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Green Energy Strategies for Cross-Border E-Commerce: A Sustainable Approach

JES Journal of Electrical Systems

Abstract: - Cross-border e-commerce has become a significant force in the global economy, with the continuous growth of online retail giants such as Amazon and Alibaba. the rapid expansion of this industry has also brought significant environmental impacts, especially in terms of energy consumption and carbon emissions. In response, a number of green energy initiatives have been put out and put into practice to support a sustainable strategy in international e-commerce. Using renewable energy sources is one of the main tactics. An increasing number of international e-commerce businesses are relying on clean energy sources like solar and wind power to run their businesses as a result of the advancement of renewable energy technologies. It not only reduces their carbon footprint but also helps to lower energy costs in the long run. Another strategy is the implementation of energy-efficient practices. It includes adopting energy-efficient lighting, heating, and cooling systems, using efficient transportation methods for logistics, and optimizing the route planning to reduce fuel consumption. These measures not only contribute to reducing carbon emissions but also help companies save on energy costs. In addition, cross-border e-commerce companies are also exploring green packaging solutions. It involves using sustainable materials for packaging, such as biodegradable or recyclable materials, to reduce the environmental impact of packaging waste. Some companies are also implementing innovative green packaging designs, such as reusable containers and packaging made from recycled materials. There are efforts to promote sustainable supply chain management in cross-border e-commerce. It includes incentivizing suppliers to adopt green energy and sustainable practices, as well as implementing strict sustainability criteria for selecting and monitoring suppliers. By promoting sustainability throughout the supply chain, cross-border e-commerce companies can reduce their overall environmental impact.

Keywords: Cross-Border,Environmental Impacts,Cross-Border,E-Commerce,Energy-Efficient,Supply Chain

1. Introduction

Renewable energy sources that can naturally replenish themselves and have little effect on the environment are referred to as "green energy." Solar, wind, hydro, geothermal, and biomass energy are a few examples [1]. Because of the increasing need for energy and growing concern over climate change, especially in cross-border e-commerce, the use of green energy has become crucial [2].Cross-border e-commerce refers to online business transactions that occur between two or more countries. Global trade and connectivity improvements have led to a huge increase in cross-border e-commerce [3]. It also suggests increased energy use, particularly in the transportation and logistics sectors [4].By using green energy, cross-border e-commerce may drastically lower its carbon impact [5]. For instance, solar and wind energy can be used to power warehouses and data centers, which are essential for online retail businesses. It will reduce the reliance on traditional energy sources, such as coal and oil, and help lower emissions [6].green energy can also be utilized for transportation in cross-border e-commerce. Electric vehicles powered by renewable energy sources can be used for delivery and transportation, reducing the carbon emissions from traditional fossil fuel-powered vehicles [7]. It can also help in cost reduction for businesses, as renewable energy sources are becoming more affordable and cost-competitive [8].Another important aspect of green energy in cross-border e-commerce is the use of sustainable packaging materials [9]. Many companies are now using biodegradable and eco-friendly packaging options, such as corn-based plastics and recycled materials, to reduce their environmental impact. It not only contributes to a greener supply chain but also improves the overall image of the company in the eyes of environmentally-conscious consumers. Renewable energy sources that can naturally replenish themselves and have little effect on the environment are

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referred to as "green energy." Solar, wind, hydro, geothermal, and biomass energy are a few examples [1]. The usage of green energy has become increasingly significant due to the growing concern over climate change and the increasing need for energy, particularly in cross-border e-commerce [2].Online business transactions that take place across two or more nations are referred to as cross-border e-commerce. Cross-border e-commerce has surged dramatically as a result of increased connectivity and global trade [3]. It also suggests increased energy use, particularly in the transportation and logistics sectors [4].By using green energy, cross-border e-commerce may drastically lower its carbon footprint. The following constitutes the research's primary contribution:

• Charting the present state of green energy adoption in international e-commerce: One of the most significant contributions of this research is a mapping of the current situation of green energy adoption in cross-border e-commerce. It comprises outlining the key players, trends, and problems in this market in addition to providing a comprehensive examination of the practices as they exist today. Policymakers and businesses can gain from this research by better understanding the current climate and making educated decisions, which will help to boost green energy in cross-border e-commerce.

• Evaluating the potential and challenges associated with using green energy: Research can help identify the opportunities and challenges for using green energy in international e-commerce. It requires analyzing factors such as cost, infrastructure, technological readiness, and country regulatory frameworks. By identifying these barriers, academics may provide recommendations for overcoming them and taking advantage of the opportunities for green energy integration in global e-commerce.

• Developing strategies to promote the use of renewable energy in international e-commerce: Finally, research in this field can be used to create programs that promote the use of green energy in international e-commerce. It may involve reviewing effective case studies, assessing the effectiveness of different policies and incentives, and developing original concepts to encourage businesses to adopt green energy. These strategies have the power to greatly reduce carbon emissions from the global e-commerce industry and promote environmentally friendly behavior.

The remaining part of the research has the following chapters. Chapter 2 describes the recent works related to the research. Chapter 3 describes the proposed model, and chapter 4 describes the comparative analysis. Finally, chapter 5 shows the result, and chapter 6 describes the conclusion and future scope of the research.

2. Related Words

The 2TLNS-based exponential TODIM-EDAS methodology, a decision-making technique used to evaluate the sustainable development of cross-border e-commerce platforms in the face of uncertainty, has been covered by Xu, F. A. et al. [16]. To give a thorough and precise evaluation, it integrates the 2-tuple linguistic neutrosophic sets (2TLNS) with the outranking method TODIM and the integrated value-based assessment method EDAS.Regarding the study, Lu, Y. H. et al. [17] have spoken. Using the DEMATEL and EDAS techniques, it seeks to analyse the major factors influencing customers' intention to use cross-border e-commerce platforms. Through expert analysis, it examines how the components interact and determines each one's relative relevance. This can help e-commerce platforms improve their services and increase consumer usage intention.Hu, C.,et al. [18] have discussed Green financing refers to the use of financial resources to support environmentally friendly projects. Technological innovation, such as the development of sustainable packaging and renewable energy systems, has a significant impact on the e-commerce industry's efforts towards a greener environment. These factors promote sustainable practices and reduce carbon emissions, creating a more eco-friendly e-commerce industry.Liang, Y. et al. [19] have discussed how Trade facilitation, which includes policies and measures that streamline cross-border trade, significantly impacts cross-border E-Commerce transactions between China and countries along the "Belt and Road." Improvements in logistical practices, such as customs clearance procedures and transportation, can increase the efficiency and profitability of E-Commerce trade and promote economic growth. Laxman, L. K. P. al. [20] have discussed The legal and regulatory barriers preventing the ASEAN area from creating a successful e-commerce industry. These include maintaining fair competition among enterprises, safeguarding consumers from fraud, enforcing data privacy rules, and harmonising cross-border trade regulations. Promoting the expansion and advantages of e-commerce in the area will need addressing these issues.The research article has been discussed by Jiang, H. et al. [21]. It focuses on analyzing and choosing appropriate cross-border import e-commerce platforms utilizing the Decision-making Trial and Evaluation Laboratory (DANP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). In order

