GSJ: Volume 14, Issue 3, March 2026, Online: ISSN 2320-9186
www.globalscientificjournal.com

Risk Analysis of China's Overseas Energy Investment Projects: Based on the Analysis of Wind Power Projects in Bangladesh (COX BAZAR)

Abstract: This study aims to assess the risks associated with overseas energy investment projects of China, specifically focusing on wind power projects in Bangladesh. Using the FUZZY-DEMATEL method, the study analyzes the various risk factors of China's overseas energy investments. The FUZZY-MCDM approach is applied to identify the main criteria and sub-criteria for these risk factors, with expert opinions used to evaluate the interactions between them. The results indicate that wind power projects face various risks, including political, environmental, economic, social, and technical risks. These five risk factors are further broken down into sub-criteria, where the cause group influences the effect group. This article aims to evaluate these risk criteria and recommend the best management strategies. It urges Chinese investors to carefully consider these risks when making investment decisions to reduce potential losses. Furthermore, the study seeks to guide the government in strengthening investment oversight, improving planning, and promoting corporate governance. Additionally, the findings contribute to a deeper understanding of investment risk management within the context of China's Belt and Road Initiative.

Keywords: Cox Bazar, Investment Risk, Wind Power project, FUZZY-DEMATEL Analysis.

1.Introduction

Wind power is now a commonly used clean energy source due to ongoing technological advancements and falling costs. Several important considerations need to be made when funding wind energy projects abroad. First, political risks are important because they can create uncertainty and increase the possibility of financial losses. These factors include political instability, changes in government policy, and political disputes between nations. International conflicts, changes in foreign policy, and changes in political leadership can all have a big effect on how stable investments are. Market volatility, inflation, and currency changes are all strongly related to economic risks, and they can represent serious obstacles to foreign energy investments. Energy demand, pricing, and financing possibilities can all be impacted by economic downturns, recessions, or changes in the market, which can eventually result in losses for investors.

China faces many risks associated with its foreign energy investments, including social, political, and economic ones. Therefore, finding ways to reduce these dangers is a topic that needs a lot of study. The contradiction between national objectives and corporate aims is one of the most important variables driving the risks involved, along with political tensions, economic difficulties, and cultural differences. It is frequently challenging for businesses to handle these political and economic concerns on their own. The Chinese government has attempted to address these issues by implementing policy measures meant to stabilize the economy in the face of international unpredictability, but these policies have not yet offered a complete answer.

Furthermore, environmental risks, regulations, and concerns are becoming increasingly significant in overseas energy investments. Changing environmental regulations, the impacts of climate change, and the global push to reduce greenhouse gas emissions all have the potential to affect the viability and profitability of energy projects. Social risks include cultural differences, challenges in communication among project stakeholders, and the impact of social instability, such as strikes or protests. Finally, technical risks are crucial to consider, as they involve technological factors like the availability of advanced technology, skilled labor, and the performance reliability of new energy technologies. These technical challenges, which also include resource acquisition, transportation, and the operational capacity of energy facilities, are key determinants of the success of overseas energy projects.

Theoretically, it is possible to determine the theoretical significance of China's foreign energy investment projects by comparing and evaluating the economic development status of China and Bangladesh. This analysis reveals notable disparities in energy development between China and Bangladesh. Meanwhile, it enhances the theoretical understanding of this field and helps to advance global energy cooperation and trade. Practically speaking, it supports the growth of the energy technology and equipment manufacturing sectors in China and Bangladesh, particularly in the wind and solar power generation sectors; enhances the economic and social advantages of businesses across the globe; aids in the preservation of natural resources and the improvement of the ecological and social environment; helps to optimize resource allocation; facilitates the realization of the shift in economic growth mode; supports international cooperation in resource and environmental protection; and supports the quick and coordinated development of pertinent industries as well as the local economy and society.

2. Literature review

Investing in overseas renewable energy projects presents a range of uncertainties due to the involvement of multiple risk factors, making risk analysis a critical subject in academic literature. Decision-makers often face difficulties in assessing these risks due to various economic, political, social, and technological uncertainties that could lead to investment failures. Scholars have widely explored these challenges, focusing on methods to evaluate and mitigate risks associated with overseas energy investments. Several studies have examined investment risks in renewable energy projects using different methodologies.(Tan et al., n.d.)provide a foundational understanding of China's overseas investments in the wind and solar industries, emphasizing trends, drivers, and the need for further research while acknowledging data limitations. It also highlights the necessity for further research to improve understanding of China's potential to reduce emissions through its overseas investments. (Dockner et al., 2013) analyzed company risk based on investment options rather than direct investment positions, while (Zhang et al., 2016) applied a real options model to assess resource investment in renewable energy. (Tietjen et al., 2016) compared the risk perspectives of renewable and fossil energy markets, identifying electricity prices as a key determinant for power plant investments. (Hach et al., 2016) considered capacity payment as a risk factor, analyzing the interaction between renewable energy projects and natural gas power plants. (Farfan & Breyer, 2017) evaluated national power systems using sustainability indicators also highlighted political and regulatory risks as high-risk factors, with economic, socio-cultural, and infrastructure risks categorized as moderate to low risks
.

Political instability and regulatory uncertainties significantly impact China's overseas energy investments. Changes in political leadership, foreign policies, and diplomatic relations can create uncertainties, increasing financial risks for investors. Regulatory risks arise from inconsistent enforcement, complex licensing requirements, and shifting policy frameworks, which can influence project feasibility and profitability.(Yang et al., 2023) highlights that China's energy infrastructure investments in BRI countries face significant political risks. These risks arise from disputes with host countries, which can lead to investment losses or failures.

Economic risks, including inflation, currency fluctuations, and market volatility, further complicate investment decisions, as economic downturns can affect energy demand and pricing structures.(Kang et al., 2021) discusses the economic risks associated with coal-power investment projects in Indonesia, particularly focusing on investments made by Chinese enterprises. The paper highlights the significance of coal-power projects in Indonesia, It emphasizes the role of Chinese enterprises in financing and developing these projects, which is a growing trend in the region. It utilizes a combination of methodologies, including the fuzzy comprehensive evaluation method and the Analytic Hierarchy Process (AHP), to assess and rank the risks associated with overseas engineering projects in the coal sector, the paper provided early warning results regarding the economic risks of coal power investments, suggesting that while there are opportunities, careful consideration of the associated risks is essential for investors.

Environmental and social risks are becoming increasingly critical, with climate regulations, greenhouse gas emission targets, and land use conflicts affecting investment stability. (Huang, 2019)emphasizes that Chinese investments in the BRI will significantly affect the environment of the host countries. It highlights the reciprocal relationship between the host country's resource endowments and its environmental capacity. This means that not only do investments impact the environment, but the existing environmental conditions and resources of the host country can also influence the nature and success of these investments. Technical risks related to the availability of advanced technology, the reliability of new energy systems, and the expertise required for maintaining wind energy infrastructure also pose challenges for overseas projects.(Xu et al., 2023)study introduces a multi-level system dynamics method designed to analyze the investment risk associated with wind power projects. The research explores the interrelationships between several critical factors that impact technical risk and policy risk.

According to (Rahman & Alam, 2021)Bangladesh has actively sought renewable energy solutions to mitigate power shortages and reduce reliance on fossil fuels. With its long coastal belt, Cox's Bazar is identified as a strategic location for wind energy generation (*BANGLADESH: Renewable Energy Policy of Bangladesh*, n.d.) aims to generate 10% of its electricity from renewables by 2030. However,(Anjum, 2024) suggests that wind energy presents a viable alternative for Bangladesh. The geographical and climatic conditions of the country are conducive to harnessing wind power, which could significantly contribute to the energy mix and reduce reliance on fossil fuels.

Research methods

To address these risks, Multi-Criteria Decision-Making (MCDM) approaches have been employed for investment evaluation. Due to the uncertainty in decision-making, FUZZY logic has been integrated into MCDM methodologies to enhance precision. Scholars such as (Büyüközkan & Güleryüz, 2017) utilized the Analytic Network Process (ANP) to evaluate risk factors in renewable energy projects, while (Wu et al., 2018) applied the FUZZY-MCDM model in China to rank renewable energy investments based on economic, social, environmental, and technological factors. These methodologies facilitate a comprehensive understanding of risk interactions in overseas investments, helping investors make informed decisions.

Despite the extensive research on risk assessment in renewable energy projects, a gap exists in applying FUZZY-MCDM and FUZZY-DEMATEL methodologies specifically to wind power projects in Bangladesh. Bangladesh's renewable energy sector is still developing, and a structured risk assessment framework for wind power projects, particularly in Cox's Bazar, is lacking. While existing studies have analyzed potential investment risks, they often fail to establish interdependencies between risk factors and neglect the application of advanced decision-making models like FUZZY-DEMATEL. Addressing this gap, this study aims to assess the risks associated with China's wind power investments in Cox's Bazar by integrating FUZZY-MCDM and FUZZY-DEMATEL techniques to evaluate risk criteria and sub-criteria.

