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ROLE OF CLIMATE CHANGE MITIGATION STRATEGIES IN RESPONSIVE GREEN HUMANITARIAN SUPPLY CHAINS

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ABSTRACT

Purpose: Climate change is major source of disasters, economic problems and human casualties which require dedicated humanitarian operations for their management. Green humanitarian supply chains reduce impact on climate while still performing humanitarian operations. The study carries out a comprehensive examination of climate change mitigation strategies, associated laws and rules and their role in responsive green humanitarian supply chains.

Design/Methodology: Explanatory research design, quantitative method and deductive approach have been used for this cross-sectional study. Data collected through survey from 401 respondents was analyzed using SmarPLS4.

Findings: The impact of renewable energy, reforestation, carbon capture and storage innovations, electrical transportation and wetland restoration strategies in mitigation of climate change and associated laws and rules has been evaluated. We found that climate change mitigation strategies and associated laws and rules have positive significant relationship with responsive green humanitarian supply chains (GHSC). Laws and rules partially mediate the relationship between Renewable Energy, Reforestation, Carbon Capture and Storage innovations and Electrical Transportation and GHSC but mediation for Wetland Restoration is insignificant.

Theoretical/Practical Implications: It is crucial to have well-coordinated strong laws, rules and protocols with equally potent implementation strategy to ensure the efficacy of climate change mitigation strategies and greening initiatives for HSC. Through the combination of legal, technological, ecological and policy approaches, we can enhance the efficacy of measures contributing towards responsive green humanitarian supply chains. Humanitarian supply chain professionals and environmentalists can benefit from the findings for their application in respective fields.

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Originality: This is a nascent study on the critical topic having immense theoretical as well as practical contributions for both climate change mitigation and responsive green humanitarian supply chain management.
Keywords: *Climate change mitigation strategies, responsive green humanitarian supply chains, laws and rules, renewable energy, reforestation, carbon capture and storage innovations, electrical transportation, wetland restoration.*

Paper type: Research Paper

INTRODUCTION

The term "Climate Change" refers to an abrupt shift in weather patterns that is mostly brought about when greenhouse gases are emitted into atmosphere. Greenhouse gases cause radiations to be absorbed by the atmosphere of the earth resulting in climate change (UN, 2024). It is amongst the critical concerns of current century, having a direct impact on people, businesses and global environment (Iqbal & Ghauri, 2011) requiring immediate humanitarian intervention. Due to enhanced greenhouse emissions, storms, heat waves, as well as other catastrophic weather conditions are occurring more frequently and with greater intensity (UN, 2024). The year 2023 has been declared as the hottest year ever recorded for the Earth, in the previous 100,000 years (The New York Times, 2024). Extreme weathers are amongst the top natural disasters in the Global Risk Perception (Zahidi, 2024). Rising greenhouse gases are harming aquatic environments (NOAA, 2024). Global warming has disrupted agricultural techniques endangering lives and global nutritional stocks (Annappa at al., 2023). These difficulties exacerbate social and economic inequality particularly in impacting regions.

Mitigation measures of climate change, such as cutting emissions of greenhouse gases, increasing energy from renewable sources (IRENA, 2024), utilizing carbon capture and storage (CCS) (ITF, 2019), switching to environmentally friendly transportation (FAO, 2022), Reforestation and wetland restoration are essential. Such mitigation actions need to be effective if we want to meet climate change targets while protecting Earth for future generations. USA's "Clean Air Act 1970" and Swedish government's "Climate Neutral Cities – 2030 initiative" are innovative actions on climate change (Pereverza at al., 2025). Similarly, Climate Change Action Plan (2013-2020) by Canada was an excellent initiative in this field (Tchinda & Talbot, 2025). Laws and rules for climate change compliance play vital role in climate change mitigation strategies. Most countries of the World have enacted laws and rules essential to effectively mitigate climate change but mostly, they are not rigorously enforced.

Over last 50 years, 62 percent of disasters, 82 percent causalities and 99 percent of economic issues are attributed to climate disasters (WMO, 2021). Humanitarian organizations saved millions of people and helped poor and least prepared countries (OCHA, 2022). Humanitarian organizations also share a portion of environmental damage when they operate. Green humanitarian supply chains operate in a way which reduce impact on environment while ensuring timely delivery of humanitarian aid (Dubey, et al., 2017). Donor governments and agencies also enforce legislations,

protocols or policy guidelines on humanitarian organizations to reduce damage to environment like UK's DFID: Carbon Management Plan and Smart Rules; EU Climate adaptation strategy, EuropeAid guidelines and Denmark Environmental Assistance to Developing Countries and USAID regulations etc (Tull, 2019). However, humanitarian supply chains are directly or indirectly affected by consequences of natural disasters (Kovacs and Sigala, 2021). While humanitarian supply chains are committed to speedy aid delivery to most vulnerable populations and they prioritize lifesaving over other obligations; would they be able to coup up with such pressures alongside following laws and protocols for greening and without harm to environment? Would their efficiency and responsiveness will be compromised or not and to what extent? Can we enhance the responsiveness of green humanitarian supply chains (GHSC) without compromising their core responsibilities? There is a knowledge gap about effects of climate change mitigation strategies and associated laws, rules, guidelines and protocols of HSC on responsiveness of GHSC.

Therefore, there is a need to study role of climate change mitigation strategies and associated laws and rules in greening of humanitarian supply chains yet ensuring their responsiveness. This will contribute towards ensuring dynamic, agile and responsive green humanitarian supply chains which can serve the humanity in severe climate change conditions and disasters.

Research Questions: The paper will explore following aspects of climate change and green humanitarian supply chains: -

RQ1: What climate change mitigation strategies are available?

RQ2: How climate change mitigation strategies effect greening of humanitarian supply chains?

RQ3: What is role of climate change mitigation strategies and associated laws, rules, guidelines and protocols towards responsive green humanitarian supply chains?

