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Barriers for Business to Engage in Carbon Trading Through the Indonesian Carbon Exchange: An Analytical Hierarchy Process Approach

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ABSTRACT: This study investigates the barriers faced by businesses in participating in carbon trading through the Indonesia Carbon Exchange (IDXCarbon). Although Indonesia has committed to reduce greenhouse gas emissions by 31.89% with national efforts and 43.20% with international assistance, participation in IDXCarbon is still limited. Using the Analytical Hierarchy Process (AHP) method, this study identifies and ranks barriers based on expert evaluation in four main criteria: Impact on Risk Management and Uncertainty; Impact on Business Operation and Strategy; Impact on Financial and Profitability, and Impact on Regulatory Compliance and Stakeholder Engagement. The main barriers identified were Concern Over Loss of Sustained Revenue; Lack of Company Understanding and Capability; Additional Explicit Costs; Bureaucratic Complexity; Low Level of Transparency; and Limited Trading Volume. The results of this study are expected to guide policymakers and business leaders in improving their effectiveness and participation in carbon trading, thereby contributing to Indonesia's ambitious emissions reduction targets.

KEYWORDS: Analytical Hierarchy Process, Carbon Trading, Indonesian Carbon Exchange.

1. INTRODUCTION

This Greenhouse gas emissions are a major source of climate change and global warming that can have adverse impacts on society, the environment, and health (Zhang et al., 2019). These emissions mainly come from the use of fossil fuels, deforestation, and industrial processes. This results in what is called the greenhouse effect, as shown in Figure 1, where heat on Earth that should be reflected off the Earth is trapped because of the greenhouse gases that accumulate in the atmosphere. Mora et al. (2018) said that by 2100, the world's population will face many harmful climate conditions such as extreme heat waves, sea level rise, and stormy weather if GHG emissions are not drastically reduced. Climate change and global warming can also affect human health such as respiratory problems, heat-related illnesses, and the spread of viruses or bacteria (Mora et al., 2018). Therefore, there is a need for action from the global community to address these issues.

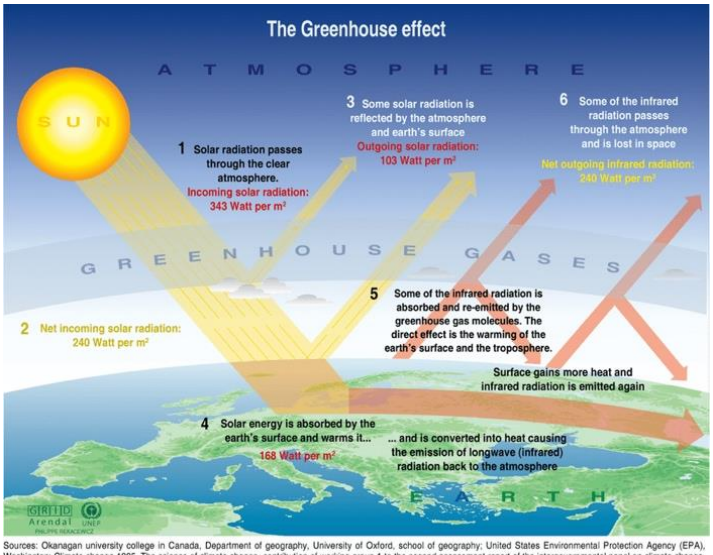

Figure 1. Greenhouse Effect Schematic (Osselin, 2013)

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Indonesia's target to keep the earth's temperature below 1.5°C is stated in the Enhanced Nationally Determined Contribution document in 2022. In the document, Indonesia is committed to reducing greenhouse gas (GHG) emissions by 31.89% with its national efforts and 43.20% with international assistance. One important tool to reduce GHG emissions is through carbon trading schemes (Stavins, 2001). Carbon exchanges have been proven to reduce carbon emissions in the energy and industrial sectors in European countries (Ellerman & Buchner, 2007). In Indonesia, carbon exchange is a relatively new issue. The Indonesian Carbon Exchange (IDXCarbon) was just launched on September 26, 2023. This is also in line with the updated world agreement. Originally, countries followed a general guideline called the Kyoto Protocol. The Kyoto Protocol recognizes three kinds of schemes: Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emission Trading (IET). There was a study by Ellis, Jane & Kamel, Sami. (2007) on barriers to CDM project implementation. They divided the types of CDM implementation barriers into four, namely (1) Country-level barriers related to CDM, (2) Country-level barriers not specifically related to CDM, (3) Project-level barriers, and (4) International-level barriers. This research discusses CDM, which is not mentioned in the Paris Agreement. Indonesia signed the Paris Agreement on April 22, 2016. In the context of the Paris Agreement, the mechanism most similar to the Clean Development Mechanism (CDM) of the Kyoto Protocol is Article 6 of the Paris Agreement. Article 6 outlines a framework for international cooperation on climate change mitigation, including market mechanisms. According to the Secretary of the Directorate General of Sustainable Forest Management of the Ministry of Environment and Forestry, Drasospolino, there are two main mechanisms: cap and trade and carbon offset. Both mechanisms are traded through the Indonesian Carbon Exchange. Due to changes in the agreement, from the Kyoto Protocol to the Paris Agreement, CDM research is no longer relevant to serve as a foundation. Therefore, new research is needed on carbon trading through the carbon exchange in Indonesia.

The implementation of carbon exchanges in Indonesia tends to be late compared to other countries. Compared to the European Union, it launched its carbon exchange often called EU ETS in 2005. In Brazil itself, a national carbon exchange was introduced through the National Climate Change Law in 2009. Brazil has a huge potential to generate carbon credits of 1.2-1.9 GtCO2eq per year (brvcm.org, n.d.). However, according to Verra and Gold Standard, Brazil issued average carbon credits per year between 2019 and 2021 of only 21 MtCO2eq or less than 2% of its total annual potential. Therefore, the Brazilian Initiative for the Voluntary Carbon Market (BRVCM) was established to organize and channel efforts to identify market barriers and create mechanisms to maximize Brazil's VCM (brvcm.org, 2022). According to President Joko Widodo's speech during the launch of the Indonesia Carbon Exchange at the Indonesia Stock Exchange (IDX) Building, the potential carbon credits that can be captured per year is approximately 1 GtCO2eq or Rp3 Trillion. However, there are only 48 companies participating in the Indonesia Carbon Exchange as of February 5, 2024.

This research will analyze the barriers for companies to contribute to carbon trading. Carbon trading is limited by carbon trading through carbon exchanges. From the results of the researcher's interview with the Director of Derivative Finance and Carbon Exchange Supervision at the Financial Services Authority, Mr. Lufaldy Ernanda, the researcher found that the Indonesian carbon exchange is still quiet, in terms of transactions and the number of service users, and the addition of the number of business actors tends to be small, which is around 24% on average (IDXCarbon,). This research also addresses the need for regulators, in this case the Ministry of Environment and Forestry of Indonesia (KLHK) and the Financial Services Authority (OJK), to analyze what factors prevent businesses from contributing to carbon trading through carbon exchanges.

2. LITERATURE REVIEW

2.1 Carbon Market Concept

The carbon exchange concept is actually downstream from the concept of achieving net zero emissions and is the final step for entities compared to other greenhouse gas reduction concepts. To achieve net zero emissions, a company must first conduct a thorough audit to identify and understand the sources of emissions in its operations, such as facility operations and energy use up the supply chain (sciencebasedtargets.org, n.d.). Based on the results of the audit, companies can set realistic emission reduction targets with specific timelines. Emission reduction strategy measures involve improving energy efficiency through the adoption of more efficient technologies, transitioning to renewable energy use, adopting new technologies for cleaner production processes and supply chain optimization to reduce emissions across the value chain. For unavoidable emissions, companies need to invest in carbon removal projects, such as tree planting or carbon capture and storage technologies, and purchase carbon credits to cover the remaining emissions (goldstandard.org, 2021). The final step in the process is reporting and evaluation of the strategy, which aims to ensure the effectiveness of the emission reduction efforts.

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II.1.1 SDG 13: Climate Action

The Sustainable Development Goals (SDGs) are globally agreed goals to reduce poverty, protect all that makes the planet livable, and ensure that all people enjoy peace and prosperity, now and in the future (Morton, Pencheon, & Squires, 2017). Formulated by United Nations member states in 2015, the SDGs have 17 global goals. Each of the 17 goals has targets and indicators of achievement. All goals, targets, and indicators can be seen on the website https://sdgs.un.org. One of the goals of the SDGs is the thirteenth SDG, namely "Take urgent action to combat climate change and its impacts". According to SDG 13, it has the following targets and indicators.

