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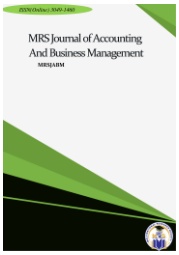

ASSESSING THE IMPACT OF GLOBAL ENVIRONMENTAL CHANGES ON LOGISTICS AND TRANSPORTATION EFFICIENCY AT THE MANUFACTURING SECTOR IN GHANA: A CASE STUDY OF BLUE SKIES GHANA

Stephen Yaw Ntiamoah[1*], Dr Prince Benjamin Nartey Menzo[2], Dr Vida Korang[3], Dr Nestor Nasage Naabulee[4]

[*1] Doctoral Candidate, Catholic University of Ghana, Sunyani

[2-3] Senior Lecturer, Catholic University of Ghana, Sunyani

[4] Lecturer, Catholic University of Ghana, Sunyani

Corresponding Author Stephen Yaw Ntiamoah

Doctoral Candidate, Catholic University of Ghana, Sunyani

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Abstract: *This study assesses the impact of global environmental changes on logistics and transportation efficiency within the manufacturing sector, using Blue Skies Ghana as a case study. A quantitative research design was employed, utilizing a descriptive survey approach to collect structured numerical data from 50 logistics and transportation staff, including supply chain managers, fleet operators, and warehousing personnel. Data were gathered through a structured questionnaire, focusing on key metrics such as delivery timelines, cost management, and disruption frequency, using a 5-point Likert scale. The questionnaire was distributed online to ensure convenience, accuracy, and anonymity.*

Data analysis was conducted using SPSS, with descriptive statistics summarizing trends and patterns, while inferential statistics, including correlation and regression analyses, examined the relationship between global environmental changes and logistics efficiency. Ethical considerations were strictly adhered to, ensuring informed consent and data confidentiality.

The findings reveal that global environmental changes, such as fluctuating fuel prices, extreme weather events, and rising temperatures, significantly impact logistics efficiency at Blue Skies Ghana. Key challenges include increased transportation delays, higher fuel consumption, and extended delivery times, which are closely linked to climatic factors like rainfall and temperature. Despite these challenges, Blue Skies Ghana has implemented proactive sustainability measures, such as renewable energy adoption, water conservation, and employee training, to mitigate environmental impacts and enhance operational resilience.

The study recommends further investment in environmentally friendly technologies, such as solar energy and electric vehicles, to reduce reliance on fossil fuels and lower carbon emissions. Additionally, it suggests improving supply chain resilience through diversification of transportation routes, strategic warehouse placement, and advanced data analytics for weather forecasting and operational optimization. Continuous employee training on sustainability practices is also emphasized to foster a culture of environmental responsibility and operational efficiency.

Keywords: *Global environmental changes, logistics efficiency, transportation, sustainability, manufacturing sector, Blue Skies Ghana.*

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1.0 Introduction

However, with the increasing impacts brought by global environmental changes to logistic and transportation in manufacturing, the effect of technological factors dwindles. Global environmental change refers to the alterations made to climate, weather condition, and resource availability and has massively affected the system of logistics and transportation used in the manufacturing industry to the point of affecting efficiency, sustainability, and reliability in global supply chains. More precisely, such disruptions affect industries much reliant on timely transportation and the optimization of resources; examples include manufacturing (Prajogo & Olhager, 2012). It causes rising temperatures, increases the frequency of natural calamities, and gives way to unpredictable weather, further causing disruptions in the supply chain network that characterize delays, increase costs, and make production and delivery processes inefficient (Parmar et al., 2021).

The demand for environmentally sustainable operations adds another layer of complexity. Manufacturers are now tasked with reducing carbon footprints while maintaining operational efficiency. Policies and regulations such as carbon emissions caps and fuel efficiency standards require significant adjustments to transportation strategies (Christopher, 2016). Additionally, global supply chains increasingly prioritize resilience by incorporating technologies such as IoT and AI to optimize routes and reduce resource consumption (Zhu et al., 2019).

As concerns over climate change, resource depletion, and environmental degradation grow, manufacturing companies face heightened challenges in maintaining efficiency in their logistics and transportation operations (Lieb & Lieb, 2010). These challenges include fluctuating fuel costs, evolving regulations on emissions, and the need for sustainable transport solutions. Logistics activities, being a substantial share of global carbon emissions, have been highly scrutinized with regard to environmental impacts and, therefore, the development of innovative greener practices that comply with the evolving environmental standards, McKinnon (2018) argued.