LITERATURE REVIEW

Causes of year 2023, being the hottest in the Earth's 100,000 years history are being investigated by scientists (The New York Times, 2024). Emissions of greenhouse gases continued unchecked and drove temperature rise to record peaks (The New York Times, 2024). Therefore, lowering emissions of greenhouse gases is essential for reducing its effects (Fawzy et al., 2020). Emissions put additional strain on the environment and ecological systems (Fawzy et al., 2020). Over the span of 20 years, rapid increase in solar and wind energy (The New York Times, 2024) hasn't been sufficient to stop the growth of electricity generation through gas and coal; because, need for power has increased globally much more quickly compared to the usage of clean energy, forcing petroleum and coal to take up the void (Bustreo, 2019).

Though mitigation strategies including laws and rules have been put in place but has not been managed efficiently (EEA, 2020). Moreover, greening of humanitarian supply chains will also need special focus for retaining their responsiveness. The degree to which we can choreograph that effort will largely depend upon our

capability to offer suitable rewards for mitigation, whether via market-driven techniques, governmental involvement, multinational accords, unilateral measures or a combination of any of them.

Responsive Green Humanitarian Supply Chains

Humanitarian supply chains which reduce harm to environment while still being responsive to disaster management and humanitarian aid delivery are called green humanitarian supply chains (Jilani et al., 2018). Humanitarian supply chains are under lot of pressure to due increased load of global crises due to climate change, other natural disasters or conflicts. Disasters damage the environment and response through humanitarian supply chain also contribute to environmental degradation. If we want to reduce damage to environment, HSC must also adopt such practices which do not contribute to damage; rather they reduce the harm to environment by following green practices. These may include reduction of carbon emissions, conservation of resources and avoiding waste (Besiou et al., 2021). Saving lives, providing shelter, medical and food etc to effected populations quickly and effectively under stressful environment is critical function of humanitarian supply chains. Over past few decades, there has been an increased consideration for following green practices by humanitarian logistics (Ramirez-Villamil and Jaegler, 2025). For HSC engaged in humanitarian operations it is demanding task to do both humanitarian work as well as avoid or reduce damage to environment, as speed and efficacy of delivering aid cannot be compromised (Ramirez-Villamil and Jaegler, 2025). Therefore, a fine balance is required to maintained between both, as both are critical for humanity. Whether by adapting to greening practices, laws, protocols and guidelines, HSC can perform their core task is still required to be evaluated in current climate change mitigation and increasing disasters' scenarios.

Role of Climate Change Mitigation Strategies in Responsive Green Humanitarian Supply Chains

Typical mitigation strategies use carbon reduction techniques and methods (Fawzy et al., 2020). Fresh array of techniques, have the ability to seize and remove CO2 from environment. Pires (2019) advocated that the primary approaches for reducing emissions are bioenergy capturing and storing carbon, increase in afforestation and reconstruction of wetlands.

Renewable Energy

During recent years World used 18.1% renewable energy as compared to total energy which was consumed during 2017. Photovoltaic solar energy, solar power, thermal energy from the sun, tidal power, geothermal energy, biomass power and hydroelectricity are some of the most popular forms. Renewable energy may be used for the construction and manufacturing industries. Examples of de-carbonization

initiatives using renewable energy sources include the utilization of thermal sunlight and the conversion of commercial final usage fuels to integrated heat and electricity generations. Transition from fossil to renewable sources also poses significant challenges but Germany has innovatively integrated these technologies into their existing infrastructure (Radtke, 2025). Moreover, renewable energy-powered electrolysis generated hydrogen has promised as a sustainable resource for sector de-carbonization.

Humanitarian supply chains using electric cars powered by green power, solar plates and promotion of hydroelectricity and windmills are illustration of use of renewable energy. Therefore, we can say that climate change mitigation efforts through renewable energy can directly assist in green humanitarian supply chain responsiveness.

Hypothesis 1: *Climate change mitigation efforts through renewable energy strategy positively contributes towards responsive green humanitarian supply chains.*

Reforestation

CO2 is taken up from the environment by growing trees. Thus, forestry is a biogenic negative emissions technique that is crucial to fight against global warming. The Royal Society (2018) argued that forest management techniques and operations should be properly managed because they have an impact on the ecosystem. Their benefits include enhanced effectiveness of soil, improved air quality, good water quality, ecosystems as well as prevention of flooding. For essential mitigation effects, substantial tracts of land are needed (Royal Society, 2018).

Additionally, there are bidirectional linkages between climatic-smart reforestation and humanitarian supply chains' efforts for supporting community reforestation campaign through CSR initiatives. For instance, reforestation along the shore or in watersheds may assist in mitigation of catastrophic occurrences. The creation of benefits for environmentally conscious replanting, like compensation for watersheds conservation may be supported by humanitarian supply chain partners.

Reforestation will directly help in improving the environment in which humanitarian supply chains would be operating. Therefore, reforestation efforts by humanitarian supply chains will contribute towards their greening and improve their responsiveness.

Hypothesis 2*: Climate change mitigation efforts through reforestation strategy positively contributes towards responsive green humanitarian supply chains.*

Carbon Capture and Storage Innovations

CO2 emitted by energy sources including petroleum, natural gas and coal is stored for an extended period in natural reserves. Reducing emissions while still using fossil fuels is the primary goal (Fawzy et al., 2020). There are three technologies used for this purpose which include oxyfuel burning, initial combustion as well as post-

combustion. Storage of CO2 may be done at drained oil fields, empty gas locations or coal accommodation and subterranean saltwater aquifers. Use of stored CO2 to produce compounds, energy sources, tiny algae, cement construction supplies and better extraction of oil is another avenue following carbon capture (Fawzy et al., 2020). Productivity improvements, alongside fuel shifting, are extremely important for mitigating measures (GCCSI, 2022). Increases in burning fuel effectiveness and turbine generating energies allow thermal energy facilities to operate more efficiently (REN21, 2019). Important roles in improving effectiveness are additionally performed by integrated power and heat systems (REN21, 2019).