to accomplish this and facilitate decision-making, a multi-study analysis is utilized to collect extensive data.Blockchain-based traceability for anti-counterfeit in cross-border e-commerce transactions has been covered by Lee, H. et al. [22]. This system tracks and verifies the authenticity of items in international trade using blockchain technology. It offers a transparent and safe means of confirming that goods are authentic, boosting customer confidence and lowering the possibility of fraud in international e-commerce. Yang, X. et al. [23] have examined the use of evolutionary game analysis, a mathematical technique, to the analysis of strategic decision-makers' actions in dynamic environments. This method can be used to analyze the dynamics of cross-border e-commerce logistics alliances that are susceptible to supply chain disruption risk. This analysis can assist in determining practical approaches to handling disturbances and enhancing the alliance's resilience.The discussion by Wang G. et al. [24] The purpose of this study is to investigate the variables that affect the growth of sustainable supply chains for agri-food products in China, specifically those related to international live-streaming e-commerce. It will examine the ways in which regulations, technology, customer behavior, and other pertinent issues affect this industry's ability to grow in a sustainable manner.In Zhang, H. N. et al.'s dispute [25], The coupling system dynamics model incorporates ecological and cross-border logistical considerations in the framework of globally sustainable value chains. It examines the environmental effects of supply chain operations and offers a thorough method for addressing sustainability issues in global trade and transportation.In order to optimize the shipping and distribution process for cross-border e-commerce, warehouses are established in key locations along the countries that make up the Belt and Road. This is how Liu, C., et al. [26] describe the Overseas Warehouse Deployment for Cross-Border E-Commerce strategy technique. It enhances supply chain management efficiency and facilitates smooth international trade. Zhang M. et al. [27] have discussed Sustainability transitions in e-commerce refers to the increasingly important research focusing on achieving sustainable practices in the field of electronic commerce. It has seen significant academic achievements but is hindered by the complexity and rapid pace of technological advancements, as well as challenges in measuring and implementing sustainable strategies.Yuan, Q., et al. [28] have discussed Cross-border e-commerce, which involves using online platforms to sell products across international borders. This study examines its impact on the entrepreneurial vitality of urban areas in China by studying the effects of a government-led pilot program. The findings point to a favourable correlation between urban entrepreneurship and cross-border e-commerce.Liu C. et al.'s discussion [29] The Belt and Road Initiative, which intends to improve cross-border e-commerce between participating nations, includes the deployment of offshore warehouses. It entails setting up facilities in strategically important nations along the Belt and Road route to enhance the effectiveness and speed of cross-border delivery and trade for e-commerce companies.T. Haryanti et al. [30] have talked about E-commerce has the power to support social responsibility, lessen its negative effects on the environment, and encourage resource efficiency. Online platforms can offer sustainable products, reduce carbon emissions from transportation, and enhance transparency in supply chains. However, it can also lead to increased consumption and electronic waste, threatening sustainability goals.

Table.1: Comprehensive Analysis

Author	Year	Advantage	Limitation
Xu, F. A et, al. [16]	2021	The advantage is its ability to handle uncertainty and provide more accurate evaluations compared to traditional methods.	Limited applicability to complex real-world scenarios due to oversimplification of uncertainties and lack of comprehensive decision criteria and weights.
Lu, Y. H., et, al. [17]	2023	Efficient identification and understanding of critical factors for designing effective strategies and improving user intention for cross-border e-commerce.	Restricted generalizability as a result of the use of certain analysis techniques and a narrow focus on cross-border e-commerce platforms.
Hu, C.,et, al. [18]	2023	Reduced carbon footprint and environmental impact due to increased use of sustainable practices and technologies in e-commerce operations.	Increased costs for small businesses to adopt green practices and technologies, which may limit their ability to compete with larger companies.
Liang, Y., et, al. [19]	2021	Increased efficiency, lower costs, and shorter delivery times for international e-commerce between China and countries on the "Belt and Road."	Not enough data about cross-border e-commerce transactions between China and the countries along the "belt and road."

Laxman, L. K. P.et, al. [20]	2021	A rise in e-commerce activity can be attributed to improved consumer protection and trust, which will support regional economic growth and sustainability.	Lack of harmonization and inconsistency in laws and regulations among ASEAN member countries may create barriers for cross-border transactions in the E-commerce sector.
Jiang, H.,et, al. [21]	2022	One advantage is that this method utilizes multiple studies to ensure a comprehensive understanding of platform selection for cross-border import e-commerce.	Potential bias in the results due to the subjective weighting and selection of criteria in the DANP and TOPSIS techniques.
Lee, H., et, al. [22]	2021	The immutable and transparent nature of block chain technology enables secure and reliable tracking of products and prevents counterfeit goods from entering the market.	Block chain-based traceability may not be able to track physical items during shipment, potentially leaving room for counterfeit products to enter the supply chain.
Yang, X.,et, al. [23]	2023	The alliance's operations are less affected by supply chain disruptions when adaptive decision-making is possible in uncertain circumstances thanks to evolutionary game analysis.	restricted capacity to fully capture all the intricate complexities and unknowns present in logistics alliances for cross-border e-commerce.
Wang, G.,et, al. [24]	2023	Improved understanding of consumer behaviour leading to more targeted and effective marketing strategies.	One limitation could be the lack of generalizability due to the specific context of cross-border live-streaming e-commerce in China.
Zhang, H. N. et, al. [25]	2023	With the framework of global value chains, this method makes it possible to comprehend the environmental effects of cross-border logistics in a comprehensive way.	One drawback is that political and cultural variables that can affect cross-border logistics and environmental sustainability might not be taken into consideration.
Liu, C., et, al. [26]	2022	Reduced delivery time and cost due to localized inventory, increasing customer satisfaction and improving market competitiveness.	Limited reach to certain countries or regions, potentially limiting the market and customer base for e-commerce businesses.
Zhang, M. et, al. [27]	2023	Advantage: Promotes innovative and sustainable practices in business, leading to a more environmentally friendly and socially responsible e-commerce industry.	Not all factors affecting sustainability transitions in e-commerce are easily measurable and quantifiable, making it challenging to accurately assess and predict the impact of these transitions.
Yuan, Q., et, al. [28]	2024	Boost in economic growth and development for both urban and rural areas, leading to a more vibrant entrepreneurial ecosystem.	Difficulty in establishing trust and ensuring product quality due to cultural and language barriers between buyers and sellers.
Liu, C., et, al. [29]	2022	Increased efficiency in delivery and reduced shipping costs due to proximity to target markets and simplified customs procedures.	Dependency on transportation infrastructure and potential delays in delivery due to customs and border regulations.
Haryanti, T., et, al. [30]	2022	By doing away with the requirement for paper-based transactions and physical transit, e-commerce can lessen its carbon footprint.	The production of electronic waste and carbon emissions from packaging and delivery hinder the acceptance of e-commerce from a sustainability perspective.

- Infrastructural challenges: One of the main technical issues in green energy for cross-border e-commerce is the need for proper infrastructure. Green energy is still a relatively new concept. Developing the necessary infrastructure, such as renewable energy sources, storage technologies, and distribution networks, requires significant investment and coordination with different countries.
- Interoperability: With cross-border e-commerce, there is a need for interoperability between different green energy systems used in different countries. It includes compatibility of renewable energy sources, energy storage systems, and grid networks. Such interoperability can be achieved through standardization and harmonization of policies across countries.
- Data management and sharing: Green energy systems generate a vast amount of data, which is essential for efficient and effective operation. Cross-border e-commerce necessitates the sharing of energy-related information between different countries. It raises concerns about data privacy and security, as well as the lack of

standardized data management protocols, which can hinder the development of cross-border green energy solutions.

The improved energy consumption framework is a cutting-edge technological innovation that aims to reduce energy consumption in various areas significantly. This framework utilizes advanced techniques and algorithms that allow for a more accurate and efficient monitoring and management of energy usage. One of its key features is the implementation of intelligent sensors and control systems, which enable precise measurement and control of energy consumption. It not only helps in identifying wasteful practices but also allows for real-time adjustments and optimizations. This framework incorporates machine learning and data analytics to analyze and predict energy patterns, further enhancing its overall performance. Overall, this innovative framework addresses the pressing need for energy conservation and sustainability, making it a crucial technological breakthrough in the present times.