1. Target 13.1 “Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries”;
    a. indicator 13.1.1 “Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population”
    b. Indicator 13.1.2 “Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030”
    c. Indicator 13.1.3 “Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies”
2. Target 13.2 “Integrate climate change measures into national policies, strategies and planning”;
    a. Indicator 13.2.1 “Number of countries with nationally determined contributions, long-term strategies, national adaptation plans and adaptation communications, as reported to the secretariat of the United Nations Framework Convention on Climate Change”
    b. Indicator 13.2.2 “Total greenhouse gas emissions per year”
3. Target 13.3 “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning”;
    a. Indicator 13.3.1 “Extent to which (i) global citizenship education and (ii) education for sustainable development are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment”
4. Target 13.a “Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible”;
    a. Indicator 13.a.1 “Amounts provided and mobilized in United States dollars per year in relation to the continued existing collective mobilization goal of the $100 billion commitment through to 2025”
5. Target 13.b “Promote mechanisms for raising capacity for effective climate change-related planning and management in the least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities”
    a. Indicator 13.b.1 “Number of least developed countries and small island developing States with nationally determined contributions, long-term strategies, national adaptation plans, and adaptation communications, as reported to the secretariat of the United Nations Framework Convention on Climate Change”

2.1.2 Kyoto Protocol & Paris Agreement

Under SDG 13, the reporting of actions centers on the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC has organized meetings between countries that have resulted in agreements. One such agreement is the Kyoto Protocol. The Kyoto Protocol is an international treaty that was adopted in 1997 and came into force in 2005. The main objective of this protocol is to reduce GHG emissions that cause global warming. The protocol sets legally binding emission reduction targets for developed countries or Annex I countries for the first commitment period which is 2008--2012. Flexibility mechanisms such as the Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emissions Trading (IET) were introduced to help countries achieve their targets in a cost-efficient manner. What followed was an agreement called the Paris Agreement. Adopted in 2015 and entered into force in 2016, the Paris Agreement marks a new chapter in global efforts to combat climate change. Compared to the Kyoto Protocol, the Paris Agreement provides a more inclusive and flexible framework, with a long-term goal of keeping global temperature increases below 2°C above pre-industrial levels and striving to limit such increases to 1.5°C. The Agreement introduces

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Nationally Determined Contributions (NDCs) where each country sets its own emissions reduction target, reflecting the principle of shared responsibility but differentiation and individual country capabilities.

2.1.3 Nationally Determined Contributions

Indonesia is one of the countries that agreed to the Paris Agreement. One of the responses is the creation of the Enhanced Nationally Determined Contributions document in 2022. As shown in Table 1, Indonesia is committed to reducing GHG emissions by 31.89% on its own and 43.20% with international assistance. The document also states that there are five sectors that are obliged to contribute to GHG emission reduction. These sectors are also regulated in Presidential Regulation No. 98 of 2021 on the Implementation of Carbon Economic Value for Achieving Nationally Determined Contribution Targets and Controlling Greenhouse Gas Emissions in National Development. The five sectors are energy; waste; industrial processes and product use; agriculture; and forestry. In the regulation, there are also regulated sub-sectors, namely power generation; transportation; buildings; solid waste; liquid waste; garbage; industry; rice fields; livestock; plantations; forestry; and peat and mangrove management. In addition, the presidential regulation also opens opportunities for other sectors and sub-sectors in accordance with the development of science and technology.

Table 1. Emission Reduction Target (Enhanced NDC Indonesia, 2022)

Sector	GHG Emission Level 2010* (MTon CO_2-eq)	GHG Emission Level 2030 MTon CO_2-eq			GHG Emission Reduction MTon CO_2-eq		GHG Emission Reduction % of Total BaU		Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012
		BaU	CM1	CM2	CM1	CM2	CM1	CM2		
1. Energy*	453.2	1,669	1,311	1,223	358	446	12.5%	15.5%	6.7%	4.50%
2. Waste	88	296	256	253	40	43.5	1.4%	1.5%	6.3%	4.00%
3. IPPU	36	69.6	63	61	7	9	0.2%	0.3%	3.4%	0.10%
4. Agriculture	110.5	119.66	110	108	10	12	0.3%	0.4%	0.4%	1.30%
5. Forestry and Other Land Uses (FOLU)**	647	714	214	-15	500	729	17.4%	25.4%	0.5%	2.70%
TOTAL	**1,334**	**2,869**	**1,953**	**1,632**	**915**	**1,240**	**31.89%**	**43.20%**	**3.9%**	**3.20%**

Notes: **CM1**= Counter Measure 1 (*unconditional mitigation scenario*)
CM2= Counter Measure 2 (*conditional mitigation scenario*)
*) Including fugitive.
**) Including emission from estate and timber plantations.

2.1.4 Carbon Trading & Carbon Market

In order to reduce GHG emissions, the regulation also regulates the procedure for organizing carbon economic value (NEK). According to Article 47 paragraph 1, the implementation of NEK is carried out through the following mechanisms.

1. Carbon Trading;
2. Result-based payment;
3. Levy on Carbon; and/or
4. other mechanisms in accordance with the development of science and technology as determined by the Minister.

Broadly speaking, the above mechanisms are divided into two types: non-market mechanisms and market mechanisms. The first non-market mechanism is the Result-Based Payment (RBP). RBP is a financial approach that intensifies the achievement of results from climate and environmental actions (https://www.gcftf.org). The second non-market mechanism is the Carbon Levy, which is a levy on GHG emissions generated by the use of fossil energy sources as fuel (Purwienanti & Purwanto, 2023). An example of a carbon levy is a carbon tax. Meanwhile, carbon trading is a market-based mechanism to reduce GHG emissions through the buying and selling of carbon units.

The next type of mechanism is a market mechanism. Market mechanisms are also known as carbon trading. Carbon trading is traded through carbon exchanges. Carbon exchange is divided into two kinds of markets, namely compliance market and voluntary market (Lovell, 2010). A compliance market is a regulated or legal market according to the prevailing regulations. This market is mandatory for companies in certain sectors and there is a cap on emissions for companies so that companies with emissions above the cap must buy carbon units from companies with emissions below the cap. This scheme is also known as a cap-and-trade scheme (https://ww2.arb.ca.gov). This scheme can be seen in Figure 2 below.

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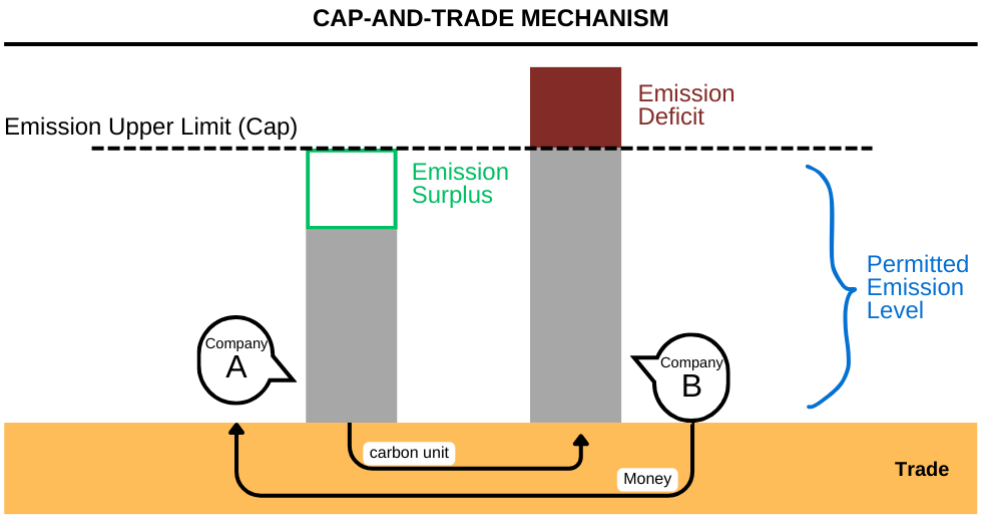

Figure 2. Cap and Trade Mechanism

Examples of Cap-and-Trade mechanism can be found in the European Union's carbon market (EU ETS) and Korea's carbon market (Korea ETS). Table 2 below shows a comparison between the two countries' carbon markets.