Since donor agencies in their protocols have mandated humanitarian supply chains to support and contribute towards lowering damages to environment, they can assist in technological advancements in distribution and transmission infrastructure for improving their efficiency. Humanitarian supply chains operators can join ventures for Carbon Capture and Storage innovations which will contribute towards mitigation of climate change as well as their greening and responsiveness.

***Hypothesis 3**: Climate change mitigation efforts through carbon capture and storage innovation strategy positively contributes towards responsive green humanitarian supply chains.*

Electrical Transportation

Organization for economic cooperation and development (OECD) member nations are attempting to curtail one's independence, especially when it comes to driving (Gifford & Nilsson, 2014). Airborne congestion of the atmosphere, traffic jams, space used by transportation networks and the standard of living in cities are important issues to be considered (Pucher et al., 2010). Altering travel habits is quite more difficult than altering habits related to composting or perhaps conserving energy in the home (Garling & Schuitema, 2007; Gifford & Nilsson, 2014). Taking a different route for a specific journey which requires a longer period to get there, is a significant limitation (Garling & Schuitema, 2007). Therefore, humanitarian supply chain operators may plan awareness campaigns for encouraging voluntarily altering travel habits having significant advantages.

Any alternative to gasoline that might be utilized in cars will help in reducing greenhouse gas emissions from transportation (Pucher et al., 2010). Humanitarian organizations can follow themselves and spread awareness among masses for encouragement of public transit, promotion of remote working and telecommuting, encouraging carpooling and ride sharing as advocated by Gifford & Nilsson (2014); Pucher et al. (2010) and Nilsson et al. (2014). These measures will not only help in mitigation of climate change but will also improve greening and responsiveness of humanitarian efforts.

***Hypothesis 4**: Climate change mitigation efforts through electrical transportation strategy positively contributes towards responsive green humanitarian supply chains.*

The hydrological, geochemical and biological functioning of wetland areas are crucial at the basin levels (Ellen et al., 2015). Wetlands use various physical, chemical and biological mechanisms that aid in the elimination of pollutants (Ellen et al., 2015). Nilsson et al. (2011) identified chemical mechanisms that precipitate metallic elements and phosphate by means of iron, aluminum or calcium as well. Utilization of building and rehabilitation techniques for wetlands to remove pollution paid rich dividends. Preparation, architecture, reconstruction and preservation need a thorough understanding of the environmental features of wetlands. To predict pollution movement at watershed and drainage sizes, we can employ a variety of methods including Soil and Water Assessment Tool (SWAT).

Donor governments like USA, UK, EU and other developed countries have given guidelines and protocols to humanitarian organizations to reduce damage to environment (Tull, 2019). In their efforts to reduce damage to environment and play their part in improving it; humanitarian organizations can collaborate with other civil or governmental organizations for wetland restoration as part of their CSR. This will definitely ensure the greening and responsiveness of humanitarian supply chains.

Hypothesis 5*: Climate change mitigation efforts through wetland restoration strategy positively contributes towards responsive green humanitarian supply chains.*

Laws, Rules, Guidelines and Protocols Governing Mitigation of Climate Change and Greening of Humanitarian Supply Chains

International frameworks include, United Nations Framework Convention (UNFCCC, 1992), Kyoto Protocol, Paris Agreement (UNFCCC, 2015), UN Convention on the Law of the Sea (UNCLOS), Carbon taxation (World Bank, 2018) and laws requiring energy efficiency in structures, gadgets, and automobiles (IEA, 2020). National laws have been enacted by almost all nations on conservation of water, food, clean air, emissions, energy efficiency, renewable energy, pollution control and effective climate mitigation and adaptation (Pereverza et al., 2025).

Laws, rules, guidelines and protocols to be used by different humanitarian agencies for greening are very rare (WWF, 2017). However, donor governments do provide guidelines to ensuring greening of humanitarian supply chains (Tull, 2019). UK aid DFID includes Environment guide (2003), HERR (2011), Carbon management plan (2013) and Better program delivery (2019). EU guidelines include Climate Adaptation Strategy, Union Civil Protection Mechanism Decision, Emergency Response Coordination Centre and EuropeAid: Guidelines on the Integration of Environment and Climate Change in Development Cooperation. Denmark - Danida; Irland – Irish Aid; Sweden – Sida; Australia - Department of Foreign Affairs and Trade (DFAT). USA: The US Agency for International Development (USAID), Code of Federal Regulations, Environmental Compliance Procedures and NEP Anet.

Incentives and subsidies for projects utilizing renewable energy, credits for taxes, loans, or aid, may greatly boost investment in sustainable energy technology as advocated by International Renewable Energy Agency (IRENA, 2024). Feed-in Tariffs (FiTs) by providing a steady stream of income or guaranteed reimbursements for the power generated by clean energy sources, can stimulate investments. Laws that stipulate that a particular amount of energy must originate from environmentally friendly sources have the potential to stimulate desire for clean energy sources (World Bank). Laws pertaining to accreditation and standardization certification guarantee the security and use of technology for clean energy (UN, 2023). Laws mandating social effects assessments and community participation processes can strengthen clean energy schemes (IRENA, 2024). Humanitarian supply chains can benefit from such measures. Regulatory monitoring ensuring that laws and rules are implemented is crucial for preserving the trust of investors and accomplishing policy objectives (European Commission, 2021).

Laws that establish efficiency and effectiveness for green humanitarian supply chains have the potential to stimulate development and enhance their effectiveness. By balancing demand as well as supply, laws that permit flexible prices and demand management techniques may assist in increasingly successful incorporation of clean energy sources. Therefore, we may say that laws and rules mediate between mitigation of climate change renewable energy strategy and responsive green humanitarian supply chains.

