



THE RELATIONSHIP BETWEEN GREEN SUPPLY CHAIN PERFORMANCE, ENERGY DEMAND, ECONOMIC GROWTH AND ENVIRONMENTAL SUSTAINABILITY: AN EMPIRICAL EVIDENCE FROM DEVELOPED COUNTRIES

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ABSTRACT. Background: This study is for examining the association between green logistics, energy demand, renewable energy consumptions, environmental performance and sustainable economic development in a panel of nineteen developed economies around the globe over the period from 2008 - 2017. In addition, the article expands domain of green logistics from firm level to country level and also connects national scale economic indicators with green logistical performance.

Methods: The study employs Pools OLS (ordinary least square) statistical technique to check hypothesis, while secondary data have been used, which were downloaded from the World Bank.

Results: The results reveal that the green logistics indicators have strongly positive correlation with green energy sources, FDI inflows, and Trade openness. On the other hand, greenhouse gas emissions and carbon emissions have negative correlation with green logistics. Furthermore, renewable energy is a driving factor of green logistics and supply chain operations which also promote environmental and economic sustainability.

Conclusion: This article provides the insight of the association between green logistics performance and national scale economic and environmental indicators. In addition, this research will help practitioners, senior managers and policymaker to understand the importance of renewable energy and green practices in logistical operations.

Key words: Renewable energy; Trade openness; Greenhouse gas emissions; Green Supply chain management; Economic development.

INTRODUCTION

In modern and integrated global supply chain management, logistics and transportation play an important role in the way from suppliers to consumers' door. Global logistics operations have posed a significant threat to the environmental beauty in terms of poor air quality, climate change, greenhouse gases and carbon emissions [Gruner and Power 2017, Ai et al. 2015]. The idea of eco-friendly logistics or green logistics is considered as an environmental innovation. The basic aim of eco-friendly logistics is to mitigate harmful

effects of logistics operations on environmental sustainability. Accordingly to Dekker et al., [2012] logistics operations are a mainly contributor of carbon emissions, while green logistics build a sustainable balance between social, environmental and economic growth [Ceranica et al., 2017]. European commission [EUROPA, 2011 and 2017] report confirmed that transport is the main cause of air pollution in terms of burning fossil fuel and energy. Undeniably, transport related industry is connected with almost 10 million people, which accounts for around 5% of total employment and generates about 4.6% in gross domestic product. Khan et al., [2017a]

conducted a panel study in the context of European countries to explore the association between green logistics and economic indicators. Seen from the findings, greenhouse gas and carbon emissions would affect product value added and GDP per capita income of countries. Due to electronic media and social websites, consumers are more aware of ecological and polluted products as compare to before. In addition, regulatory authorities and governmental bodies are more aggressive to put environmental-friendly policies into practice.

Undeniably, the adoption of green practices in logistics and business operations provides opportunities to build competitive advantages against their competitors. Khan and Dong, [2017] highlighted that green logistics does not only improve environmental performance in terms of reduction in carbon emissions, greenhouse gas emissions, climate change, and global warming, but will also enhance

economic performance and build competitive advantages [Simão et al., 2016]. Zaman and Shamsuddin, [2017] did a study on green logistics, and the results showed that logistics indicators are well-connected with the industry value added, energy prices, and trade openness, etc. that provoke GSCM (green supply chain management) in the area. Aldakhil et al., [2018] explored the relationship between green logistics, economic factors (GDP, Trade openness, and FDI inflows) and environmental indicators (CO₂ emissions). Seen from the results, the significantly positive association between green logistics indices and country's per capita income, which confirmed that supply chain management is integrated with country's economic development and corporate environmental policies that are necessary for continuous payoffs. Vachon and Mao [2008] emphasized the importance of implementing green practices in logistics operations for protecting environmental sustainability.

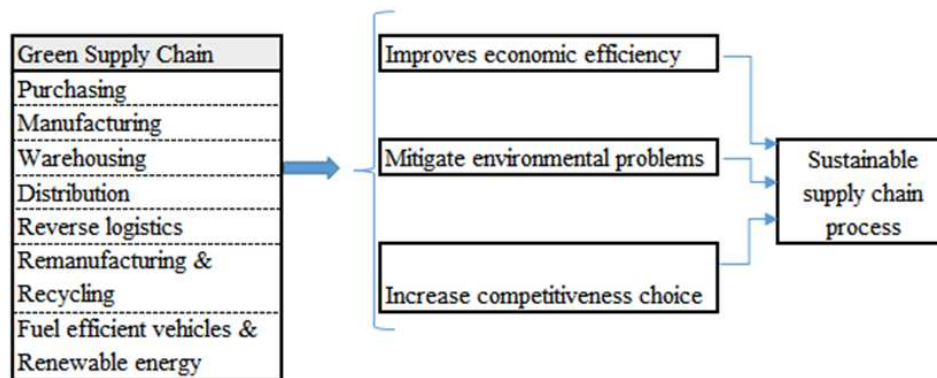


Fig. 1. Relationship between green supply chain, economic growth and environmental factors