Table 2. ETS Comparison

Category	EU ETS	Korea ETS
Start of operation (year)	2005	2015
Sectoral coverage	Maritime, Domestic Aviation, Power, and Industry	Maritime, Domestic Aviation, Power, Industry, Waste, Transport, and Buildings
Cap	• 1,386 MtCO2e (2024, electricity and heat generation, industrial manufacturing and maritime transport), • 28.9 MtCO2e (2024, aviation)	• 547.9 MtCO2e (2024)
GHGs covered	CO2, HFCs, N2O, PFCs, SF6	CO2, HFCs, N2O, PFCs, SF6, CH4
Average auction price	EUR 83.24 (USD 90.00)	KRW 10,672 (USD 8.17)
Average secondary market price	EUR 83.47 (USD 90.25)	KRW 9,999 (USD 7.66)
Total revenue since beginning	EUR 184 billion (USD 206 billion)	KRW 1,176.75 billion (USD 901.14 million)

A voluntary market is a market that allows companies or organizations outside the mandatory sector in the compliance market or voluntarily. Organizations and companies that successfully reduce their emissions can sell their carbon units to companies that need them. Of course, both markets are regulated in different ways (Lovell, 2010). Not only emission reductions, but carbon projects that remove carbon emissions through mangrove projects, renewable energy, waste decomposition, etc. can also sell their carbon removal efforts in the form of carbon credits. this scheme is called carbon offsetting or carbon crediting. This scheme can be seen in Figure 3 below.

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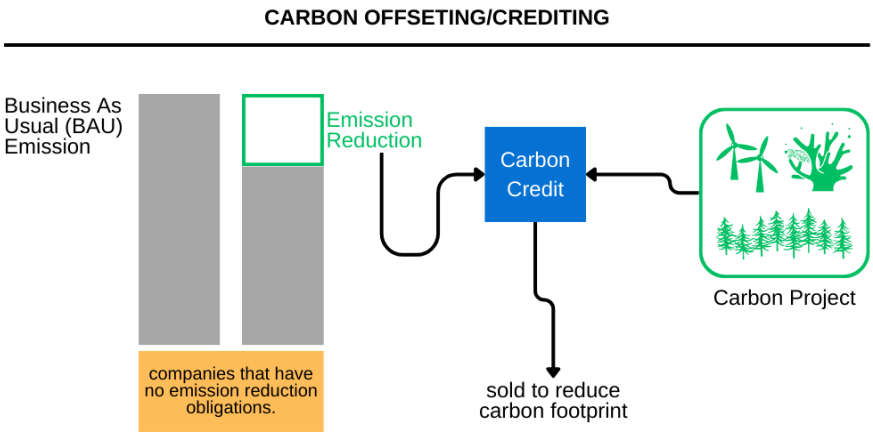

Figure 3. Carbon Offsetting/Crediting Mechanism

2.1.5 Carbon Trading & Carbon Market in Indonesia

In Indonesia, both markets are available on the Indonesian Carbon Exchange or IDXCarbon. IDXCarbon was launched on 26 September 2023 by President Joko Widodo. This launch is based on the legal/regulatory umbrella that is regulated in terms of laws and agency regulations. In Indonesia, regulations related to carbon trading are regulated as follows.

1. Law No. 16/2016 on the Ratification of the Paris Agreement
2. Law No. 4/2023 on the Development and Strengthening of the Financial Sector (P2SK)
3. Presidential Regulation No. 98/2021 on the Economic Value of Carbon (NEK)
4. OJK Regulation No. 14/2023 on Carbon Trading through Carbon Exchange
5. Minister of Environment and Forestry Regulation No. 21/2022 on the Implementation Procedure of Carbon Economic Value
6. Minister of Environment and Forestry Regulation No. 7/2023 on Forestry Sector Carbon Trading Procedures
7. OJK Circular Letter No. 12/2023 concerning Procedures for Organising Carbon Trading through the Carbon Exchange

In accordance with the above regulations, the carbon exchange is included in the secondary market. Companies wishing to enter the carbon exchange must first be registered in the primary market, in this case, the National Registry System for Climate Change Control (SRN PPI) managed by KLHK. The stakeholders of the carbon exchange in Indonesia can be seen in Figure 4.

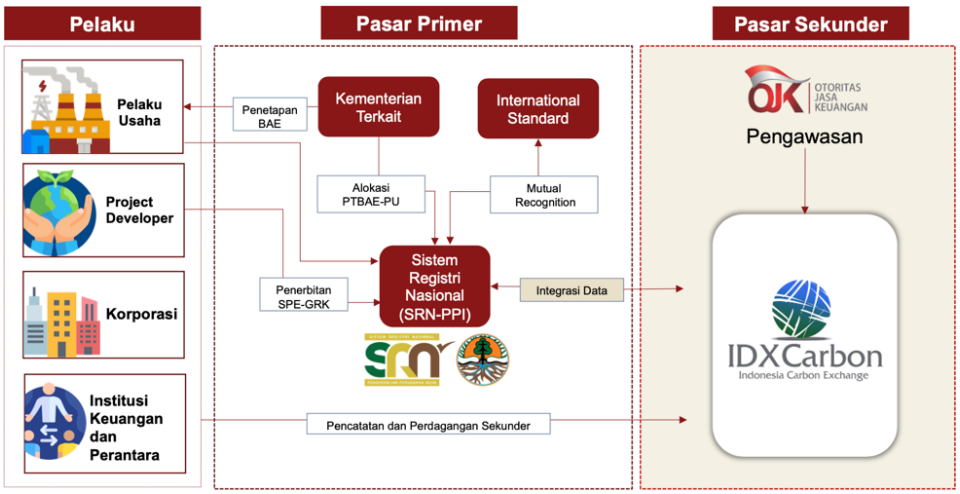

Figure 4. Carbon Trading Ecosystem in Indonesia (OJK Seminar, 2023)

In Indonesia, the implementation of the compliance market has not yet been realized. The current market is only a voluntary market. This is due to the lack of readiness of the relevant ministries to set caps on emissions from each sector. The voluntary market has been

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running since its launch on 26 September 2024. Currently, as of June 2024, there are two projects registered in the Indonesia Carbon Exchange, namely the Lahendong Unit 5 & Unit 6 Project by PT Pertamina Geothermal Energy Tbk and the Natural Gas Fired New Power Plant Development Project PLTGU Blok 3 by PT PLN Nusantara Power. The Indonesian Carbon Exchange currently has 67 participants with an average daily volume of 17 tCO2eq and an average daily value of Rp1,070,944. The average price of carbon credits in the regular voluntary market is Rp59,171 per tCO2eq. To date the total value of carbon credits is Rp5,880,840,200.00 with a total transaction volume of 114,486 tCO2eq.

2.2 Analytical Hierarchy Process

The measurement of physical and psychological events has long been recognized. By physical we mean the field of what is modernly known as discernible things as it relates to some kind of objective reality outside of the individual taking the measurement. Psychological, on the other hand, relates to a person's subjective view of his or her own world and experiences. The question is whether there is a consistent theory that can address these two worlds of reality without compromising any of them (Saaty, 1987). There are actually many techniques that can be used for decision-making using measures in the physical and social fields. However, according to Teng & Jaramillo (2005), of the existing research, the two most prominent methods are the Analytical Hierarchy Process (AHP) (Saaty, 1980) and the Analytical Network Process (ANP) (Saaty, 1996). Teng & Jaramillo (2005) stated that AHP has both advantages and disadvantages, as it is powerful and easy to use (Saaty, 1980), and considers the hierarchical relationships among factors reviewed by decision-makers, namely quality, flexibility, and cost, but is weak in terms of interrelationships among factors (Sarkis & Srinivas, 2002). Whereas ANP has the potential to produce outstanding results. Therefore, Saaty created the ANP model to overcome the problems in the Analytical Hierarchy Process (AHP) model by incorporating information about the correlation between factors in the decision-making process. As a result, stronger results can be produced by the ANP model although the process becomes longer and more complicated due to the correlation factor.