Hypothesis 6*: Laws and rules positively mediate the relation between climate change renewable energy strategies and responsive green humanitarian supply chains.*

Mediating Role of Laws and Rules between Climate Change Reforestation Strategy and Responsive Green Humanitarian Supply Chains

The existence and effectiveness of laws and rules governing forestry efforts have a major impact on the cost effectiveness of these efforts (Busch et al., 2024). Land use policies for replanting operations can be made more efficient by enforcing laws that limit deforestation and designate sites for replanting (FAO, 2022). Laws mandating thorough forest administration planning guarantee that efforts to reforest are carefully thought out and viable in the long run, (FAO, 2022). Laws encouraging the implementation of cutting-edge technology for tracking forestry initiatives, such as satellite imagery and Geographic Information Systems can increase precision and efficacy (Ellison et al., 2012). Clearly defined legal provisions pertaining to land ownership and native residents' rights can help to avert disputes and guarantee initiatives to reforest as reforestation is a multi-mission strategy (Delay, 2024). To ensure that restoration aims are accomplished, efficient laws that combine fines for violations and rewards for surpassing requirements are required (EU, 2024).

The environmental advantages of replanting can be increased by CSR efforts by humanitarian supply chains through adoption of native species and safeguarding already-existing ecosystems. Forestry initiatives can be supported and HSC can assist communities nearby if rules mandating public input and participation are in place (Ellison et al., 2012). Therefore, adoption of laws and rules support greening of humanitarian supply chains through climate change mitigation measures.

Hypothesis 7*: Laws and rules positively mediate the relation between climate change reforestation strategies and responsive green humanitarian supply chains.*

Mediating Role of Laws and Rules between Climate Change Carbon Capture & Storage Innovations Strategy and Responsive Green Humanitarian Supply Chains

Monetary assistance, exchange of data, and dissemination of technology may all be improved by adhering to international norms. Policies that support cross-border CCS initiatives maximize the utilization of resources at the local, national, and international levels. Robust regulatory supervision, coupled with sanctions for non-adherence and rewards for surpassing benchmarks, guarantees that carbon capture and storage (CCS) initiatives accomplish their ecological and functional objectives (Global CCS Institute, 2022). Swedish government's Climate Neural Cities – 2030 initiative helped intercity, local and national government coordination with international agencies and proved very effective in achieving the objectives (Pereverza et al., 2025).

Objectives for climate change which are coherent at governmental level and descending down to communities and individuals, will support greening of humanitarian supply chains. General population should be encouraged to contribute towards addressing the climate change (Tchinda & Talbot, 2025). Humanitarian supply chains can contribute towards mobilization and encourage involvement of all stake holders for contribution towards climate resilience. Therefore, we conclude that climate change mitigation initiatives support a greener and responsive humanitarian suppl chain.

Hypothesis 8*: Laws and rules positively mediate the relation between climate change carbon capture and storage innovations strategies and responsive green humanitarian supply chains*

Mediating Role of Laws and Rules between Climate Change Electrical Transportation Strategy and Responsive Green Humanitarian Supply Chains

Policies that provide electric cars (EVs) and the facilities necessary for recharging them with tax credits, discounts, or subsidy can increase customer interest and hasten acceptance (UNEP, 2020). Charging Infrastructure Rules require charging stations of their vehicles should be available at public locations, businesses, and homes (IEA, 2021). Rules mandating that all new construction have electric vehicle (EV) charging stations installed or prewired to accommodate subsequent installations make it easier for charging stations to grow (IEA, 2021). Zero Emission Vehicle (ZEV) rules require producers for manufacturing specific proportion of cars with zero emissions (UNEP,

2020). Laws that eliminate or lower license charges for battery-powered vehicles can help to offset the initial expenses and encourage their use. Laws that exclude or lower tolls and congestion fees for electric automobiles will promote their adoption in cities and lower their operational costs.

Humanitarian supply chains that support time-of-use charges and intelligent charging technology, promote off-season charging, maximize network efficiency and lessen load on the power grid promotes green HSC. Therefore, HSC using clean energy are considered to be more responsive and reliable while engaged in humanitarian operations.

Hypothesis 9*: Laws and rules positively mediate the relation between climate change electrical transportation strategies and responsive green humanitarian supply chains.*

Mediating Role of Laws and Rules between Climate Change Wetland Restoration Strategy and Responsive Green Humanitarian Supply Chains

Mangroves, salt marshlands, and supratidal ecosystems, collectively known as wetlands on the coast, are significant falls of carbon and offer a variety of other benefits to the ecosystem. Restoring wetlands along the coast helps achieve the SDGs in this Century of ecological restoration due to its many advantages (Twomey et al., 2024). N2O is a powerful greenhouse gas that has the possibility to cause 298 times more warming on Earth than CO2. By eliminating excessive nitrogen, regenerated coastal wetland areas also significantly contribute to better quality of water. The de-nitrification is a method that may be used to extract seawater nitrogen sequentially in the form of transitional byproducts. Unhealthy carbon rich soils, including ones found inside wetlands are conducive to de-nitrification. When the wetlands prolong, the carbon will rise, promoting de-nitrification and lowering nitrogen flow into nearby rivers.

Although restoring coastal wetlands might improve the sustainability of water and enhance Carbon preservation, they require proper regulations. Similarly, restoring flooding to formerly agricultural areas need public awareness and rules. Advantages of restoration efforts in mitigating climate change may also help greening of humanitarian supply chains. Humanitarian efforts for the effected community will integrate the population and increase the responsiveness of HSC.

Hypothesis 10*: Laws and rules positively mediate the relation between climate change wetland restoration strategies and responsive green humanitarian supply chains.*

Conceptual Framework

Keeping in view the factors identified during literature review, conceptual framework has been developed. The conceptual framework (Figure 1) shows the interaction of different variables amongst each other.