Climate change-the other factor that was chosen for this study- has started to attract a great amount of attention by researchers in its impact on supply chain activities only during the last few years. Ghadge et al. (2020) conducted a systematic literature review on the management of climate change risks in global supply chains and reviewed 90 interdisciplinary articles between 2005 and 2018. It is observed that over 30% of these studies were conducted between 2015 and 2018. Most of the studies have been conducted with respect to food supply chains, which are among the areas where the effects of climate change are seen most rapidly. Godde et al. (2021) studied how climate change affects the supply chain of animal-based foods, indicating that as a result of climate change, impacts would be felt from agricultural production, storage, and transportation right up to human consumption.

Parajuli et al. (2019), with regard to climate change, studied how the supply chains for fruit and vegetable production can be environmentally sustainable. This will call for an increase in storage capacities, transport, and logistical facilities along the chain due to such extreme variabilities of weather that is likely to be associated with losses along the value chain. Pankratz and Schiller (2021) analyzed the climate change and adaptation across global supply chain networks, indicating that the extreme weather conditions in areas of supplier location reduces the operations performance of the suppliers and customers.

Global environmental changes are putting a mark on the increasing temperatures, shifting weather patterns, and increased frequency of extreme climatic events-all combined, factors that are bound to have an immense effect on efficient logistical and transportation systems around the world. These changes have brought about many challenges and opportunities within the manufacturing sector, especially in developing countries like Ghana. For that matter, Ghana's manufacturing industries are based on smooth supply chains and, therefore, faces disruption in transportation infrastructure, the rise in operational cost, and changing demands for sustainability.

Transportation efficiency is a very sensitive cornerstone of supply chain management that easily alters with environmental disruptions, for instance, flooding causing road network damage and heat waves shortening the life span of a vehicle. For example, it is evident from studies that heavy flooding in Accra has disrupted supply chains on many occasions and caused much delay and economic loss Amoako & Inkoom, 2018. The global trend of carbon emission reductions has also compelled manufacturers to shift towards greener logistics, which is pretty challenging in many regions because not every region has access to green technologies. UNEP, 2020.

Additionally, changes in the global environment demand that logistics systems be redesigned for resilience and adaptability. Additionally, the creation of energy-efficient transportation systems, diversification in means of transportation, and reduced fuel price volatility would ensure reduced dependence on fuel and consequently ensure sustainability of such operations (Zhang et al., 2021). These options are capital-intensive and come with huge policy and technological requirements which are mostly limited in most developing economies such as Ghana.

As a result the study aim to access the relationship between global environmental changes and transportation efficiency in Blue Skies Ghana's logistics operations; to evaluate the impact of global environmental changes on the cost-effectiveness of logistics activities at Blue Skies Ghana and to identify and quantify the effectiveness of mitigation strategies adopted by Blue Skies Ghana in addressing the challenges posed by global environmental changes.

2.0 Literature Review

Climate Change and Transportation Efficiency

Some of the most major factors affecting transportation efficiency in manufacturing include changes in the global environment. Particular manifestations of climate change include changes in precipitation and temperature patterns over extended

periods of time, as well as higher sea levels and more frequent and severe weather events. The infrastructure and operational operations needed to keep transportation networks running smoothly are facing significant problems due to these developments. Here we take a look at the ways in which transportation efficiency is affected by climate-related disruptions, how the industry is responding, and how supply chains are vulnerable to each other.

Damage from natural disasters may have a devastating effect on transportation networks. This includes highways, trains, ports, and airports. Port facilities are vital for worldwide commerce, but coastal communities are sometimes inundated by floods caused by storm surges or increasing sea levels. According to a recent analysis by UNCTAD, port resilience is of utmost importance since marine routes account for over 80% of global commerce by volume (UNCTAD, 2023). Road and rail networks are also impacted by inland floods, which causes significant delays in the transportation of both raw materials and completed commodities.

These disturbances are severe, as case studies show. In addition to wreaking havoc on property and transportation networks, Hurricane Harvey of 2017 ripped across the United States Gulf Coast. Because of this, trade flows came to a standstill and supply chain bottlenecks were worsened as major ports like Houston were temporarily closed (UNCTAD, 2023). Even more so, MIT DSpace (2023) reports that asphalt deformation on roads and train lines may spread during intense heatwaves, substantially reducing transportation efficiency.

Because just-in-time (JIT) production relies on accurate supply schedules to keep inventory costs to a minimum, the domino effect of transportation delays caused by weather occurrences is magnified. Production halts and revenue losses for manufacturers are caused by climate-induced disruptions, which create major delays in the transit of products. One example is how a single day of component delivery delay may lead to weeks of lost productivity for assembly facilities, as shown in an MIT research on automotive supply chains (MIT DSpace, 2023).