2.2.1 Analytical Hierarchy Process Definition

AHP is a method developed by Saaty (1980). AHP is a tool for decision-making by setting priorities to find the best by reducing complex decisions into a series of pairwise comparisons and then correlating the results. AHP also checks the consistency of the decision maker's evaluation (Bohanec et al., 2008). AHP incorporates useful techniques to check the consistency of decision-makers' evaluations, thereby reducing bias in the decision-making process. AHP can be considered as a tool capable of translating evaluations, both qualitative and quantitative, made by decision-makers into multicriteria rankings (Hadadian, 2017). In the process, AHP is not regulated regarding the number of respondents. However, respondents in AHP need to have a strong role in the topic or an expert (Hadadian, 2017). AHP involves the following steps: defining criteria and alternatives, organizing them into a hierarchical model, performing pairwise comparisons, deriving a prioritized scale through mathematical calculations, and checking the consistency of the judgments made. The results of pairwise comparisons are used to calculate a set of priorities for criteria and alternatives, which guides the decision-making process (Saaty, 1980). Highlighting that the rankings generated by AHP can be arbitrary due to the subjective nature of pairwise comparisons and the assumption of the principle of hierarchy composition, AHP thus relies heavily on individual judgment which introduces a degree of subjectivity (Dyer, 1990). In addition, achieving and maintaining a high level of consistency can be challenging, especially with a larger number of elements and participants (Ishizaka & Labib, 2009).

2.2.2 Analytical Hierarchy Process Implementation

According to Saaty's research (1987) and Hadadian (2017), AHP has the following working steps.

1. Determine the hierarchy structure
2. Determine the weight of criteria with pairwise comparisons
3. Giving the value of each alternative
4. Rank the alternatives according to the weight of the criteria

According to Saaty (1996), a hierarchy is a representation of a complex problem in a multi-level structure where the first level is the goal, followed by the level of criteria and sub criteria, and at the bottom level is the alternative. In compiling the hierarchy, Saaty (1996) provides the following guidelines. (1) Determine the general objective. What is your goal? What is the main question? (2) Determine the sub-objectives of the overall goal, if relevant, and the timeframe that affects the decision. (3) Define the criteria that must be met to fulfill the sub-objectives of the overall objective. Note that criteria or subcriteria can be specified in terms of

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parameter value ranges or verbal intensities such as high, medium, or low. (4) Define the subcriteria under each criterion. (5) Specify the actors involved. (6) Specify their objectives. (7) Specify their policies. (8) Specify the options or outcomes. (9) When making a yes or no decision, take the most favorable outcome and compare the advantages and disadvantages of making the decision with not making it. (10) Analyze the benefits and costs using marginal value.

After determining the hierarchical structure, researchers need to determine the weight of each criterion measured. Determining the weight of these criteria using pairwise comparisons. First of all, by creating a matrix containing two elements to be compared, then giving a scale value from 1--9 which assesses the level of importance between the two elements. A scale value of 1 means that both elements are equally important while a scale of 9 means that one element is very important compared to the other. The explanation can be seen in Table 3.

Table 3. Pairwise Comparison Scale (Saaty, 1980)

Scale	Definition
1	Equal importance
3	Slight importance
5	Obvious importance
7	Strong importance
9	Very strong importance
2, 4, 6, 8	Intermediate values

In addition, each pairwise comparison requires a reciprocal assessment: if element A is assigned a certain importance value compared to element B, then element B will receive a reciprocal value in its comparison with A. This system ensures consistency, and a consistency ratio (CR), where a CR of 0.1 or less generally indicates acceptable consistency (Saaty, 1980). Finally, the matrix is normalized to calculate the priority vector and give the relative weights of the elements, which facilitates informed and balanced decision-making. This method is praised for its effectiveness and simplicity. It allows structured evaluation of complex decision matrices by decomposing the matrix into simpler comparative judgments (Saaty, 1980).

After obtaining the weights of the criteria elements, each alternative can be given an assessment or scoring alternatives. This assessment is done by giving numbers to all alternatives and conformity with the criteria. After the assessment, the weight of the criteria and alternative values will be obtained so that they can be ranked according to the calculation results.

2.2.3 Checking the Consistency

According to Hadadian (2017), inconsistency can occur when pairwise comparisons are performed. One example is as follows. We assume there are three criteria that are pairwise compared, then the respondent chooses the first criterion twice as important as the second criterion (C1 = 2C2), while the second criterion is three times more important than the third criterion (C2 = 3C3). The respondent may unintentionally choose that the first criterion is as important as the second criterion, so this is considered inconsistent. Logically, the first criterion would be six times more important than the third criterion (C1 = 2 x 3C3 = 6C3), so respondents should be able to select a scale of six or more on the comparison of the first criterion and the third criterion.

If the pairwise comparison matrix is not appropriate, and in the case of incomplete consistency, Jalaliyoon et al. (2012) say that the matrix cannot be used in normalising the columns to obtain the Wi. Therefore, the Eigenvector technique can be used to obtain a consistent priority set with equation 5 below.

$$e^T = (1,1,\dots,1)$$

$$W = \lim_{k\to\infty} \frac{A^k.e}{e^T.A^k e}$$

Taherdoost (2020) simplifies the Analytical Hierarchy Process (AHP) calculation formula by converting raw data into absolute values and normalized weights w = w1, w2, w3,..., wn, as shown in equation 5 below.

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$$Aw = \lambda_{max}, \lambda_{max} \geq n$$

$$\lambda_{max} = \frac{\sum ajwj - n}{wl}$$

$$A = \{aij\}, with\ a_{ij} = \frac{1}{a_{ij}}$$

A : Pairwise comparison
w : Normalized weight vector
λ_{max} : Maximum eigen value of matrix A
a_{ij} : Numerical comparison between the values i and j

After finding out how the two values differ, the results must be validated to ensure that the evaluation is accurate. Calculating the Consistency Ratio (CR) is the next step. In his study, Saaty (1980) provided an approach to calculate the consistency of a comparison matrix. This approach depends on whether the consistency ratio (CR) is acceptable or not. If the consistency ratio value is below 10% (CR < 0.1), the comparison matrix is considered consistent. To calculate CR, you must first calculate the consistency index (CI). The consistency index calculates the consistency of the comparison matrix by comparing the average ratio (Lambda x) minus the number of criteria (n) and the number of criteria minus one (n-1). The CR and CI equations are as follows.

$$CR = \frac{CI}{RI}; CI = \frac{\lambda x - n}{n - 1}$$

A comparison matrix is said to be perfectly consistent if CI=0. After calculating CI, it can be continued to calculate CR by comparing CI and random index (RI). RI is a comparison matrix where the values are said to be perfectly random. The Table 4 below shows RI if the number of criteria is below or equal to 10 (n ≤ 10).

Table 4. Random Index (Saaty, 1980)

Matrix Size	1	2	3	4	5	6	7	8	9	10
Random Index (RI)	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

3. METHODOLOGY

3.1 Research Design

This research is conducted by following several steps of research methodology that are shown in the research design Figure 5 below.

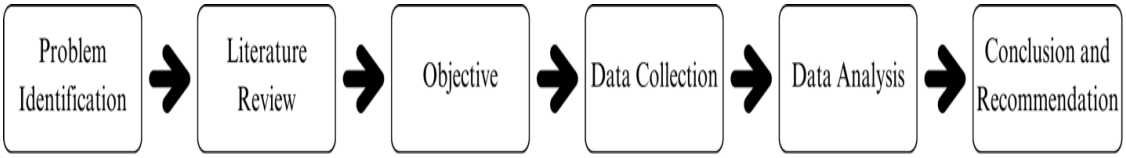

Figure 5. Research Design

3.1.1. Problem Identification

The first step in this research is to determine what problem to solve. This research uses previous literature related to carbon trading to see the implications of the problem. Researchers combined previous literature with current real data on carbon trading in Indonesia's carbon exchange. The problems found were then validated by relevant stakeholders such as carbon trading experts and the regulator for the Indonesian Carbon Exchange (IDXCarbon).

3.1.2. Literature Review

The literature review is a stage in research where the concepts, theories, and methodologies, used have been grounded through previous research. Researchers searched for literature from online sources such as e-journals, books, and interviews with stakeholders. The key paper for this research is by Muthia Ramadhani (2022) entitled Subcontractor Selection Application Using Analytical Hierarchy Process Method at Ritz Garment. The literature review helped in determining the criteria and barriers used in

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the Analytical Hierarchy Process (AHP) method as the method used in this research. The literature review also explains the definition and stages that must be done using the Analytical Hierarchy Process (AHP) method.