According to Abrams et al. [2017] the green logistics is a complete system responsible for the environment, not only dealing with forward logistics, [Chunguang et al., 2008] but also covering the reverse logistics including waste recycling, energy recovery, remanufacturing, and disposal in landfill. Khan et al., [2016] and Maritime, [2016] examine the influence of green management operations on customer satisfaction and long-term orientation. The findings revealed that green practices enhance customer trust and satisfaction with improved positive image of firms. Zhu et al., [2008]

inspected the linkage of senior management support and the adoption of green practices in supply chain operations in context of Chinese manufacturing industry. After the control on the influence of marketing, cost pressures, supplier and firm size, they found significantly positive relationship between senior management support and adoption of green practices. The significance of green logistics across the European countries is desirable to promote their ecological products in international markets including Asian and African markets. Fig.1. displays the

relationship between environmental-economic factors and green supply chain.

In previous empirical studies, a number of researches conducted their research on firm-level to explore the benefits of green practices adoption in supply chain and business operations, and very few researchers conducted empirical studies on macro-level to identify and explore the association between green supply chain management, economic growth and environmental performance [Khan et al., 2018, Aldakhil et al., 2018] in the context of BRICS countries. But this research will provide a clear picture of green logistics and supply chain on macro-level indicators in the context of twenty-two developed economies around the globe. Furthermore, this research will help to find relationship between national economic and environmental indicators including, trade openness (TOP), foreign direct investment inflows (FDI inflows), greenhouse gas emissions (TGHT), energy consumption, CO₂ emissions, Fossil fuel consumptions (Fossil), and renewable energy consumption with green logistics performance. The rest of research paper is arranged as follows: section 2 discusses some relevant research papers and development of hypothesis in terms of green logistics, economic growth and environmental sustainability. Section 3 covers the data source and methodology of research. Section 4 displays analysis and discussion on results. Section 5 includes conclusion, policy analysis and future research work.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The relationship between energy demand and green logistics

The relationship between green logistics and energy demand is extensively discussed in supply chain and logistics industry. On the other hand, green practices require renewable energy sources which can control the harmful effects of logistical operations. Halldórsson and Kovács [2010] focused that, at enterprise' operational level, it is required to improve environmental sustainability through adoption of green practices in supply chain operations.

Anable et al. [2012] argued that transportation congestion and long lead-time emits greater carbon emissions, which is a cause of environmental degradations and poor human health. Iakovou et al. [2010] results indicated that waste biomass can be an appropriate solution for minimizing the heavy reliance on fossil fuel energy, but, the cost of waste biomass utilization is the main burden on firms' profitability statement. [Mraihi, Abid 2013] highlighted that correlation between economic development and greater energy consumption in logistics operation is one of the important relations, which should be further studied. Undeniably, logistics plays a vital role in countries' economic growth, while transport and logistics operations are heavily dependent on energy and fossil fuel consumption, which is polluting and destroying the environmental sustainability. Bhattacharya et al. [2016] and Khan et al. [2018] found that renewable energy usage in supply chain operations cannot only improve environmental performance in terms of mitigating carbon emissions but also improve economic development. Aldakhil et al. [2018] suggested that regulatory authorities and/or governmental bodies should encourage the usage of renewable energy in supply chain activities for better environmental growth and sustainable growth of economy.

Limanond et al. [2011] conducted a research in the context of Thailand to find out the association between energy demand, economic growth and transportation industry. They found that economic development is positively correlated with energy demand. Khan et al. [2016] argued that firms cannot adopt green practices in their business operations without adoption of renewable energy sources. Khan et al. [2017] conducted a research and its findings indicated that logistics activities consume greater energy and also increase demand of energy, which results in an improved industry value added activities and countries' economic development. Therefore, we suggested the following hypothesis:

- H1: The greater energy demand is positively associated with logistics performance
- H2: The greater renewable energy consumption has positive correlation with green logistics performance