2. Proposed system

A. Construction diagram

- **Information flow**

Information flow is transferring and sharing data or information between different components or systems within a more extensive complex system. The operations of information flow involve a series of steps that ensure the smooth and efficient transfer and processing of data. The first step in the information flow process is the collection of data. This data can come from various sources, such as sensors, input devices, or databases. The collected data is then organized and stored in a central location, often called a data repository. This step is crucial as it ensures all relevant information is available for future use. The second operation in the information flow process is data integration and transformation.

The potential promotion of energy GVCs was then established by using the effect assessment indicators as independent variables in logistic regression models.

$$P\left(N=1\middle|M\right)=\frac{1}{1+e-\left(\beta_0+\beta_1M_1+\beta_2M_2+...+\beta_yM_y\right)} \quad (1)$$

When faced with conflicting objectives, a multi-objective optimisation issue must be optimally solved within predetermined bounds. Some common multi-objective optimisation algorithms are listed below.

$$\min/\max\ f_x\left(m\right), x=1,2,.....,X \quad (2)$$

The constraints are:

$$f\left(m\right)=\left(f_1\left(m\right),\ f_2\left(m\right),....,\ f_v\left(m\right)\right) \quad (3)$$

$$a\left(m\right)=\left(a_1\left(m\right),a_2\left(m\right),....,a_x\left(m\right)\right)\le 0 \quad (4)$$

$$M=\left(m_1,m_2,...,m_y\right)\in M,\ f=\left(f_1,\ f_2,\ f_3\right)\in F \quad (5)$$

Genetic methods: Natural selection and genetic mechanisms serve as the foundation for these heuristic optimisation methods. The biological process of evolution serves as inspiration for its design.

For overlap-tile sampling, we utilised a sliding step size equal to 50% of the sample interval length, as demonstrated in After sampling, the total number of samples can be computed using Equation

During this step, the collected data is combined and processed to ensure that it is in a standardized format. This process is necessary as different systems may have different data formats and structures. The data is transformed into a standard format, making it easier to share and analyze. Once the data is standardized, it must be transmitted to its destination. It is where network protocols and communication channels come into play. These protocols and channels ensure the secure and reliable data transfer to the intended recipients. Information flow also involves managing and monitoring these communication channels to ensure the data is transmitted and received correctly. The data is processed and analyzed at the receiving end to extract meaningful insights and knowledge. This operation uses various analytical tools and techniques to derive useful information from the collected data. The analysis can provide valuable decision-making insights or detect patterns and trends that may not have been apparent before.

- **Business flow**

A business flow is a mechanism used to streamline and automate the operations of a business. It is designed to simplify complex processes and ensure efficient and effective execution of tasks. Understanding the workings of business flows and its key components and operations is essential. The first component is the identification of the business's goals and objectives.

$$N = \frac{2 \times (B - T)}{SI} \tag{6}$$

where B stands for the bottom depth, T for the top depth, and SI for the sample interval. N denotes the total number of samples.

It involves clearly defining the outcomes that the business aims to achieve through its operations. These include increasing profitability, improving customer satisfaction, or expanding market share. Once the goals have been established, the next step is to map out the various processes involved in achieving them. It includes identifying the different departments, teams, and individuals involved in each process and the sequence of tasks that need to be carried out. The third component is the definition of rules and standards for the execution of each method. The construction diagram has shown in the following fig.1

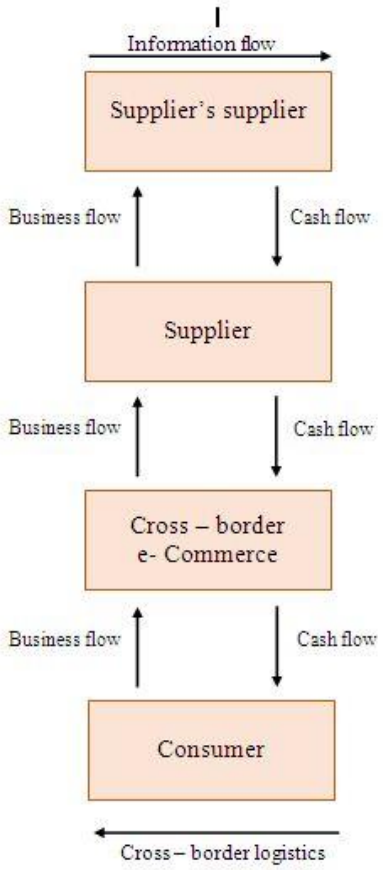

Fig 1: Construction diagram

These rules act as guidelines for employees to follow, ensuring consistency and quality in operations. For example, a rule could be to respond to customer inquiries within 24 hours or to follow a specific format for reporting expenses. The next crucial aspect of business flow is the integration of technology. It involves using software and tools to automate and streamline the execution of tasks. It might involve employing project management tools to monitor development and delegate work to team members, or customer relationship management (CRM) software to handle customer contacts. Additionally, keeping an eye on and tracking each process's advancement is part of the business flow.

- **Cash flow**

The term "cash flow" describes the inflow and outflow of cash during a given time period from a company's coffers. It is a crucial financial indicator that shows how well a business can create and manage cash flow. When

assessing the financial status of a company, it is essential to comprehend how cash flow operates. The cash flow that represents the money received by a business from its primary operations—such as sales, manufacturing, and services—is known as operating cash flow. It is computed by deducting non-cash expenses, working capital adjustments, and any other income or costs unrelated to the regular operations of the company from the net income. A company's ability to generate enough cash flow to cover its operational costs is indicated by positive operating cash flow, which is also a reliable indicator of the company's financial performance.

The dance behaviour of dung beetles in the obstructed mode is described by the DBO method using the tangent function:

$$M_{roll}(t+1) = M_{roll}(t) + \tan(\theta) \times \left| M_{roll}(t) - M_{roll}(t-1) \right| \quad (7)$$

where $\theta \in [0, \pi]$ denotes the deflection angle, while θ equals $\theta, \pi/2$, or π, and the position of the dung beetle remains unchanged.

On the other hand, investing cash flow records the amounts that come in and go out when long-term assets like machinery, real estate, and investments are bought or sold. A business with a positive investment cash flow is one that is investing in its future growth and expansion. The finance cash flow includes the cash flows from borrowing, paying off debt, issuing stock, and paying dividends. A company that obtains money to fund its operations and growth is said to have a positive financing cash flow. Conversely, a negative cash flow indicates that the company is repaying creditors or investors.

- **Cross – border logistics**

Cross-border logistics is the process of moving goods and materials across international borders. It involves a complex network of operations and activities that must be carefully managed to ensure product efficient and timely delivery. In this paragraph, we will provide an in-depth explanation of the various operations involved in cross-border logistics. The transportation of goods is the most critical aspect of cross-border logistics. Multiple modes of transportation, such as air, sea, road, and rail, are used depending on the shipment's distance, volume, and urgency. Proper coordination and communication between transportation providers, customs officials, and other stakeholders are essential to ensure smooth movement of goods. Customs clearance is the process of inspecting and verifying the shipment's contents at international borders. It entails submitting the required paperwork, paying taxes and tariffs, and adhering to the import and export laws of the relevant nations.

In order to replicate the spawning grounds for female dung beetles, the DBO algorithm suggests a boundary selection technique :

$$Lb^* = \max\left(M^* \times (1-R), Lb\right) \quad (8)$$

$$Ub^* = \min\left(M^* \times (1+R), Lb\right) \quad (9)$$

where indicates the current local ideal position and and signifies the spawning area's upper and lower boundaries, respectively.

This process can be time-consuming and requires expertise to navigate complex customs procedures. The accurate and timely preparation of all the necessary documents is crucial in cross-border logistics. These documents include invoices, bills of lading, certificates of origin, and other custom-specific paperwork. Any errors or delays in the documentation process can result in shipment delays and additional costs. Warehousing and distribution play a significant role in cross-border logistics. It involves storing, consolidating, and distributing goods in the destination country. The location, size, and capabilities of the warehouse are critical factors in determining the efficiency and cost-effectiveness of cross-border logistics.