This research follows a structured methodology, beginning with a review of existing literature on risk analysis in China's overseas energy projects, including case studies on renewable energy investments. The FUZZY-DEMATEL method is adopted to analyze the risk factors influencing the Cox's Bazar wind power project, including technical, economic, political, and social risks. Additionally, the study proposes risk mitigation strategies for investors and policymakers, offering practical recommendations to enhance investment security and project sustainability. To develop a comprehensive risk assessment framework, the study combines desk research, reviewing academic literature, government reports, and industry data. However, limitations exist, such as data insufficiency due to the lack of transparency in some energy markets and the neglect of sustainability

factors in previous research. Moreover, due to the limited availability of real-world studies on the Cox's Bazar wind power project, certain risk criteria may have been overlooked.
By integrating FUZZY-MCDM and FUZZY-DEMATEL models, this study aims to bridge the gap in professional risk assessment for wind power projects in Bangladesh. The findings will contribute to the development of a structured risk evaluation system, helping investors navigate the uncertainties associated with China's overseas energy investments. Through this analysis, the study provides valuable insights into managing risks effectively and improving decision-making strategies for renewable energy projects in emerging markets.

Tabel 02

- Using literature resources and expert judgment to evaluate expert opinions (determining the hazards and consequences of COX BAZAR wind power projects.
- Building an evaluation expert scale.
- Constructing an average fuzzy comparison direct relationship matrix for expert evaluation.
- Normalized Fuzzy Direct Relationship Fuzzy Matrix.
- Calculate the overall relationship fuzzy matrix.
- Establishing a structural model.
- Deblurring technique.
- Risk causal diagram.
- Result evaluation.

Table 1: Implementation table of the FUZZY-DEMATEL method in this article

This study aims to conduct a comprehensive analysis of the risks and challenges of China's overseas energy projects based on a specific case study of the COX-BAZAR wind power project in Bangladesh. This study will be relevant to policymakers, investors, and other stakeholders involved in the development and financing of such projects.

3. Risks of China's Overseas Energy Investment Projects

3.1 Risk influencing factors of China's overseas energy investment projects

China's green energy investment in countries along the "Belt and Road" has been growing, but investment failures are also increasing. Few studies have comprehensively evaluated the investment risks of green energy in countries along the route based on these influencing factors. Some of the most important ones are:

Political risk: Overseas energy projects may be affected by the political environment of the destination country, including political instability, policy uncertainty, government intervention, etc. For example, political conflicts or policy changes may lead to project delays or terminations.

Economic risk: The project may be affected by the economic environment of the destination country, including currency exchange rate fluctuations, economic downturn, tax and regulatory environment, etc. These factors may increase project costs, reduce project returns, and even lead to project losses.

Technical risk: The project may face technical risks, including technical difficulties, supply chain issues, equipment failures, etc. These issues may lead to increased project costs, delays in project timelines, and even affect the feasibility and economic benefits of the project.

Social risk: The project may be affected by the social environment of the destination country, including cultural differences, social opposition, safety issues, etc. For example, social opposition may lead to project obstruction or termination, and safety issues may affect the stability and safety of the project.

Environmental risk: The project may be affected by environmental regulations of the destination country, including environmental protection, carbon emissions, and other aspects. These regulations may increase project costs, limit project scale and development speed, and may even lead to project termination.

Strategic risk: Overseas energy projects may be affected by the international political and economic environment, including trade wars, geopolitical risks, investment protection, etc. These factors may lead to project uncertainty and risks, affecting the long-term development of the project.

These risks will affect the success and profitability of investment projects. The influencing factors include the overall economic environment, government policies and regulations, the development of local infrastructure, and the social and political stability level of the host country. Chinese companies must consider these risk factors and develop effective risk management strategies when investing and making decisions in overseas energy projects, in order to minimize project risks and ensure the successful implementation of the project.

3.2 Brief Introduction to the COX-BAZAR Wind Power Project

The COX-BAZAR wind power project is a joint venture between China National Energy Corporation, China National Machinery Import and Export Corporation (CMC), and Bangladesh Power Development Board (BPDB). The project aims to develop a 100 MW wind power plant for COX-BAZAR in the southeastern coastal region of Bangladesh. This project is part of Bangladesh's plan to increase renewable energy capacity and reduce dependence on fossil fuels. Bangladesh has set a goal of 10% of electricity coming from renewable energy by 2021 and 20% from renewable energy by 2030. The COX-BAZAR wind power project is the largest renewable energy project in Bangladesh

One of them is expected to increase the country's renewable energy production capacity. It is expected that the project will also contribute to the development of local infrastructure and create employment opportunities in the region. The project faces a series of risks and challenges, including political instability, regulatory uncertainty, environmental issues, and financing challenges. Therefore, it is necessary to develop a comprehensive risk assessment and management strategy to ensure the successful implementation of the project. The COX-BAZAR wind power project is a significant investment in renewable energy in Bangladesh, which is a positive development for the country's energy structure and its commitment to reducing dependence on fossil fuels. However, several factors need to be evaluated to assess the success of the project.

3.3 Risk indicators for COX-BAZAR wind power projects

In the context of a low-carbon economy and sustainable development, renewable resources have attracted global attention. Firstly, the difficulty of extracting other fossil fuels is increasing. On the other hand, the pollutants generated by the use of fossil fuels have a negative impact on the environment. Renewable energy sources such as wind and solar energy have gradually been applied in many fields such as electricity due to their clean and diverse sources. The global energy consumption structure and market structure are changing, and the renewable energy market is further opening up. The Belt and Road countries are rich in renewable energy resources. In addition, China and countries along the "the Belt and Road" are increasingly cooperating on renewable energy projects. China's energy demand is rapidly growing, which has led to the country investing in energy projects overseas. These projects can bring significant benefits to the host country, but they also pose risks to China. One of the main risks is the political and economic stability of the host country. In this article, we will analyze the risks associated with China's overseas energy investment projects, with a focus on the wind power project of COX-BAZAR in Bangladesh. According to the International Country Risk Guidelines (ICRG), evaluating the investment risk of wind power projects in Bangladesh requires consideration of five indicators, namely investment environment, political, economic, environmental, technological, and social risks. In addition, according to the Energy Information Administration (EIA), environmental constraints and resource potential are the two main indicators reflecting a country's energy situation. Therefore, we also consider them as indicators of our work. As shown by Wu et al. (2020) ; Zhang et al. (2017) are assessing investment risks, and therefore this work also includes indicative signals about the investment environment, mainly regarding the operational environment of Bangladeshi companies. Investors and policymakers face various uncertainties in renewable energy decision-making due to the enormous investment and technological requirements. When the project is carried out internationally, these uncertainties become even more critical in terms of scale. As a result, investment in Cox Bazar wind power projects also increases risks, which must be carefully identified and evaluated. Understanding the importance of these risks will help you choose the best course of action to address them. Table 2 lists the five aspects of risks and related secondary standards considered in this survey, based on the information provided.

Dimension	Risk description	Risk factor	Describe	Reference
	This standard evaluates the political stability in Bangladesh and its potential impact on project success,	internal conflict（INT）	Internal conflicts such as civil unrest and anti-government demonstrations may also lead to revolutions and regime changes (such as the Arab	(kibria etc,2004), (jiong huang