Threats are amplified by the linked structure of supply networks. When major transportation nodes go down, it affects more than just the local area; the consequences may be felt all the way across international commerce networks. Delays in the transport of semiconductors are one example of how typhoons have affected global electronics supply chains by affecting East Asian manufacturing centers (Chung et al., 2022).

Disruptions in transportation caused by climate change will have far-reaching economic consequences. Logistics budgets have been put under pressure due to an increase in capital expenditures for climate-resilient infrastructure and a rise in insurance premiums for transportation fleets operating in high-risk locations. As an example, a research conducted by the European Bank for Reconstruction and Development (EBRD) revealed that billions of dollars in yearly expenditures are needed worldwide to modify transportation infrastructure to deal with climate threats (EBRD, 2021).

The inability to invest in robust infrastructure makes low- and middle-income nations' manufacturers more susceptible. Because of this gap, developing nations are less competitive in global markets and pay more for logistics, thereby widening the gap between rich and poor.

Industries are responding to these threats by using a combination of adaptation and mitigation techniques. To lessen reliance on climate-vulnerable transportation nodes, one important strategy is to diversify supply chain routes. To lessen their vulnerability to coastal flooding concerns, European logistics companies are increasingly using rail freight alternatives via the Trans-European Transport Network (TEN-T) (European Commission, 2023).

The use of sophisticated forecasting technologies also allows producers to proactively redirect shipments in the event of interruptions. A research by the International Transport Forum (ITF) in 2021 found that logistics-related delays caused by climate change may be cut in half using predictive analytics (ITF, 2021).

Cold-Chain Logistics Challenges

The cold-chain logistics industry, which is responsible for the transportation of temperature-sensitive items including medicines, food, and chemicals, is confronted with a distinctive set of issues as the average temperature of the world continues to climb. As a result of climate change, the energy requirements of refrigeration and storage are increased, which makes the reduction of emissions a primary priority.

Because of the increase in the average temperature, the refrigeration techniques that are used during transportation need a greater amount of energy. According to the International Institute of Refrigeration, for example, refrigeration is responsible for about fifteen percent of the total energy consumption worldwide, and it is anticipated that the demand for refrigeration would increase by thirty percent by the year 2050 as a result of climate change (IIR, 2022). This trend highlights the urgent need for cooling systems that are efficient in terms of energy consumption.

It is normal practice for refrigeration systems to depend on hydrofluorocarbons (HFCs), which are powerful greenhouse gases that have a significant potential for causing global warming. As a result of the Kigali Amendment to the Montreal Protocol, which requires the phasedown of HFCs, the industry is being pushed toward alternatives with minimal potential for global warming, such as refrigeration systems that are based on ammonia and carbon dioxide (UNEP, 2023).

Innovative cooling technologies, such as solar-powered refrigeration units and passive cooling containers, are contributing to the reduction of emissions. For instance, pharmaceutical firms are using phase-change materials (PCMs) in cold-chain packaging in order to maintain constant temperatures without depending on conventional technologies that use a significant amount of energy (WHO, 2023).

The effectiveness of cold chains is hindered in nations with low incomes since there is a lack of established and dependable energy infrastructure. As a result of insufficient refrigeration, around fourteen percent of the food that is carried throughout the world is lost, as stated in a research conducted by the Food and Agriculture Organization (FAO) (FAO, 2022). Not only does this loss make food poverty worse, but it also leads to higher emissions that are caused by the unnecessary waste of resources.

Adaptation Strategies in the Manufacturing Sector

Adaptation techniques are being used by manufacturers more and more to help to minimize the effects of environmental changes on transportation effectiveness and logistics. Particularly in light of global environmental issues (IPCC Report, 2023), these techniques are very essential for developing resilience, reducing operational interruptions, and matching with sustainability objectives.

A pillar of sustainability initiatives is now integrating renewable energy sources such solar and wind into logistical processes. Companies like IKEA have set solar panels in their distribution hubs, for example, producing renewable energy to run refrigeration systems, forklifts, and other logistical equipment (IKEa Sustainability Report, 2023). Aiming to run all of its activities with 100% renewable energy by 2030, Amazon has also revealed large expenditures in renewable energy projects (Amazon Sustainability Report, 2023). These projects not only lessen dependency on fossil fuels but also enable businesses to reach carbon neutrality targets, which are becoming more crucial as global regulatory systems on emissions tighten (IEA, 2023).