3.1.3. Objective

The purpose of this research is to answer the previously identified problem of finding the biggest obstacles for companies in conducting carbon trading through the Indonesia Carbon Exchange (IDXCarbon). To achieve this goal, this research uses the Analytical Hierarchy Process (AHP) method and compiles the criteria that companies can experience if they face these barriers. After the criteria and barriers are assessed and compared using the Analytical Hierarchy Process (AHP) method, the biggest barrier can be found.

3.1.4. Data Collection

In conducting research, data is required for analysis. In this study, the researcher collected primary data from respondents who are considered to have expertise and stakeholders in carbon trading in Indonesia. We obtained a total of 8 respondents, divided into industry players, academics and consultants, and regulators. The data collected were respondents' assessments of which criteria had greater weight and which barriers were more relevant. Respondents were previously contacted through personal messages and asked for their willingness to be respondents in this study. Data was collected using a questionnaire designed to be completed online, and a video on how to complete the questionnaire was attached.

3.1.5. Data Analysis

After obtaining the data needed for the research, researchers can use the Analytical Hierarchy Process method to analyze the data. Using Microsoft Excel, they will be able to rate each criterion according to the literature review. To select barriers, the analytical hierarchy process model consists of four criteria that have been proposed and approved by experts, including Mr. Lufaldy Ernanda from the Financial Services Authority (OJK). The experts will rate each criterion. After that, the calculations performed with this technique will be used to assign weights to each criterion. Once the weight of each criterion has been determined, each barrier can be assessed, which will result in a score for each barrier. Then, an overall score can be calculated for all barriers based on the results of this method, and the best barrier can be determined.

3.1.6. Conclusion and Recommendation

Based on the results of the data analysis, the researcher will be able to make conclusions regarding the research objectives. This conclusion must be able to fulfill the research objectives and help overcome the problem. In addition to the conclusion, the last step of this research will also provide recommendations to businesses and regulators regarding what they should do based on the research that has been conducted. In addition, this step can also be filled with recommendations for further research on this topic.

3.2 Research Method

The main analysis method in this research is the Analytical Hierarchy Process (AHP). AHP is a method developed by Saaty (1980). AHP is a tool for decision-making by setting priorities to find the best by reducing complex decisions into a series of pairwise comparisons and then correlating the results. AHP also checks the consistency of the decision maker's evaluation (Bohanec et al., 2004). The steps in this method are to determine the hierarchical model, pairwise comparison the criteria, check for consistency, assign values to the Barriers, and rank the Barriers.

3.2.1 Establish The AHP Model

The first step in the AHP method is to formulate the decision-making with a structured hierarchy. The hierarchy structure has three different levels: objectives, criteria, and alternatives. With this hierarchical structure, options are evaluated based on criteria that are calculated with weights to achieve the decision-making objectives. However, this research is slightly different. The researcher wants to evaluate the obstacles of a goal. Usually, AHP has a Goal-Criteria-Alternatives formula, while this research is more about Goal-Criteria-Barriers. This formula has been used in Jun Ichihara & Toshihiro Uchida's research to prioritize barriers to implementing CDM projects in Indonesia. Some previous studies used AHP as a tool to determine barriers such as barriers in implementing CDM projects in Indonesia (Ichihara & Uchida, 2014), a study of the operating effects of a regional carbon market in Fujian province, China (Lin et al., 2023), evaluating barriers to implementing the Joint Crediting Mechanism in Indonesia (Ichihara & Uchida, 2016), and evaluating barriers to adopting sustainable consumption and production initiatives in supply chains (Luthra et al., 2016).

3.2.2 Criteria and Barriers

Criteria and barriers were determined through a literature review process. The literature in question belongs to Ellis & Kamel (2007), Xia, Li, & Zhu, (2020), Ichihara & Uchida (2014), Zhao, Wu, & Li, (2017), Suk et al. (2017), and Moxey et al. (2021). After going

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through the literature review process, the researcher validated the findings with an expert in the field of the Indonesian Carbon Exchange. The expert was Mr. Lufaldy Ernanda, a director of the supervisor of derivative financial products and carbon exchanges at the Indonesian Financial Services Authority. The researcher asked about the suitability of the literature review and the knowledge possessed by the expert. The details of the four criteria are as follows.

Criterion 1: Impact on Financial and Profitability

This criterion evaluates how participation in a carbon exchange affects the financial stability and profitability of the company. This includes the effect on revenue, cost efficiency, and potential profits from the sale of carbon credits (Ichihara & Uchida, 2014). Evaluation under this criterion looks at the company's ability to generate additional revenue through carbon credit trading, as well as the impact of carbon trading activities on the company's operating and investment costs.

Criterion 2: Impact on Risk Management and Uncertainty

These criteria focus on how carbon trading affects the risk profile and uncertainties that companies face. This includes market risks, such as fluctuations in the price of carbon credits, compliance risks associated with changes in carbon regulations, and reputational risks. The evaluation aims to identify and manage risks that may affect a company's operations and finances in the context of carbon trading, as well as quantify uncertainties related to future carbon market and policy developments (Ichihara & Uchida, 2014).

Criterion 3: Impact on Regulatory Compliance and Stakeholder Engagement

This criterion assesses how regulatory compliance and stakeholder engagement affect a company's success in carbon exchanges. It looks at the need to comply with applicable carbon trading regulations, both nationally and internationally (Ellis & Kamel, 2007), as well as the importance of maintaining good relationships with stakeholders, including governments, customers, investors and the general public (Lufaldy Ernanda, private interview, 31/01/2024). The criteria also include an assessment of how companies can leverage stakeholder engagement to enhance reputation and support sustainability initiatives.

Criterion 4: Impact on Business Operation and Strategy

This criterion explores how carbon trading affects a company's day-to-day business operations and long-term strategic planning. This includes adjustments in operations to reduce emissions, investments in green technologies, and integration of sustainability goals into business strategy. The criterion aims to assess the extent to which carbon trading can be a driver of innovation, operational efficiency, and market differentiation (Xia, Li, & Zhu, 2020), as well as influence a company's strategic decision-making and resource allocation.

From each of these criteria, we will look for which criteria have the greatest impact on the company. Furthermore, the explanation of the six barriers is as follows.

Barrier 1: Concern Over Loss of Sustained Revenue

Companies in sectors such as forestry, land use and manufacturing are concerned that their participation in carbon trading could reduce productivity and revenue. For example, peatland managers are concerned about losing productivity and agricultural benefits, as well as tax breaks, due to peatland restoration (Moxey et al., 2021).

Barrier 2: Limited Trading Supply

The relatively new Indonesian Carbon Exchange faces constraints in trading volume due to a lack of supply and demand. Companies do not yet feel the need to participate in carbon trading, and the low frequency of trading may affect companies' psychology to participate in the carbon exchange (Zhao, Wu, & Li, 2017).

Barrier 3: Low Level of Transparency

Lack of transparency in the carbon market creates mistrust. Inconsistent information and information asymmetry between emission-reducing firms and policymakers make it difficult to make informed decisions (Zhao, Wu, & Li, 2017). Policy vagueness, information delays, carbon price uncertainty, and lack of accounting systems set up for emissions trading are some examples of information barriers (Suk et al., 2017).

Barrier 4: Additional Explicit Costs

Significant initial investment is required for activities such as carbon projects and emission reductions. High entry costs and operating costs in carbon markets can reduce market liquidity and enthusiasm (Zhao, Wu, & Li, 2017), thereby hindering market efficiency. These costs include administrative costs, risk assessment, and other costs associated with carbon trading (Suk et al., 2017).

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Barrier 5: Lack of Company's Understanding and Capability

The level of understanding of carbon trading and carbon asset management needs to be improved among companies (Zhao, Wu, & Li, 2017). In the UK, for example, there is limited awareness of peatland restoration and the Peatland Code (Moxey et al., 2021). Lack of specialized knowledge, equipment and skills, especially at the local level, can lead to irrational investment behavior and carbon price fluctuations.

Barrier 6: Bureaucratic Complexity

The bureaucratic processes associated with green finance applications and carbon trading procedures are perceived to be overly complex (Moxey et al., 2021), adding barriers for companies to participate in carbon trading.

A. 3.2.3 Data Collection

After selecting the four criteria and six barriers above, the researcher collected data using a questionnaire survey of carbon exchange stakeholders in Indonesia. The AHP questionnaire was conducted based on the pairwise comparison method and scoring the barriers. The pairwise comparison method asks respondents to make pairwise comparisons regarding the importance of criteria and the importance of barriers. A scale of 1—9 was used in the pairwise comparison. The questionnaire can be seen in Figure 6 below.

