Measuring the Impact of Adopting Smart Energy on Technological Progress, Operations Performance and Green Environment: Logistics Companies in ALEXANDRIA, EGYPT as a case study

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Received on: 06 February 2022 Accepted on: 01 April 2022 Published on: 28 May 2022

Abstract

Purpose: This study aims to investigate the role of the use of smart energy in logistics companies to increase technological progress, improve operation performance and lead to a green environment.

Design/ methodology/ approach: Primary data were collected through a questionnaire. This questionnaire targeted 80 employees of supply chain department working at logistics companies located in Alexandria, Egypt. The collected data were analyzed through using data testing using validity and reliability, descriptive analysis, testing regression assumptions, normality test for the research variables, correlation and regression.

Findings: The results succeeded to prove that the use of smart energy has a significant effect on technological progress, operation performance and green environment.

Research implications/ limitations: This research provides a clear understanding to the decision makers and policy makers of the suitable ways of applying smart energy projects in the logistics companies in Alexandria, Egypt. It also shows the positive effect of smart energy projects on other variables, which encourages applying the smart energy projects, whether in the logistics companies or in other fields. Moreover, this study has a limitation regarding the sample as it depends on a sample of 80 employees at a certain context: the logistics industry.

Originality: This paper adds new dimensions to the framework of smart energy, whereas previous studies only focus on the application and the usage of smart energy without focusing on its impact on other dimensions.
Keywords: Green Environment, Operation Performance, Smart Energy, and Technological Progress.

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

Introduction

The technological progress, performance of operations and green environment nowadays represent the main factors that companies aim to reach (Fernando et al., 2019). Technological progress was proved as a main factor that leads to achieve economic and financial growth on the long term (Donou-Adonsou et al., 2016). Moreover, operation performance is related to the development of product efficiency, improvement of the processes, conformity of quality and short times lead (Croom et al., 2018). Finally, green environment represents a significant dimension in achieving sustainable development (Nishant et al., 2020).

The importance of the aforementioned three dimensions has forced the companies to look for the best and cheapest ways to achieve them. Smart energy system is considered as an approach in which smart electricity, heat and gas networks are combined with storage technologies to determine the aspects of exclusion among them to achieve an ideal solution for each sector separately and for a comprehensive energy system (Gondal, 2019). Smart energy system reduces the cost of renewable energy systems as it focuses on energy efficiency and provides the final use to create the flexibility of the energy system (Mathieson et al., 2015). Also, there is a great interest in bringing a smart energy system to improve the quality, reliability and efficiency of logistics processes and reduce stress on the system (Gellings, 2020).

Many studies have focused on the adoption of smart energy cities and smart energy projects among different countries. For example, Quijano-Sánchez (2020) studied the development of smart cities in Mexico. Both researchers depended on making semi-structured interviews in order to collect data. The targeted sample was six employees at the Ministry of Economic Development in Mexico City. The researchers identified many drivers that led to smart energy adoption. In addition, they found that any changes or innovations required in the government services and processes in Mexico need to have a legally empowered political decision.

In this research, the researcher focuses on smart energy hub adoption by logistics companies located in Alexandria, Egypt, where it aims to investigate the impact of adopting smart energy inside logistics companies located in Alexandria, Egypt on technological progress, operation performance and green environment. Accordingly, three objectives are developed: the first objective is to identify the effect of smart energy adoption on technological progress. The second objective is to determine the extent to which smart energy affects operation performance. The third objective is to find the effect of smart energy on green environment in the logistics companies located in Alexandria, Egypt.

Through observing the previous literature, the researcher noticed that there are two main gaps: the first gap is that there are no studies that examined the adoption of smart energy in the logistics context inside Egypt. The second gap is that previous studies had focused only on the adoption and establishment of smart energy projects inside one or more countries, without paying any attention to examining the impact of adopting those projects on technological progress, operation performance and green environment. Thus, this paper is trying to fill in those two gaps.

The research has a number of contributions that will add to the academic body of knowledge and literature regarding a clear understanding of smart energy, technological progress, operation performance and green environment. Therefore:

- This research aims to investigate the impact of adopting smart energy inside logistics companies located in Alexandria, Egypt on technological progress, operation performance and green environment, which is rarely found in the literature as there is a shortage of the studies investigating this adoption in Egypt.
- The researcher introduces a clear background of the adoption of smart energy projects and smart cities in Egypt, while the previous literature introduces this concept inside different countries.
- Some of the previous research studies focused

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

only on the adoption of smart energy in one or more countries without linking it with other factors; therefore, in this research, all the factors are connected to reach to the best results, especially in Egypt.

Therefore, the contribution of theory can be represented as that: to investigate the link between the use of smart energy on technological progress, operation performance and green environment at logistics companies in Alexandria, Egypt. This is something that previous studies have not addressed because the previous literature have not discussed the impact of all of these factors together, so researchers should work on conducting more studies on the impact of more factors on technological progress, operation performance and green environment to ensure the best adoption of smart energy.

However, there are some practical contributions represented in giving the decision makers a comprehensive grasp of the use of smart energy influence technological progress, operation performance and green environment. Furthermore, insights into additional use of smart energy that influence technological progress, operation performance and green environment are shared.

This paper is divided into seven sections: section one is the introduction, section two represents the literature review, section three discusses the research contribution, section four is the research methodology, section five is the research variables and framework, section six represents the empirical studies and findings, and, finally, section seven introduces the research discussion.

Literature Review

This section represents the literature review related to the research topic. It is divided into three parts: adoption of smart energy in different countries, adoption of smart energy in Egypt and, finally, the research hypotheses' development.