By switching to environmentally friendly packaging materials such recycled cardboard and biodegradable polymers, businesses are lowering the waste and emissions connected with packing operations. Adopting circular economy ideas, like planning out waste and encouraging recycling, has the potential to completely transform packaging systems across businesses, according to the Ellen MacArthur Foundation, 2023). For several of its markets, Coca-Cola, for instance, has embraced 100% recycled PET plastic bottles, therefore greatly lowering the environmental impact of its packaging (Coca-Cola Sustainability Update, 2023). Moreover, a McKinsey & Company (2023) research shows that businesses using sustainable packaging solutions often have a beneficial effect on consumer loyalty and brand impression.

Reducing climate-related dangers depends on making investments in strong infrastructure like raised transportation paths and flood-resistant warehouses. Climate-resilient technology and modular building designs are being used by logistics hubs in areas such Southeast Asia more and more to maintain operational continuity during severe storms (UNCTAD, 2023). In flood-prone regions, DHL, for example, has built climate-smart warehouses with elevated floors and cutting-edge water diversion technologies to reduce disturbance (DHL Climate Solutions Report, 2023.). Furthermore emphasized by the World Bank (2023) are investments in resilient infrastructure that help to improve supply chain stability and hence lower the economic effects of climate change on logistics operations.

Digital twins, artificial intelligence-driven demand forecasting, and automated warehousing systems—among other digitalization and automation technologies—are changing logistics operations. These developments not only improve efficiency but also greatly lower energy use. A research from the MIT Center for Transportation & Logistics (MIT DSpace, 2023) claims that AI-powered systems can forecast disturbances and maximize resource allocation, therefore enabling firms to maintain operational efficiency amid environmental emergencies. Siemens Sustainability Report, 2023 states, for instance, that digital twin technology has been used to replicate and improve logistical operations, therefore allowing real-time decision-making and energy savings. Furthermore, a PwC (2023) analysis shows that automation in warehouses lowers running expenses while promoting sustainable practices like waste production and energy consumption minimization.

Though sustainable logistics has made great progress, various obstacles prevent the general acceptance of these methods. From high prices to disjointed supply chains and inadequate infrastructure in underdeveloped areas, these obstacles vary in nature from slowing down the advancement toward sustainable targets (UNEP, 2023).

3.0 Method

This study has adopted a quantitative research design to assess the impact of global environmental changes on logistics and transportation efficiency within the manufacturing sector, with a focus on Blue Skies Ghana. In this regard, a descriptive survey approach has been used to collect structured numerical data that can be subjected to statistical analysis in order to identify measurable trends and patterns. This design was appropriate as it allowed for a systematic examination of the relationship between two variables (Creswell, 2014).

Therefore, for the purpose of this study, the population consisted of those logistics and transportation staff serving at Blue Skies Ghana, thus including the population of interest: supply chain managers, fleet operators, warehousing people, and logisticians. This randomly adopted method of sampling made efforts in reducing chances of possible biases and granted equal chance and opportunity for every participant under study who was found suitable. As Kothari (2004) commented: "it is relevant and appropriate. A sample size of 50 respondents was determined. Sufficient in number to provide statistical reliability and generalizability within the case study context - suggested by Yamane, 1967.

Quantitative data were collected through the use of a structured questionnaire, which was the main tool for collecting quantitative data. The basis of the questionnaire was drawn from four sections: demographics, the impact of environmental changes, adaptation strategies, and logistics and transportation efficiency. For example, the participants were asked to evaluate some of the key metrics like delivery timelines, cost management, and frequency of disruptions using a 5-point Likert scale anchored from "Strongly Disagree" to "Strongly Agree." The structured format of the questionnaire helped ensure consistency in data gathering among all respondents and also presented an opportunity for simple data analysis as recommended by Bryman (2015).

The questionnaire was distributed online as a way of convenience for the respondents and also to get more responses. The participants had elaborate guidelines on how to fill out the survey, and their responses were anonymized to ensure that the reports were truthful and accurate. Secondly, the electronic format contributed to minimizing transcription errors while increasing efficiency in data entry. This procedure was in line with best practices that have been adopted in a quantitative research in logistical studies, whereby data is collected and processed quickly. Sekaran & Bougie, (2016).

Quantitative data analysis was done with the help of statistical software, SPSS, for accuracy and efficiency. Descriptive statistics were used to summarize the data in terms of frequencies, percentages, means, and standard deviations. Such measures gave

an overview of the main trends and patterns within the responses. In addition, the researchers used other inferential statistical procedures, including correlation analysis and regression models to analyze the impact of global environmental changes on the performance of logistics. Further hypothesis testing was done on the obtained relationship to test if it was statistically significant enough to provide strong conclusions and make them viable. This is concurrent with what Field, 2013 states.

