an increasingly environmentally conscious market and to reduce operational risks and improve their long-term sustainability (Dobrowolski & Drozdowski, 2022; Liu et al., 2022). Individuals are also becoming increasingly aware of the impact of their consumption patterns, and many are starting to change their lifestyles to be more sustainable by choosing environmentally friendly products and services. This growing awareness marks a shift towards a more sustainable and environmentally friendly economy, where investments that consider environmental aspects are becoming increasingly crucial for a better future for our planet (Tariq & Xu, 2022).

The challenge of comprehensively evaluating green investments has become a focus of attention in economic and sustainability discussions. Green investments, which aim to promote environmentally friendly and sustainable business practices, need to improve their comprehensive evaluation. One of the main challenges is the complexity of the factors that must be considered in assessing such investments' environmental and financial impacts. Climate change and environmental degradation are highly complex phenomena, and their impacts are often difficult to measure directly (Busch et al., 2021; Nguyen et al., 2023). Existing evaluation frameworks often need to be revised to holistically integrate environmental and financial aspects. Traditional approaches to assessing investments often focus on short-term financial returns without considering long-term environmental and sustainability impacts (Almarri & Blackwell, 2014; Becchetti et al., 2022). Decision makers often face difficulties in making investment decisions that genuinely consider these two aspects in a balanced manner, so a more holistic and sophisticated evaluation framework is needed to take both dimensions into account to overcome this challenge properly. This involves the development of more sophisticated measurement methods for environmental impacts and a deeper understanding of how environmental aspects can influence the long-term financial performance of investments (Gibb & Christie, 2024; Ruales et al., 2020). The challenge of thoroughly evaluating green investments requires a holistic, innovative, and sustainable approach to ensure that they positively impact the environment and long-term

economic sustainability.

This research aims to build a comprehensive framework that can be used to evaluate green investments, including the development of a system that considers the overall environmental impacts and financial returns of green investments. It is hoped that decision-makers can make better investment decisions that consider short-term financial factors and long-term environmental and sustainability impacts with a robust and integrated framework. The main aim of this research is to provide valuable tools for stakeholders in making investment decisions that are sustainable and have a positive impact on the environment. Green investment refers to investment practices that support sustainable development and preserve the environment. This investment involves allocating funds to projects or assets that positively impact the environment, whether in reducing carbon emissions, more efficient use of resources, or promoting environmentally friendly technologies. The main aim of green investment is to positively improve environmental quality and promote sustainable economic growth; this can include investment in renewable energy such as solar and wind power, environmentally friendly infrastructure projects, or the development of green technology (Becchetti et al., 2022).

Several studies have explored various aspects of green investment and their impact on the environment and finances. One of them is research conducted by (Hagspiel et al., 2021), who highlight the importance of integrating environmental factors in investment decision-making. They found that investors who consider environmental factors tend to achieve better returns in the long term. Research by (Gu et al., 2021b) explored the relationship between green investment and corporate financial performance. They found that companies that adopt green investment practices tend to have better financial performance in the long term. Research by (Yuan et al., 2023) examined the impact of green investments on climate change mitigation in the energy sector. They found that investment in renewable energy can significantly reduce carbon emissions and accelerate the transition to a low-carbon economy. Another research conducted by (Zhang and Yousaf, 2020) examined the influence of public policy on green investment in the capital market. They conclude that appropriate policy incentives can encourage the growth of green investment and increase market awareness of sustainable investment practices. Research by (Shen et al., 2021) considers the implications of green investments for financial risk management. They found that green investments can reduce risk exposure to climate change and adverse environmental events, thereby strengthening the resilience of investment portfolios.

The concept of green investment also includes social and ethical principles, where investors strive to ensure that their investments provide good financial returns and positive social and environmental benefits. Green investment is an increasingly crucial financial instrument in promoting sustainable development and responsiveness to society's global environmental challenges (Shen et al., 2021). The investment appraisal approach refers to the method or approach used to evaluate investment projects or financial assets; this approach includes various analytical techniques used to assess an investment's potential benefits and risks and decide whether the investment is worth making. One commonly used approach is fundamental analysis, which involves a fundamental assessment of a company or project's financial health and growth prospects.