Dimension	Risk description	Risk factor	Describe	Reference
Political risk	such as the risk of political instability, the possibility of changes in government policies or regulations, and the possibility of geopolitical tensions that may affect the project.		Spring of 2011). Domestic turmoil can also increase the risk of external conflicts.	2022).
		External conflicts（EXT)	External conflicts can affect government stability.	
		corrupt（COR）	The Bangladeshi government will ensure that the project is not affected by corruption.	
		Government stability（GST)	A stable political environment can ensure the investment and management of foreign companies, while the poor environment in Bangladesh may affect foreign companies.	
Environmental risks	Cox's Bazar is one of the most vulnerable regions in Bangladesh, often experiencing extreme rainfall, landslides, and flash floods. The Rohingya refugee youth who were forcibly displaced from Myanmar to Cox bazar in Bangladesh have become the biggest threat to the Cox bazar environment.	Extreme rainfall（ETR）	The Cox's Bazar region in Bangladesh is classified as an extreme rainfall area due to its geographical location.	（kibria2004），（Abdi wahabIslametc2022），Mohammed(2011) .
		Rohinaga Crisis（RC）	There are 980000 refugees and asylum seekers from Myanmar in neighboring countries. Approximately 919000 Rohingya refugees reside in Kutupalong and Nayapara refugee camps in the Cox Bazar region of Bangladesh - these camps have developed into one of the largest and most densely populated refugee camps in the world.	
Economic risks	This standard evaluates the financial feasibility of a project, such as project costs, expected revenue from power generation, available levels of subsidies or incentives, and the availability and cost of financing.	Operation and maintenance costs（OMC）	Operation and maintenance costs refer to all expenses, excluding debt repayment costs and capital improvement costs, incurred during the operation and maintenance of leased units and buildings or complexes that are part of them, as well as public areas, including but not limited to: real estate tax, business tax and expenses, insurance, sewer service fees, utilities, cleaning services, professional property management fees, swimming pool maintenance External building and site maintenance, supplies, equipment, garbage removal, elevator services, and security services or systems.	Wu(2018),Colak etc（2017），Wang（2020）MdAkramuzzamanetc(2017), Karamoozianetc2022。
		Equivalent electricity cost（EEC）	The cost of evaluating prosthetic installation and operating the energy station exceeds the expected project lifecycle.	
		Investment expenditure（INE）	Investment expenditure refers to the expenditure incurred by individuals, businesses, or governments to create new capital assets such as machinery and construction	
Social risk	This standard evaluates the social and environmental impacts of the project, such as potential impacts on local communities, potential impacts on biodiversity and ecosystems, and the potential of the	social welfare（SOB）	Social welfare includes all benefits to society. This includes both personal interests and external interests for other parts of society.	Abdi wahabIslametc（2022），Asifetc（2020），Colak（2017），Wang
		Public resistance（PRE）	Represent the public's challenge to renewable energy projects, environmental factors, and other unexpected factors caused by the migration of high-risk residents.	

Dimension	Risk description	Risk factor	Describe	Reference
	project to promote sustainable development.	Employment opportunities (EMO)	Recruitment, installation, operation, and maintenance of power plants throughout their lifecycle	（2020）, Sukran （2017）。
Technical risks	This standard evaluates the technical feasibility of the project, such as the available wind resources, the quality and reliability of the wind turbine technology used, and the required transmission and distribution infrastructure for the project.	Technical maturity (TEM)	TEM solutions can help you focus on the organizational network infrastructure provided by telecommunications operators and hardware providers (i.e. telecommunications services, including MPLS, leased lines, internet connectivity, SDWAN, voice fixed line PRI, POTS, VOIP channels and other data services, as well as usage, mobile devices and usage, and IT asset routers, firewalls, servers, etc.) throughout your lifecycle, including purchasing new services, managing inventory Invoice billing, support, and maintenance.	Pavlos(2008), Wang （2020）, Duan （2018）。
		Technical research and development capabilities （TRDC）	It shows how much money was spent on technology research and development. It also demonstrates the ability to understand market demands and address technological challenges	
		Technical efficiency (TEE)	If a company produces the maximum output with minimal inputs (such as labor, capital, and technology), it is considered technically efficient. Technical efficiency does not require unemployed resources.	
		Capacity coefficient （CF）	Capacity factor (CF) refers to the ratio of the average load (or power output) of a power generation system or unit to the rated capacity of the system or unit during a predetermined time period.	
		Technical faults in wind turbine system （TFTS)	The most common external wind turbine failures are usually caused by bird strikes, lightning strikes, rainfall, blade furniture detachment, delamination, leading edge corrosion, or blade cracks leading to blade damage.	

Table 2: Risk assessment indicators for COX-BAZAR wind power investment

4.Evaluation Methods for Overseas Energy Projects in China

4.1 Introduction to FUZZY DEMATEL Method

FUZZ-DEMATEL (Decision Testing and Evaluation Laboratory) is a method that combines fuzzy logic and multi-criteria decision-making to analyze complex systems. When the environment becomes complex, effective decisions are always preferred. Decision-makers tend to evaluate complex and ambiguous situations to determine the causal relationship of the problem and make meaningful and effective decisions. To make meaningful decisions or actions, it is important to understand the causal relationship of a problem when it is filled with uncertainty. Fuzzy decision-making determines the importance of different factors in a given system and their interdependence in complex decision-making situations. The FUZZ-DEMATEL method uses fuzzy logic and probability theory to represent the uncertainty and imprecision of data, which makes the decision-making process more accurate and reliable. This method is commonly used in management, engineering, and other fields to solve complex problems. FUZZY-DEMATEL has various advantages, such as the ability of the fuzzy DEMATEL method to handle complex problems involving a large number of standards and factors. It can handle imprecise and uncertain information or data. The fuzzy DEMATEL method can prioritize standards and factors by providing rankings or importance scores. The fuzzy DEMATEL method can help decision-makers better understand the decision-making process and make wiser decisions. The FUZZY-DEMATEL model and main formulas are as follows:

Model: The main steps of the Fuzzy DEMATEL model are as follows: a. Collect factors related to the problem. b. Quantify the relationship between each factor using fuzzy numbers through methods such as questionnaires or expert evaluations. c. Construct a standardized fuzzy matrix. d. Calculate the total factor flow and factor influence. e. According to the positive or negative impact of factors, they are classified into strong positive influencing factors, strong negative influencing factors, self-influencing factors, and neutral factors. f. Determine the priority relationship between factors based on the classification results.

Formula: In Fuzzy DEMATEL, the following main formulas are involved:

Fuzzy matrix formula: $\mathrm{R} = [\mathrm{r}(\mathrm{i},\mathrm{j})](\mathrm{n} \times \mathrm{n})$ Among them, $\mathrm{r}(\mathrm{i},\mathrm{j})$ Indicates the relationship between the i factor and the j factor.

Standardized fuzzy matrix formula: $\mathrm{T}(\mathrm{i},\mathrm{j}) = \mathrm{r}(\mathrm{i},\mathrm{j})/\sum(\mathrm{r}(\mathrm{i},\mathrm{k}) + \mathrm{r}(\mathrm{k},\mathrm{j}))$ Among them, K represents any integer from 1 to n.

Total factor flow formula: $\mathrm{F}(\mathrm{i}) = \sum(\mathrm{T}(\mathrm{i},\mathrm{j}) + \mathrm{T}(\mathrm{j},\mathrm{i}))$ Among them, j represents any integer from 1 to n.

Factor influence formula: $\mathrm{I}(\mathrm{i}) = (\mathrm{F}(\mathrm{i}) + \mathrm{F}(\mathrm{j}))/2$ Among them, j represents any integer from 1 to n.

4.2 Fuzzy DEMATEL evaluation steps

Although traditional quantitative methods provide precise solutions, they are effective in addressing human-centered issues caused by the complexity of human factors. Therefore, the concept of fuzzy set theory introduced by (Zadeh, 1965) is commonly used for the uncertainty and fuzziness related to the environment in these types of real-world problems. Real-world applications and decision-making problems need to be carried out under uncertainty, with unclear constraints and possible actions. The DEMATEL method is a well-known synthesis method used to obtain structural models that provide complex accidental relationships between real-world factors. The DEMATEL method is superior to other techniques, such as component analysis (AHP), as it considers interdependence in system factors through causal diagrams, which are overlooked in traditional techniques. Based on the analysis of the COX-BAZAR wind power project in Bangladesh, this method can be used to analyze the risk factors related to overseas energy projects in China. We evaluated the risk standards identified through the FUZZY-MCDM process in the FUZZY environment. We attempt to illustrate the interrelationships between standards (Table 2). Using triangular fuzzy data to identify each hazard in the sample questionnaire pattern (Table 6), we attempted to identify the impact of each factor. Then we convert the data into fuzzy numbers from language variables. For these data, the FUZZY data analysis method includes the following steps:

The foundation of the DEMATEL method includes the following steps:

(1) In this step, the elements related to the problem and the degree of influence between them are formed. The influencing factors of complex systems are evaluations, brainstorming, or expert opinions defined based on literature data.