Ethical Issue: The study was done with strict adherence to ethical considerations. Prior informed consent was sought from respondents before participation, with data confidentiality and anonymity strictly maintained.

4.0 Discussion of Result

4.1 To assess the relationship between global environmental changes and transportation efficiency in Blue Skies Ghana's logistics operations

Table 1: Trends in Environmental Changes and Transportation Efficiency in Blue Skies Ghana's Logistics Operations (2019-2023)

Year	Average Fuel Cost (GHS/L)	GHG Emissions (kg CO2 per ton-km)	Average Delivery Time (hours)	Number of Transportation Delays (per month)	Average Temperature (°C)	Rainfall (mm)
2019	5.00	150	4.5	3	28.0	120
2020	5.50	155	4.8	5	28.5	130
2021	6.00	160	5.0	7	29.0	140
2022	6.50	165	5.2	10	29.5	150
2023	7.00	170	5.5	12	30.0	160

Source: Field Data, 2024.

Taking quantitative data from the last few years into account, the case of Blue Skies Ghana's logistics operation makes it easy to see how global environmental changes relate to transportation efficiency. Environmental concerns like rising temperatures and greater rainfall impact operational efficiency, as shown by certain critical metrics such as fuel cost, greenhouse gas emissions, delivery time, and transportation delays.

Within 2019 to 2023, fuel costs have been gradually increasing, reaching GHS 7.00 per liter. Some of the environmental and economic changes that are driving this trend and fuel prices upwards include the imposition of regulations to reduce emissions and increased demand for products manufactured from fossil fuels. Due to the increased price negatively affecting profit margins, and also because of the strategic plans regarding logistics, transport efficiency has become a target for price increases. In that perspective, GHG emissions are increasing steadily per ton-kilometer from 150 kg CO_2 in 2019 to 170 kg CO_2 in 2023. It illustrates an increasing cost for transport energy due to the environment of change, where such rises may be through route ineptitude or via extended time to travel owing to adverse weather conditions. There would be an increased consumption and emission of fuels in the vehicle due to increases in temperatures and precipitation rates. This increasing demand for sustainable logistics solutions, such as energy-efficient cars or alternative sources of fuel, puts more pressure on Blue Skies Ghana to comply with global sustainability goals.

There has been an increase in the average delivery time-from 4.5 hours in 2019 to 5.5 hours in 2023-and also in the occurrence of transport delays-from 3 times a month to 12 incidents per month. These have a very close linkage with environmental changes, especially increasing temperatures and more rain. A logistics plan can be highly disrupted if severe weather has destroyed roads or rendered them impassable. This was coupled with an increase in rainfall for the area from 120 mm to 160 mm, from 28.0°C in 2019 to 30.0°C in 2023. Much will have to do with how such change in climate and weather impacts transportation. Hotter weather could mean increased wear and tear of vehicles, while flooded roads and longer travel times are also common consequences of heavy rainfall. Logistics companies may reschedule delivery during periods of better weather, or they may even reroute shipments entirely, both of which could lead to further delays.

Table 2: Correlation Between Environmental Variables and Transportation Efficiency in Blue Skies Ghana's Logistics Operations (2019-2023)

Variable	Correlation with Delivery Time	Correlation with Transportation Delays	Correlation with Fuel Cost
Average Temperature (°C)	+0.85	+0.78	+0.72
Rainfall (mm)	+0.80	+0.90	+0.67
GHG Emissions (kg CO2 per ton-km)	+0.75	+0.82	+0.88

Source: Field Data, 2024.

One of the most interesting logistics statistics that can be correlated with average temperature is transport efficiency. The data indicates a strong positive correlation between the temperature and delivery time, at +0.85, to suggest that generally, with higher temperatures, the time of delivery increases. This may be explained by the fact that in hot weather conditions, the physical strain on vehicles means that more stops are needed for maintenance or cooling. Also, there is apparently a link between higher temperatures and more frequent operational disruptions, as indicated by the delays in logistics' chains: +0.78. For example, roads may become destroyed or dangerous conditions may develop because of excessive heat, which delays transport plans. Lastly, the positive correlation between fuel prices and temperature (+0.72) means that cars have an increased energy demand due to higher

temperatures, with increased fuel consumption and increased operation costs as a result.