Part One: Adoption of Smart Energy in Different Countries

This section is going to discuss previous studies that had introduced the impact of smart energy adoption in different countries; for example, Noppers et al. (2016) aimed to investigate the extent to which the evaluations of instrumental, symbolic and environmental attributes can explain the actual adoption of smart energy systems that facilitate sustainable energy use. The findings assured that the adopters of smart energy systems evaluated the symbolic attributes of these systems more positively than non-adopters, while both groups did not differ in their evaluation of the instrumental and environmental attributes of smart energy systems.

In addition, Macke et al. (2018) identified the development of smart city in Brazil. Data were collected through a questionnaire survey that was distributed among residents, and a total of 400 answers were collected. The analysis of data proved that the success of smart cities is recognized when achieving socio-structural relations, material well-being, environmental well-being and community integration.

Moreover, Wang (2020) introduced the development of smart energy in the logistics industry inside China as a case study. The researcher concluded that China succeeded to achieve a great success in adopting smart energy inside the logistics context. Additionally, China started to work on a transition from a vast logistics country to a worldwide logistics powerhouse.

Furthermore, Tan and Taeihagh (2020) investigated the adoption of smart urban development projects and strategies in developing countries through collecting previous literature that has investigated this adoption. Both researchers depended on analyzing a sample of fifty-six studies and concluded that the adoption of smart urban development projects and strategies in African developing countries has started recently, and it is expected that by year 2050, the African countries will achieve a growth rate of urban population with 16%.

Besides, Bhattacharya et al. (2020) evaluated three smart cities in India through utilizing the index of Smart

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

Sustainable City Development (SSCDI). This index helped in capturing economic, social, cultural, environmental and lifestyle dimensions inside the three cities.

Bhattacharya et al. (2020) assured the importance of energy efficiency, urban mobility and water supply as well as usage of ICT among citizens in any smart city. In addition, in the Indian context, the researchers indicated that any planning of smart cities needs to ensure good life quality for the citizen, which includes affordable housing with good quality, cost efficient physical infrastructure, safety and security, quality education, entertainment, ease of seeking and obtaining public services, efficient healthcare, transparency and opportunities for participation in governance.

In addition, Rześny-Cieplinska and Szmelter-Jarosz (2021) studied the adoption of smart energy in the logistics industry. The researchers adopted a three-layer methodology: first was collecting previous literature, second was making interviews with urban logistics stakeholders and third was analysis of interviews. The results proved significant differences between the opinions of the interviewed group. Moreover, results can contribute to the scientific discussion about the analysis of the goals of stakeholders of smart logistics.

According to the previous studies, which are investigated in this section, the impact of smart energy adoption had been discussed in different countries, so it is important to know the impact of smart energy adoption in Egypt and know the difference, as the focus of the present study is Egypt. Therefore, the adoption of smart energy in Egypt is discussed in the next section.

Part Two: Adoption of Smart Energy in Egypt

This section identifies the impact of smart energy in Egypt, where it introduces the adoption and development of smart energy in different contexts inside Egypt. Before the 2011 revolution of Egypt, lack of technology and internet access leads to a delay in the institutional service inside Egypt. In addition, urban development was neglected, which negatively affected the performance of public service (Hamza, 2016). Moreover, there was a huge development gap between the rural and the urban parts of Egypt; also, this gap occurred between governorates and cities, as approximately 40% of the development investments took place only inside Cairo Governorate (Gil-Garcia et al., 2015).

After the revolution, the government started to pay more attention to adopting sustainable urban development projects. Those projects were recommended by the World Bank and the European Union, aiming to revive the Egyptian economy. Moreover, the European Union gave financial aid of 200 million euros to the Egyptian government in order to help Egypt in its smart cities projects. Egypt started to work on smart cities that depend on utilizing smart energy.

Smart cities aimed to reach urban development in different fields (economic, social and political). Nowadays, there are 20 projects of smart cities all over Egypt. Those smart projects are being implemented through cooperation between the public and the private sectors (such as the projects of smart electricity). New Cairo project, named "Smart village", represents one of the most important projects of those twenty projects. The central government had chosen New Cairo city to apply smart energy systems in different fields, such as smart healthcare, smart water and smart electricity. New Cairo city council succeeded in making some reforms in public institutions. It also succeeded in making collaboration with the private sector in order to build up the new electricity networks project under the public accountability and military management as a government agency (Alsaid, 2021).

In addition, Hamza (2015) saw that "Smart Village" is a village that was established by the collaboration between the Egyptian government and the investors of the private sector in 2001. This village is considered as a successful model of a smart city since the government established this village aiming to host the information technology companies and provide essential services standards (high standards buildings and landscape, networks security, etc.). Finally, the researcher concludes that this village faced some obstacles regarding practical application.

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

Although the European Union provided financial aid to the Egyptian government to help it in implementing the smart projects, this aid only covered the cost of infrastructure network in New Cairo project. This pushed the government to depend on the collaboration with the public sector (Alsaid, 2021). On the other hand, the lack of funding forced the Egyptian government to make political pressure on the public institutions around the whole cities (Alsaid and Ambilichu, 2020).