The association between economic growth and green logistics

Green practices in logistical and supply chain operations improve the economic growth. Further, green manufacturing, green purchasing and ecological design of products are supportive to enhance economic performance of firms [Khan et al. 2018, Khan, Dong 2017, Zhang, Zhao 2012]. Zaman and Shamsuddin, [2017] did this research on 15 selected panel countries, and the findings revealed that green logistics enhances the FDI inflows and trade openness, and mitigate the harmful effects of business operations in terms of reduction in carbon emissions, fossil fuel consumptions and greenhouse gas emissions, which improves air quality and resolve the problems of climate change. Hansen and Rand, [2006] and Khan et al., [2017] FDI (foreign direct investment) inflows act as one of the backbone for healthier economic growth. The findings confirmed that FDI inflows are significantly and positively correlated with sustainable economic development. Bengoa and Sanchez-Robles, [2003] did this study on 18 Latin American countries with the panel data during 1970 to 1999, and the results showed that green supply chain operations build positive image of the country, which attracts the foreign investors. [Khan et al. 2017] argued that the industry, manufacturing share in GDP is negatively affected by greater carbon emissions. Shahbaz et al. [2015] conducted a panel research on African countries and found that energy consumption increases carbon emissions, while usage of biofuel and renewable energy may enhance environmental beauty. In addition, biofuel energy sources are inexpensive as compare to fossil fuel [Khan et al. 2018].

The increasing FDI makes significant contributions to economic growth of China [Wei et al. 2015]. The country is the second largest foreign direct investment recipient in the world and these foreign direct investments bring knowledge, capital and new managerial skills. [Lu et al. 2010] conducted an empirical study in China to explore the relationship between FDI inflows and green logistics operations. The findings revealed that green practices in logistical operations improve the

efficiency of logistical operations and reduce environmental degradations.

Wanzala and Zhihong [2016] the inefficient logistics system ignoring environment discourages investments and incurs heavy costs in the supply chain systems such as higher import duties, expensive storage and delayed customs clearance due to polluted materials, reduce exports and opportunities in European and Western countries. On the other hand, green logistics does not only attract foreign investors and tourists but also increases the export opportunities and captures new markets in international arena. Based on the above cited research papers, we construct the following hypothesis:

H3: The green logistics performance is positively correlated with foreign direct investment

H4: The green logistics performance is positively correlated with greater business and trade openness

The association between environment and green logistics performance

A number of studies were conducted for figuring out the relationship between environmental sustainability and logistics performance [Van-Hoek 1999]. Hayami et al. [2015] argued that air pollution in terms of carbon emissions and greenhouse gas emissions are severely increasing due to polluted supply chain operations and failure of governmental bodies. Similarly Boin, Kelle, and Whybark [2010] warned we should be prepared for environmental disaster due to the greater carbon emissions that were increasing day-by-day. Wiebe, J. [2014] highlighted the sustainability issues and explained that the main problem was not what people were doing, but how they were doing, for example, if firms manufacture products with green energy, they will protect the environmental beauty and also reduce the costs and build competitive advantage in terms of customer satisfaction and trust with improved logistical operations and efficient delivery to customers. Dangelico and Pontrandolfo [2013] found that corporate sector financial performance is positively correlated with green logistical and supply chain operations, and CO₂ emissions are not

only negatively correlated with environmental performance but also reduce overall organizational performance [Huiying Zhang Fan Yang 2016].

The primary goal of greening logistics and supply chain processes are to reduce “footprints and carbon emissions” but due to adoption of ecological practices, firms may improve their financial performance [Khan et al. 2016]. In addition, [Colicchia et al. 2016] the firms’ better reputation and positive image are linked with green practices and building environmental collaboration with their supply chain partners. Simão et al., [2016] and Hahn et al., [2010] findings revealed that many times firms are pressurized by international organizations and governmental bodies to implement ecological practices in their supply chain activities, and even such green practices may negatively correlated with firms’ economic performance, and huge investment on green technologies and worker trainings may shrink firms’ profitability [Walley and Whitehead, 1994]. But in the long run, green investment is positively correlated with enterprise operational, environmental and financial performance and also builds

competitive advantage in terms of positive image and reputation in the market. With the above cited research papers, we develop the following hypothesis:

H4: The environmental concerns in logistics operations are positively correlated with the green logistics performance.

DATA SOURCE AND METHODOLOGY

This research draws the relationship between economic growth, environmental performance, and energy demand with green logistics operations in a panel of 19 developed countries. Definitely, energy acts as a key contributor in supply chain and transportation activities and a backbone of economic growth. But sustainable environmental and economic development is negatively correlated with polluted logistical operations. This article mainly interlinks logistics operations with national scale environmental and economic indicators. Table 1 shows the definitions of construct.