(2) Constructed a direct relationship matrix. Then, the importance of the measurement scale was redefined.

$$\begin{bmatrix} 0 & x_{12} & \dots & x_{1n} \\ x_{21} & 0 & \dots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \dots & 0 \end{bmatrix}$$

Use equation (2) to establish a normalized direct relationship matrix based on the direct relationship matrix.

$$\lambda = \frac{1}{\max_{1 \le i \le n}\left(\sum_{j=1}^{n} x_{ij}\right)}, i, j = 1,2, \dots, n$$

$$N = \lambda X$$

Obtain the total relationship matrix (T) through formula (4).

$$T = \lim_{k \to \infty}(N + N^2 + \dots + N^k) = N(1 - N)^{-1}$$

In this step, the sum of the values in each column and row is the matrix calculated in the total relationship. Therefore, D_i represents the sum of the i row, R_j Represents the sum of the j column. The indirect impact between direct factors is represented by D_i and R_j Indicating separate locations.

$$D_i = \sum_{j=1}^{n} t_{ij}(i = 1,2, \dots, n)$$

$$R_i = \sum_{i=1}^{n} t_{ij}(j = 1,2, \dots, n$$

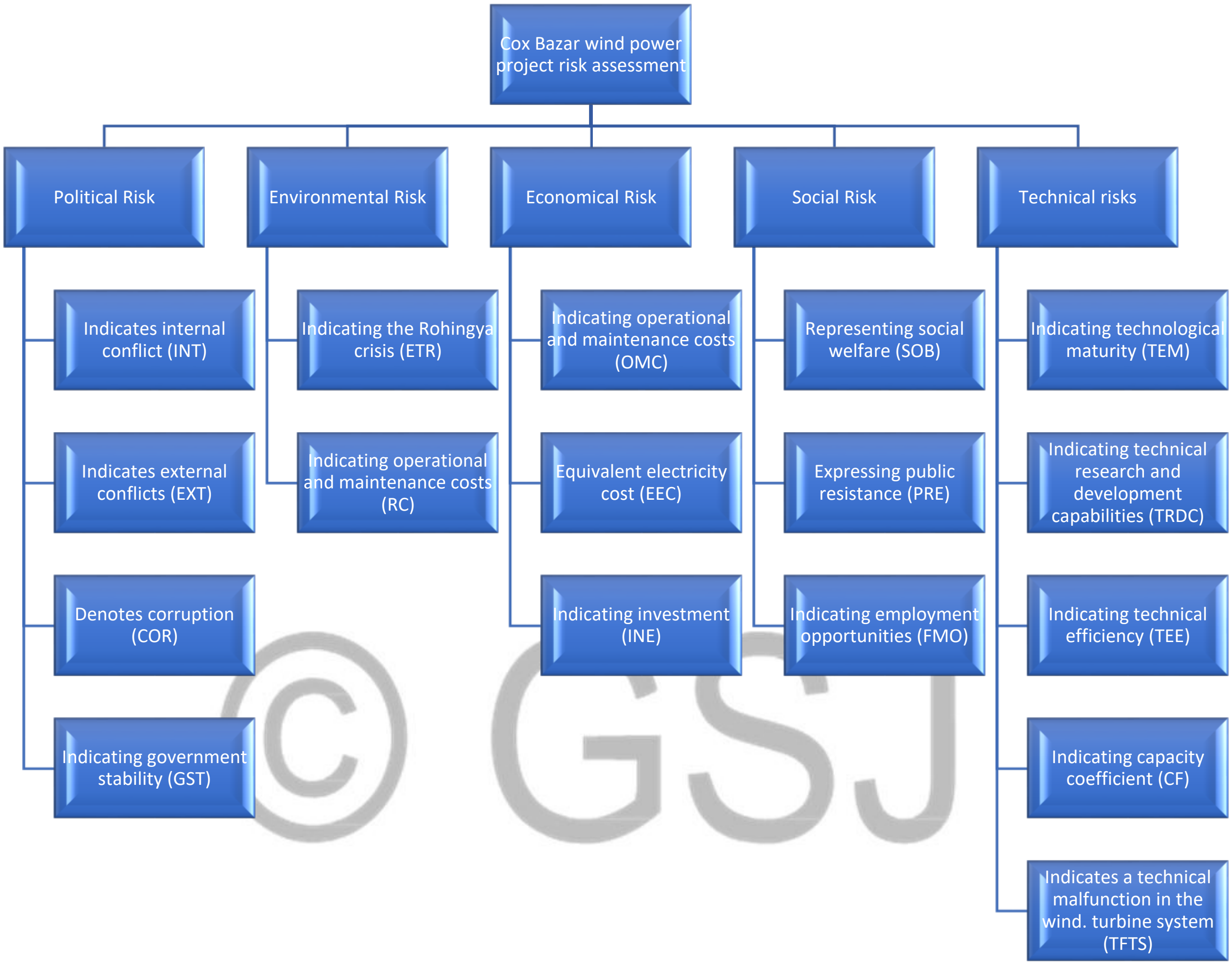

Table 3: Level structure of Cox Bazar wind power project and interdependence between standards and sub-standards

(6) At this stage, the causal relationship diagram is established. The horizontal axis （D+R） is the sum of R and D, and the vertical axis （D－R） is the subtraction of R from D. （D+R） is defined as "prominence," indicating the importance of the standard, while (DR) is defined as "relationship," indicating the degree of influence. If （D－R） is negative, the standard is grouped into an effect group. This means it is influenced by other standards. If （D－R） is positive, it means it has a significant impact. It should be improved first.

In this study, the FUZZ-DEMATEL method was used to evaluate the causal relationship of accidents during the construction process. This combination is used for human imprecise and subjective essential judgments. Use interval sets instead of real numbers in FUZZY set theory. Linguistic terms are converted to FUZZY numbers. The proposed method is beneficial for revealing the relationship type and severity for each criterion. The analysis process of the FUZZY-DEMATEL method is explained as follows:

Step 1: Define evaluation criteria.

Step 2: Select a group of experts with relevant knowledge and experience to evaluate the impact of paired comparison factors.

Step 3: Define the FUZZY language scale to handle ambiguity in human assessment. The language variable "influence" is used in conjunction with a five-level scale that includes the following items: no influence, very low influence, low influence, high influence, and extremely high influence in Li's proposed group decision-making scale. The FUZZY numbers (Table 4) provide these language terms.

Step 4: Obtain the initial direct relationship matrix through paired comparison. Develop the initial fuzzy direct relationship matrix Z^k by introducing FUZZY pairwise effects into the evaluator n×n The relationship between the components in the n matrix, where k is the number of experts. Therefore, the direct relationship matrix is established as $Z^k = [z^k{}_{ij}]$ where Z is n×n Non negative matrix n; z_{ij} represents the direct impact of factor i on factor j; And when i＝j , the diagonal element z_{ij}=0.

For simplicity, represent Z^kas,

$$z_{ij}^{k} = (l_{ij}, m_{ij}, u_{ij})$$

$$Z^k = \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{matrix} \begin{bmatrix} [0,0] & \otimes z_{12}^k & \dots & \otimes z_{1n}^k \\ \vdots & \vdots & \vdots & \vdots \\ \otimes z_{n1}^k & \otimes z_{n2}^k & \dots & [0,0] \end{bmatrix}$$

Step 5: Use the matrix Z that directly relates to the overall fuzziness.

$$D = \frac{Z^k}{\max_{1 \le i \le n} \sum_{j=1}^{n} z_{ij}}, i, j = 1,2, \dots, n$$

Step 6: Use expression (9) to calculate the total relationship matrix T, where n × The n-identity matrix is represented by I. Calculate the upper and lower limits separately.

$$T = D(I - D)^{-1}$$

Where, $\mathrm{T = D + D^2 + \cdots += \sum_{i=1}^{\infty} D^i}$

Step 7: Determine the sum of each row i and column j from the T matrix, with the following equations:

$$T = [t_{ij}]_{nxn} \qquad i, j = 1,2, \dots n$$

$$r_i = \sum_{1 \le j \le n}^{n} t_{ij} \qquad \forall i$$

$$c_j = \sum_{1 \le i \le n}^{n} t_{ij} \qquad \forall i$$

Step 8: The causal diagram uses the horizontal axis $(r_i + c_j)$ and vertical axis $(r_i - c_j)$ The horizontal axis "prominence" refers to the importance of the factor, while the vertical axis "relationship" displays the degree of influence. If the $(r_i - c_j)$ axis is positive, the factor belongs to the cause group. Otherwise, if the $(r_i - c_j)$ axis is negative, the factor is in the effect group. Causal diagrams can transform complex factor relationships into easily understandable structural models, providing awareness of problem-solving.