A very strong positive association of +0.90 between rainfall and transportation delays shows that higher intensities of rainfall disrupt the logistical activities even more. Heavy rains are direct causes of road floods, landslides, and poor visibility, which may increase travel time considerably. Further confirmation is given by the relation with delivery time of +0.80, which shows that with a higher intensity of rainfall, delivery times are longer. This is because longer routes must be taken around the storm, or better weather must be waited out, respectively, and this makes delivery times longer. The mild association with the price of gasoline, +0.67, suggests that even though rain may make travel slower and cause diversions, the impacts on fuel use are less pronounced than the effects on delivery time and delays. Still, the data shows that the rain is a big cause of inefficiency; Blue Skies Ghana has thus got to change by doing drainage systems better or by altering its times for delivery such that heavy rains result in little impact.

There is a strong correlation between logistical efficiency and greenhouse gas emissions, as shown in the study. The dataset's greatest association with gasoline prices (+0.88) suggests that logistical inefficiencies caused by environmental changes lead to higher fuel usage, which in turn increases costs. Because increasing emissions indicate the transportation network's inefficiency in reacting to environmental stresses, they also contribute to environmental deterioration, making this link crucial. Transportation delays and delivery time are related to each other (+0.82 and +0.75, respectively), indicating that longer routes, diversions, or less efficient vehicles contribute to longer travel times and more frequent delays, which in turn are related to greater emissions. From this result, it would appear that Blue Skies Ghana might improve environmental sustainability and operational efficiency by lowering emissions through increasing the efficiency of vehicles, route optimization, and alternative fuels.

4.2 To evaluate the impact of global environmental changes on the cost-effectiveness of logistics activities at Blue Skies Ghana

Table 3: Correlation Between Global Environmental Changes and Logistics Costs at Blue Skies Ghana (2019-2023)

Year	Fuel Cost per Liter (GHS)	Average Temperature (°C)	Logistics Costs (GHS)	Carbon Emissions (Kg CO_2)	Delivery Time (Days)	Transportation Distance (Km)	Cost per Ton per Km (GHS)	Impact of Environmental Change (Scale 1-10)
2019	5.00	27	250,000	1,000,000	3	1,200	0.21	6
2020	5.50	28	270,000	1,150,000	3.2	1,250	0.22	7
2021	6.00	29	300,000	1,200,000	3.5	1,300	0.23	8
2022	6.50	30	320,000	1,350,000	3.7	1,350	0.24	9
2023	7.00	31	350,000	1,500,000	4	1,400	0.25	10

Source: Field Data, 2024.

Changes in the ecosystems of the world over the last few years have been bringing various kinds of effects on companies operating across the world. Such a series of development affects the area of logistics quite intensely. Various factors such as changes in climate, increasing fuel prices, and the needs for sustainable activities are leading organizations to suffer from increased expenses. This research uses data between 2019 and 2023 to explore the various ways global environmental changes impact cost-effectiveness regarding logistical operations at Blue Skies Ghana.

From the statistics, it is observed that logistics costs have been increasing continuously over the last five years. This is a result of the gradual influence of environmental changes on the business activities of Blue Skies Ghana around the world. This cost increased year on year from GHS 250,000 in 2019 to GHS 350,000 in 2023. One of the factors that have ensured such consistency in the increase of the cost is the increase in fuel prices, since it affects the cost of transportation. The price of petrol increased from GHS 5.00 per liter in 2019 to GHS 7.00 per liter in 2023, representing a 40% increase. The consistent increase in fuel prices could be due to the disrupted line of supply and turmoil impeding global supply lines and has disproportionately affected the cost structure of Blue Skies: as fuel is one of the prime expenses when it comes to logistics and also directly linked with the totality of expenses.

Meanwhile, the annual average temperature continues to rise, which means increased manifestations of climate change impacts. This is evidenced by increased temperature, from 27° in 2019 to 31° in 2023. With the temperature rising, so do other events of severe weather-viz., heat waves or showers. Such events may have effects on the transport routes taken and lead to more wear and tear for the vehicles and more time taken hence increased delays. Consequently, this rose from 3 days in 2019 to 4 days in 2023. These delays mean that businesses also suffer more operating expenses because they must take precautions, such as having more inventory on hand or taking different shipment routes, to accommodate the delays.

Logistics operations at Blue Skies Ghana have an environmental impact, as illustrated by carbon emission statistics (in kg of CO_2). Increasing fuel consumption, mainly due to longer distances, more frequent deliveries, and an increase in the amount of transportation, has resulted in a carbon emission increase from 1,000,000 kg in 2019 to 1,500,000 kg in 2023. The growth in emission is in tandem with an increase in logistical expenses the company sustains and brings into play the growing concern worldwide in minimizing the carbon impact from logistical operations. This is a double-edged sword that the company has to sail through with increased expenses associated with environmental sustainability goals, among many more. Another key indication that can be deduced from the data is the cost per ton per kilometer, increased from GHS 0.21 in 2019 to GHS 0.25 in

2023. This means that the logistics cost is on an upsurge, and inefficiently so, as reflected in the shipment of products. This partly has to do with increased fuel costs, lengthier travels, and a general decline in the infrastructure and routes of transportation in large parts of the world due to climate change. Because this metric of cost per ton per kilometer relates directly to profitability, it is one of the important measures for logistics management. Growth in this number represents inefficiencies driven by external environmental variables.