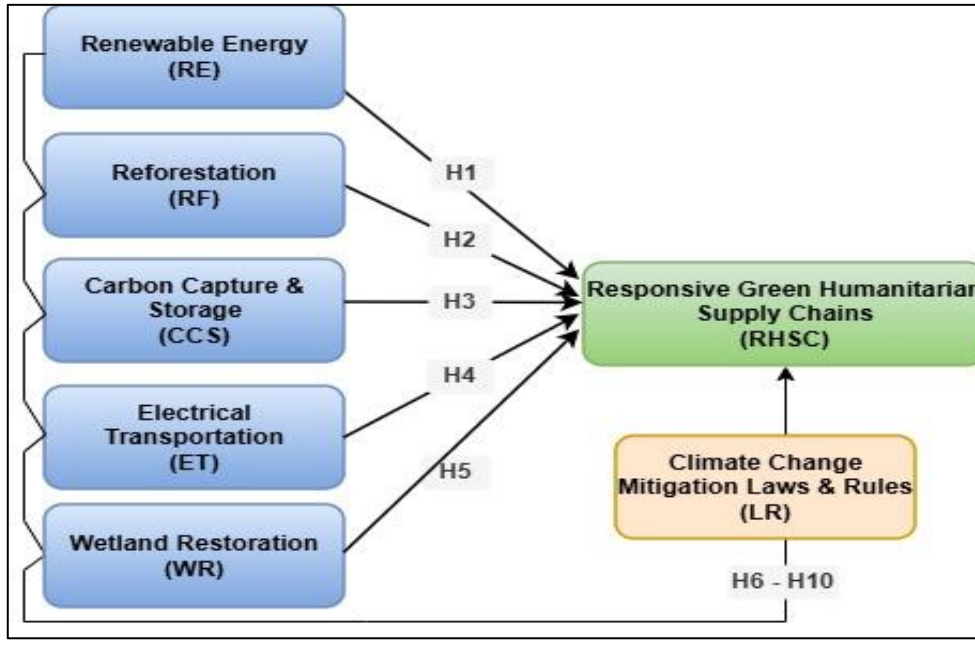

Figure 1: Conceptual Framework

Theoretical Foundation of the Study

Sustainability theory provides foundation for this research paper. The sustainability theory was coined by Elkington in 1997. He highlighted that the traditional profit is not sufficient rather it should also have triple bottom approach including social, economic and environmental benefits (Elkington, 1997). Beamon in 1999 gave the concept of greening the humanitarian supply chains which mandated the humanitarian supply chains to follow green practices to reduce the harmful effects of supply chains to environment (Beam, 1999). Similarly, Mishra and Pandey (2025) highlighted the requirement for sustainable goals for protection of environment at global level. Therefore, sustainability theory is applicable to both triple bottom approach by providing equal access to relief, reducing carbon emissions and yet function within budget. Similarly, green humanitarian supply chains reduce harm to environment while still being responsive to catastrophic conditions by providing speedy aid to effected populations.

METHODOLOGY

Explanatory research design (Babbie, 2020; Creswell & Creswell, 2018) and deductive approach has been used for this study. It is a cross sectional study in which quantitative method has been used. The study is aimed at finding "Role of Climate Change Mitigation Strategies in Responsive Green Humanitarian Supply Chains". Therefore, professionals and individuals related to climate change and humanitarian

supply chains have been selected. Only individuals having practical or hand on experience of working in these fields in any capacity were selected. These included officials of ministry of climate change and disaster management authority, International and local non-governmental organisations (NGOs), Functionaries of government/ local government, Civil society organisations and general public and Students.

Since it was difficult to identify and reach out to all members of all organizations therefore, convenience sampling technique was employed. In view of various factors established for sample size in different methods like, Rule of Thumb method (Krejcie & Morgan, 1970); Taro Yamane formula (Yamane, 1965) and A-priori calculator for sample size calculation (Soper, 2020) and climate change and humanitarian supply chains being a global phenomenon, sample of 500 was selected. Information collection from respondents was done through survey as it can target large number of respondents (Creswell & Creswell, 2018), being cost effect and time efficient (Groves et al., 2009). Questionnaire was administered through 10 trained enumerators to local respondents and through mail/ google forms link shared on WhatsApp to distant ones. The questionnaire has been adapted from UNDP study on climate change used by Dr. Stacy A.A. Hope (Hope, 2016). The questions were arranged on a Five Pointer Likert Scale; where Very Ineffective = 1; Ineffective = 2; Effective Enough = 3; Effective = 4 and Very Effective = 5.

DATA ANALYSIS AND RESULTS

Smart PLS4 has been used for data analysis. Questionnaire was distributed to 500 individuals however, 450 responded. 30 questionnaires were half or improperly filled therefore these were rejected. 19 responses had standard deviation zero as every column had same value therefore, they were also deleted. Finally, 401 responses were selected for analysis.

Demographic Profile

Table 1 shows the demographic details of the respondents. The sample consisted of 69.58 percent male and 30.42 percent female. 16.21 percent respondents were below 18 years of age, 21.21 percent were 18-35 years, 41.15 percent were 35-50 years and 21.43 percent over 50 years. Overall 83.79 percent respondents were above 18 years of age.

Employment wise 23.44 percent were employees of climate change department/ DMA, 28.43 percent were employees of NGOs, 20.69 percent were employees of local govt, 9.48 percent were civil society members and 17.96 percent students. Bulk of the respondents were from three major groups including climate change department, DMA and local govt employees.

Educational results indicate that 35.91 percent respondent were under graduate, 28.18 percent graduate, 27.18 percent masters and 8.73 percent were having qualification above masters. Result show that most of the respondents (64 %) are graduate or above

who are well educated and aware of climate change, laws and rules governing the mitigation strategies of climate change and humanitarian supply chain operations.