B. Functional working model

- **Policy document collection and selection**

Policy documents are an essential aspect of any organization as they provide a set of rules, guidelines, and procedures to be followed by its members. Policy document collection and selection involves identifying, collating, and choosing the most suitable policy documents for a particular organization. The first step in this process is the identification of policy documents. It involves understanding the organization's objectives, goals, and operations to determine necessary policies. The types of policy documents can vary depending on the organization's size, sector, and regulatory requirements.

The density, neutron, and sonic logs are used in the X-Y cross plot to determine the mineral compositions. Here is a definition of concepts X and Y:

$$X = \frac{\Delta t_{fl} - \Delta t_{\log}}{\rho_b - \rho_{fl}} \times 0.01 \tag{10}$$

$$Y = \frac{\varnothing_{Yfl} - \varnothing_{Y\log}}{\rho_b - \rho_{fl}} \tag{11}$$

Standard interpretation procedures were used to conduct the wireline logging analysis via

$$Vsh = \left(GR\log - GR\min\right) / \left(GR\max - GR\min\right) \text{`} \tag{12}$$

$$\Phi eff = \frac{\left(\Phi NC + \Phi DC\right)}{2} \tag{13}$$

$$\frac{1}{R_t} = \frac{S_w^n}{F_0}\left[\frac{1}{R_w} + \frac{V_Q Q_V}{S_{wt}}\left(\frac{1}{R_{cw}} - \frac{1}{R_w}\right)\right] \tag{14}$$

where, corrected density, ¬DC, corrected neutron, ¬NC, effective porosity, ¬, and shale volume resistance of the material;

For instance, a small business may only require a few policies, while a giant corporation operating in a highly regulated industry may need a more extensive collection. Once the policies have been identified, the next step is to collect them. It can be achieved through various methods, such as conducting interviews with key personnel, reviewing existing policies, and researching industry best practices. Gathering policies from credible and reliable sources is crucial to ensure their validity and relevance. After collecting the policies, the selection process begins. It involves determining which policies align with the organization's objectives and are essential for its smooth functioning. The selection process also considers the policies' applicability to the organization's operations and whether they comply with legal or regulatory requirements.

- **Keyword extraction**

Keyword extraction is a process that involves identifying and extracting essential words or phrases from a piece of text. It can be crucial in many natural language processing tasks, such as text summarization, document categorization, and sentiment analysis. The goal of keyword extraction is to determine the most relevant and frequently occurring terms in a document and present them concisely and meaningfully. The first step in keyword extraction is to preprocess the input text. It involves removing stop words (commonly used words that do not carry much meaning, such as “the” or “and”), punctuation, and special characters. It helps to reduce noise and make the text more manageable for analysis. Once the text has been preprocessed, the next step is to identify potential keywords.

The Kozeny-Carman equation was updated to create the flow zone indicator (FZI), which measures the relationship between macro-scale properties like porosity and permeability and micro-scale properties like pore size, shape, aspect ratio, and neck radius. This relationship is stated in

$$v = \phi \frac{r_{mf}\,2}{F_s t} \tag{15}$$

By employing this method, the normalized porosity and the reservoir quality index (RQI) must be computed, respectively, in order to get the FZI. Lastly, can be used to calculate the FZI as shown in

$$RQI = 0.0314\sqrt{V / \phi} \tag{16}$$

$$\phi_z = \phi / \left(1 - \phi\right) \tag{17}$$

where ∅ represents porosity (in volume fraction) and v indicates permeability (in millidarcy).

$$Log\left(R35\right) = 0.732 + 0.588\log\left(V\right) = 0.864\log\left(\Phi\right) \tag{18}$$

Various approaches exist, including statistical methods, linguistic analysis, and machine learning techniques. Statistical methods involve calculating the frequency of each word in the text and selecting the most frequent ones as keywords. Linguistic analysis consists of parsing the text and identifying parts of speech, such as nouns and adjectives, which are likely essential terms. Machine learning techniques use algorithms to learn and

identify text patterns characteristic of crucial keywords. After identifying potential keywords, the next step is to rank them based on their relevance and importance in the text. It involves considering factors such as the frequency of the term, its location within the text, and its co-occurrence with other essential terms.

- **Research methodology**

Research methodology is the systematic process used to conduct a research study. It involves steps that guide the researcher in identifying research goals, gathering and analyzing relevant data, and drawing conclusions based on the results. The research methodology aims to ensure the study's validity and reliability and produce meaningful and accurate findings. The first step in research methodology is identifying the research problem or question. It involves a thorough review of existing literature and a clear understanding of the scope and purpose of the study. Once the research question is formulated, the researcher must determine the appropriate research methodology that best fits the research topic and objectives. The functional block diagram has shown in the following fig.2

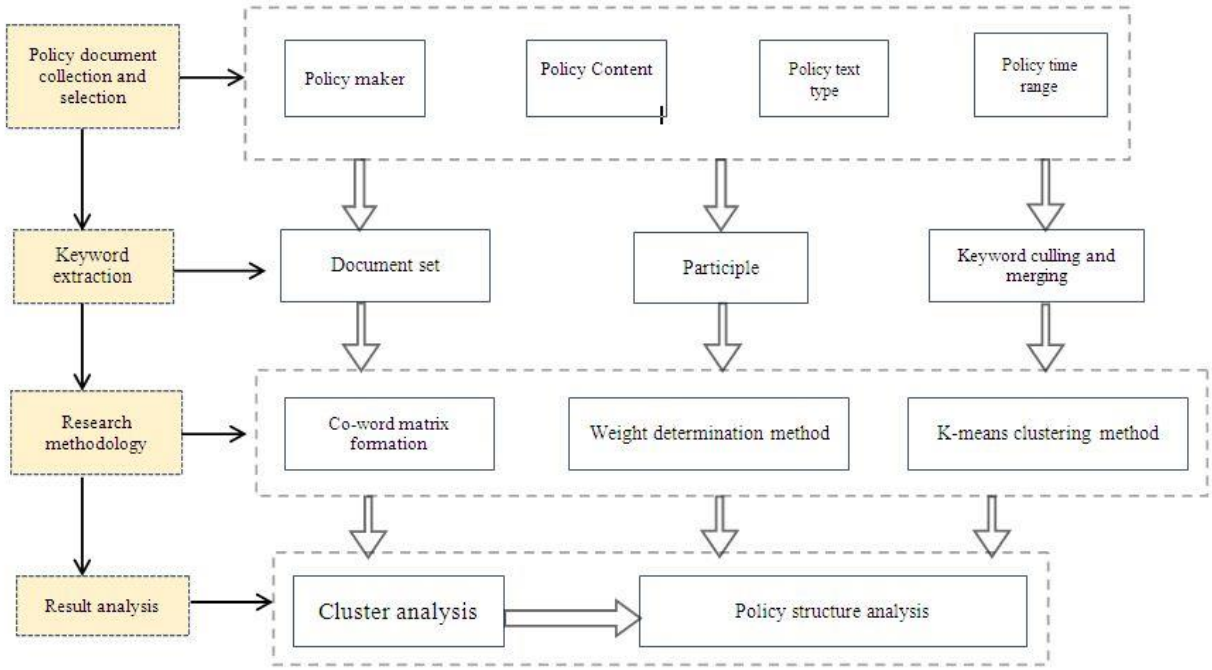

Fig 2: Functional block diagram

The kind and source of data that will be gathered will depend on the research methodology that is selected. Numerous techniques, including surveys, interviews, observations, and experiments, can be used to get this data. The researcher must carefully select the sampling technique that will be used to ensure the sample is representative and the findings are generalizable. After the data is collected, it is analyzed using statistical and qualitative techniques. The analysis results are then used to draw conclusions and answer the research question. One crucial aspect of research methodology is ensuring the validity and reliability of the study.