Beside the smart cities projects, the Egyptian government has started to pay a great attention to using clean and renewable resources of energy, as it has started to focus more on the production of natural gas as a cleaner resource of energy than coal or any other harmful resources. The Egyptian government made partnerships with international companies regarding the exploration of natural gas, in which Egypt has succeeded to be a major regional center for its production and exporting. Moreover, Egypt is considered as one of the first Middle Eastern Countries that aims to utilize nuclear power, as it has succeeded in developing technological nuclear infrastructure inside Cairo, after working with the International Atomic Energy Agency (IAEA) and international partners (Bahgat, 2013). Additionally, it is noticed that Egypt has a great chance to produce solar energy from the Western Desert, wind energy from the Gulf of Suez and hydropower energy from the River Nile. However, investments in these resources of energy are still limited (Ibrahim, 2012).

Therefore, it is noticed that Egypt has recently started to adopt smart energy projects. First, smart projects have depended on financial aids that came from external resources. Additionally, projects of smart energy and smart cities represent projects done by the government or by cooperation between the public and the private sectors. It is also noticed that projects of smart energy are very costly to the Egyptian government, which leads the government to put pressure on the public institutions. Besides those projects, the Egyptian government started to depend on renewable and clean resources of energy to be adopted all over Egypt.

Finally, it could be noted that there is a gap in research that investigated the adoption of smart energy in Egypt, as well as those studies that focused only on smart cities projects without focusing on smart energy in a certain industry or project (Hamza, 2016; Alsaid and Ambilichu, 2020 and Alsaid, 2021). Other studies, such as; Ibrahim (2012) and Bahgat (2013), focused only on the conversion from non-renewable resources to renewable and clean resources of energy without focusing on smart energy projects.

Part Three: Research Hypotheses

This section develops the research hypotheses. It is observed that there is a lack of studies that investigate the effect of adopting smart energy on other variables. Regarding this relationship, it is noticed that there are no previous studies that have investigated the effect of smart energy on technological progress, but at the same time, there are some studies that have linked the technological factors and information technology with smart energy. For example, Ferreira et al. (2014) examined the roles of Artificial Intelligence (AI) and Information and Communication Technologies (ICT) on the development of smart grids. This analysis included the research and development processes among different regions in the world. The results had proved that both of AI and ICT had a significant impact on smart grids adoption. On the other hand, this study worked on providing simulation tools that aimed to develop control strategies, which aimed to provide stable solutions to address the challenges that the smart grids' development faces.

In addition, Vijai and Sivakumar (2016) examined the adoption of internet of things (IoT) system located inside smart cities through utilizing India as a case study. Results indicated that the urbanization and growth of population led to increasing the demand of basic resources like water. Therefore, the government adopted IoT systems aiming to reach a proper usage of water, through the commitment of proper monitoring and management of distribution systems of water.

Moreover, Connolly et al. (2016) investigated the impact of smart energy on the technological and economic changes. The findings of analysis showed that by using the approach of smart energy system, a 100 percent of renewable energy system in Europe is technically possible without consuming an unsustainable amount of

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

bioenergy. This is due to the additional flexibility that is created by connecting the electricity, heating, cooling and transport sectors together, which enables the intermittent renewable penetration of over 80% in the electricity sector.

Furthermore, Biresselioglu et al. (2018) examined the barriers and motivators affecting the European decision-makers in the development of smart and green energy technologies, the adoption of smart energy and green energy technologies among decision makers. The analysis depended on the identification of three levels of formal social decision-making units: Formal Social, Collective Decision-Making, and Individual Consumers engaging in joint contracts. The analysis proved that the definition of "smart grid" is strongly related to the technological developments in the EU energy sector, which causes a lack of a common understanding regarding this concept. This interpretation across member states in turn causes a variance in responses among governing bodies, which are reflected on the public policies and regulations that address this issue.

Besides, Wang et al. (2019) investigated the adoption of smart energy in China and its influence on energy service business model. Through this study, the researchers succeeded in developing new solutions to solve the challenge of smart energy for the State Grid Corporation of China's business model. Moreover, the analysis proved that both of innovation and reformation will be doomed and embraced by smart energy in the Chinese energy system, which includes technological progress and system mechanism reform. This study proved that the technological progress is considered as a main factor that helps in adopting smart energy, while the current study examined the effect of smart energy on technological progress.

According to the above studies, it clearly appears that there is a lack in studies that investigated the effect of smart energy on technological progress. Thus, the current study has a contribution in studying this relation as well as it has another contribution regarding testing this relation in Logistics Context inside Egypt. Therefore, the researcher develops the first hypothesis:

H_1: There is a significant relationship between the use of smart energy and technological progress of corporation

Regarding this hypothesis, it is noticed that most of studies have focused only on the adoption of smart cities inside the country and evaluating the performance of these cities without investigating the effect of smart energy on the operation performance inside a certain industry. For example, Noppers et al. (2016) aimed to investigate the extent to which the evaluations of instrumental, symbolic and environmental attributes can explain the actual adoption of smart energy systems that facilitate sustainable energy use. The findings assured that the adopters of smart energy systems evaluated the symbolic attributes of these systems more positively than non-adopters, while both groups did not differ in their evaluation of the instrumental and environmental attributes of smart energy systems.

In addition, Chasin et al. (2020) aimed to analyze the effect of smart energy projects on the business model. Moreover, a comparative study was done between the business models that use smart energy and those that use traditional ones. The researchers depended on analyzing 175 energy firms. The results showed that the traditional energy had a hesitancy regarding the revision of their BMs. Instead, smart energy prefers to build on BM extensions by outsourcing the innovation activities in subsidiaries or by using partnerships. Finally, this study had provided an overview of the current smart energy market for private households, which can represent a starting point for BM innovation, especially for energy utilities.