Reliability and Validity

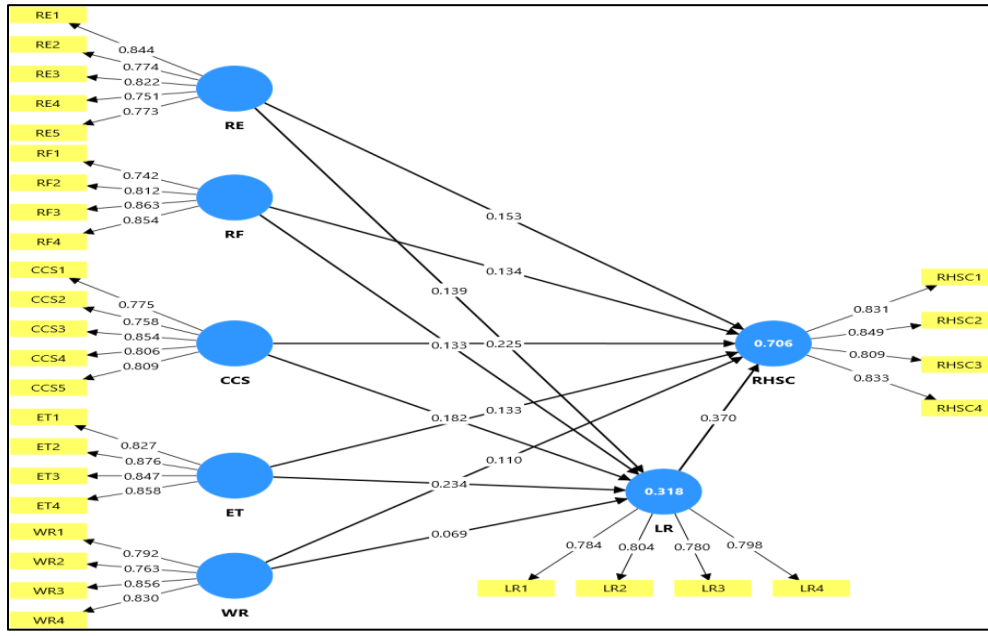

Figure 2 Research Model

Figure 2 shows the research model. Strength and relation of indicator and latent variable is indicated through outer loading. Zero value indicates no relationship and 1 indicates perfect relationship (Hair et al., 2019). As per values in research model (figure 2) all items have positive relationship with latent variables. For all latent variables minimum value is 0.742 for item RF1 and maximum value is 0.876 for ET2 which indicate that all items have strong positive relationship with their latent variables.

Table 2 shows the reliability and validity measures. Reliability is established if Cronbach's alpha value is >0.7 (Hair et al., 2019). All values in the Table 2 are above 0.7 which indicate good reliability and internal consistency. Composite reliability (rho_a) value is >0.7, which is considered good reliability (Hair et al., 2019). Composite reliability values are between 0.811 and 0.895; thus, reliability of constructs is further strengthened. Composite reliability (rho_c) value >0.7 is also considered to be a good reliability. As given in Table-2, all values are >0.7 which indicate good reliability. Similarly, a value of AVE >0.50 is good validity. All values of AVE in Table 2 are >0.50 which indicate good validity. This is also called convergent validity. Convergent validity is confirmed if two or more measures of the same construct are in agreeable limits ie if AVE exceeds 0.50.

Discriminant Validity

All values of discriminant validity (Table 3) are within acceptable limits and meets the required criterion of discriminant validity (Henseler et al., 2015). Table 3 shows discriminant validity (HTMT ratio).

R-Square Values

R Square is the measure of how much change an independent variable brings into dependent variable. An R square 0 indicates no change whereas R square 1 indicates a perfect change. It is expressed in terms of % age. More closer to 1, more change is expected and that is better (Cohen, 1988). Value of R2 is 0.706 while value of adjusted R2 is 0.702 (as given in Table 3) which indicates that 70.2% variance is explained by IVs.

Structural Model Analysis

Figure 3 below shows the relationship of various factors. Values in Table 4 indicate individual effect of each mitigation component like Renewable Energy (0.154, p=0.001), Reforestation (0.132, p=0.00), Carbon Capture and Storage Innovations (0.224, p=0.00), Electronic Transportation (0.133, p=0.00) and Wetland Restoration (0.111, p=0.006) has positive significant effect on Responsive Green Humanitarian Supply Chain (Cohen, 1988). These results indicate that all IVs (RE, RF, CCS, ET and WR) have a significant positive relationship with RHSC thus ***Hypotheses 1 to 5 are accepted***. Mediating laws and rules also have significant positive effect on Responsive Green Humanitarian Supply Chain (0.371, p=0.00). LR partially mediates the relationship between IVs and RHSC.

Mediating Role of Laws and Rules between Climate Change Mitigation Strategies and Responsive Green Humanitarian Supply Chains

Values in table 5 show mediation effect of Laws and Rules. If the value is less than 20%, it indicates weak mediation. Value between 20-50% indicates moderate mediation and value over 50% indicates strong mediation. Values for RE, RF, CCS and ET are 24.9%, 27.20%, 23.10% and 39.40% respectively which indicate partial mediation effect between these variables and RHSC. Mediation value for WR is 18.70% whereas its p value is 0.203 which is insignificant. Therefore, we may conclude that laws and rules partially mediate relationship between RE, RF, CCS, ET and RHSC therefore, ***H6, H7, H8 and H9 are accepted*** whereas, mediation for WR is also weak and insignificant therefore, ***H10 is rejected***.

Table 1: *Demographic Profile of Respondents*

Details	Frequency	Percent	Cumulative Percent
Gender			
Male	279	69.58	69.58
Female	122	30.42	100
Age Profile			
< 18 Years	65	16.21	16.21
18 to 35 Years	85	21.21	37.42
33 to 50 Years	165	41.15	78.57
Over 50 Years	86	21.43	100
Occupation			
Climate Change/ DMA	94	23.44	23.44
NGOs	114	28.43	51.87
Govt/ Local Govt	83	20.69	72.56
Civil Society/ Public	38	9.48	82.04
Student	72	17.96	100
Education			
Under Graduate	144	35.91	35.91
Graduate	113	28.18	64.09
Masters	109	27.18	91.27
Higher than master	35	8.73	100
Total	**401**	**100**	