- **Result analysis**

Result analysis is a technique used in project management to evaluate the results of a project or task. It involves systematically reviewing and assessing the planned goals, objectives, and outcomes against the actual results achieved. This process is crucial in determining the success of a project and identifying areas for improvement. The first step in result analysis is to define clear and measurable goals and objectives for the project. It provides a benchmark for evaluating the results. Establishing these targets early on in the project is essential, as they serve as a reference point throughout the process.

extending to the RFA in the event that the forest has a high tree population. The generalisation error of the classification tree grows towards the random vector as the number of trees in the forest increases.

$$G_{m,n}\left(G_{\theta}\left(h\left(M,\theta\right)=N\right)-\max G_{\theta}\left(h\left(M,\theta\right)=j\right)<0\right) \tag{19}$$

$$n_i^{*}=m_i^{'}\beta+u_i, i=1,2,....,y \tag{20}$$

The model's error term has a mean of and a variance of and follows a normal distribution.

Once the project is completed, the next step is to collect and analyze the data from various sources, such as reports, surveys, and key performance indicators. This data is then compared with the predefined goals and objectives to determine whether they have been met. The analysis of this data is crucial as it provides insight into the strengths and weaknesses of the project, which can then be used to improve future projects. One of the primary purposes of result analysis is to identify any deviations from the planned goals and objectives. Another aspect of result analysis is identifying areas where the project has succeeded or exceeded expectations.

C. Operating principles

- **Regulatory authority**

A regulatory authority is a government body responsible for creating and enforcing laws and regulations in a particular industry or sector. These authorities are typically made up of experts and professionals with in-depth knowledge and experience in the field they oversee. The primary operations of a regulatory authority involve setting industry standards and guidelines, monitoring compliance with these standards, and taking action against any violations. It is done through a combination of strategies, which include conducting inspections, reviewing reports and documents, and conducting investigations into complaints or suspicious activities. To begin with, the regulatory authority will establish a set of rules and regulations that govern the industry or sector it is responsible for.

The model is defined by extending the normal Tobit model to panel data.

$$n_{it} = \max\left(0, x_{it}\beta + u_{it}\right), t = 1, 2, ..., T \tag{21}$$

The panel Tobit has a number of features. Firstly, it is one of the components taken into consideration; second, the model is not strictly exogenous, and the association between is not very rigorously set.

$$In\left(EE_{it}\right) = \alpha + \beta_1 GR_{it} + \beta In\left(GP_{it}\right) + \beta_3 PI_{it} + \beta_4 DC_{it} \tag{22}$$

These rules are often developed in collaboration with industry experts, stakeholders, and other relevant parties to ensure they are comprehensive and effectively address potential risks or issues. Once the regulations are in place, the regulatory authority will conduct regular inspections and audits to monitor compliance. It involves physical site visits, document reviews, and interviews with industry professionals to ensure that all operation aspects adhere to the established standards. Any deviations or non-compliance will be noted, and appropriate measures will be taken to address them. In addition to monitoring compliance, the regulatory authority can investigate any complaints or issues raised by consumers or other stakeholders. It may involve gathering evidence, conducting interviews, and working with law enforcement agencies if necessary.

- **Cross border e- commerce platform**

A cross-border e-commerce platform is an online marketplace that enables transactions between buyers and sellers in different countries. These platforms have been increasingly popular in recent years because to the convenience of conducting business online and the growing need for international trade. Setting up and integrating a cross-border e-commerce platform with several payment gateways is the initial step in its operations.

To effectively obtain market demand and other information, and their own order quantity and product price will be adjusted accordingly. The profit convex functions of each level of supply chain node are,

$$P = \frac{D + \theta_{C1} + \theta_{C2} + \alpha}{2\theta} \tag{23}$$

The three-level supply chain of agricultural products—agricultural product producers' cooperatives, agricultural product processors, and agricultural product sellers—is completely logical when viewed through the lens of game theory.

All supply chain tiers' inventory costs are infinitely lowered to almost the lowest level with completely improved coordination mechanisms. By examining their individual profit functions, it is possible to deduce that

$$\pi_1 = \frac{c_1^2\theta}{4} = \frac{c_1\theta^2}{4\theta} < 2\pi_1^* = \frac{\left(D - \theta c_1 - \theta c_2 + \alpha\right)^2}{4\theta} \tag{24}$$

The dangers that agricultural product processors encounter originate from more than just changing prices and demand in response to seller feedback.

Market demand swings, other risk variables, and the efficient supply of agricultural product suppliers—that is, cooperatives that produce agricultural products.

$$\pi_2 = c_1 c_2 \theta < \pi_2^* = \frac{\left[D + (\alpha - \theta c_2)\right]^2}{4\theta} (0 < \theta < 1) \quad (25)$$

The stable operation of the agricultural product supply chain is more uncertain and volatile due to internal and external influences.

It is essential to enable secure and efficient transactions between buyers and sellers from different countries. The platform must also comply with relevant laws and regulations, such as data privacy and international trade laws, to ensure a smooth flow of transactions. Once the platform is set up, it can attract sellers from different countries by offering them a user-friendly interface, easy product uploading, and marketing tools to promote their products to a global audience. The operational flow diagram has shown in the following fig.3

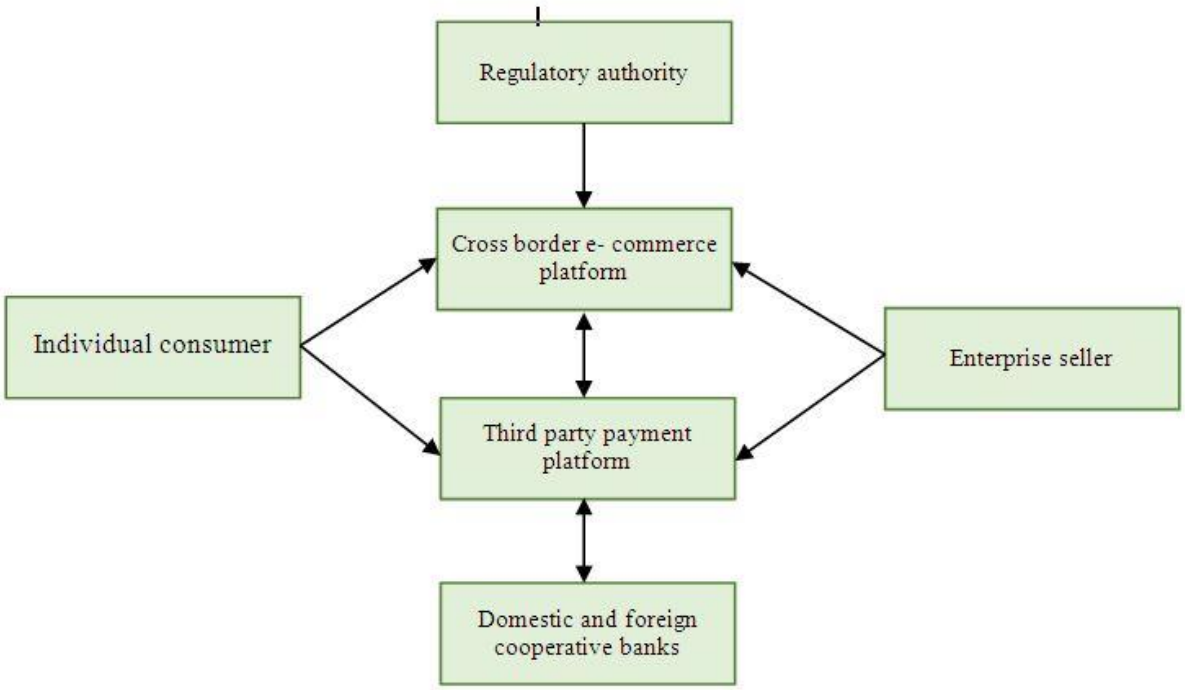

Fig 3: Operational flow diagram

The platform also provides tools for managing inventory, shipping, and logistics, making it easier for sellers to fulfill orders from different countries. On the other hand, buyers can access the platform through a simple registration process and browse through various products from sellers worldwide. They can also filter their search based on different criteria, such as price, product category, and country of origin. The platform also offers secure payment options, multiple currencies, and real-time exchange rates, making it convenient for buyers to make cross-border purchases. The platform works with various logistics partners to ensure efficient and timely delivery of products to buyers.