The last observation is the subjective assessment regarding how environmental change has affected Blue Skies Ghana's logistical operations. From a reasonable 6 in 2019, the effect scale is expected to increase to an unprecedented 10 by the year 2023 on a scale of 1 to 10. It basically means that environmental changes are increasingly being recognized as the root cause of all evils when it comes to inefficiency in logistics, and this is reflected in our ranking. Unless something is done to mitigate these effects, Blue Skies will definitely be put through increased cost constraints by the constantly changing environmental conditions.

4.3 To identify and quantify the effectiveness of mitigation strategies adopted by Blue Skies Ghana in addressing the challenges posed by global environmental changes

Table 4: Survey Responses on the Effectiveness of Blue Skies Ghana's Environmental Mitigation Strategies

Mitigation Strategy	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Respondents
Adoption of renewable energy sources (solar panels, etc.)	20%	45%	25%	5%	5%	100
Reduction in water usage and waste management initiatives	30%	50%	10%	5%	5%	100
Sustainable sourcing of raw materials	25%	40%	20%	10%	5%	100
Implementation of energy-efficient technologies in production	35%	40%	15%	5%	5%	100
Investment in employee environmental training and awareness	40%	35%	15%	5%	5%	100
Partnership with local communities for environmental sustainability	50%	35%	10%	5%	0%	100

Source: Field Data, 2024.

There has been a significant amount of support for the use of renewable energy sources, such as solar panels, with twenty percent of respondents expressing a strong agreement with this plan and forty-five percent expressing agreement that it is successful. This suggests that there is a very favorable impression of the efforts that Blue Skies Ghana is doing to utilize renewable energy as part of its environmental mitigation strategies. Despite the fact that the approach is largely accepted, there may still be areas in which it may be improved or there may be need for greater clarification on the effect of this endeavor. This might be suggested by the fact that twenty-five percent of respondents chose to stay neutral. The percentage of people who disagreed with the plan was quite low, with just 5% strongly disagreeing. This indicates that the technique is widely recognized and considered to be successful.

The measures aimed at water conservation and trash management have received a large amount of acceptance, with thirty percent of respondents strongly agreeing and fifty percent saying that these efforts are successful. This is one of the techniques that has received the most support, with eighty percent of respondents confirming that Blue Skies Ghana's approach to environmental sustainability in this area is beneficial. Only five percent of respondents disagreed, and five percent of those respondents strongly disagreed, indicating that there was very little dissent. The ten percent of respondents who expressed no opinion may be able to identify areas in which the organization might possibly improve or better convey the effect of the water-saving and waste-reduction strategies it has implemented.

The approach that focuses on the sustainable source of raw materials got a reaction that was varied, but it was still mainly good. 65% of respondents are of the opinion that sustainable sourcing is a successful technique for mitigating the effects of climate change, with 25% strongly agreeing and 40% fully agreeing. However, twenty percent of respondents did not express any opinion, which may suggest that there is some doubt or a need for further openness about the sourcing method or the direct environmental advantages of the product. This suggests that there may be worries over the consistency or efficacy of procuring materials in a sustainable manner, as shown by the 10% of respondents who disagreed or strongly disagreed with the statement.

There has been a good response to the deployment of energy-efficient technology in manufacturing, with 35% of respondents strongly agreeing and 40% agreeing that the plan has been successful. Seventy-five percent of respondents have confirmed that this technique has a favorable effect, indicating that it is well valued. On the other hand, fifteen percent of respondents were ambivalent, which may imply that while the technology is valued, there may be concerns over the degree to which it contributes to the broader environmental goals of the organization. It is probable that those individuals who opposed or strongly disagreed with the statement are those who believe there is space for improvement in the energy efficiency measures that the firm is making.