Table 1. Definition of Constructs

| Constructs | Definitions |
|-----------------------------------|---|
| GLP (green logistics performance) | The logistics green practices has been adopted by regulatory authority to reduce emissions, while GLP has been calculated by efficiency of customs clearance process to reduce carbon emissions, Quality of trade and transport-related infrastructure, and competence and quality of logistics services with minimum possible emissions. |
| FDI (foreign direct investment) | Foreign direct investment inflows is a leading indicator of handsome economic activities. FDI inflows used as a proxy for economic indicator |
| REC | REC is the renewable energy (% of total final energy consumptions). |
| Energy | Energy is the energy consumption (Kg of oil equivalent per capita) |
| Fossil Fuel | Fossil is the fossil fuel energy consumption (% of total); fossil fuel is the key contributor of emissions |
| TGHG | TGHGs indicate the total greenhouse gas emissions (Kt of CO ₂ equivalent) |
| TOP | TOP is the trade openness (percent of gross domestic product) used as a proxy for economic indicator |
| CO2 | CO2 is the carbon emissions (metric tons per capita) emits through logistics systems, which does harm to environmental sustainability. |

We adopted the following equation to examine the green logistics performance with panel of 19 developed economies (Germany, Italy, Spain, United Kingdom, United States of America, Poland, Norway, Netherlands, Switzerland, Belgium, Sweden, Turkey, Australia, New Zealand, Malaysia, Japan, South Africa, Qatar, and Indonesia) i.e.,

$$GLP_{it} = \beta_0 + FDI_{it}\beta_F + TGHG_{it}\beta_T + Fossil_{it}\beta_{FF} + TOP_{it}\beta_{TO} + CO2_{it}\beta_c + Energy_{it}\beta_E + REC_{it}\beta_R$$

Where, GLP indicates whole green logistics performance; FDI shows foreign direct investment inflows; TGHG indicates Total greenhouse gas emissions (Kt of CO₂ equivalent); Fossil shows fossil fuel energy consumption (% of total); TOP means Trade openness (percent of gross domestic product); CO₂ reflects to Carbon emissions (metric tons per capita); Energy shows Energy consumption (Kg of oil equivalent per capita); and REC indicates Renewable energy (% of total final energy consumptions).

This empirical study is primarily to explore the relationship of explanatory variables

(foreign direct investment inflows, energy demand, renewable energy consumptions, fossil fuel, total greenhouse gas emissions, carbon emissions and trade openness) on logistics performance. We employed Pooled OLS (ordinary least square) statistical method to test our research hypothesis. Pooled OLS is the most effective and suitable statistical method when data is stationary on level [Vachon and Mao, 2008]. The research selected a panel of 19 developed economies around the globe and samples were downloaded from World Bank website during the period of 2008 to 2017 [World Bank, 2018].

RESULTS AND DISCUSSION

Table 2 shows the descriptive statistics of explanatory and dependent variable. The table indicates that all the selected variables have a strong positive mean value and a significant peak of the distribution, which endorses the improved logistics operations support to the 19 developed economics.

Table 2. Descriptive Statistics

| | GLP | FDI inflow | Energy | CO2 | TGHG | Fossil | TOP | REC |
|-----------|-----------|------------|----------|---------|---------|---------|-----------|----------|
| Mean | 3.232691 | 7.762446 | 5410.211 | 8.53814 | 705,561 | 88.6611 | 826315.31 | 19.98616 |
| Median | 3.151000 | 4.021357 | 5061.371 | 6.40142 | 719,251 | 88.0142 | 563212.58 | 11.03681 |
| Maximum | 4.730000 | 81.11279 | 9433.119 | 23.5611 | 781,985 | 93.1247 | 998759.91 | 66.24874 |
| Minimum | 2.154000 | -2.617194 | 163.8105 | 0.40118 | 561,059 | 81.6241 | 389212.89 | 0.009641 |
| Std. Dev. | 0.570698 | 8.847209 | 2231.577 | 5.10263 | 64,810 | 3.0291 | 425231.17 | 16.61512 |
| Skewness | -0.521041 | 4.314704 | 0.509147 | 0.81521 | -0.4401 | -0.4089 | 0.6692141 | 1.163454 |
| Kurtosis | 2.011720 | 40.31114 | 2.324551 | 2.72118 | 2.102 | 3.2076 | 2.3155423 | 3.256227 |

Table 3. Correlation Matrix

| | GLP | FDI inflow | Energy | CO2 | TGHG | Fossil | TOP | REC |
|------------|----------|------------|-----------|-----------|----------|----------|----------|----------|
| GLP | 1.000000 | | | | | | | |
| FDI inflow | 0.239731 | 1.000000 | | | | | | |
| Energy | 0.571393 | 0.077207 | 1.000000 | | | | | |
| CO2 | 0.420421 | 0.078731 | 0.811122 | 1.000000 | | | | |
| TGHG | 0.215451 | 0.095142 | 0.742912 | 0.71125 | 1.000000 | | | |
| Fossil | 0.526897 | -0.655213 | 0.882143 | 0.95267 | 0.26517 | 1.000000 | | |
| TOP | 0.985421 | 0.985235 | 0.829976 | 0.23514 | 0.85267 | 0.74168 | 1.000000 | |
| REC | 0.276257 | 0.236142 | -0.349946 | -0.536392 | -0.46223 | -0.12436 | 0.856289 | 1.000000 |

Table 3 indicates the correlation matrix and it can be found that environmental factors CO₂

emissions, greenhouse gas emissions, fossil fuel consumption, energy demand and

renewable energy consumptions have positive correlation with logistics performance indicator. Logistics operations act as a significant generator of carbon emission due to greater consumption of fossil fuel and energy demand, while renewable energy consumption is growing in trend and many developed and developing countries are changing towards renewable energy sources.