Fuzzy Language Scale for Language Terminology Respondent Evaluation	
No impact（NI）	(0,0.1,0.3)
The lowest impact（VL)	(0.1,0.3,0.5)
Low impact（LI)	(0.3,0.5,0.7)
High impact (HI)	(0.5,0.7,0.9)
Very high impact（VH)	(0.7,0.9,1)

Table 4: Fuzzy Language Scale Evaluated by Respondents

5. Case Study (COX-BAZAR Wind Power Project)

5.1 Risk factor evaluation of Cox Bazar wind power project

The COX BAZAR wind power project is a significant investment in renewable energy in Bangladesh. However, the success of the project depends on the aforementioned technical, financial, environmental, social, and political factors (Table 2). A comprehensive risk assessment and management strategy should be implemented to ensure the success of the project. In this study, we used second-hand expert data to analyze the COX-BAZAR wind power project. Secondary data is obtained from secondary sources that do not directly participate in the study, but serve as supporting data for the study. The data used is time series data from 2011 to 2020. The data sources used in this study include the Bangladesh Central Bureau of Statistics, the International Trade Center, the WITS World Bank, e-books, preliminary studies, the internet, and other media publications related to research materials. In this article, we will use the risk factors in Table 2 to evaluate the COX-BAZAR wind power project using the FUZZY-DEMATEL method. During this process, the following steps are taken:

Identifying risk factors: In risk identification, an extensive literature review and witnesses from evaluators were used to identify 17 safety causal factors related to the COX-BAZAR wind power project. Before implementing this method, five evaluators actively involved in energy projects evaluated causal risk factors. The influence of

evaluators in power projects varies with the situation, serving as an indicator of their risk level. Table 2 presents the characteristics of five decision evaluators. The evaluators expressed their thoughts on the impact of the project. The evaluators used five levels of scales, including the impact relationships of the following scale item factors: extremely low, low, medium, high, and extremely high (see Table 4). Paired comparisons were conducted using linguistic variables. The scores of the average language proficiency evaluator's opinions are shown in Table 6. The initial direct relationship matrix was obtained using the fuzzy scale shown in Table 3. By utilizing the existence of the initial direct relationship matrix, a normalized fuzzy direct relationship matrix "N" was established. The normalized fuzzy direct relationship matrix can be expressed using expression (7) (Table 7). After obtaining the normalized direct relationship, the overall relationship fuzzy matrix was derived. This can be obtained by using the expression (8), where it represents $n \times n$ identity matrix. The overall relationship fuzzy matrix is shown in Table 8. Established a structural model. After constructing matrix T, （$r_j + C_j$） and （$r_j - C_j$） represent the determination, respectively. In expression (9),
$r_j$and $C_j$is composed of rows and columns of matrix T. When （$r_j + C_j$） represents the importance of factor I, （$r_j - C_j$） represents the influence of network factor i. The results are shown in Table 9. Using the Region Center (COA) deblurring technique, deblurring （$r_j + C_j$） and （$r_j - C_j$） were performed to obtain the best Non Fuzzy Performance (BNP) value. The deblurring risk factors in the COA process are represented by a curve representing their membership function. Clear value of r_j, C_j （$r_j + C_j$） and （$r_j - C_j$） are shown in Table 9, respectively.

Code	Risk factor
INT	Indicates internal conflict.
EXT	Indicates external conflicts.
COR	Denotes corruption.
GST	Indicating government stability.
ETR	Indicates extreme rainfall.
RC	Indicating the Rohingya crisis.
OMC	Indicating operational and maintenance costs.
EEC	Equivalent electricity cost.
INE	Indicating investment.
SOB	Representing social welfare.
PRE	Expressing public resistance.
EMO	Indicating employment opportunities.
TME	Indicating technological maturity.
TRDC	Indicating technical research and development capabilities.
TEE	Indicating technical efficiency.
CF	Indicating capacity coefficient.
TFTS	Indicates a technical malfunction in the wind. turbine system.

Table 5: Risk factor codes

专 家 意 见	INT1	EXT	COR	GST	ETR	RC	OMC	EEC	INE	SOB	PRE	EMO	TME	TRDC	TEE	CF	TFTS
INT	1	LI	LI	HI	LI	HI	HI	HI	HI	LI	LI	NI	HI	HI	VL	VH	VH
EXT	HI	1	VH	LI	LI	VL	NI	VL	LI	HI	NI	HI	VH	LI	HI	VH	LI
COR	VH	LI	1	NI	HI	NI	NI	NI	VH	LI	HI	LI	VH	VH	NI	LI	HI
GST	NI	NI	LI	1	HI	NI	HI	VH	LI	VH	VH	LI	NI	NI	NI	LI	VH
ETR	HI	LI	HI	HI	1	LI	VL	NI	VL	LI	HI	NI	HI	VH	LI	HI	VH
RC	HI	NI	NI	HI	LI	1	VH	VH	LI	HI	NI	VH	HI	LI	LI	VH	VH
OMC	LI	LI	HI	NI	HI	VH	1	VH	LI	HI	LI	VH	VH	NI	NI	LI	VL
EEC	VH	LI	LI	VL	LI	LI	VH	1	VH	HI	VL	LI	NI	MI	LI	LI	LI
INE	VH	LI	LI	HI	VL	HI	VH	HI	1	VH	NI	LI	LI	NI	NI	NI	VL
SOB	VH	VH	HI	LI	HI	VH	HI	LI	LI	1	HI	VH	LI	LI	HI	NI	VH
PRE	NI	LI	LI	VL	HI	LI	NI	NI	LI	VH	1	LI	VH	VH	HI	LI	HI
EMO	VH	LI	LI	HI	LI	HI	LI	VH	LI	NI	NI	1	VH	VH	NI	LI	VL
TME	NL	VH	HI	LI	NL	NL	HI	LI	VH	VH	HI	LI	1	VH	LI	VL	LI
TRDC	LI	HI	HI	LI	VH	VH	HI	LI	HI	VH	HI	VH	LI	1	VH	NI	LI
TEE	HI	LI	HI	NI	HI	VH	LI	HI	VH	LI	VH	LI	NI	NI	1	VH	HI

CF	NI	VH	LI	HI	LI	VH	VH	NI	LI	HI	LI	VH	LI	NI	VH	1	VH
TFTS	HI	VH	LI	NI	LI	VL	NI	VL	LI	HI	NI	HI	VH	LI	HI	VH	1

Table 6: Language assessment of evaluator opinions (average)

	INT			EXT			COR			GST			ETR			RC			OMC			EEC		
INT	1	1	1	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.5	0.7	0.9
EXT	0.5	0.7	0.9	1	1	1	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.1	0.3	0.5	0	0.1	0.3	0.1	0.3	0.5
COR	0.7	0.9	1	0.3	0.5	0.7	1	1	1	0	0.1	0.3	0.5	0.7	0.9	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3
GST	0	0.1	0.3	0	0.1	0.3	0.3	0.5	0.7	1	1	1	0.5	0.7	0.9	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1
ETR	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	1	1	1	0.3	0.5	0.7	0.1	0.3	0.5	0	0.1	0.3
RC	0.5	0.7	0.9	0	0.1	0.3	0	0.1	0.3	0.5	0.7	0.9	0.3	0.5	0.7	1	1	1	0.7	0.9	1	0.7	0.9	1
OMC	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1	1	1	1	0.7	0.9	1
EEC	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.1	0.3	0.5	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1	1	1	1
INE	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0.1	0.3	0.5	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9
SOB	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7
PRE	0	0.1	0.3	0.3	0.5	0.7	0.3	0.5	0.7	0.1	0.3	0.5	0.5	0.7	0.9	0.3	0.5	0.7	0	0.1	0.3	0	0.1	0.3
EMO	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1
TME	0	0.1	0.3	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	0	0.1	0.3	0	0.1	0.3	0.5	0.7	0.9	0.3	0.5	0.7
TRDC	0.3	0.5	0.7	0.5	0.7	0.9	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7
TEE	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9
CF	0	0.1	0.3	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0	0.1	0.3
TFTS	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0	0.1	0.3	0.3	0.5	0.7	0.1	0.3	0.5	0	0.1	0.3	0.1	0.3	0.5

	INE			SOB			PRE			EMO			TME			TRDC			TEE			CF			TFTS		
INT	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	0	0.1	0.3	0.5	0.7	0.9	0.5	0.7	0.9	0.1	0.3	0.5	0.7	0.9	1	0.7	0.9	1
EXT	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7
COR	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0	0.1	0.3	0.3	0.5	0.7	0.5	0.7	0.9
GST	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.3	0.5	0.7	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0.3	0.5	0.7	0.7	0.9	1
ETR	0.1	0.3	0.5	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1
RC	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1
OMC	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0	0.1	0.3	0	0.1	0.3	0.3	0.5	0.7	0.1	0.3	0.5
EEC	0.7	0.9	1	0.5	0.7	0.9	0.1	0.3	0.5	0.3	0.5	0.7	0	0.1	0.3	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7	0.3	0.5	0.7
INE	1	1	1	0.7	0.9	1	0	0.1	0.3	0.3	0.5	0.7	0.3	0.5	0.7	0	0.1	0.3	0	0.1	0.3	0	0.1	0.3	0.1	0.3	0.5
SOB	0.3	0.5	0.7	1	1	1	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.7	0.9	1
PRE	0.3	0.5	0.7	0.7	0.9	1	1	1	1	0.3	0.5	0.7	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	0.5	0.7	0.9
EMO	0.3	0.5	0.7	0	0.1	0.3	0	0.1	0.3	1	1	1	0.7	0.9	1	0.7	0.9	1	0	0.1	0.3	0.3	0.5	0.7	0.1	0.3	0.5
TME	0.7	0.9	1	0.7	0.9	1	0.5	0.7	0.9	0.3	0.5	0.7	1	1	1	0.7	0.9	1	0.3	0.5	0.7	0.1	0.3	0.5	0.3	0.5	0.7
TRDC	0.5	0.7	0.9	0.7	0.9	1	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	1	1	1	0.7	0.9	1	0	0.1	0.3	0.3	0.5	0.7
TEE	0.7	0.9	1	0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0	0.1	0.3	0	0.1	0.3	1	1	1	0.7	0.9	1	0.5	0.7	0.9
CF	0.3	0.5	0.7	0.5	0.7	0.9	0.3	0.5	0.7	0.7	0.9	1	0.3	0.5	0.7	0	0.1	0.3	0.7	0.9	1	1	1	1	0.7	0.9	1
TFTS	0.3	0.5	0.7	0.5	0.7	0.9	0	0.1	0.3	0.5	0.7	0.9	0.7	0.9	1	0.3	0.5	0.7	0.5	0.7	0.9	0.7	0.9	1	1	1	1