Moreover, Bhattacharya et al. (2020) evaluated three smart cities in India through utilizing the index of Smart Sustainable City Development (SSCDI). This index helped in capturing economic, social, cultural, environmental and lifestyle dimensions inside the three cities. Bhattacharya et al. (2020) ensured the importance of energy efficiency, urban mobility and water supply as well as usage of ICT among citizens in any smart city. In addition, in the Indian context, the researchers indicated that any planning of smart cities needs to ensure good life quality to the citizen, which includes

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

affordable housing with good quality, cost efficient physical infrastructure, safety and security, quality education, entertainment, ease of seeking and obtaining public services, efficient healthcare, transparency and opportunities for participation in governance.

Furthermore, Liang et al. (2020) succeeded in reviewing concept models of global smart cities and smart energy systems. Moreover, they succeeded in developing a business model. Data were collected through reviewing the connotations of smart energy systems, smart energy city, and the definition of SET according to China's national conditions. Through this review, the gaps and barriers of developing SET in China were identified. In addition, the researchers determined four main stakeholders in China: China's central government, international organization, China's regional government, and enterprises, where some recommendations were provided to those stakeholders regarding the development of smart energy towns in China. Finally, a business model innovation was designed that aims to support the economic development.

Accordingly, it is noticed that there are no studies that showed the impact of smart energy adoption on operation performance, neither in the logistics field nor in other fields. Therefore, the current study has a contribution regarding this point and by that the second hypothesis is developed, which states that:

H_2: There is a significant relationship between the use of smart energy and operation performance

Regarding this hypothesis, it is noticed that previous studies have only focused on studying the effect of smart energy on pollution and carbon dioxide. For example, Liu et al. (2012) investigated smart cities in China. The Chinese government had an aim in establishing low-carbon cities. Thus, the researchers aimed to introduce the success of adopting low-carbon cities in China through taking Suzhou of Jiangsu Province as a case study. After collecting data about the province, the results proved that it is impossible to investigate an absolute carbon emission reduction, but at the same time it was possible to reduce the intensity of carbon dioxide emissions in China.

In addition, Pan et al. (2020) examined the adoption of smart energy inside the logistics in China, which leads to reducing the carbon emissions. Therefore, the researchers worked on investigating the main factors influencing the establishment of Smart Logistics in Chinese cities through utilizing the Binary choice model. Results proved that freight volume, logistics employment and total social retail represented main factors that determine whether the city needed to establish Smart Logistics or not. Moreover, results proved that smart logistics helped in reducing carbon emissions.

Moreover, Shi et al. (2020) aimed to investigate the relationship between smart energy, artificial intelligence and low-carbon economy. The researchers aimed to examine this relation, as there are problems existing in the optimization of power generation industry in China. The researchers collected data about annual load, electricity price, climate data of a southern power grid, uses the statistical variation particle swarm optimization algorithm, and uses the historical runoff and rainfall data. Depending on the collected data, an optimal operation model of power industry was established, where this model was developed based on both of the artificial intelligence and the protection of low-carbon environment.

Furthermore, Fenton (2020) analyzed the adoption of smart energy in the logistics context inside Europe. This research referred to an example of the Clean truck project that was established in Stockholm city. This project aimed to utilize the renewable fuels on the logistics transport in order to reduce greenhouse gas emissions and air pollution caused by the logistics industry. The success of this project led to making the City of Stockholm and two fuel suppliers own the European funding for a project that engaged stakeholders in the logistics context and purposed to overcome first-mover problems.

Besides, Zhu et al. (2021) illustrated the challenges, obstacles, and, on the other hand, the opportunities that face the adoption of smart energy in the context of carbon dioxide reduction. Through this research, four opportunities and ten obstacles were identified regarding the conducting of smart energy systems to reduce carbon emissions. Finally, the researchers provided

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

some recommendations, which were represented in the following points: smart energy system research should begin with a combination of technological innovation and practical application. In addition, the smart energy systems key technology should consider the needs of people's daily life to evolve in a more intelligent and diverse path.

According to the above studies, it clearly appears that there is a lack in studies that investigated the effect of smart energy on green environment. Thus, the current study has a contribution to studying this relationship in the Logistics Context inside Egypt. By that, the third hypothesis is developed; which states that:

H_3: There is a significant relationship between the use of smart energy and green environment

This research aims to investigate the impact of adopting smart energy inside logistics companies located in Alexandria, Egypt on technological progress, operation performance and green environment. Smart energy represents an advanced source of energy that depends on clean and renewable resources of energy that are characterized by their low costs. Therefore, this energy helps in reaching technological progress, improving the performance of operations and leading to a green environment (Omer, 2008).

Through surveying the literature review, the researcher succeeds in identifying different definitions related to the concepts and terminologies of the research variables, as well as choosing the suitable definition of each of the independent variables (smart energy) and dependent ones (technological progress, operation performance and green environment) related to the research topic (Dincer and Acar, 2018).

The previous literature also helped the researcher to get a clear background of the adoption of smart energy projects and smart cities inside different countries. Moreover, previous studies showed that each country depends on its own way regarding the adoption of smart projects, where some of them fully succeeded in adopting those projects, while others find some obstacles in the application (Dryjanski et al., 2020).

From the previous literature, the researcher found that there are shortages of studies that investigated the adoption of smart energy projects in Egypt. There are few studies, such as Hamza (2016), Alsaid and Ambilichu (2020), and Alsaid (2021) that only focused on smart cities in Egypt without focusing on particular projects, industry or context that adopted smart energy. On the other hand, there are studies that have investigated the adoption of smart energy projects in the logistics context in other countries, such as Liu et al. (2012), Pan et al. (2020), Fenton (2020), Wang (2020), and Rześny-Cieplinska and Szmelter-Jarosz (2021).