Table 2: Reliability and Validity Measures

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CCS	0.861	0.871	0.9	0.642
ET	0.875	0.895	0.914	0.726
LR	0.803	0.811	0.87	0.626
RE	0.852	0.854	0.895	0.63
RF	0.835	0.841	0.89	0.671
RHSC	0.851	0.854	0.899	0.69
WR	0.828	0.844	0.885	0.658

Table 3: Discriminant Validity (HTMT ratio)

	CCS	ET	LR	RE	RF	RHSC	WR
CCS							
ET	0.43						
LR	0.548	0.465					
RE	0.826	0.434	0.533				
RF	0.553	0.243	0.431	0.512			
RHSC	0.789	0.558	0.827	0.751	0.606		
WR	0.7	0.362	0.452	0.589	0.515	0.659	

Figure 3 Structural Model

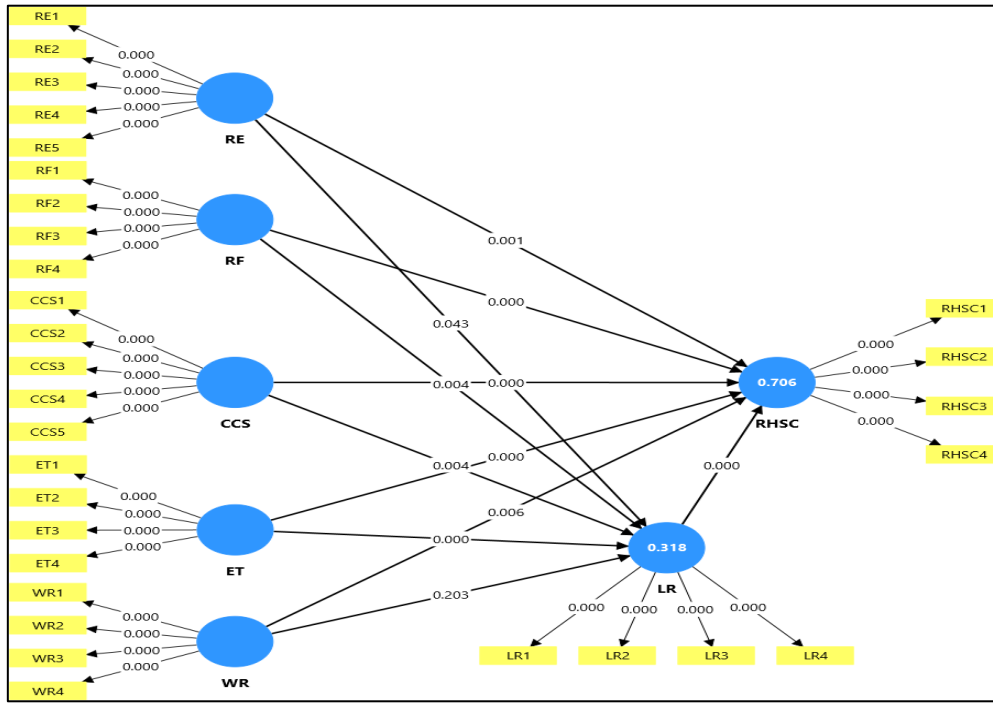

Table 4: Path Coefficients

Path Coefficients	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/ STDEV)	P Values	Hypothesis Decision
RE -> RHSC	0.154	0.155	0.045	3.414	0.001	H1 accepted
RF -> RHSC	0.132	0.134	0.036	3.685	0	H2 accepted
CCS -> RHSC	0.224	0.223	0.048	4.652	0	H3 accepted
ET -> RHSC	0.133	0.133	0.034	3.906	0	H4 accepted
WR -> RHSC	0.111	0.11	0.04	2.771	0.006	H5 accepted
LR -> RHSC	0.371	0.369	0.034	10.96	0	H6 to H9 accepted
RE -> LR	0.138	0.14	0.068	2.026	0.043	
RF -> LR	0.133	0.136	0.046	2.863	0.004	
CCS -> LR	0.182	0.182	0.062	2.917	0.004	
ET -> LR	0.233	0.231	0.044	5.355	0	
WR -> LR	0.069	0.069	0.054	1.274	0.203	H10 rejected

Table 5: Mediation Effect

Predictor	Indirect Effect	Direct Effect	Total Effect	Sobel z	Mediation % (VAF)	P value	Interpretation
RE	0.0512	0.154	0.2052	1.99	24.90%	0.043	Moderate mediation
RF	0.0493	0.132	0.1813	2.80	27.20%	0.004	Moderate mediation
CCS	0.0675	0.224	0.2916	2.84	23.10%	0.004	Moderate mediation
ET	0.0864	0.133	0.2194	4.76	39.40%	0	Moderate mediation
WR	0.0256	0.111	0.1366	1.27	18.70%	0.203	No meaningful mediation

DISCUSSION

Significant and positive relationship of all IVs with DV indicate that the main components of climate change mitigation strategies and their role in green humanitarian supply chains have been correctly identified. Value of LR effect (0.371) is highest for RHSC which indicate that respondents feel that laws and rules have a very significant role to ensure responsive green humanitarian supply chains. Similarly, weak values for WR indicate that the laws governing these components are unable to regulate them in right direction or not being implemented in true letter and spirit. Insignificant p value for WR also indicate that the laws and rules governing this component are not effective enough to regulate it. The rules governing WR need to be refined and adopted as part of wholesome strategy. These laws and rules need to be implemented across the board to accrue desired outcomes.

Responsive Green Humanitarian Supply Chains can be ensured in two ways. One is following mitigation strategies and other one is adoption of Green Humanitarian Supply Chains. Mitigation and adoption will work in tandem to cope with many facets of the RHSC. Measures for reducing severity of climate change concentrate on cutting emissions of greenhouse gases, whereas, adoption entails making adjustments to functioning of humanitarian operations. Most important facet of mitigation is to avoid potential harm. Setting priorities for activities and efficiently assigning expenditures are important for mitigation. Massive expenditures in conservation of energy, green power, and carbon capture and storage techniques are necessary for mitigation initiatives. However, expenditures in facilities, environmental reconstruction, and social resilience initiatives might form part of adoption efforts. It is necessary to carefully weigh the affordability, additional benefits, and immediacy choices while weighing such objectives.