Table 7: Normalized initial direct relationship fuzzy matrix

	INT	EXT	COR	GST	ETR	RC	OMC	EEC	INE	SOB	PRE	EMO	TME	TRDC	TEE	CF	TFTS
INT	0.72	0.62	0.64	0.65	0.65	0.71	0.62	0.61	0.68	0.69	0.62	0.63	0.64	0.69	0.64	0.69	0.72
EXT	0.66	0.62	0.62	0.00	0.61	0.66	0.00	0.00	0.62	0.66	0.00	0.62	0.62	0.63	0.62	0.64	0.67
COR	0.65	0.00	0.62	0.00	0.00	0.63	0.00	0.00	0.62	0.64	0.00	0.60	0.00	0.63	0.00	0.00	0.63
GST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ETR	0.68	0.60	0.64	0.63	0.70	0.72	0.61	0.61	0.67	0.70	0.62	0.64	0.64	0.70	0.65	0.67	0.70
RC	0.63	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.61	0.62	0.00	0.00	0.00	0.63	0.00	0.62	0.63
OMC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEC	0.63	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.60	0.61	0.00	0.00	0.00	0.61	0.00	0.00	0.62
INE	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOB	0.64	0.00	0.00	0.60	0.62	0.66	0.00	0.00	0.61	0.69	0.00	0.63	0.00	0.63	0.61	0.62	0.66
PRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMO	0.65	0.00	0.00	0.60	0.61	0.65	0.00	0.00	0.62	0.61	0.00	0.64	0.00	0.64	0.00	0.00	0.64
TME	0.65	0.61	0.61	0.63	0.62	0.67	0.00	0.00	0.67	0.68	0.00	0.00	0.66	0.64	0.61	0.63	0.68
TRDC	0.64	0.00	0.61	0.00	0.62	0.66	0.00	0.00	0.64	0.66	0.00	0.64	0.00	0.68	0.62	0.64	0.65
TEE	0.66	0.00	0.60	0.61	0.61	0.69	0.00	0.00	0.64	0.66	0.00	0.00	0.60	0.62	0.66	0.68	0.65
CF	0.62	0.00	0.00	0.00	0.60	0.67	0.00	0.00	0.63	0.64	0.00	0.62	0.00	0.63	0.62	0.63	0.66
TFTS	0.62	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.65

Table 8: Full relation fuzzy matrix

Code	r_i	C_j	$r_i + C_j$	$r_i - C_j$
INT	11.20	10.74	21.94	0.46
EXT	10.52	9.50	20.02	1.03
COR	10.15	9.85	19.99	0.30
GST	9.32	9.97	19.30	-0.65
ETR	11.15	10.22	21.38	0.93
RC	10.11	11.04	21.14	-0.93
OMC	9.21	9.60	18.80	-0.39
EEC	10.00	9.48	19.48	0.52
INE	9.63	10.50	20.14	-0.87
SOB	10.45	10.81	21.26	-0.35
PRE	9.20	9.48	18.68	-0.28
EMO	10.22	10.14	20.36	0.08
TME	10.71	9.96	20.66	0.75
TRDC	10.54	10.57	21.11	-0.02

TEE	10.60	10.04	20.64	0.57
CF	10.34	10.36	20.70	-0.02
TFTS	9.77	10.88	20.65	1.11
Max			21.94	
Min			18.68	
Average			20.37	

Table 9: $\boldsymbol{r_i}$Clear value of $\boldsymbol{C_j}$. （$r_j + C_j$） and （$r_j - C_j$）

Draw a causal diagram after obtaining the horizontal axis （$r_j + C_j$） and the vertical axis （$r_j - C_j$） And （$r_j + C_j$） refers to the influence between standards, while （$r_j - C_j$） refers to the relationship between influence standards. The causal diagram is shown in Figure 1.

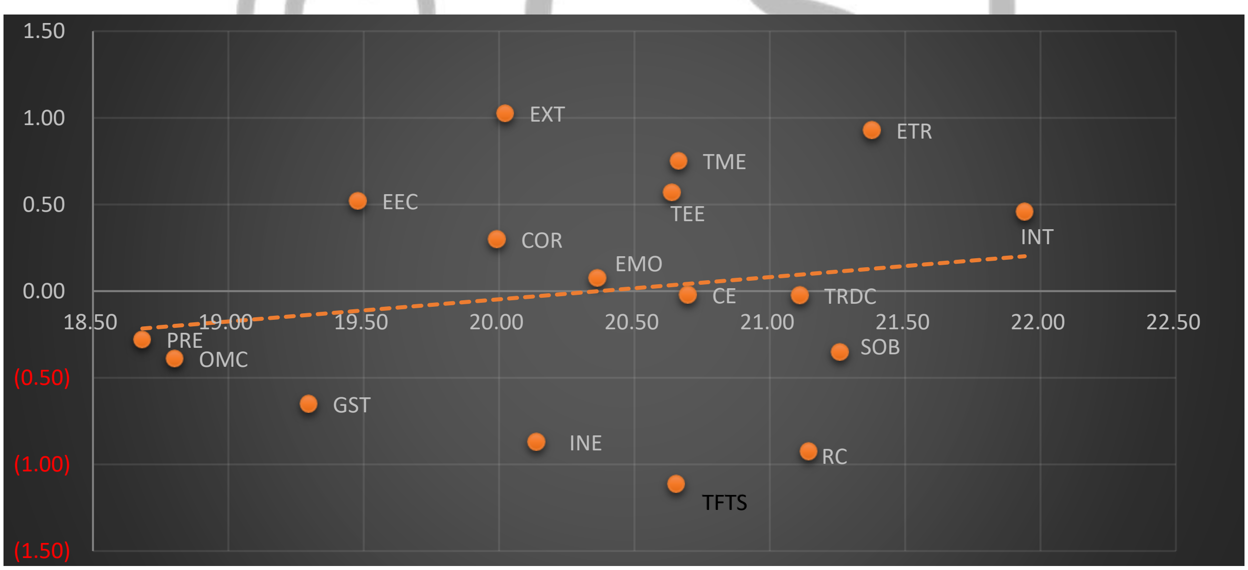

Figure 1: Causal diagram

6.FUZZY-DEMATEL Result Analysis

6.1 Result analysis

This study combines FUZZY system theory with DEMATEL method to develop a systematic method for assessing potential occupational hazards and risks in COX-BAZAR wind power projects. According to the causal diagram, the summary results are as follows. The evaluation criteria divide EXT, ETR, TME, EEC, TEE, COR, EMO, CE, TRDC, INT into the cause criteria group, while the effect criteria group includes PRE, OMC, GST, INE, SOB, RC, and TFTS that need improvement. Due to the influence of causal factors on the effect group criteria, it should be given priority. The cause group standard refers to the meaning of the impact standard, while the effect group standard refers to the meaning of the affected standard. Considering the interdependence between factors, special attention should be paid to the causal group criteria related to their impact on the effect group criteria.

By improving the causal factors, the influencing factors develop simultaneously. Therefore, based on the rich experience and knowledge of the evaluators, PRE, OMC, GST, INE, SOB, RC, and TFTS are key risk factors that need to be considered in the Cox's Bazar wind power project. The most important cause of occupational hazards in accidents is that TFTS has the highest （$r_j - C_j$） value of 1.11, which means that more consideration should be given to the overall system of TFTS regarding key occupational hazards in wind power projects. EXT has the second highest （$r_j - C_j$） degree of significant impact on other etiological factors. EXT has a significant impact on other etiological factors, with the degree of （$r_j - C_j$） ranking second. In addition, the r of ETR_ The i-value ranks second (10.71) and has a prominent impact on causal factors. The same (ETR) is another important factor, as the （$r_j - C_j$） value ranks third (0.75). In addition, INT has r_ The i-value is the highest (11.20). If the value of （$r_j - C_j$） is negative, then this viewpoint is classified as an influencing group (hazard) and is largely influenced by other factors.