No	Criteria (A)	Skala									Skala								Criteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
1	Impact on Financial and Profitability																		Impact on Risk Management and Uncertainty

No	Criteria (A)	Skala									Skala								Criteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
2	Impact on Financial and Profitability																		Impact on Regulatory Compliance and Stakeholder Engagement

No	Criteria (A)	Skala									Skala								Criteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
3	Impact on Financial and Profitability																		Impact on Business Operation and Strategy

No	Criteria (A)	Skala									Skala								Criteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
4	Impact on Risk Management and Uncertainty																		Impact on Regulatory Compliance and Stakeholder Engagement

No	Criteria (A)	Skala									Skala								Criteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
5	Impact on Risk Management and Uncertainty																		Impact on Business Operation and Strategy

No	Criteria (A)	Skala									Skala								Criteria (B)
		9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	
6	Impact on Regulatory Compliance and Stakeholder Engagement																		Impact on Business Operation and Strategy

Figure 6. Pairwise Comparison Questionnaire

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The scoring barrier is that respondents are asked to rate whether the obstacle affects the criteria. The questionnaire can be seen in Figure 7 below.

Impact on Financial and Profitability	1	2	3	4	5	6	7	8	9	10
Concern Over Loss of Sustained Revenue										
Limited Trading Volume										
Low Level of Transparency										
Additional Explicit Costs										
Lack of Company Understanding and Capability										
Bureaucratic Complexity										

Impact on Risk Management and Uncertainty	1	2	3	4	5	6	7	8	9	10
Concern Over Loss of Sustained Revenue										
Limited Trading Volume										
Low Level of Transparency										
Additional Explicit Costs										
Lack of Company Understanding and Capability										
Bureaucratic Complexity										

Impact on Regulatory Compliance and Stakeholder Engagement	1	2	3	4	5	6	7	8	9	10
Concern Over Loss of Sustained Revenue										
Limited Trading Volume										
Low Level of Transparency										
Additional Explicit Costs										
Lack of Company Understanding and Capability										
Bureaucratic Complexity										

Impact on Business Operation and Strategy	1	2	3	4	5	6	7	8	9	10
Concern Over Loss of Sustained Revenue										
Limited Trading Volume										
Low Level of Transparency										
Additional Explicit Costs										
Lack of Company Understanding and Capability										
Bureaucratic Complexity										

Figure 7. Scoring Barrier Questionnaire

Because the respondents of this study are more than one, to calculate using this method an average is needed, namely using a geometric average. The following is the formula for the geometric average.

$$\left(\prod_{i=1}^{n} x_i\right)^{\frac{1}{n}} = \sqrt[n]{x_1 x_2 \dots x_n}$$

AHP does not rely on a statistical large sample theory (Ichihara & Uchida, 2014). It is very common to apply this method to small samples. In this study, the total sample size was 8 consisting of 5 businesses, 1 regulator, and 2 researchers which can be seen in the Table 5 below.

Table 5. List of Respondent

Type	Name	Position	Institution
Regulator	Lufaldy Ernanda	Director of Financial Derivatives and Carbon Exchange Supervision	Otoritas Jasa Keuangan
Researcher	Sadiid Arifin	Sustainability Researcher	World Resources Institute
Researcher	Melia Famiola, S.T.P., M.T, Ph.D.	Assistant Professor from Entrepreneurship and Technology Management Interest Group	School of Business and Management, Institut Teknologi Bandung
Business	Titin Alfiani	Biodiversity and Environment Management Officer	PT Pamapersada Nusantara
Business	Asni Ibrahim	Chief Executive Officer	PT Jejak Ekologi Nusantara (Jentara)

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Business	Faiz Zaidan Alharkan	Carbon Business Development Analyst	PT Pertamina Power Indonesia
Business	Robi Ginting	Head of Policy and Project Advisory	PT Iklim Muda Sentosa (CarbonEthics)
Business	Faelasufa	Chief Executive Officer	PT Digital Lestari Indonesia (CarbonShare)

In addition to the AHP survey, we also interviewed stakeholders of carbon exchanges in Indonesia simultaneously to get their concrete experiences on the barriers. This complemented the quantitative results of the AHP and provided a more complete picture of the barriers.

3.2.4 Checking The Consistency

The next stage of the AHP method is to test the consistency of the data. The consistency of the data is as follows. If Criterion A is greater than Criteria B and Criterion B is greater than Criterion C, then Criterion A must be greater than Criterion C. If it turns out that the respondent's answer A is smaller than C, then the respondent's data is inconsistent. Consistency in AHP can be calculated using the consistency ratio. To find the consistency ratio, you can divide the consistency index (CI) by the random index (RI). Previous research assumes that the pairwise comparison matrix is consistent if the consistency ratio is less than 10% (Cr < 0.1) (Jarek, 2016).

3.2.5 Data Analysis and Result

After calculating the consistency index, the barriers that had been formulated were rated by respondents through a questionnaire. The questionnaire contained a table of each barrier rated 1--10, with 1 indicating very irrelevant and 10 indicating very relevant, against each criterion. the questionnaire can be found in the appendix. After that, to rank the barriers, the overall score of each barrier must be calculated. Once the weight of the criteria is determined, the overall score of each barrier can be done by multiplying the global weight of each criterion by the score of each barrier. After that, the results of each obstacle are added to get the overall score. Once the overall score for each barrier is calculated, the ranking of the barrier can be determined and will determine the barrier that has the highest score. After that, the barrier with the highest score will be selected as the biggest barrier for the business.

4. DATA ANALYSIS AND RESULT

4.1 Structuring the Decision Model

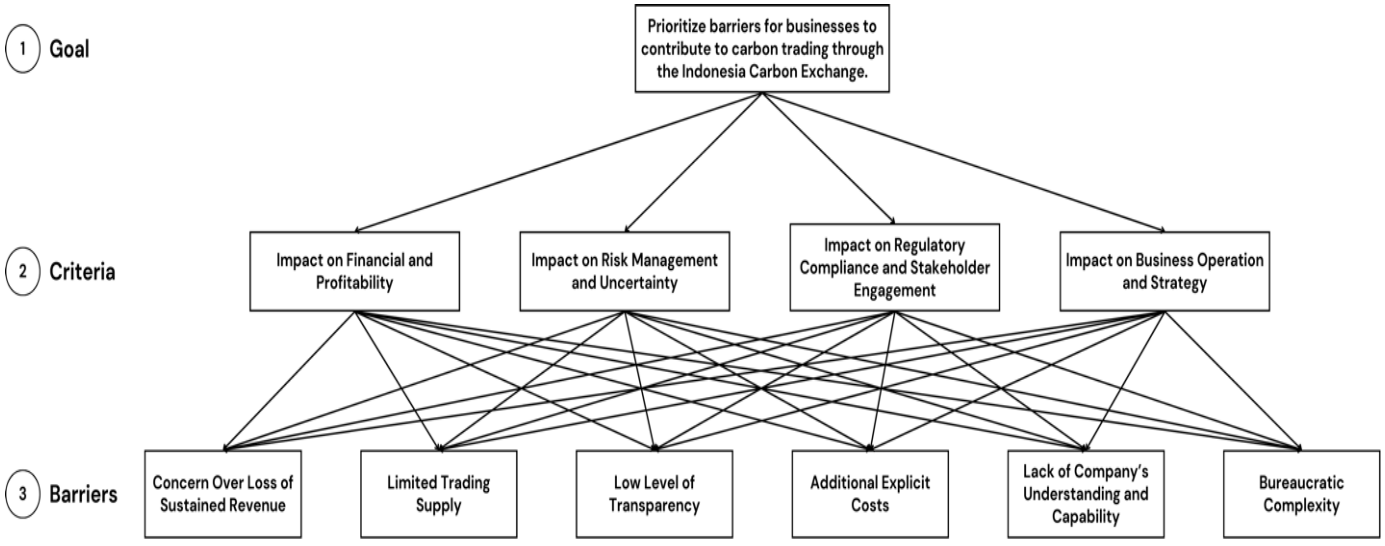

Figure 8. AHP Hierarchy Structure

The AHP hierarchical structure was created through the process described in Chapter 3. As shown in Figure 8, the hierarchical structure consists of three hierarchical levels. Level 1 is the goal for decision selection, which is to determine the biggest barriers

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for businesses to contribute to carbon trading through the Indonesian Carbon Exchange. Level 2 is the criteria, namely Impact on Financial and Profitability; Impact on Risk Management and Uncertainty; Impact on Regulatory Compliance and Stakeholder Engagement; and Impact on Business Operation and Strategy. Level 3 is a hierarchy of barriers, including Concern Over Loss of Sustained Revenue; Limited Trading Supply; Low Level of Transparency; Additional Explicit Costs; Lack of Company Understanding and Capability; and Bureaucratic Complexity.