Foreign direct investments (FDI) inflow and Trade openness have positive relationship with logistics operations. It means FDI inflow and Trade openness are improved by environmental friendly policies in business and logistics activities. Energy efficiency is positively associated with FDI inflows and

logistics performance. Carbon emissions and greenhouse gas emissions have negative correlation with green energy consumption, as renewable energy consumption is increasing and CO₂ emissions and greenhouse gas emissions are decreasing, which is the positive sign for healthy and environmental friendly logistics operations. Finally, FDI inflows are positively associated with renewable energy sources, because REC (renewable energy consumption) is a first step towards greener production and logistics operations, and REC provides opportunities to invest in a country, which is a positive sign for green logistics performance and economic and environmental sustainability.

Table 4. Unit root tests

| Variables | Levin, Lin & Chu Test | | ADF- Fisher Test | | PP- Fisher Test | |
|------------|-----------------------|--------|------------------|--------|-----------------|--------|
| | At level | | At level | | At level | |
| | T-statistics | Prob. | T-statistics | Prob. | T-statistics | Prob. |
| GLP | -19.4131 | 0.0000 | 137.015 | 0.0001 | 215.51 | 0.0000 |
| FDI inflow | -4.18247 | 0.0000 | 246.761 | 0.0000 | 285.08 | 0.0000 |
| Energy | -6.09683 | 0.0000 | 181.213 | 0.0000 | 214.176 | 0.0000 |
| CO2 | -7.8911 | 0.0000 | 185.775 | 0.0000 | 216.141 | 0.0000 |
| TGHT | -6.1454 | 0.0000 | 173.225 | 0.0000 | 212.136 | 0.0000 |
| Fossil | -8.9101 | 0.0001 | 186.264 | 0.0002 | 274.012 | 0.0000 |
| TOP | -5.8421 | 0.0003 | 179.361 | 0.0000 | 229.221 | 0.0000 |
| REC | 3.45838 | 0.0315 | 71.7959 | 0.0431 | 84.0082 | 0.0324 |

Before applying pooled OLS statistical method, we need to confirm our all explanatory and dependent variables are stationary at level to fulfil the prerequisite requirement of pooled OLS statistical method. Table 4 indicates the unit root test by considering three different criteria including ADF- Fisher Test, Levin, Lin & Chu Test, and PP- Fisher Test. Seen from the findings of unit

root tests, it can be confirmed that our all endogenous and explanatory variables are stationary at level.

After fulfilling the essential parametric assumptions, OLS statistical method was adopted to test hypothesis. Table 5 indicates results of hypothesis.

Table 5. Hypotheses Testing for Green Logistics Performance

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------------|-------------|------------|-------------|-------|
| (Constant) | 3.1015 | 0.117147 | 26.47564 | 0.000 |
| Energy | 0.0003 | 0.000491 | 7.625093 | 0.000 |
| REC | 0.0097 | 0.002943 | 3.325409 | 0.001 |
| FDI inflow | 0.0086 | 0.004145 | 2.083032 | 0.039 |
| CO2 emissions | -0.015 | 0.022258 | -4.966705 | 0.000 |
| TGHG emissions | -0.035 | 0.359174 | -3.893521 | 0.002 |
| Fossil Fuel | -0.049 | 0.554136 | -4.100534 | 0.001 |
| TOP | 0.0521 | 0.898726 | 5.125436 | 0.000 |

a. Dependent variable: Green logistics performance (F = 39.174, <0.001; Adjusted R = 61.4%)

The co-efficient of parameter estimates suggest the 'Energy' (.0003, $p < 0.01$), 'REC' (.0097, $p < 0.01$), 'FDI inflow' (.0086, $p < 0.05$), and 'TOP' (.0521, $p < 0.01$) reflect a statistically significant and positive effect on green logistics performance. For another side, 'CO₂ emissions' (-0.1105, $p < 0.01$) and 'TGHG emissions' (-0.035, $p < 0.01$) have suggested a significantly negative impact on green logistics performance. The results of pooled OLS analysis show that exogenous variables including Energy, REC, Trade openness and FDI inflow have statistically significant and positive relationship with green logistics performance, while CO₂ emissions and greenhouse gas emissions are negatively correlated with green logistics performance.