In this study, INT had the highest （$r_j + C_j$） value throughout the entire process. However, compared to other factors in the effect group, their （$r_j - C_j$） values are very high. This means that it has a significant impact on other factors. However, its （$r_j + C_j$） score ranks second among other effect group criteria. ETR has an impact on improving the system because its （$r_j - C_j$） value is very low (-0.65). It is easily influenced by other factors. SOB has the third highest （$r_j + C_j$） value throughout the entire process. The other factors have moderate （$r_j + C_j$） values. Their （$r_j + C_j$） values are relatively low, which is a strong influence.

6.2 Preventive measures for risk factors

Considering the results, managers are able to identify the key causal factors of occupational hazards that require regular preventive measures to be taken. The preventive measures for the most critical reasons (Table 10) are presented in the construction industry.

Code	Key factors	Safety instructions
PRE	Public resistance	Make them believe that the project will bring prosperity, as the Cox's Bazar wind power project is a renewable energy project that will not cause environmental damage. After the Cox's Bazar wind power project is integrated into the national grid, it will be a major asset for Bangladesh.

Code	Key factors	Safety instructions
OMC	Operation and maintenance costs	Encourage manufacturers to continuously reduce the cost of replacing parts and use non OEM, cheaper parts to operate damaged equipment until it completely fails before repair (band aid method). Organize reliability teams/departments to address equipment reliability issues, upgrade materials and equipment specifications, and make equipment "hard" by integrating process control solutions to better control the occasional use of fault prevention technology and predictive maintenance services.
GST	Government stability	Providing basic services, national resource management, political restraint and accountability, citizen participation and empowerment
INE	Investment expenditure	Transfer payments will not increase the economic value of a country; Therefore, they should not be included. The purchase of second-hand goods is not included as they do not affect the total value of the produced goods and services. However, if purchasing second-hand goods involves brokerage fees, the paid brokerage fees will be included in the cost calculation. When purchasing assets such as bonds and stocks, it means that ownership changes and does not affect the value of goods and services; Therefore, the transaction does not involve cost calculation. However, when adopting the expenditure method, the commission paid for the transfer of shares was taken into account.
SOB	social welfare	The percentage of public welfare improvements for COX-BAZAR wind power projects and their application in specific fields will be high. This project will benefit society. More job opportunities will be opened up, and we must describe these opportunities to the surrounding society.
RC	Rohingya Crisis	Any sustainable solution to the Rohingya crisis requires addressing the root causes of the crisis, including recognizing Rohingya citizenship in Myanmar and the basic rights of Rohingya people. These are the steps that the Myanmar authorities must take. The culture of impunity enjoyed by the Myanmar military must also be addressed, if not domestically, through international pressure. As long as refugees remain in Bangladesh, the scale of the humanitarian crisis faced by displaced Rohingya people requires the Bangladeshi government to eliminate obstacles, United Nations agencies to strengthen coordinated response measures, and international donors to provide sufficient support for humanitarian efforts.
TFTS	Technical faults in wind turbine system	Wind energy experts consult on various turbine accidents, analyze the occurrence to determine the cause and effect. These events include: electrical failures, mechanical failures, cabin fires, blade failures, structural collapses, vibration or resonance effects, transportation accidents. By paying attention to these issues, we can shorten the damage rate.

Table 10: Reasons and Countermeasures for Construction Site Risks

6.3 Conduct sensitivity analysis:

Sensitivity analysis is an analytical technique based on hypothesis analysis (such as how independent factors affect the dependent variable), used to predict the results of analysis under specific conditions. Investors usually consider the conditions that affect their potential investment to test, predict, and evaluate the results. Sensitivity analysis is conducted to test the reliability of the decisions made by evaluators. Understand the effectiveness weights of various combinations using decision criteria weights (maintaining equality) and adjust more weights for any evaluator, and conduct sensitivity analysis by Emoton et al. (2016) [27]. In the first scenario, assume that the weights of all five criteria are equal. In other cases, we emphasize one evaluation criterion at a time and evenly distribute the weights of the other criteria. Table 11 shows detailed information on weights. Change the weight of each evaluator based on the impact and risk parameters to analyze the degree of change in causal relationships. Considering that the environmental, economic, and political risks posed by the evaluators pose

GSJ: Volume 14, Issue 3, March 2026
ISSN 2320-9186

greater risks to the Cox's Bazar wind power project, their weight is higher than that of other evaluators based on their situation. The formula for one-time sensitivity analysis includes comparing the project results of different levels or individual variable values (such as net present value, internal rate of return, or any other related indicators) while keeping other variables constant. The formula is as follows:

Sensitivity=(result under new variable value - result under baseline variable value)/(baseline variable value)

	Scenario 1	Scenario 1	Scenario 1	Scenario 1	Scenario 1
Political risk	0.2	0.15	0.15	0.2	0.25
Environmental risks	0.2	0.4	0.4	0.4	0.35
economic risks	0.2	0.3	0.35	0.3	0.3
social risk	0.2	0.05	0.05	0.05	0.05
Technical risks	0.2	0.1	0.05	0.05	0.05

Table 11: Different important weights of evaluators in scenario analysis

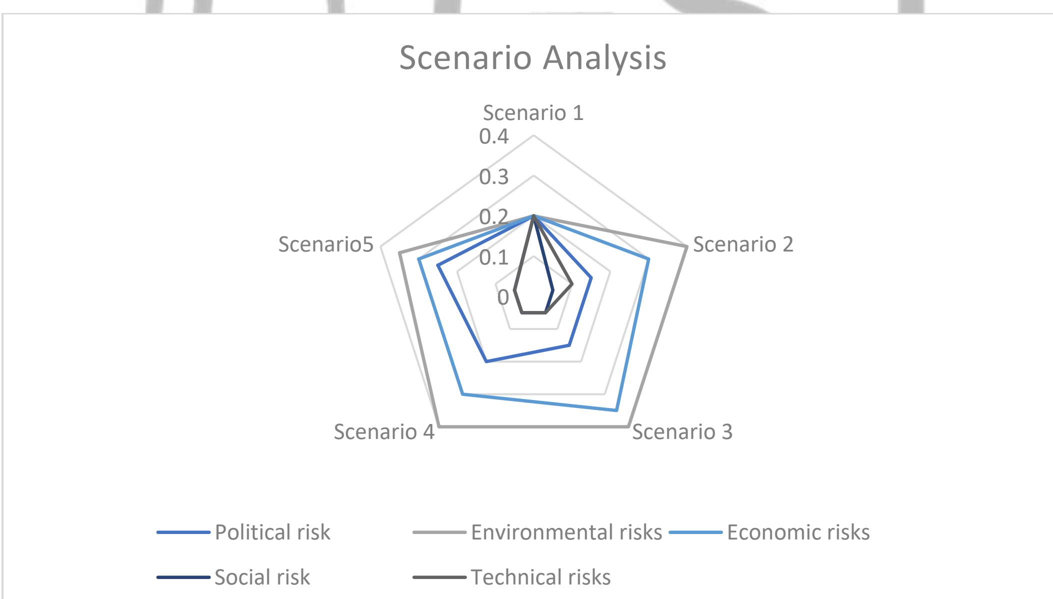

Figure 2: Scenario causal diagram

The results indicate that assuming the weights of all five criteria are equal in the first scenario. In other cases, we emphasize that one evaluation criterion has equal weights to the other criteria. The weight of environmental risks is the highest, while the weight of economic, political, social, and technological risks is the lowest. The ranking of causal factors remains unchanged in all cases. Sensitivity analysis showed robust and effective results, close to those of consulting and evaluators. Therefore, the evaluator's understanding of the cause of the accident is sufficient for the construction industry to conduct this study.

7. Conclusion and recommendations

7.1 Main conclusion

This study aims to improve the fuzzy DEMATEL method by implementing 17 standards to analyze the causal factors of key occupations in COX-BAZAR wind power projects. Therefore, this study proposes a new occupational risk assessment method to evaluate accidents in wind power projects, which helps wind power project managers make correct decisions on accident prevention strategies. The proposed method is superior to traditional techniques as it reveals the relationships between factors and their impact on each criterion, as well as their relationships and strengths.