4.2 Criteria Weights Calculation

The data collected to calculate the pairwise comparison was collected through a questionnaire. The questionnaire contains judgments from carbon experts. The results of the questionnaire can be found in the Appendix A. Once the assessments from the respondents have been collected, the results are averaged using the geometric average. This calculation is done to get one pairwise comparison value from many respondents. For example, the pairwise comparison of the Impact on Financial and Profitability criteria can be seen below.

$$\left[\left(\frac{1}{5}\right) \times \left(\frac{1}{3}\right) \times (5) \times (7) \times (8) \times \left(\frac{1}{8}\right) \times \left(\frac{1}{3}\right) \times \left(\frac{1}{5}\right)\right]^{\frac{1}{8}} = 0{,}7925$$

The number one-fifth from the left, $(\frac{1}{5})$, is obtained from the first respondent who rated the Impact on Financial and Profitability criteria as one-fifth, $(\frac{1}{5})$. For the number one-third from the left, $(\frac{1}{3})$, obtained from the second respondent who rated the Impact on Financial and Profitability criteria as one-third, $(\frac{1}{3})$. And so on until the number one-fifth from the right, $(\frac{1}{5})$, is obtained from the eighth respondent who rated the Impact on Financial and Profitability criteria as one-fifth, $(\frac{1}{5})$. The result of this calculation is 0,7925 which is determined to be the pairwise comparison value of the Impact on Financial and Profitability criteria. The results of other geometric average calculations can be seen in Table 6.

Table 6. Pairwise Comparison Matrix In Terms of All Criteria

Criteria Matrix	Impact on Financial and Profitability	Impact on Risk Management and Uncertainty	Impact on Regulatory Compliance and Stakeholder Engagement	Impact on Business Operation and Strategy
Impact on Financial and Profitability	1	0,7925	1,2062	0,8717
Impact on Risk Management and Uncertainty	1,2619	1	1,2166	1,3267
Impact on Regulatory Compliance and Stakeholder Engagement	0,8291	0,8219	1	0,7293
Impact on Business Operation and Strategy	1,1472	0,7537	1,3712	1

Based on the pairwise comparison matrix above, the weight of each criterion can be calculated. After that, the priority of each criterion can be determined based on its weight. The results of the calculations that determine these weights and priorities can be seen in Table 7 below.

Table 7. Weight and Priority of All Criteria

Criteria	**Weight**		**Priority**
	Decimal	**Percentage**	
Impact on Financial and Profitability	0,2362	23,62%	3
Impact on Risk Management and Uncertainty	0,2966	29,66%	1

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Impact on Regulatory Compliance and Stakeholder Engagement	0,2085	20,85%	4
Impact on Business Operation and Strategy	0,2588	25,88%	2
TOTAL	1	100%	

From Table 7 above, we can conclude that the most important criterion is Impact on Risk Management and Uncertainty. This means that the Risk Management and Uncertainty factor is a factor that greatly impacts the Company if the barriers to carbon trading occur. Risk Management and Uncertainty means that the Company is very concerned about risk both in terms of reputation and market risk, namely the level of market price fluctuations. This criterion aims to identify and manage risks that may affect the Company in the context of uncertainty of carbon trading through the Indonesia Carbon Exchange.

The criterion with the second largest weight is Impact on Business Operation and Strategy. This criterion is an important concern because the operation of a company is the key to a company. Whether the company has environmentally unfriendly operations or may be willing to change them to reduce greenhouse gas emissions. With carbon trading in place, decision-makers need to plan their company's short- and long-term strategy. For example, decision-makers may plan their operational strategy, investment strategy, and plans to reduce greenhouse gas emissions. This change in strategy can change the culture and daily activities of the company down to the lowest level of employees.

The third highest weighted criterion is Impact on Financial and Profitability. This criterion means that if a company conducts carbon trading through the Indonesia Carbon Exchange, it can have an impact on the company's cash flow, financial statements, and financial decisions. In conducting carbon trading, companies will be faced with decisions that can reduce or increase company costs. Likewise, it can also affect the company's income in the context of business as usual (BAU). According to Mr. Robi Ginting, financial and profitability can still be adjusted and more flexible to adapt to changes.

Finally, the criteria with the lowest weight is Impact on Regulatory Compliance and Stakeholder Engagement. The results show that this criterion is not a criterion that is highly considered by the company. This criterion means that companies need to look at the regulations, and their dynamics, that exist and how companies, as well as other stakeholders, respond to them. According to Mrs. Faelasufa, whatever the regulations are, companies need to comply with the rules and regulations that apply in Indonesia. So this criterion is not one that the company pays much attention to.

4.3 Checking the Consistency

Once the criteria weights have been determined through pairwise comparison, consistency must be calculated to ensure the consistency of the data. Consistency can be reviewed through consistency ratio (CR) which means if CR is less than 0.1 then the data is considered consistent and can be used. The calculation results can be seen in Table 8 below.

Table 8. Consistency Calculation

Symbol	Formula	Value	
Lambda x (λx)	$\sum(criteria\ sum \times criteria\ weight)$	4,0157	
Consistency Index (CI)	$\frac{\lambda x - n}{n-1}$	0,0052	
Random Index (RI)	n = 4; RI = 0,9	0,9	
Consistency Ratio (CR)	$\frac{CI}{RI}$	0,0058	0,58%

After the calculation, according to Table 4.3 above, the data shows that the consistency ratio (CR) is 0.58%. Because this figure is below 0.1 or 10%, the data is said to be consistent and can be used for research.

4.4 Scoring the Barriers

The assessment of barriers has been carried out by respondents by giving a value to each barrier against each criterion through a questionnaire. The results of the obstacle assessment questionnaire can be seen in the Appendix A. After data collection, the results

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of the assessment of the respondents were made the average to be the same as the average weight of the criteria and in accordance with the needs of the AHP calculation. The following is the obstacle value of each criterion which can be seen in Table 9 below.

Table 9. Barriers Scoring Toward Criteria

Barrier	Barrier Score			
	Impact on Financial and Profitability	Impact on Risk Management and Uncertainty	Impact on Regulatory Compliance and Stakeholder Engagement	Impact on Business Operation and Strategy
Concern Over Loss of Sustained Revenue	7,97	4,99	4,62	7,47
Limited Trading Volume	3,17	5,81	4,62	5,41
Low Level of Transparency	3,56	6,44	5,65	5,14
Additional Explicit Costs	7,24	5,67	4,91	6,07
Lack of Company Understanding and Capability	4,36	6,09	6,69	7,04
Bureaucratic Complexity	5,61	4,36	7,20	5,43

Based on Table 9 above, it shows the value of barriers against each criterion. These results will be used to calculate the overall value of each barrier. From the results of these calculations, an overall score will be determined to determine the ranking of each barrier. To determine the overall score, it can be calculated by multiplying the barrier score by the criteria. below is Table 10, which is the result of the calculation or the result of the overall score value.

Table 10. The Overall Score of Barriers Toward Criteria

Barrier	Overall Score				Total
	Impact on Financial and Profitability	Impact on Risk Management and Uncertainty	Impact on Regulatory Compliance and Stakeholder Engagement	Impact on Business Operation and Strategy	
Concern Over Loss of Sustained Revenue	1,8832	1,4805	0,9631	1,9326	6,2593
Limited Trading Volume	0,7491	1,7226	0,9631	1,4008	4,8356
Low Level of Transparency	0,8413	1,9102	1,1777	1,3290	5,2582
Additional Explicit Costs	1,7103	1,6828	1,0245	1,5708	5,9885
Lack of Company Understanding and Capability	1,0304	1,8058	1,3956	1,8223	6,0541
Bureaucratic Complexity	1,3262	1,2938	1,5020	1,4052	5,5271

To get a more readable picture, here is a table of the tendency of each barrier from each criterion. In Table 11, the Concern Over Loss of Sustained Revenue barrier has a percentage of 23,24% against the Impact on Financial and Profitability criterion compared to other barriers in the same criterion.