Besides only reducing pollutants or building climate preparedness, each mitigation measure has its own advantages. Putting money towards public transit, for instance, additionally lowers pollutants but also promotes accessibility and improve air quality. Likewise, preserving and repairing ecological systems delivers ecological

benefits and serves as a home for wildlife in addition to emission's reduction. Humanitarian supply chains can spread public awareness through CSR initiatives. There are additional compromises in mitigation strategies, especially when it comes to resources distribution and land usage. For example, the growth of biomass commodities for mitigating could conflict against the area required for agriculture or the preservation of ecosystems. The uncertainty and extent of impacts from climate change determine the scope and duration of mitigation initiatives. Since the advantages of mitigation generally spread across years or even millennia, forecasting and investments are necessary.

Moreover, strategies ought to be put into place quicker in reaction to dangers that are more imminent, such as extreme temperatures and humanitarian supply chains need to strike fine balance between greening and mitigation strategies. To minimize the hazards related to unchecked global warming and to prevent limitation of elevated emissions routes, swift action is critical. Environmental consequences adversely influence poor people, especially marginalized populations and nations with low incomes. Consequently, humanitarian supply chains must give priority to those who are most vulnerable while offering fair utilization of assets and managerial procedures. In a same vein, mitigation approaches must take into account both economic as well as social ramifications for all parties involved and refrain from escalating existing disparities.

Practical Implications

Humanitarian operations planned while giving due consideration to environment surely increases its responsiveness and sustainability by reducing project cost, DRR, enhancing gender equality, increasing food security and being energy efficient. Climate change mitigation strategies are required to be enforced by governments and organizations by improving laws and rules. Enforcement of laws and rules is hallmark of success of any mitigation strategies and greening efforts of HSC. This entails integrating environmental risk evaluations into policy for the use of land, construction of infrastructure and response to disasters through GHSC. Limits and subsidies need to be implemented by governments to lower the release of greenhouse gases in all industries including HSC. This might entail giving specific goals to be met for ensuring reduction of emissions by each HSC. It will also include establishing mechanisms for pricing carbon and encouraging the use of clean energy by offering financial incentives and tax breaks.

Strategies directed to reduce pollution or emissions of GHG include encouraging alternatives of transportation with current Information Technology (IT) advancements, sharing a vehicle particularly in cities, management for the utilization of land especially in higher metropolitan concentrations, promoting the adoption of greener forms of transportation, decreasing the total budget on transportation and maybe altering the working style like work from home etc. Authorities, HSC and residents may successfully mitigate the fundamental sources of global warming and

adjust with its repercussions by following green practices. These best practices will result into a safer and healthier future for everyone.

Moreover, governments and organizations need to work on the efficacy of laws and rules governing the Wetland Restoration. These rules need to be aligned with the desired outcomes. Making these rules stricter but practical will ensure positive outcomes. Advanced nations need to take lead in this regard and set a good precedence for others to follow. International organizations like UN and its subsidiary organizations need to evaluate the reasons for less performing laws and rules and improve upon the existing ones to enhance their role in mitigation and adoption strategies.

Following is suggested to enhance the effectiveness and responsiveness of green humanitarian supply chains:-

- Enhanced level of CCS targets be given at humanitarian organizations, regional and country level. Hard to de-carbonize sectors such as heating and heavy duty transport should be focused for targeted reduction of emissions. These targets be made mandatory and binding on all HSC. Financial and credit ratings of all humanitarian organizations be linked to their performance as per given targets.
- Funding in CCS technologies be encouraged by giving special incentives in terms of credit facilitations and donations to humanitarian operations.
- Mutual collaborations and partnerships for CCS be encouraged at humanitarian, country, regional as well as global scale.
- Binding laws for wetland restoration with more incentives and penalties need to be enacted at every tier from global to individual state level.
- Laws and rules to ensure maximum wetland restoration on public land be enacted to give specific target areas by all member nations of UNO.
- Use of latest technologies including bioengineering be encouraged to enhance the resilience in extreme weather and soil conditions.

LIMITATIONS

Certain mitigation solutions, such as upgraded nuclear power plants other smart measures need constant evaluation and innovations. They confront several technological difficulties, such as high prices and other scaling problems. Few mitigation strategies require additional resources and technological innovations to take effect. Considering poor nations and businesses, the initial expenditures of switching to environmentally friendly infrastructure and technology may be unaffordable. Implementation of energy-efficient and green energy initiatives is hampered by a shortage of funding and investment possibilities. Poor neighborhoods may become more susceptible to environmental hazards if they have restricted availability of funds. These issues could not be studied in this research at length.

There are connections between the changing climate along with other worldwide problems including healthcare, nutrition and inequality to be addressed by Responsive Green Humanitarian Supply Chains. Isolating the effects of the changing climate might make these problems worse or have unexpected repercussions. It takes

coordinated methods to address several issues at once by GHSC. Moreover, there could be more components of mitigation strategies which could be explored to completely mitigate the effects of climate change and adopt green practices to make the environment cleaner and healthier for future generations.

CONCLUSION

Laws, rules, guidelines and protocols to mitigate climate change and enhance the efficacy of these strategies and to encourage the greening of humanitarian supply chains do exist. Few are implemented in letter and spirit while others are not, depending upon particular psyco-social setup of particular organization or nation. Laws and rules regarding RE, RF, CCS and ET are performing well while those related to WR and greening of HSC are being ignored on pretext or the other. A well-rounded strategy incorporating mitigation as well as adoption of green practices are required for effectively combating climate change effects and making humanitarian organizations really responsive at the same time. We can strive for a more durable and healthy future in the midst of changing climates by acknowledging their complimentary nature, prioritizing activities, maximizing additional benefits, taking size and time into account, and dealing with equality issues.

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