While there is a diverse body of research discussing investment appraisal approaches, a

few critical studies have provided valuable insights in this context. One of the studies conducted by (Huang and Lei, 2021) explores the use of fundamental analysis models in assessing stock investments in the capital market. This research deeply explains how fundamental factors such as revenue, profits, and growth can influence stock valuations. Another study (Chen & Ma, 2021) investigated the effectiveness of technical approaches in identifying market trends and making timely trading decisions. This research provides a deeper understanding of technical indicators such as moving averages and relative strength index (RSI) in market analysis. Research by (Z.-Z. Li et al., 2021) explores risk analysis methodologies used in assessing investment risk and identifying effective risk management strategies; this research provides valuable insight into developing risk management approaches that can help investors reduce the impact of risk on their portfolios. Research conducted by (Tu et al., 2021) explored the use of combined analysis models in investment assessment that combine fundamental, technical, and value approaches. This research provides insight into how integrating multiple approaches can improve the overall quality of investment appraisals.

A technical approach also involves analyzing charts and indicators to identify market trends and the best moments to enter or exit an investment. The valuation approach may include a comprehensive risk analysis to identify potential risks associated with the investment and evaluate their possible impact on investment results (Hossain et al., 2022). There is also a value-based approach, where the intrinsic value of an investment is determined based on economic, fundamental, or fair value factors. This approach to investment assessment is essential in helping investors make rational and informed decisions about allocating their funds and ensuring that their investments match their financial goals and risk tolerance.

Research Design and Method

The method used in this research is qualitative, with case studies as one of the techniques used. Qualitative methods are used to gain an in-depth understanding of theoretical concepts and green investment evaluation processes. Case studies are used as a verification method to test the validity and effectiveness of the proposed framework in actual practice. This research method describes the framework for developing a green investment evaluation approach. This framework description provides an overview of the theoretical concepts and variables in evaluating green investments. The evaluation steps are explained in detail to provide practical guidance on implementing the framework in practice. These steps include data collection, analysis, and interpretation of evaluation results. Case case studies are used as a verification method to test the validity and effectiveness of the proposed framework. Actual green investments are evaluated using the developed framework, and the results are then compared with independent evaluations or other measurements to verify the accuracy and reliability of the approach (Metzger & Schinas, 2019). This research methods section provides a solid foundation for developing, implementing, and verifying a comprehensive and practical green investment evaluation approach.

Results and Discussion

Green Investment Assessment Framework

The green investment assessment framework is essential because it provides a systematic and holistic approach to evaluating investments that impact the environment. In an era where sustainability and environmental responsibility are increasingly becoming a significant concern, green investment has become essential in promoting sustainable development. This framework provides a structural basis for measuring the environmental impact of investments, considering not only the potential financial returns but also the long-term implications for ecosystems and society (Metzger & Schinas, 2019; Verma et al., 2021). The Green Investment Assessment Framework is essential for several reasons that are very relevant in the current economic and environmental context, namely as follows:

a. The Importance of Sustainability: Green investments drive sustainable economic growth and contribute to climate change mitigation efforts. By considering environmental aspects in the investment decision-making process, this framework helps ensure that investments are in line with sustainability principles.
b. The Need for Comprehensive Evaluation: Green investments often involve complex and diverse environmental, financial, and social impacts. The green investment assessment framework provides the necessary structure to thoroughly evaluate all these aspects, enabling decision-makers to make more informed decisions.
c. Encouraging Responsible Business Practices: This framework encourages more responsible business practices by considering the environmental and social impacts of investments. This can help improve a company's image, reduce reputation risks, and provide long-term added value for stakeholders.
d. Meeting Investor Demand: More and more investors are realizing the importance of environmental and social factors in their investment decision-making. Thus, a green investment assessment framework is essential to meet this demand and provide investors with the information they need to make informed decisions.
e. Compliance with Environmental Regulations: Increasingly stringent environmental regulations encourage companies and investors to consider environmental impacts in their investment decisions. By having a robust green investment assessment framework, companies can ensure that they comply with applicable regulations and reduce legal risks.

The Green Investment Assessment Framework also helps direct investment in a more sustainable, responsible, and resilient direction, in line with the demands of an era that increasingly pays attention to environmental sustainability. Based on the analysis in this research, the framework used has several stages as follows:

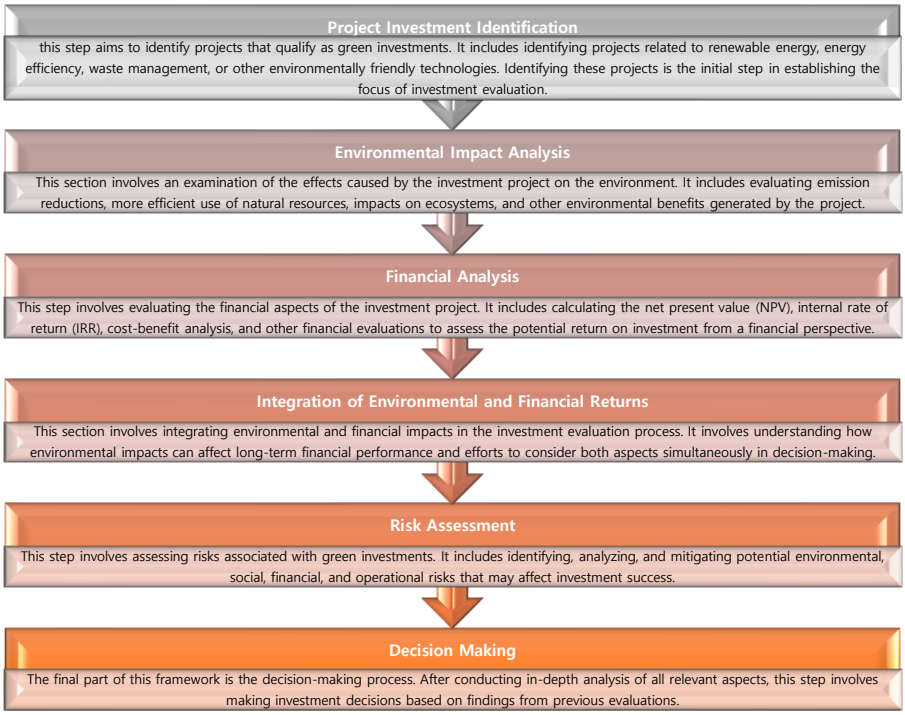

Figure 3. Green Investment Assessment Framework
Source: data proceed

The first step is to establish selection criteria that cover various aspects, from environmental impact to potential financial returns. Once these criteria are established, the next step is to look for potential investment projects and analyze them carefully. This process allows organizations to select projects that best suit their goals in adopting green investment practices.

Environmental Impact Analysis focuses on assessing a selected investment project's impacts; the initial stage involves identifying various possible environmental impacts, such as greenhouse gas emissions, use of natural resources, or habitat destruction. Then, further evaluation is carried out to measure and evaluate the quantitative and qualitative impact. Organizations can develop appropriate mitigation strategies, such as adopting environmentally friendly technologies or implementing sustainable management practices, to minimize environmental negative impacts. Organizations can ensure that selected investment projects provide adequate financial returns and pay attention to and reduce negative impacts on the environment through this approach. Identifying investment projects and analyzing environmental impacts is an essential step in building a sustainable investment portfolio that aligns with the organization's commitment to sustainable development.

The Financial Analysis and Integration of Environmental and Financial Returns section in the green investment assessment framework is essential in ensuring that investment decisions generate adequate financial returns and positively impact the environment. At this stage, an in-depth analysis of the financial aspects of the investment project is carried out, including cost estimates, income projections, and calculation of expected investment returns. By considering these aspects, the organization can evaluate the potential financial benefits that will be obtained from the green investment. This stage also includes integrating environmental and financial returns, which includes an assessment of environmental values

that may not be directly reflected in financial figures but significantly impact the overall value of the project. For example, reducing carbon emissions or more efficient use of energy can have added value in the long term, both in terms of company reputation and in reducing risks related to environmental regulations. Integrating environmental and financial returns allows organizations to gain a more holistic understanding of the value of green investment projects. By simultaneously considering financial and environmental aspects, organizations can make more innovative and sustainable investment decisions. The result is the adoption of green investment practices that benefit companies financially and contribute positively to the environment and society.

The Risk Assessment and Decision-Making section of the green investment assessment framework is a crucial stage that enables organizations to identify, evaluate, and manage the risks associated with the green investments under consideration. At this stage, a comprehensive assessment is carried out of various risks that may arise during the project life cycle, both financial risks and environmental risks. Financial risks may include changes in government policy, commodity price fluctuations, or market uncertainty, while environmental risks may include risks related to climate change, habitat impacts, or environmental crises.

The next stage is to evaluate each risk's potential impact on the investment project, both in financial and environmental terms. This step allows organizations to assess acceptable levels of risk and develop appropriate mitigation strategies to reduce those risks. Mitigation strategies may include portfolio diversification, the use of appropriate financial instruments, or the implementation of more environmentally friendly technologies. This section also involves making final decisions regarding green investment. Informational decision-making requires a balance between the potential financial returns and risks associated with an investment, as well as considering the desired environmental impact, and by considering the results of previous risk assessments and financial analysis, organizations can make informed and evidence-based investment decisions.

Calculation of Net Present Value (NPV and Internal Rate of Return on Green Investments

Net Present Value (NPV) and Internal Rate of Return (IRR) analysis are essential for evaluating green investments. NPV allows decision-makers to assess the financial benefits of a project by considering the time value of money. NPV measures the net financial value of projects that aim to develop or implement environmentally friendly technologies or practices. By calculating the difference between the present value of the cash flows generated by a project and its initial costs and operating costs, NPV helps determine whether the investment is generating positive net profits.