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Table 11. The Relative Significance of Barriers with Respect to Each Criterion

Barrier	Overall Score			
	Impact on Financial and Profitability	Impact on Risk Management and Uncertainty	Impact on Regulatory Compliance and Stakeholder Engagement	Impact on Business Operation and Strategy
Concern Over Loss of Sustained Revenue	23,24%	15,49%	15,02%	19,68%
Limited Trading Volume	12,68%	17,85%	14,33%	15,48%
Low Level of Transparency	11,97%	17,51%	16,38%	13,87%
Additional Explicit Costs	21,13%	16,84%	14,68%	16,77%
Lack of Company Understanding and Capability	13,73%	17,51%	19,11%	19,03%
Bureaucratic Complexity	17,25%	14,81%	20,48%	15,16%
	100%	100%	100%	100%

4.5 Ranking the Barriers

Since the criteria weights and obstacle values have been obtained, the overall score of each obstacle can be calculated. The results of the multiplication are added according to each barrier to get the overall score. The results of the overall score can be seen in Table 12 below. From the overall score, the ranking of the barriers can be determined.

Table 12. Overall Scores and Ranking for Barriers

Barriers	Overall Score	Ranking
Concern Over Loss of Sustained Revenue	6,2593	1
Limited Trading Volume	4,8356	6
Low Level of Transparency	5,2582	5
Additional Explicit Costs	5,9885	3
Lack of Company Understanding and Capability	6,0541	2
Bureaucratic Complexity	5,5271	4

Based on Table 12, the barrier that has the highest overall score is Concern Over Loss of Sustained Revenue, which is 6,2593. The second highest barrier is Lack of Company Understanding and Capability, which is 6,0541. The third highest barrier is Additional Explicit Costs with an overall score of 5,9885. The next highest order is Bureaucratic Complexity, Low Level of Transparency, and Limited Trading Volume with an overall score of 5,5271; 5,2582; and 4,8356.

The Concern Over Loss of Sustained Revenue barrier means that there is a high fear of revenue loss from participating in carbon trading. Especially for companies in sectors such as forestry, land use, manufacturing, etc. carbon trading may reduce the productivity of their business processes. The second highest barrier is the Lack of Company Understanding and Capability. Companies still have a lack of understanding and capability especially in the field of carbon emissions, carbon trading, and carbon management. Even companies are still not aware of environmental, social, and governance (ESG) issues. This was validated from interviews with respondents. The third highest barrier is the Additional Explicit Costs barrier means that companies are very concerned about the costs of entering into carbon trading. These costs include initial investment costs, ongoing operational costs, administrative costs, and other costs associated with carbon trading.

The next highest barrier is Bureaucratic Complexity, which means that there is complexity with bureaucratic processes related to carbon trading, carbon projects, and sustainability finance. The next highest barrier is the Low Level of Transparency. This means inconsistent information, a lack of transparency, and a lack of systems and policies related to carbon trading that make decision-making difficult. This was also validated by Mrs. Titin Alfiani that Indonesia's regulatory infrastructure is still far behind. The

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lowest barrier is Limited Trading Volume, which makes companies distrust the Indonesian Carbon Exchange. Companies do not feel the need to participate in carbon trading and the low frequency of trading may affect their psychology to participate.

Based on these results, it was found that the three highest barriers were barriers originating from within the company. This means that actions or policies need to be taken to overcome barriers originating from within the company. Companies can anticipate this by finding alternative sources of income that are more sustainable or developing new products and services that are more environmentally friendly. These can open new markets, reduce dependence on unsustainable income, and restructure revenues and costs (Hernandez, 2019). Companies can also anticipate by increasing their understanding and capabilities through capacity building (Plambeck, 2012; Biedenkopf, Eynde, & Walker, 2017).

Meanwhile, the other three barriers are barriers that come from outside the company. Actions and policies from outside the company, in this case the regulator, are needed to overcome these barriers. Bureaucratic Complexity can be addressed by improving coordination and communication between companies and regulatory authorities in carbon trading. Regulators also need to simplify bureaucratic processes and speed up permits for emission reduction projects (Guo, Foropon, & Ma, 2020; Gittell & Douglass, 2012). Regarding the Low Level of Transparency barrier, companies and authorities need to increase transparency by improving emissions reporting and auditing systems. The implementation of blockchain technology can provide a secure and transparent distributed ledger, enabling easy tracking and auditing of renewable energy and carbon credits, thereby reducing costs and time (Ashley & Johnson, 2018). Offset mechanisms, carbon product trading, government penalties, and carbon quota allocation are the most influential factors in willingness to participate in carbon trading (Zha, Feng, & Kong, 2022). These factors need to be further evaluated in order to increase carbon market participation to overcome the Limited Trading Volume barrier.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the research problems and research results obtained from analysis and discussion, the following are the conclusions:

1. The level of importance of the criteria for selecting barriers for businesses to participate in carbon trading through the Indonesia Carbon Exchange are Impact on Financial and Profitability with a weight of 0.2362; Impact on Risk Management and Uncertainty with a weight of 0.2966; Impact on Regulatory Compliance and Stakeholder Engagement with a weight of 0.2085; and Impact on Business Operation and Strategy with a weight of 0.2588. Therefore, the order of criteria with the highest to lowest weight is Impact on Risk Management and Uncertainty; Impact on Business Operation and Strategy; Impact on Financial and Profitability, and Impact on Regulatory Compliance and Stakeholder Engagement.
2. The overall score of the barriers for businesses in conducting carbon trading through the Indonesia Carbon Exchange are Concern Over Loss of Sustained Revenue with an overall score of 6,2593; Limited Trading Volume with an overall score of 4,8356; Low Level of Transparency with an overall score of 5,2582; Additional Explicit Costs with an overall score of 5,9885; Lack of Company Understanding and Capability with an overall score of 6,0541; and Bureaucratic Complexity with an overall score of 5,5271. Therefore, the order of barriers from highest to lowest is Concern Over Loss of Sustained Revenue; Lack of Company Understanding and Capability; Additional Explicit Costs; Bureaucratic Complexity; Low Level of Transparency; and Limited Trading Volume.
3. The criteria with the greatest weight are Impact on Risk Management and Uncertainty.
4. The biggest barrier for businesses to participate in carbon trading through the Indonesia Carbon Exchange is Concern Over Loss of Sustained Revenue.

5.2 Recommendation

5.2.1 Recommendation for the Business

Below are recommendations for Business derived from the data analysis and conclusions:

1. There is a need for initiatives, actions, or policies that can overcome barriers such as Concern Over Loss of Sustained Revenue; Lack of Company Understanding and Capability; and Additional Explicit Costs.
2. Based on the analysis, actions that can be taken are such as finding alternative sources of income that are more sustainable or developing new products and services that are more environmentally friendly.
3. Businesses can improve their understanding and capabilities through capacity building for employees and managerial levels. After that, a special department can be created that deals with sustainability or carbon related issues in particular.

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4. There is a need to restructure revenues and costs during the change of strategy to be more sustainable. Businesses need to pay attention to the additionality and externalities of the company.

5.2.2 Recommendation for the Regulator and IDXCarbon

Below are recommendations for regulators and IDXCarbon derived from the data analysis and conclusions:

1. There is a need for initiatives, actions, or policies that can overcome barriers such as Bureaucratic Complexity; Low Level of Transparency; and Limited Trading Volume.
2. Based on the analysis, possible actions include improving coordination and communication between companies and regulatory authorities. For example, there are regular meetings between regulators and IDXCarbon issuer associations so that it is found what pain is felt and what gains can be obtained.
3. Simplify the bureaucratic process of registering IDXCarbon participants and speed up the process by providing incentives and disincentives.
4. In an effort to increase transparency, it is possible to improve the emissions reporting and auditing system. Regulators need to create a complete and fundamental regulatory framework.
5. The government needs to create an independent body or institution with the purpose and focus of accelerating net zero emission in Indonesia.

5.2.3 Recommendation for Further Research

Below are recommendations for further research obtained from data analysis and conclusions:

1. In the context of methods, further research can use methods that allow more respondents or can use the Analytical Network Process (ANP) method.
2. Future research can widen or take a research scope other than the scope of this research.
3. Future research can also discuss how to overcome barriers for businesses to participate in carbon trading through the Indonesian Carbon Exchange.

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