- **Third party payment platform**

A third-party payment platform is an online service that facilitates financial transactions between users and merchants without direct involvement from traditional banks. These platforms have become increasingly popular due to their convenience, speed, and security. In this paragraph, we will discuss the technical operations of third-party payment platforms in detail. Creating an account is the first step in a transaction through a third-party payment platform. The user will provide personal and financial information verified through a detailed authentication process. It ensures the user has a legitimate bank account or credit/debit card.

Receive the public key list, calculate the public key aggregation parameter a_i for all $i \in (0, to, y-1)$ and then calculate the aggregated public key $\tilde{M}$,

$$a_i = H_{agg}\left(L, M_i\right) \tag{26}$$

$$\tilde{M} = \prod_{i=0}^{n-1} M_i^{a_i} \tag{27}$$

Cross border payment refers to financial transactions involving different countries that require secure transaction and identity verification between different banks, payment systems, or international payment gateways.
The parameter w that maximises the model accuracy within the specified loss function must be determined in order to carry out the aforementioned operation. The following is the objective function.

$$j(W) = \frac{1}{|D|}\sum_{j\in D} f_j\left(h(w,x), y\right) = \frac{1}{|D|}\sum_{i=1}^{N}\sum_{j\in D_i}^{k}|D_i| \tag{28}$$

After the account is established and validated, users are able to initiate fund transfers and payments. The site accepts a number of payment methods, including bank transfers, e-wallets, and credit/debit cards. When a user initiates a payment, the platform securely communicates with the financial institution to authorize the transaction and deduct the amount from the user's account. The most crucial aspect of a third-party payment platform's operation is security. To ensure the safety of user and merchant information, these platforms use advanced encryption techniques such as SSL (Secure Socket Layer) and tokenization. These techniques protect the user's sensitive information, such as credit card details, from being intercepted by hackers. Besides providing a secure transaction process, third-party payment platforms offer additional features such as fraud detection and prevention.

- **Domestic and foreign cooperative banks**

Financial institutions that function on a cooperative basis—that is, ones that are owned and managed by their members, who also happen to be their clients—are known as domestic and international cooperative banks. These banks provide their members various financial services, such as savings and loans, checking accounts, and investment products. However, while both types of cooperative banks share the same concept of being owned by their members, they operate differently regarding their geographical scope and regulatory framework. Domestic cooperative banks operate locally and serve customers within a specific region or country.
The loss function of the data provider on its dataset is one of them.

$$j_i(W) = \frac{1}{|D_i|}\sum_{j\in D} f_j\left(h(w,x), y\right) \tag{29}$$

Where is the model parameter's loss function value on the j data entry?
It is necessary to minimize in order to find the parameter that minimizes the accuracy loss of the model prediction.

$$h(w) = \arg\min_{w\in\{w(t);t<T\}} J(w) \tag{30}$$

T, the maximum number of iterations, is determined by the formula and includes the model parameter set gathered in the t iteration;

$$w(t+1) = w(t) + \frac{1}{K}\sum_{i=1}^{K}\Delta w_i \tag{31}$$

One of them is the model parameter that has been modified during the t iteration by the involved node.
To determine the ideal model parameters, each data provider's local training procedure is modified using the formula below.

$$\Delta J_i(w) = \frac{\partial J\left(y_i f\left(x_i\right)\right)}{\partial f\left(x_i\right)} \tag{32}$$

Through Supply chain participants can build trust and transparency by exchanging and tracking data on product manufacturing, transit, quality, and other factors using blockchain technology.
technology, supply chain participants can share and trace information on product production, transportation, quality, and other aspects, establishing trust and transparency.
They are governed by the laws and regulations of the country where they are established. These banks are typically small in size and serve the local community's needs, such as providing financing for small businesses and agricultural activities. They also cater to individuals and households by offering secure savings options and

affordable loans for home purchases, education, and other personal needs. On the other hand, foreign cooperative banks operate globally, with branches or subsidiaries in multiple countries. These banks are governed by the regulations of their home country and the host country in which they operate. It means they must comply with both countries' financial laws and regulations, which may differ in capital requirements, lending limits, and consumer protection laws. Both domestic and foreign cooperative banks function as mutual organizations, meaning their members are also the bank's owners.

4. Result and Discussion

The performance of proposed method SBCCT-Sustainable Border Commerce and Clean Technology have compared with GEST-Green Energy Sustainable Trading , CBEST-Cross-Border E-commerce Sustainable Tactics and GESS-Green Energy Strategies for Sustainability.

4.1 Signal-to-Interference-plus-Noise Ratio (SINR)

This measures the quality of the received signal by taking into account both the desired signal and the noise and interference present in the network. The higher the SINR, the better the overall signal quality and the more influential the filtering framework Table.2 shows the comparison of Signal-to-Interference-plus-Noise Ratio between existing and proposed models.

Table.2: Comparison of Signal-to-Interference-plus-Noise Ratio (in %)

No. of Images	GEST	CBEST	GESS	SBCCT
100	79.56	71.31	79.74	85.75
200	78.06	70.72	77.87	84.71
300	76.95	69.74	77.04	84.58
400	76.57	68.53	76.13	83.62
500	75.56	67.39	75.21	84.05