The findings show that energy is a most significant factor and a driving force of logistical and supply chain operations, while energy is positively correlated with logistical operations at the 1% confidence level. Similarly, Khan et al. [2017] and Shahbaz et al. [2015] confirmed that energy is the cornerstone of economic growth and supply chain and logistical operations are heavily dependent on it, while energy also increases carbon emissions and greenhouse gas emissions, which can be mitigated through adoption of renewable energy. Qureshi et al. [2016] and Anable et al. [2012] conducted an empirical study and found that economic development and energy demand have strong positive relationship. On the other hand, when some countries are suffering from energy shortfall, their economic development are very slow and due to energy shortages, their logistics and manufacturing industries are unable to significantly make contributions in economic growth.

Energy demand acts as a positive sign for economic development in developed countries and to reduce energy impact on sustainability, renewable energy and cleaner energy is an appropriate option to continue sustainable economic development through green logistics operations. Bhattacharya et al. [2016] the findings revealed that for environmental sustainability, renewable energy is the best solution which cannot be implemented in

business operations without the support of regulatory bodies to encourage green technologies in supply chain operations. Zaman et al. [2016] did a research on BRICS countries, and the findings showed that usage of renewable energy is increasing in developed countries due to proper policies implemented by lawmakers. In the context of China [Zhu et al., 2008] governments and regulatory authorities are struggling to enhance their sustainability image by using cleaner technologies and renewable energy sources [Abdul et al., 2017]. In a number of developed countries, renewable and green energy consumption approach is more flammable as compare to emerging and under-developed economies [Vance et al., 2015], while one reason is an encouragement from government and regulatory authorities in terms of tax exemptions and subsidies [Khan et al. 2018, Khan and Dong 2017, Bhattacharya et al. 2016]. The countries suffering from energy crises their economic activities are badly smashed. Grekova et al. [2014] the countries using green logistics and sustainable logistics operations can reduce the general energy consumption and increase operational efficiency by using green practices. [Vance et al., 2015] the study confirmed that using electricity from the natural gas, renewable and green sources can yield substantial reduction in costs around 17% and also play a significant positive role in improving environmental sustainability with healthier economic growth.

A number of developed countries are using 100% clean energy sourcing including Denmark and Ireland, while these countries' economic development is more sophisticated because of higher performance of green supply chain and logistics operations. The key advantage of biofuels is decreasing CO₂ emissions and greenhouse gas emissions. The fossil fuel sources are costlier as compare to renewable energy systems, because the renewable energy sources can be offered with locally available energy so as to reduce the cost of purchasing fossil fuels [Khan et al. 2017, Zawaydeh 2017], while renewable energy not only deals with air pollution, global warming, and climate change problems, but also plays a vital role in improvement of green

logistics performance. Abbasi and Nilsson [2016] explained that transportation activities have a number of negative impact on environmental sustainability. Because a large number of countries are still dependent on non-renewable energy sources, which have serious negative effect on climate change, air pollution and people's health. On the other hand, Abbasi and Nilsson, [2016] insisted that the adoption of green practices in logistics operations are inconclusive without the use of renewable energy in production and logistics activities. Egilmez and Park [2014] concluded that logistics industry are the responsible for poor air quality and environmental degradations, and these environmental issues can be dealt with usage of renewable energy in supply chain and logistical operations.

Foreign direct investment inflow and trade openness are a measure of sustainable economic development, while green practices in logistics and business activities attract foreign investor and provide export opportunities to manufacturing firms in pro-environmentalist countries including USA, UK and Germany. In well-developed economies, FDI inflow and trade volume is greater due to green practices and policies implemented by governmental bodies. Our research shows that trade openness and foreign direct investment inflows have positive relationship with green logistics operations at 1% and 5% level of confidence respectively. There is no doubt that carbon and greenhouse gas emissions have become a global issue, while regulatory authorities and corporate sectors are facing so strong pressure from local and international customers and United Nation that they have to control harmful effects and improve the environmental sustainability through adopting eco-friendly policies. Zaman and Shamsuddin, [2017] conducted a panel study on green logistics performances, the findings provide evidence that FDI inflows, energy demand, manufacturing value added, and industry value added have positive relationship with green logistics performance. Wanzala and Zhihong, [2016] polluted logistical systems do not only destroy environmental beauty but also face the threat of losing pro-environmental customers' market and also discourage export opportunities in pro-environmental countries.

In addition, polluted logistics activities would also incur huge costs in end-to-end supply chain with heavy import duties and delayed customs clearance due to polluted materials. On the other hand, polluted logistics systems also face pressure from governments and customer side in terms of heavy penalties, bad reputation and boycott of polluted firms' products [Khan and Qianli 2017].

The research conducted by Zhao et al. [2008] explored the association between green practices and governmental policies, the results indicate that environmental performance can be enhanced through strong legal enforcement by the governmental bodies. The key reason for corporate sectors to implement ecological practices includes customers' pressure, global ecosystem deterioration, and environmental policies implemented by government [Li et al. 2016]. However, some financial benefits and competitive advantages are also motivate enterprises to be engaged in green practices including, [Pearson, 2013] positive image building, reduction in costs, export opportunities, and exploring new customers' markets [Nurjanni et al. 2016, Park et al. 2016, Schaltegger, Synnestvedt 2002].