Finally, it could also be noticed that most of the previous studies have focused only on the adoption and establishment of smart energy projects inside one or more countries, without paying any attention to examining the impact of adopting those projects on other factors, as only the studies of (Noppers et al., 2016) examined the relationship between instrumental, symbolic, environmental attributes and smart energy, and the study of Fenton (2020) investigated the effect of smart energy on greenhouse gas emission and air pollution. Moreover, Pan et al. (2020) tested the effect of smart logistics on carbon emissions. Also, Bhattacharya et al. (2020) examined the effect of smart energy on six dimensions of smart sustainable city development.

Therefore, the contribution of this study is represented in linking smart energy projects and their impact on the technological progress, operation performance and green environment inside logistics companies located in Alexandria, Egypt.

Research Methodology

This study depends on positivism philosophy and deductive approach, which are suitable to the research topic. The research also depends on the quantitative design as numerical data were collected using a questionnaire that targeted employees working in supply chain departments at logistics companies in Alexandria, Egypt. The statements of the questionnaire were adopted from previous studies in order to fit the main aim of this research, so there is no need for a pilot study;

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

it is only a pretest to ensure that the formulation of these statements is conveying the meaning. Finally, the study depends on several techniques of data analysis: descriptive analysis, regression analysis and correlation analysis.

This study also depends on collecting primary data, through making a questionnaire that targeted employees working in supply chain departments at logistics companies in Alexandria, Egypt. To achieve this, the questionnaire was designed to be clear and unbiased, easy to understand and maintain the respondent's interest and motivation.

This questionnaire aims to measure the study variables: smart energy, technological progress, organizational performance and green environment, where they are measured through a 5-point Likert-scale. A Five-point Likert scale questionnaire is used to measure the impact of adopting smart energy inside logistics companies on technological progress, operation performance and green environment of agreement or disagreement with 20 items. These items were adapted and refined from previous studies as the Smart Energy statements were adapted from Kahma and Matschoss (2017), Technological Progress statements were adapted from Cohen and Olsen (2013), Operation Performance statements were adapted from Sylva (2020) and Green Environment statements were adopted from Yacob et al. (2019).

Therefore, data are described here using tables of frequencies, which show the number and the percentage of respondents sharing in the questionnaire under each category, as shown in Table 1. Therefore, in this section, the explanation about age, gender, and education are introduced with specific statistics obtained from the data collection approaches. In total, it shows that the total sample participated in this research is N=80.

Regarding age, it could be noticed that respondents at the age group of '30-39 years.' are the most frequently appearing, with a number of 33 respondents and a percentage of 41.3% of the sample under study. Considering the gender, the number of "Male" respondents are more frequently appearing than female ones, with a number of 46 responses and a percentage of 57.5%. In addition, regarding the education level, it was noticed that "Master's degree" was the most frequently appearing, with a number 35 responses and a percentage of 43.8%.

Table I: Descriptive Analysis for Respondents' Profile

Item	Frequency	Percent %	Total
Age			
22-29	5	6.3	80
30-39	33	41.3	
40-49	30	37.5	
50-59	10	12.5	
60 or older	2	2.5	
Gender			
Male	46	57.5	80
Female	34	42.5	
Education			
Bachelor's degree	32	40.0	80
Master's degree	35	43.8	
Professional degree	12	15.0	
Doctorate degree	1	1.3	

Research Variables and Framework

The main aim of this study is to examine the role of the use of smart energy in logistics companies in increasing technological progress, improving operation performance and leading to a green environment. Accordingly, research variables could be represented as follows:

Independent Variable: The Use of Smart Energy

Dependent Variables: Technological Progress of Corporation, Operation Performance and Green Environment

The following figure represents the framework of the research.

Volume 2, Issue 1, June 2022 - ISSN 2735-5969
http://dx.doi.org/10.21622/IBL.2022.02.1.001