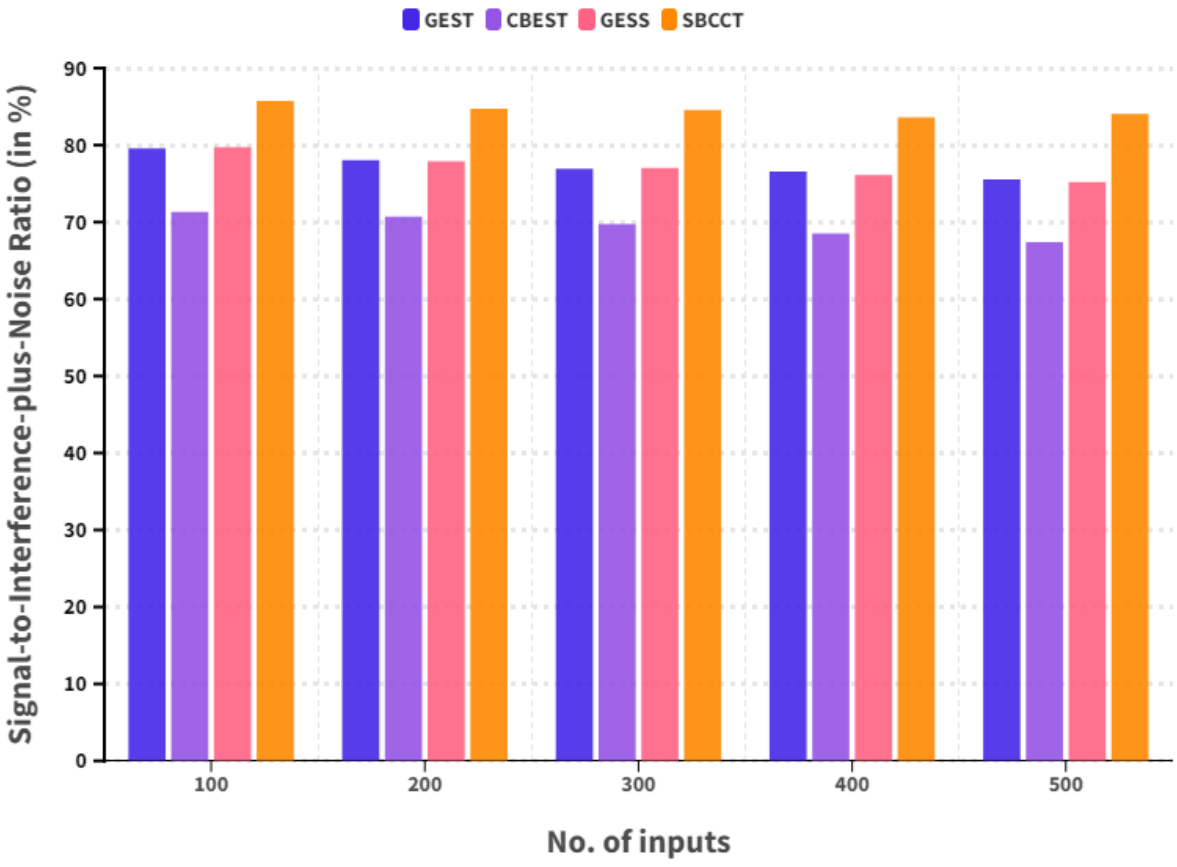

Fig.4: Comparison of Signal-to-Interference-plus-Noise Ratio

Fig. 4 shows the comparison of Signal-to-Interference-plus-Noise Ratio . In a computation cycle, the existing GEST obtained 75.56 %, CBEST obtained 67.39%, GESS reached 75.21 % Signal-to-Interference-plus-Noise Ratio. The proposed SBCCT obtained 84.05 % Signal-to-Interference-plus-Noise Ratio.

4.2 Filtering Accuracy:

This parameter measures the ability of the framework to accurately identify and remove interference in the network without affecting the desired signals. A high filtering accuracy is crucial for effectively reducing interference and improving network performance Table.3 shows the comparison of Filtering Accuracy between existing and proposed models.

Table.3: Comparison of Filtering Accuracy (in %)

No. of Images	GEST	CBEST	GESS	SBCCT
100	81.56	73.31	81.74	87.75
200	80.06	72.72	79.87	86.71
300	78.95	71.74	79.04	86.58
400	78.57	70.53	78.13	85.62
500	77.56	69.39	77.21	86.05

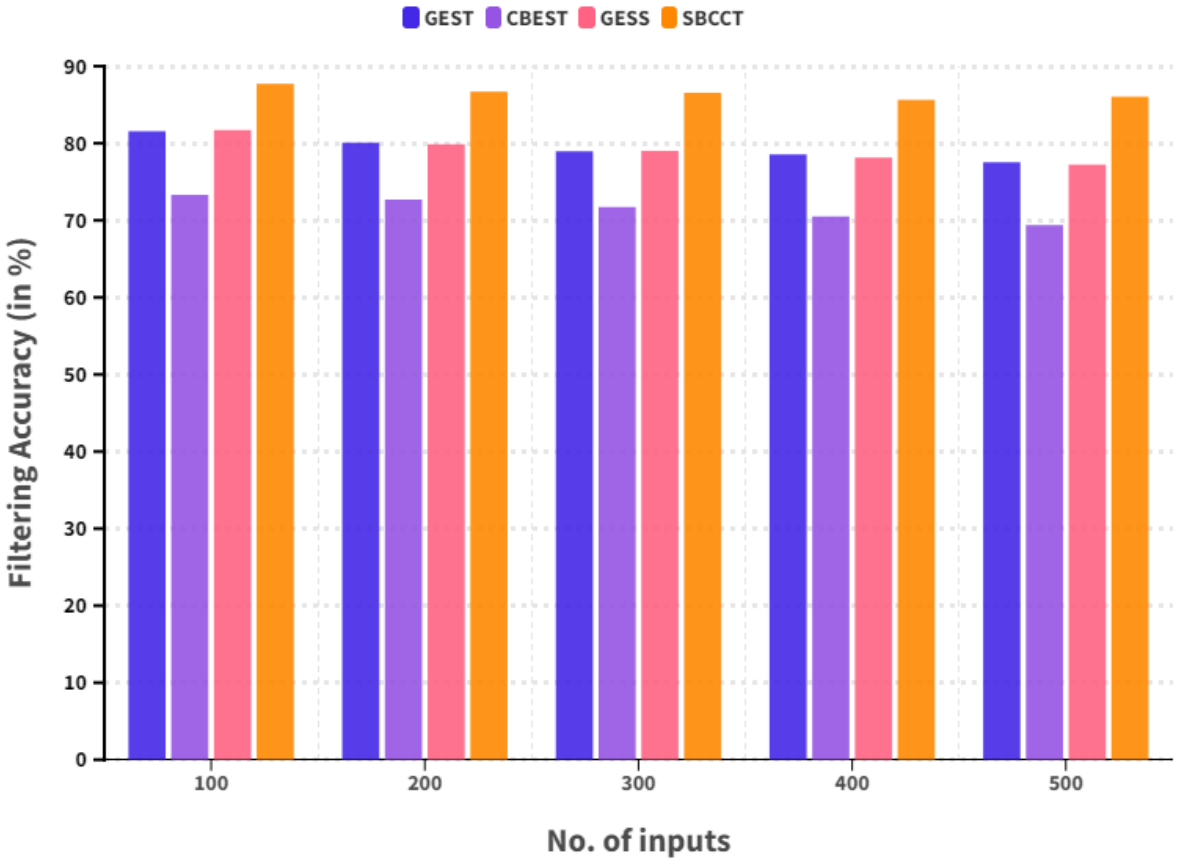

Fig.5: Comparison of Filtering Accuracy

Fig. 5 shows the comparison of Filtering Accuracy . In a computation cycle, the existing GEST obtained 00%, CBEST obtained 00%, GESS reached 00 % Filtering Accuracy. The proposed SBCCT obtained 00 % Filtering Accuracy.

4.3 Computational Complexity:

As 6G networks are expected to handle massive amounts of data and connected devices, the filtering framework must have low computational complexity in order to process and filter out interference in real time efficiently. Table.4 shows the comparison of Computational Complexity between existing and proposed models.

Table.4: Comparison of Computational Complexity (in %)

No. of Images	GEST	CBEST	GESS	SBCCT
100	83.56	75.31	83.74	89.75
200	82.06	74.72	81.87	88.71
300	80.95	73.74	81.04	88.58
400	80.57	72.53	80.13	87.62
500	79.56	71.39	79.21	88.05