IRR can be understood as the internal rate of return of an investment, which describes the discount rate that makes the NPV of an investment zero. In green investing, IRR is used to evaluate the rate of return of environmentally focused projects. Green investments with high IRR tend to attract investors because they promise a higher return rate than conventional investments. Using these two methods, decision-makers can understand the potential financial benefits and rates of return from environmentally sustainable projects.

The NPV (Net Present Value) of a project can also be understood as the net value of the current benefits (present value, PV), which is calculated by subtracting costs and benefits over

the life of the project, as well as considering the discount rate to determine this value in the initial year of project implementation; the NPV calculation is presented in the following formula.

$$\text{NPV (i, N)} = \frac{(Bt-Ct)}{(1+i)t}$$

B = Benefits / Benefits
C = Costs / Costs
i = financial or economic discount rate
t = length of time the project will operate (in years)

If the NPV of the project is positive, then it is considered feasible to run. In more precise terms, if the net benefits minus investment costs at a predetermined discount rate are more significant than zero, then the project has a positive Net Present Value (NPV). Internal Rate of Return (IRR) is the discount rate required for the NPV to be at least zero. Typically, private investors want a minimum of 10% IRR from a project, which reflects alternative rates of return if the funds were invested in other assets such as shares, government bonds, or other projects. It is important to note that when adjusting for inflation, the NPV needs to use the actual discount rate, which is calculated by the formula: r = [(1+i) / (1+π)] - 1, where π is the inflation rate.

An illustration of the NPV calculation for a project is as follows: A small project has a term of 6 years with an interest rate of 10%. The costs incurred in year 1 were IDR 500 million and in year 2 IDR 400 million. Meanwhile, the benefits received start after year 3 to year 6, with each amounting to IDR 200 million, IDR 300 million, IDR 400 million, and IDR 500 million, which are explained in the following table 1:

Table 1. Example of NPV analysis of a project

Year	Fees (IDR) (2)	Benefits (IDR) (3)	Net Benefit (4) =(3-2)	DF 10% (5) = $1/(1+r)^t$	PV 10% (6) = (4-5)
1	500		(500)	0.905	(454.3)
2	400		(400)	0.827	(302.1)
3		200	200	0.752	152.4
4		300	300	0.682	205.8
5		400	400	0.548	243
6		500	500	0.531	283.4
Total	**NPV**				**100.2**

An investment considered feasible is when the NPV is greater than 0 at a discount rate of 10%. In this case, the present (PV) benefit value is IDR 885.5, while the present (PV) cost value is IDR 784.9. Thus, the net Benefit-Cost Ratio (B/C) can be calculated by dividing the PV benefit value by the PV cost value, namely (885.5/784.9) = 1.13. This means each unit of cost provides a net benefit of 1.13.

Cost-benefit analysis (CBA) is a method for evaluating the net financial benefits of a project, which can be applied to private and public projects. The main goal of CBA is to determine whether a project is financially attractive. In principle, CBA measures the net value

of a project at its present value, which is defined as the difference between benefits and costs. CBA calculates value as the difference between the costs and benefits of a project over a certain period.

Economic costs and benefits are usually used rather than pure financial costs in the context of public projects, which means that economic externalities, price distortions, and opportunity costs can be included in CBA calculations. CBA can be conducted before or after a project is implemented as a tool to monitor and evaluate project performance. In addition, CBA is also applicable for measuring the impact of interventions or changes in a project. Despite this, CBA is rarely used to evaluate programs and policies, although, in principle, it can be used to study the effects of changes in specific political parameters. The steps for implementing CBA consist of four main activities. The first is to clarify the project specifications, including boundaries and technical specifications. Then, data on financial or economic costs and benefits are collected. Next, the value is calculated using the NPV formula. Finally, the results are validated and analyzed to decide on the project.

Conclusions

This article presents a comprehensive framework for evaluating green investments that consider financial and environmental impacts. The framework aims to assist decision-makers in identifying projects that provide high financial returns while considering positive environmental impacts. The proposed green investment evaluation method includes aspects such as Net Present Value (NPV), Internal Rate of Return (IRR), and cost-benefit analysis that considers the economic value of environmental impacts. Stakeholders are expected to be able to make more sustainable investment decisions by considering environmental and financial aspects as a whole by implementing this framework. The results of this research provide a significant contribution to the development of investment evaluation practices that take the environment into account and are expected to provide helpful guidance for practitioners and researchers in the field of green investment.

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