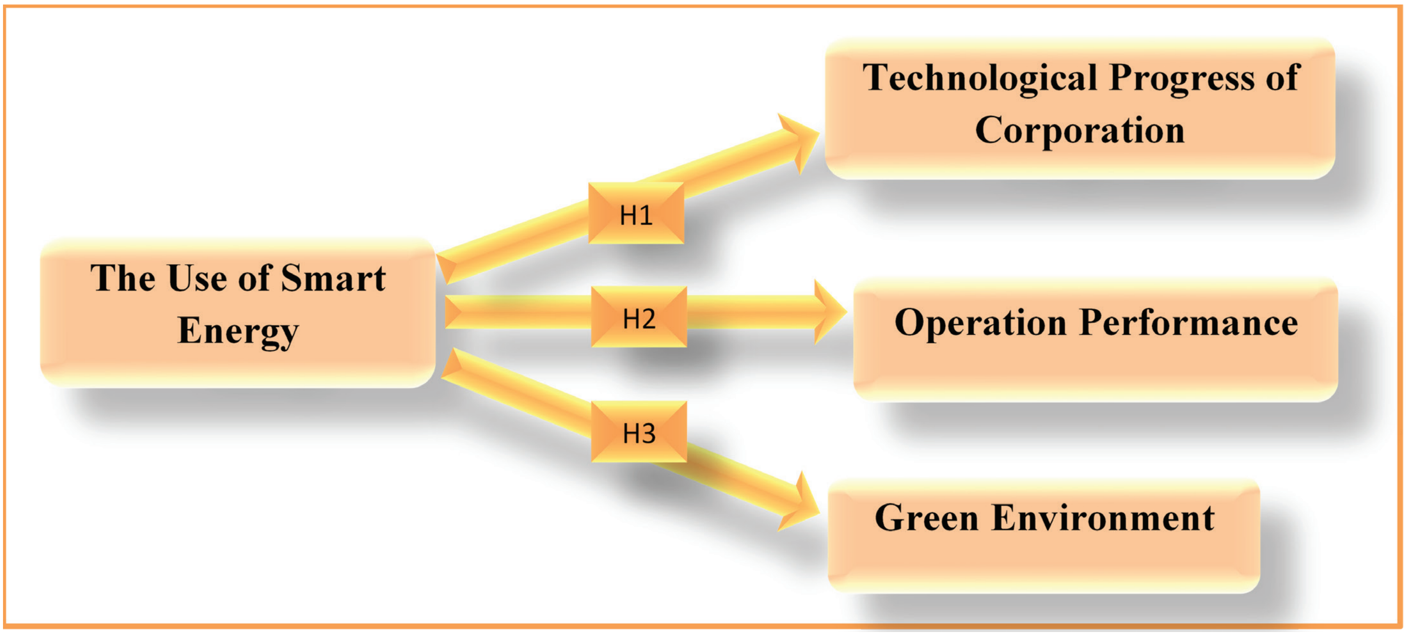

Fig. 1: Research framework

Empirical Studies and Findings

This section introduces the empirical study with the main findings and results after running the data analysis.

Data Testing for the Research Variables

In this section, the validity and reliability, discriminant validity, and confirmatory factor analysis for the statements used to measure the research variables are presented. The independent variable is Smart Energy. Additionally, the dependent variables are technological progress, operation performance and green environment.

Reliability

The reliability of the measurement model can be assessed by the Composite Reliability (CR). The measure of reliability and internal consistency of the measured variables represent a latent construct. In order to achieve the construct reliability, a value of CR ≥ 0.6 is required. From Table II, it could be observed that the values of CR for all constructs are greater than 0.60. Therefore, the composite reliability was achieved at the required level (Ahmad et al., 2016).

Table II: The Composite Reliability of the Model

Variables	Composite Reliability
Smart Energy	0.937
Technological Progress	0.936
Operation Performance	0.948
Green Environment	0.932

Descriptive Analysis

The descriptive statistics is a tool that explains and gives a distinct understanding of the features of certain data set, by giving short summaries about the respondents and how the diversification had been applied to select a representative sample for the population under study. This section is divided into two sub-sections, which are descriptive analysis for respondents' profile and descriptive analysis for the research variables.

Descriptive Analysis for the Research Variables

Table III illustrates the descriptive analysis for the research variables using the Minimum, Maximum, Mean and Standard Deviation for the research

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http://dx.doi.org/10.21622/IBL.2022.02.1.001

variables. The mean value of Smart Energy is found to be 4.5500, with a standard deviation 0.63445 with minimum and maximum equal to 3.00 and 5.00, respectively. In addition, the mean value of Technological Progress is found to be 4.5875, with a standard deviation 0.60991 with minimum and maximum equal to 3.00 and 5.00, respectively. Moreover, the mean value of Operation Performance is found to be 4.5750, with a standard deviation 0.63195 with minimum and maximum equal to 3.00 and 5.00, respectively. The mean value of Green Environment is found to be 4.6375, with a standard deviation 0.57904 with minimum and maximum equal to 3.00 and 5.00, respectively.

Table III: Descriptive Analysis for Research Variables

Variables	N	Mean	Std. Deviation	Minimum	Maximum
Smart Energy	80	4.5500	.63445	3.00	5.00
Technological Progress	80	4.5875	.60991	3.00	5.00
Operation Performance	80	4.5750	.63195	3.00	5.00
Green Environment	80	4.6375	.57904	3.00	5.00

Testing the Research Hypotheses

This section tests the research hypotheses, where the study has three hypotheses that are tested using correlation and regression analysis.

Testing the Relationship between Smart Energy and Technological Progress of Corporation
This section represents the results of testing the relationship between the research variables (Smart Energy, Technological Progress of Corporation, Operation Performance and Green Environment), where the Spearman's correlation is used depending on the results of normality test in Table IV.

It could be observed that there is a significant relationship between them as P-value is less than 0.05 (P-value =0.000). Moreover, a positive relationship is proved between Smart Energy and Technological Progress, as the correlation coefficient is more than zero (r =0.744).

In addition, it could be observed that there is a significant relationship between Smart Energy and Operation Performance as P-value is less than 0.05 (P-value =0.000). Moreover, this relationship is proved to be positive, as the correlation coefficient is more than zero (r =0.698).

Moreover, it could be observed that there is a significant relationship between Smart Energy and Green Environment as P-value is less than 0.05 (P-value =0.000). In addition, this relationship is proved to be positive, as the correlation coefficient is more than 0 (r =0.677).

Table IV: Correlation Matrix between Smart Energy, Technological Progress, Operation Performance and Green Environment

		Smart Energy	Technological Progress	Operation Performance	Green Environment
Smart Energy	Corr. Coeff.	1.000	.744**	.698**	.677**
	Sig.	.	.000	.000	.000
	N	80	80	80	80
Technological Progress	Corr. Coeff.	.744**	1.000		
	Sig.	.000	.		
	N	80	80		
Operation Performance	Corr. Coeff.	.698**		1.000	
	Sig.	.000		.	
	N	80		80	
Green Environment	Corr. Coeff.	.677**			1.000
	Sig.	.000			.
	N	80			80

Table V shows the regression model of the relationship between Smart Energy and Technological Progress. It could be noticed that there is a positive significant relationship between Smart Energy and Technological Progress, as the regression coefficient is 0.665 (β > 0) and P-value is 0.000 (P-value < 0.05). Moreover, the R-square is 0.479, which means that 47.9% of the variation of the Technological Progress can be explained by the Smart Energy.