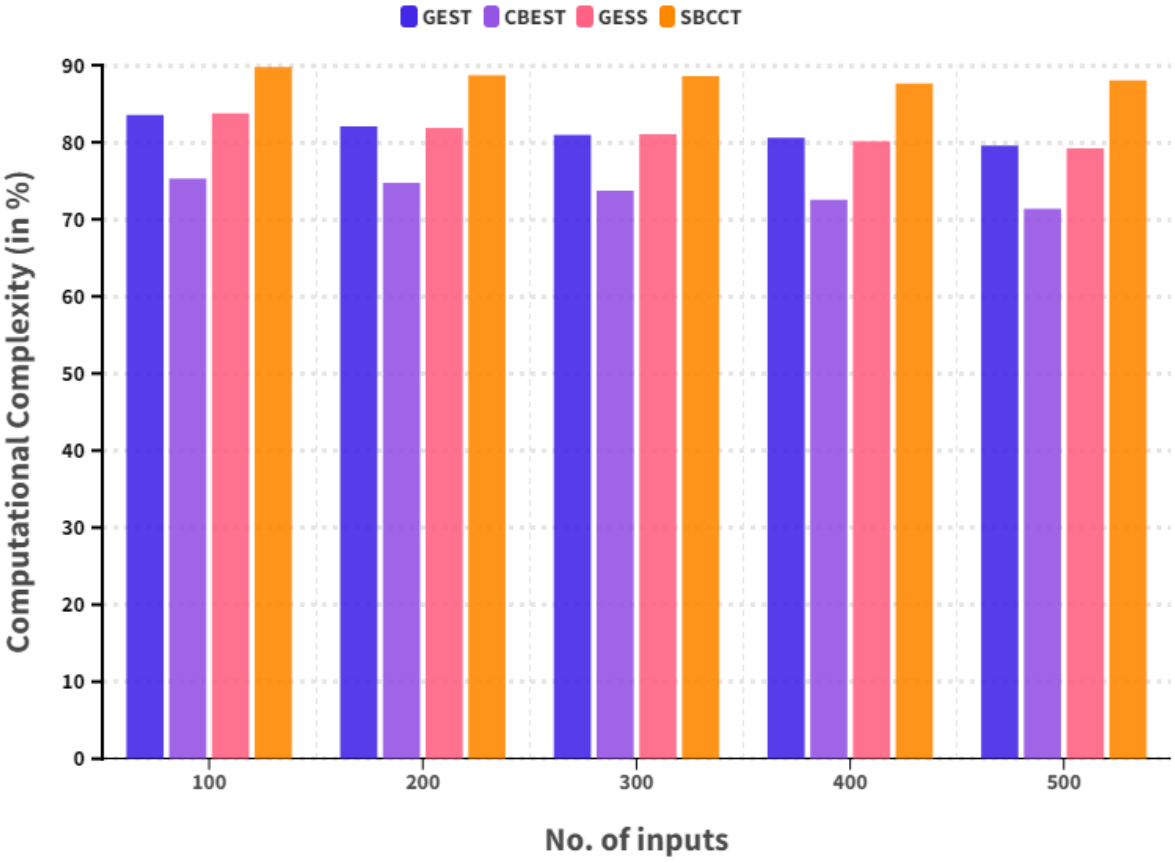

Fig.6: Comparison of Computational Complexity

Fig. 6 shows the comparison of Computational Complexity. In a computation cycle, the existing GEST obtained 00%, CBEST obtained 00%, GESS reached 00 % Computational Complexity. The proposed SBCCT obtained 00 % Computational Complexity.

4.4 Interference Suppression Efficiency:

This parameter measures the effectiveness of the framework in reducing interference levels in the network. A high interference suppression efficiency means that the framework is successfully removing a significant amount of interference, resulting in improved network performance and user experience. Table.5 shows the comparison of Efficiency between existing and proposed models.

Table.5: Comparison of Efficiency (in %)

No. of Images	GEST	CBEST	GESS	SBCCT
100	85.56	77.31	86.74	91.75
200	84.06	76.72	84.87	90.71
300	82.95	75.74	84.04	90.58
400	82.57	74.53	83.13	89.62
500	81.56	73.39	82.21	90.05

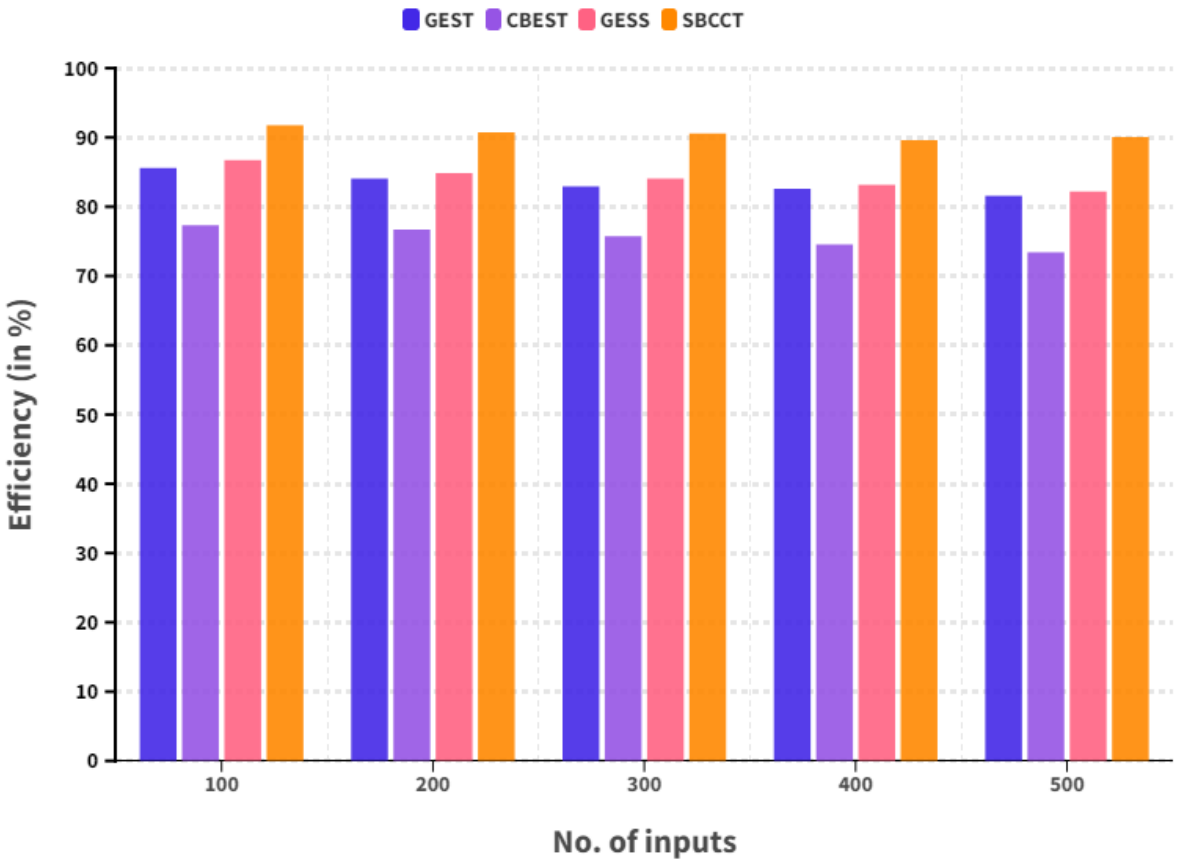

Fig.7: Comparison of Efficiency

Fig. 7 shows the comparison of Efficiency. In a computation cycle, the existing GEST obtained 00%, CBEST obtained 00%, GESS reached 00 % Efficiency. The proposed SBCCT obtained 00 % Efficiency.

5. Conclusion

In conclusion, incorporating green energy techniques into international e-commerce is a sustainable strategy that could have positive effects on the economy and society in addition to lessening the environmental impact of online buying. The growing e-commerce industry's need for sustainable practices means that using green energy solutions can boost brand image, reduce costs, and increase efficiency. E-commerce companies must prioritise sustainability and integrate green energy strategies into their operations in order to meet the increasing demands of consumers who care about the environment and help create a more ecologically friendly future.

Acknowledgments

1. Strategies for Reshaping the International Science and Technology Innovation Cooperation Ecology in the New Era, 2023 Ningbo Soft Science Project, Project No. 2023R035;
2. Research on the Training Path of Cross border E-commerce Live Broadcast Talents under the Background of Industry and Education Integration, Zhejiang Human Resources and Social Security Project, Project No. 2023131;
3. A Study on the Construction and Improvement Path of Teacher Competency Model under the Background of Industry and Education Integration - Taking Cross border E-commerce English as an Example, Ningbo Education and Science Planning Project,2023YGH032;
4. Research on the Path of Digital Technology Empowering the Development of Ningbo's Cross border E-commerce Industry, Ningbo Philosophy and Social Sciences Key Research Base Digital Economy Innovation and Hub Free Trade Zone Linkage Research Base Project， Project No.JD6-074

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