The greater greenhouse gas and carbon emissions are the indicators to represent worst environmental performance. The findings confirmed that greenhouse gas emissions and carbon emissions are negatively correlated with green logistics operations in selected panel of countries on 1% confidence level. This results are also supported by other researches, including Khan et al. [2017] and Dangelico and Pontrandolfo [2013], Aldakhil et al. [2018] suggested that companies' economic performance is negatively correlated with higher pollution, while carbon emissions and greenhouse gas emissions not only create hindrance in adoption of green practices in logistical and supply chain operations but also create negative impact on enterprise reputation and image. K. H. Lee and Wu [2014] logistics activities act as a significant contributor to CO₂ emissions and greenhouse gas emissions, and in order to mitigate the negative effects of logistical and supply chain operations, enterprises need to use renewable energy and adopt green practices in their business

operations. The Inter-governmental Panel for Climate Change (IPCC), confirmed that greenhouse gases emission by industrial [Wang et al. 2015] and logistics operations represent 21% and 14% respectively. The greater emissions are generated due to global logistics activities and freight transport with long lead-time, while these harmful effect of carbon emissions and greenhouse gas emissions can be reduced through adopting green practices in logistics operations.

The logistics and supply chain operations are greatly burning fossil fuels and generate air and water pollution including sulfur dioxide, nitrogen oxides [Silva, Zhu 2009, 2011] volatile organic compounds and particulate matter (PM 2.5). The pollution travels with storms and winds and via water ways to the residential areas [Kawamoto 2008] and causes serious health problems [Memon 2010]. Climate change and global warming issues are seriously influenced by global logistics and supply chain operations, as a means of the increase in the number of vehicles increases global carbon emissions and greenhouse gas emissions [Meyer et al. 2007], while the linkage between foreign direct investment inflows and trade volumes and sustainable logistics operations reaps economic profit and (Brooks., 2008) mitigation of negative effects of carbon emissions on the environmental beauty [Zaman, Shamsuddin 2017, Khan et al. 2017]. In addition, green logistics and supply chain operations significantly [Khan et al. 2017] enhance energy efficiency, foreign direct investment inflows, sector and economic growth in a panel of selected nineteen economies.

CONCLUSIONS

The long-term logistics policies that are eco-friendly should be made to promote usage of renewable energy and green practices in logistics and supply chain operations in order to control harmful effects of greenhouse gas emissions and carbon emissions on environmental beauty. The primary contribution of this research is to develop a green logistics model, which is well-integrated with national economic and

environmental indicators in a panel of nineteen developed economies around the globe. The study used carbon emissions, greenhouse gas emissions, trade openness, foreign direct investment inflows, energy demand, and renewable energy with the global logistics performance indices. In addition, the study found that renewable energy, foreign direct investment inflows, and carbon and greenhouse gas emissions have positive impact on green logistics operations in a panel of nineteen developed countries. The research employed pooled OLS statistical method to explore the linkage between economic, environmental and green logistics performance, while carbon emissions and greenhouse emissions are negatively correlated with green logistics performance, which may control and mitigate through adoption of renewable energy sources to decrease harmful effects on environmental sustainability and also increase foreign direct investment inflows. The results are very useful in making long-term green logistics policies that helpful for protecting environmental sustainability and controlling environmental degradation.

The logistics performance indices are considered as feasible instrument to measure the efficiency of countries policies towards sustainable economic growth and environmental performance. In addition, green logistics operations also indicate global competition war of economic growth with ecological protection. The regulatory bodies' policies to decrease carbon and greenhouse gas emissions, preserve natural resource, and reduce global warming and climate change problem which seriously damage the fauna and flora can be possibly carried out through implementing green initiatives in logistics and supply chain operations.

POLICY ANALYSIS

The research confirmed that energy demand, renewable energy sources, environmental and economic sustainability are well connected with eco-friendly polices adopted in logistical operations in a panel of nineteen developed economies. The study shows that green logistics performance

improves efficiency of energy, FDI inflows, and usage of renewable energy in business activities, while greenhouse gas and carbon emissions are decreased significantly. In similar line, renewable energy sources are positively correlated with improved performance of green logistics, attracting foreign investors and improving economic development. In other words, regulatory bodies need to encourage renewable energy usage in manufacturing and logistics operations to spur countries' FDI inflows and GDP per capita income. On the other hand, polluted logistical systems are rejected in European countries and they are not allowed to export in many pro-environmental countries because of polluted logistics vehicles. The association between logistics indices with environmental and sustainable economic development confirmed that the eco-friendly logistical operations will significantly promote environmental sustainability agenda in terms of greater utilization of biofuels, green and/ renewable energy sources.