Table V: Regression Test of Smart Energy on Technological Progress

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	R-Square
	B	Std. Error	Beta			
(Constant)	1.561	.361		4.325	.000	0.479
Smart Energy	.665	.079	.692	8.463	.000	
a. Dependent Variable: Technological Progress						

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According to the above results, the first hypothesis, which is "**There is a significant relationship between the use of smart energy and technological progress of corporation**" is fully supported.

Testing the Relationship between Smart Energy and Operation Performance

Table VI shows the regression model of the relationship between Smart Energy and Operation Performance. It could be noticed that there is a positive significant relationship between Smart Energy and Operation Performance, as the regression coefficient is 0.651 (β > 0) and P-value is 0.000 (P-value < 0.05). Moreover, the R-square is 0.427, which means that 42.7% of the variation of the Operation Performance can be explained by the Smart Energy.

Table VI: Regression Test of Smart Energy on Operation Performance

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	R-Square
	B	Std. Error	Beta			
(Constant)	1.613	.392		4.114	.000	0.427
Smart Energy	.651	.085	.654	7.625	.000	
a. Dependent Variable: Operation Performance						

According to the above results, the second hypothesis, which is "**There is a significant relationship between the use of smart energy and operation performance**" is fully supported.

Testing the Relationship between Smart Energy and Green Environment

Table VII shows the regression model of the relationship between Smart Energy and Green Environment. It could be noticed that there is a positive significant relationship between Smart Energy and Green Environment, as the regression coefficient is 0.596 (β > 0) and P-value is 0.000 (P-value < 0.05). Moreover, the R-square is 0.426, which means that 42.6% of the variation of the Green Environment can be explained by the Smart Energy.

Table VII: Regression Test of Smart Energy on Green Environment

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	R-Square
	B	Std. Error	Beta			
(Constant)	1.926	.360		5.357	.000	0.426
Smart Energy	.596	.078	.653	7.614	.000	
a. Dependent Variable: Green Environment						

According to the above results, the third hypothesis, which is "**There is a significant relationship between the use of smart energy and green environment**" is fully supported.

Table VIII shows the SEM analysis of the impact of the Smart Energy on Technological Progress, Operation Performance, and Green Environment. It could be noticed that there is a positive significant effect of Smart Energy on Technological Progress, as the estimate coefficient is 0.754 (β > 0) and P-value is 0.000 (P-value < 0.05).

Moreover, the R-square is 0.549, which means that 54.9% of the variation of the Technological Progress can be explained by the Smart Energy.

Also, it could be noticed that there is a positive significant effect of Smart Energy on Operation Performance, as the estimate coefficient is 0.717 (β > 0) and P-value is 0.000 (P-value < 0.05). Moreover, the R-square is 0.480, which means that 48% of the variation of the Operation Performance can be explained by the Smart Energy.

Finally, it could be noticed that there is a positive significant effect of Smart Energy on Green Environment, as the estimate coefficient is 0.749 (β > 0) and P-value is 0.000 (P-value < 0.05). Moreover, the R-square is 0.558, which means that 55.8% of the variation of the Green Environment can be explained by the Smart Energy.

Table VIII: SEM Analysis for the Research Model

			Estimate	P	R^2
Technological Progress	<---	Smart Energy	.754	***	.549
Operation Performance	<---	Smart Energy	.717	***	.480
Green Environment	<---	Smart Energy	.749	***	.558

The model fit indices CMIN/DF = 1.180, GFI = 0.818, CFI = 0.981, AGFI= 0.772, and RMSEA = 0.048 are all within their acceptable levels. The SEM model conducted for the effect of the Smart Energy on Technological Progress, Operation Performance, and Green Environment is illustrated in Figure 2.