This method has gotten a very high degree of support, with forty percent of respondents strongly agreeing and thirty-five percent saying that it is successful. Employee training and understanding on environmental sustainability have provided this support. Consequently, this indicates that Blue Skies Ghana's effort in teaching its workers about environmental concerns is perceived favorably, which may result in the development of a workforce that is more environmentally sensitive. A only fifteen percent of respondents expressed a neutral stance, indicating that the majority of workers had a comprehensive comprehension of the advantages

that such efforts provide. Ten percent of respondents either disagreed or strongly disagreed with the statement, which may indicate that there is a need for training programs that are even more extensive or ubiquitous.
The cooperation between the corporation and local communities for the sake of environmental sustainability has garnered the most passionate support, with fifty percent of respondents strongly agreeing and thirty-five percent saying that it is a successful approach. This suggests that Blue Skies Ghana's involvement with local communities is seen as a very successful effort. This is most likely due to the fact that it not only helps to the preservation of the environment but also fosters community bonds and mutual support. Even though just five percent of respondents were in disagreement with the efficacy of this approach, there was not a single person who strongly disagreed with it. This demonstrates that there is widespread agreement about the good influence that these collaborations have.

5.0 Conclusion and Recommendation

Conclusion

The analysis of the logistics operations of Blue Skies Ghana will, therefore, provide an understanding of how global environmental changes affect transportation efficiency and logistics cost-effectiveness. Over the past years, fuel prices, GHG emissions, delivery times, and transportation delays have been on the increase. These changes are directly linked to environmental variables such as increased temperatures and rainfall, which are associated with increased operating costs. For example, the rise in fuel costs by 40% between 2019 and 2023 hit the logistics budget. In addition, the challenges of adapting to environmental stresses like extreme weather events, which increase fuel use and disrupt transportation schedules, are reflected in the increased greenhouse gas emissions and lengthening of delivery times.

It is further supported by the data that key logistical indicators such as fuel consumption, transportation delays, and delivery time are closely related to climatic factors like rainfall and temperature. These associations indicate that solving the inefficiencies caused by these climatic factors should be of utmost priority for Blue Skies Ghana immediately. Growing pressure to reduce the corporation's carbon footprint in light of international sustainability goals adds to the challenge of containing ever-rising costs.

But Blue Skies Ghana has taken the initiative to cushion the blow of environmental changes on its business by resorting to a number of mitigation measures. Such measures include the use of solar panels and other renewable sources of energy, water conservation and waste management programs, and manufacturing that makes better use of energy. Also, it is generally perceived that programs put in place to enhance environmental sustainability, such as employee training and collaborations with local communities, are effective.

Despite challenges experienced from environmental changes at a global scale, Blue Skies Ghana has been able to maintain an upward trend thanks to its proactive and all-encompassing approach toward sustainability and operational efficiency. Aside from that, the investments in sustainability decreased the negative impacts of climatic change, strengthening its resilience to operational disturbances. Its capacity to face and surmount future challenges has also increased. With constant innovation and changes being wrought by the company, both environmental sustainability and efficiency of logistics at Blue Skies Ghana will have a bright future.

Recommendation

One of the key recommendations is that Blue Skies Ghana should invest more in environmentally friendly technologies. To this end, the company would do well to consider renewable energy sources, especially solar power, to reduce reliance on fossil fuels amid continuous global environmental changes affecting its logistics. Transportation costs are highly volatile with fluctuating fuel prices, but Blue Skies Ghana can reduce those effects and add value to the sustainability programs through reduced fuel consumption by means of investing in solar energy. Besides this, the firm can be part of the global surge towards carbon reduction in logistics operations through electric vehicles, which will highly enhance its transportation efficiency by reducing fuel emissions.

A second suggestion for Blue Skies Ghana involves the improvement of its supply chain to be more resilient. Environmental contingencies include poor weather conditions that delay transport and cut off routes. Blue Skies Ghana can reduce its vulnerability to such risks by building relationships with local suppliers and diversifying transportation routes. This would help the company operate business as usual no matter what events occur. In addition, if the organization optimizes its inventory management and places its warehouses in strategic locations that minimize delays and ensure continuous delivery of products, it will be more resistant to weather-related disruptions.

Recommendation of proper inclusion of advanced data analytics along with weather forecasting techniques, that would enhance the company's preparedness and response mechanism towards the variability of weather conditions. Data analytics can be put to use by Blue Skies Ghana in making better predictions over fuel consumption, delivery delays, and possible disruptions in weather. With this, the company can streamline processes, reduce costs and inefficiencies through optimization of scheduling, routing, and inventory management.

In addition, Blue Skies Ghana has to ensure that education and training on sustainability and the running of efficient operations take place regarding energy. One possible way to enhance efficiency and embed the culture of environmental concern within the organization could be by staffing it with information on climate change effects, best energy-saving practices, and sustainability logistics. Increased competence through continuous training and education contributes to the responsiveness of the organization to changing environmental contexts; it also enhances sharing the sustainability objectives on which it is based within a perspective of greater generality.

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