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RELACJA POMIĘDZY ZIELONYM ZARZĄDZANIEM ŁAŃCUCHEM DOSTAW, POPYTEM NA ENERGIĘ, WZROSTEM EKONOMICZNYM I ROZWOJEM ZRÓWNOWAŻONYM NA PODSTAWIE KRAJÓW ROZWIĘTYCH

STRESZCZENIE. Wstęp: Praca prezentuje wyniki analizy powiązań pomiędzy zieloną logistyką, popytem na energię, konsumpcją energii odnawialnej, wpływem na środowisko oraz zrównoważonym rozwojem ekonomicznym na podstawie 19 rozwiniętych krajów z całego świata w okresie 2008-2017. Dodatkowo, omówiono rozwinięcie zielonej logistyki z poziomu przedsiębiorstwa do poziomu kraju jak również powiązanie krajowe ekonomiczne wskaźniki z działalnością zielonej logistyki.

Metody: Zastosowano metodę statystyczną Pools OLS dla sprawdzenia postawionych hipotez, gdzie użyto dane pochodzące z Banku Światowego.

Rezultaty: Na podstawie otrzymanych wyników stwierdzono, że wskaźniki zielonej logistyki wykazują silną pozytywną korelację z zielonymi źródłami energii, przepływem FDI oraz otwartością handlu. Z drugiej strony emisja gazów cieplarnianych oraz węgla wykazuje negatywną korelację z zieloną logistyką. Dodatkowo, energia odnawialna jest wiodącym czynnikiem zielonej logistyki i operacji łańcucha dostaw, wspierającym również ekonomiczny rozwój zrównoważony.

Wnioski: Praca przedstawia powiązania pomiędzy zieloną logistyką a krajowymi wskaźnikami ekonomicznymi i ekologicznymi. Dodatkowo, daje wskazówki dla praktyków, zarządzających średniego szczebla oraz politykom dla lepszego zrozumienia istotności energii odnawialnej oraz zielonych praktyk w operacjach logistycznych.

Słowa kluczowe: energia odnawialna, otwartość handle, emisja gazów cieplarnianych, zielone zarządzanie łańcuchem dostaw, rozwój ekonomiczny

DER ZUSAMMENHANG ZWISCHEN DEM GRÜNEN LIEFERKETTENMANAGEMENT, DER NACHFRAGE FÜR ENERGIE, DEM WIRTSCHAFTLICHEN WACHSTUM UND DER NACHHALTIGEN ENTWICKLUNG AM BEISPIEL DER AUSGEWÄHLTEN HOCHENTWICKELTEN LÄNDER

ZUSAMMENFASSUNG. Einleitung: Die Arbeit präsentiert Ergebnisse der Analyse der Zusammenhänge zwischen der grünen Logistik, der Nachfrage für Energie, dem Verbrauch von regenerativer Energie, dem Einfluss auf die Umwelt und der nachhaltigen wirtschaftlichen Entwicklung am Beispiel von 19 hochentwickelten Ländern aus der ganzen Welt in den Jahren 2008-2017. Zusätzlich wurde die Entfaltung der grünen Logistik aus dem Niveau des Unternehmens auf das Landesniveau besprochen und die inländischen wirtschaftlichen Kennziffern mit Auswirkungen der grünen Logistik in Zusammenhang gebracht.

Methoden: Es wurde die statistische Pools OLS-Methode zur Bewertung der gestellten Hypothesen, wofür man die von der Weltbank gewonnenen Daten in Anspruch nahm, angewendet.

Ergebnisse: Aufgrund der erzielten Resultate stellte man fest, dass die Kennziffern der grünen Logistik eine stark positive Korrelation mit grünen Energiequellen, dem FDI-Fluss und der Aufgeschlossenheit des Handels aufweisen. Andererseits weist die Treibhausgas- und Kohlemission auf die negative Korrelation mit der grünen Logistik hin. Darüber hinaus ist die erneuerbare Energie ein führendes Element innerhalb der grünen Logistik und der operativen Lieferkette, welches auch die wirtschaftliche nachhaltige Entwicklung unterstützt.

Fazit: In der Arbeit wurden die Zusammenhänge zwischen der grünen Logistik und den inländischen, wirtschaftlichen und ökologischen Kennziffern projiziert. Außerdem gibt sie Hinweise für die Praktiker der mittleren Verwaltungsebene und für die Politiker, damit sie alle die Relevanz der regenerativen Energie und der grünen Aktivitäten innerhalb der operativen Logistik besser verstehen können.

Codewörter: regenerative Energie, Aufgeschlossenheit des Handels, Treibhausgasemission, grünes Lieferkettenmanagement, wirtschaftliche Entwicklung

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