We processed imprecise and inaccurate information by using fuzzy language scales. Due to these advantages, DEMATEL is used to better understand the impact of causal analysis standards and improve the applicability of the model. Therefore, the proposed method can represent causal relationships, which is beneficial for handling group decision-making in fuzzy environments. Based on the research results, several preventive measures can be proposed for potential occupational hazards. Firstly, it is recommended to focus on the cause group criteria as they can affect the effect group criteria. Reason standard group: The reason standard group includes EXT, ETR, TME, EEC, TEE, COR, EMO, CE, TRDC, INT risk factors The cause criteria group refers to the meaning of the impact criteria in the evaluation criteria, which describe the causes or sources of a phenomenon or problem. The effect criteria group: The effect criteria group includes PRE, OMC, GST, INE, SOB, RC, TFTS risk factors. The arrangement of the cause grouping criteria is much more difficult than the effectiveness of the grouping criteria. The effectiveness criteria group refers to the meaning of the affected criteria in the evaluation criteria, which describe the results or impacts of a certain solution, decision, or action.

The greatest impact of the cause standard is internal conflict within the government (INT). Government stability should be one of the main concerns before investment, and the greatest impact of performance standards is the technical failure of wind turbines (TFTS). Therefore, in terms of technology, project managers should take safety precautions to overcome this issue. The cause standard has an impact on the impact standard. The internal conflict of causal factors (INT) has an impact on the factors influencing the Rohingya crisis (RC). Only a stable government can solve this problem. External and internal conflicts (INT) and (ENT) have an impact on government stability (GST). Corruption (COR) directly affects Economic Secondary Standards (OMC). The Technical Risk Factors (TME) and (TRDC) have an impact on the Technical Faults (TFTS) of wind turbines. In order to address the risk factors that affect the standards, the Cause Criteria Group should be improved.

7.2 Recommendation

Based on existing information, the project appears to be making progress towards the goal of developing a 100 MW wind farm in COX-BAZAR, Bangladesh. As I mentioned in my previous response, the success of this project will depend on a series of factors, including political stability, technical feasibility, environment, financial feasibility, and social impact. The joint venture between China CMC and Bangladesh Electricity Development Commission has laid a solid foundation for the success of this project, as both companies have rich experience in the energy sector. Based on the risk analysis of Cox's Bazar wind power project in Bangladesh, the following are some suggestions:

1. The political environment in Bangladesh may be unstable, and it is recommended to conduct a thorough assessment of political risks. Political risks can be evaluated by monitoring the political situation, studying relevant policies and regulations, and understanding the attitudes of local governments.

2. Wind power projects require a significant amount of capital investment. It is recommended to develop a comprehensive financial plan and budget, evaluate the project's capital cost and return on assets, and develop corresponding funding plans and risk management measures.

3. Wind power technology may be relatively new in Bangladesh, and it is recommended to conduct a thorough assessment of technical risks. By conducting research on the local technological level and talent resources, corresponding technology transfer and training plans can be formulated to ensure the technical feasibility and stability of the project.

In summary, comprehensive risk assessment and management are required for China's overseas energy investment projects to ensure their feasibility and sustainability. At the same time, it is necessary to establish good cooperative relationships and communication mechanisms, strengthen cooperation with local governments and communities, and reduce project risks and uncertainties.

7.3 Shortcomings and Prospects

Risk analysis of China's overseas energy investment projects: Based on the analysis of wind power projects in Bangladesh (COX BAZAR), the shortcomings of the article may include the lack of specific data and case studies to support the evaluation and analysis of project risks. This may make it difficult for readers to determine the actual risks and potential impacts faced by the project. The article provides a basic analysis of political, environmental, economic, technological, and social risks, but it may require more specific and in-depth exploration of the impact and response strategies of different types of risks on projects. Although the article provides an assessment and analysis of project risks, there is a lack of specific recommendations for investment risk management. These suggestions may include how to plan and implement project risk management plans, how to develop emergency plans and strategies to address risks, etc. In the future, we can also fully consider the sustainability issues of the project, including environmental, social, and economic sustainability. These issues are crucial for China's overseas energy investment projects and need to be fully considered and managed. In summary, the article may require more specific data and case analysis to explore different types of risks more deeply, consider local cultural and social factors, provide more specific investment risk management suggestions, and fully consider the sustainability issues of the project.

However, there are still several potential prospects for China's overseas energy investment in COX-BAZAR wind power projects. These potential clients include: due to the increasing population and economic growth in Bangladesh, the country's demand for renewable energy, especially wind and solar energy, is constantly increasing. This provides an opportunity for China to invest in renewable energy projects and meet the growing energy demand in the region. The Bangladeshi government is committed to promoting renewable energy and has set a goal of 10% of the country's energy coming from renewable sources by 2021. This provides a favorable policy environment for China to invest in renewable energy projects. The Bangladeshi government has taken several measures to attract foreign investors and provide financing channels for renewable energy projects. This includes providing tax incentives and subsidies for renewable energy projects. This provides an opportunity for China to invest in renewable energy projects and benefit from these incentive measures. China's overseas energy investment projects in Bangladesh, including the COX-BAZAR wind power project, have broad prospects. By investing in renewable energy projects in Bangladesh, China can benefit from a favorable policy environment, lower production costs, and financing channels. At the same time, investing in renewable energy projects can help reduce greenhouse gas emissions, create new employment opportunities, and contribute to the sustainable development of local communities.

References

Anjum, T. (2024). WIND ENERGY POTENTIAL, PROGRESS AND CHALLENGES IN BANGLADESH: A REVIEW. In *International Journal of Renewable Energy Resources* (Vol. 14).

BANGLADESH: Renewable Energy Policy of Bangladesh. (n.d.).

Büyüközkan, G., & Güleryüz, S. (2017). Evaluation of Renewable Energy Resources in Turkey using an integrated MCDM approach with linguistic interval fuzzy preference relations. *Energy*, *123*, 149–163.

https://doi.org/10.1016/j.energy.2017.01.137

Dockner, E. J., Kucsera, D., & Rammerstorfer, M. (2013). Investment, firm value, and risk for a system operator balancing energy grids. *Energy Economics*, *37*, 182–192. https://doi.org/10.1016/j.eneco.2013.01.007

Farfan, J., & Breyer, C. (2017). Structural changes of global power generation capacity towards sustainability and the risk of stranded investments supported by a sustainability indicator. In *Journal of Cleaner Production* (Vol. 141, pp. 370–384). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2016.09.068

Hach, D., Chyong, C. K., & Spinler, S. (2016). Capacity market design options: A dynamic capacity investment model and a GB case study. *European Journal of Operational Research*, *249*(2), 691–705. https://doi.org/10.1016/j.ejor.2015.08.034

Huang, Y. (2019). Environmental risks and opportunities for countries along the Belt and Road: Location choice of China's investment. *Journal of Cleaner Production*, *211*, 14–26. https://doi.org/10.1016/j.jclepro.2018.11.093

Kang, X., Zhang, J., Zhang, H., Li, S., Zhang, Y., Zhang, K., & Li, D. (2021). Research on economic risk early-warning of China's overseas investment of coal-fired power generation: Take Indonesia as an example. *Structural Change and Economic Dynamics*, *56*, 298–309. https://doi.org/10.1016/j.strueco.2020.12.003

Rahman, M. M., & Alam, K. (2021). Clean energy, population density, urbanization and environmental pollution nexus: Evidence from Bangladesh. *Renewable Energy*, *172*, 1063–1072. https://doi.org/10.1016/j.renene.2021.03.103

Tan, X., Zhao, Y., Polycarp, C., & Bai, J. (n.d.). *CHINA'S OVERSEAS INVESTMENTS IN THE WIND AND SOLAR INDUSTRIES: TRENDS AND DRIVERS*. http://www.wri.org/publication/china-overseas-investments-

Tietjen, O., Pahle, M., & Fuss, S. (2016). Investment risks in power generation: A comparison of fossil fuel and renewable energy dominated markets. *Energy Economics*, *58*, 174–185. https://doi.org/10.1016/j.eneco.2016.07.005

Wu, Y., Xu, C., & Zhang, T. (2018). Evaluation of renewable power sources using a fuzzy MCDM based on cumulative prospect theory: A case in China. *Energy*, *147*, 1227–1239. https://doi.org/10.1016/j.energy.2018.01.115

Xu, Y., Du, R., & Pei, J. (2023). The investment risk evaluation for onshore and offshore wind power based on system dynamics method. *Sustainable Energy Technologies and Assessments*, *58*. https://doi.org/10.1016/j.seta.2023.103328

Yang, F., Gan, Q., & Guo, L. (2023). Political Risks to China's Energy Infrastructure Investment in Countries along the Belt and Road. *Energies*, *16*(18). https://doi.org/10.3390/en16186461

Zadeh, L. A. (1965). Fuzzy S e t s *. In *INFOR~ATIO~ AND CONTROL* (Vol. 8).

Zhang, M. M., Zhou, P., & Zhou, D. Q. (2016). A real options model for renewable energy investment with application to solar photovoltaic power generation in China. *Energy Economics*, *59*, 213–226. https://doi.org/10.1016/j.eneco.2016.07.028