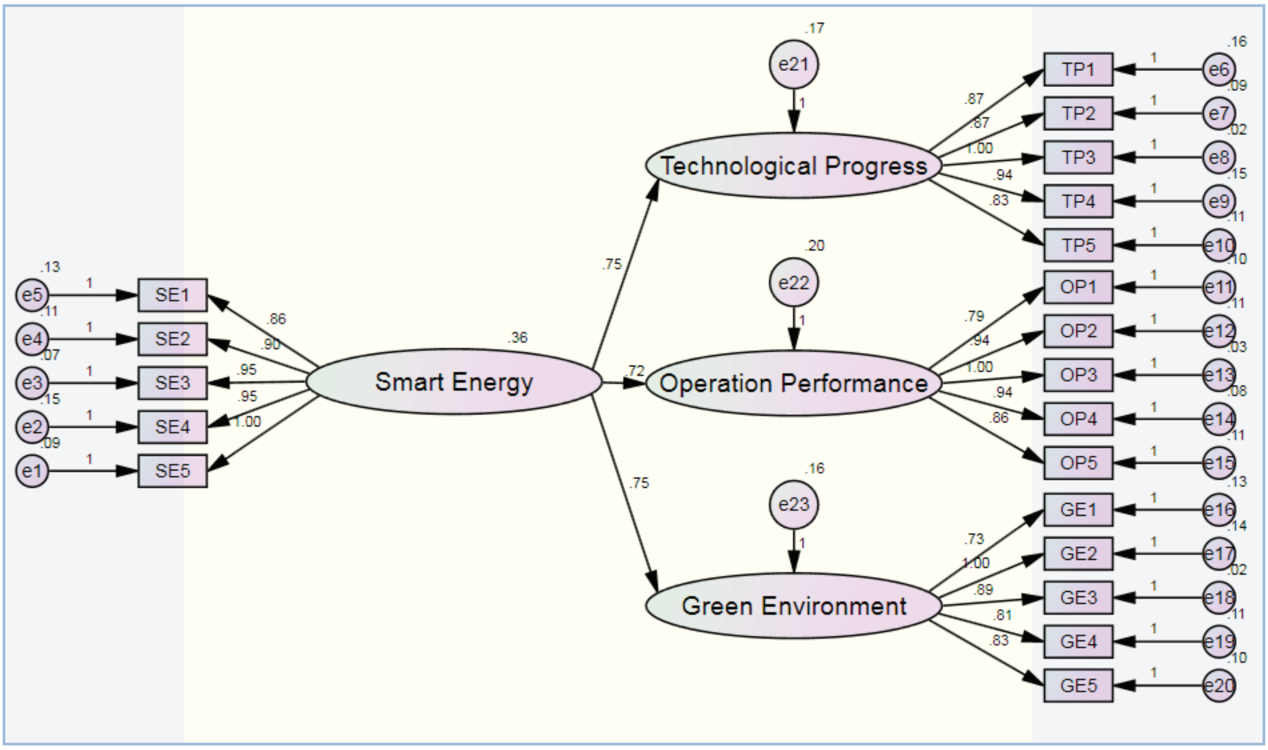

Fig. 2: SEM for the research model

Validity

This section presents the validity, discriminant validity, and confirmatory factor analysis for the statements used to measure the research variables. The independent variable is Smart Energy. Additionally, the dependent variables are technological progress, operation performance and green environment.

Convergent Validity

The convergent validity of the measurement model can be assessed by the Average Variance Extracted (AVE). Moreover, the AVE measures the level of variance captured by a construct versus the level due to measurement error; values above 0.7 are considered very good, whereas the level of 0.5 is acceptable (Ahmad et al., 2016). From Table 9, it could be observed that the value of AVE for all constructs are greater than 0.70. The required level was achieved (Ghadi et al., 2012).

Table IX: Convergent Validity of the Measurement Model

Variables	AVE
Smart Energy	0.747
Technological Progress	0.747
Operation Performance	0.785
Green Environment	0.735

Discriminant Validity

It is computed by comparing the square root of AVE values of each construct with the correlations between such construct and other constructs. Acceptable discriminant validity is achieved when the square root of AVE values of the construct is greater than the correlations between such construct and other constructs. Table X shows the discriminant validity of the

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research variables, where it could be observed that all square roots of AVE values are greater than the correlations between the corresponding construct and other constructs (Zait and Bertea, 2011).

Table X Discriminant Validity of the Research Variables

	1.	2.	3.	4.
1. Smart Energy	**(0.865)**			
2. Technological Progress	.692**	**(0.864)**		
3. Operation Performance	.654**	.590**	**(0.886)**	
4. Green Environment	.653**	.611**	.542**	**(0.857)**

Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) is a required step to confirm the factor structure extracted by the researcher as a measurement scale for each dimension before launching the structural equation modelling (SEM). AMOS 24 program was used, and ML method was applied to show the factor loading for each variable and their model fit (Marsh et al., 2014). Regarding the CFA using the covariance method, it had been illustrated using Figure 3 and the results had been shown as follows:

The model fit of the confirmatory factor analysis was computed, where it was found that the minimum discrepancy or chi-square divided by the degrees of freedom (CMIN/DF) was 1.162; the probability of getting as larger discrepancy as occurred with the present sample (p-value) was 0.000; goodness of fit (GFI) was 0.823; adjusted goodness of fit index (AGFI) was 0.774 – that evaluated the fit of the model versus the number of estimate coefficients or the degrees of freedom needed to achieve that level of fit; the Bentler-Bonett normed fit index (NFI) was 0.891, and the Tucker-Lewis index or Bentler-Bonett non-normed fit index (TLI) was 0.980 – which assesses the incremental fit of the model compared to a null model; the comparative fit index (CFI) was 0.983.

Also, the root mean square residual (RMR) was 0.018 – which shows the amount by which the sample's variances and covariances differ from their estimates obtained under the assumption that the model is correct; the root mean square of approximation (RMSEA) was 0.045 – which is an informative criterion in covariance structure modelling and measures the amount of error present when attempting to estimate the population (Hair et al., 2016). Table XI shows these indicators' value in CFA and the recommended values for them.

Table XI: Fit Indices and Thresholds for Measurement Model

Measure	**Results**	**Threshold**
Chi-square/df	1.162	< 2 excellent; < 3 good; < 5 sometimes permissible
P-value	0.000	> 0.05
GFI	0.823	> 0.80
AGFI	0.774	> 0.80
NFI	0.891	> 0.80
TLI	0.980	> 0.85
CFI	0.983	> 0.80
RMR	0.018	< 0.09
RMSEA	0.045	< 0.10

Figure 3 shows the confirmatory factor analysis applied, where the factor loadings are shown on arrows implying good factor loadings (Factor Loadings > 0.4) for the confirmatory factor analysis. These factor loadings are shown in numbers using Table XII.

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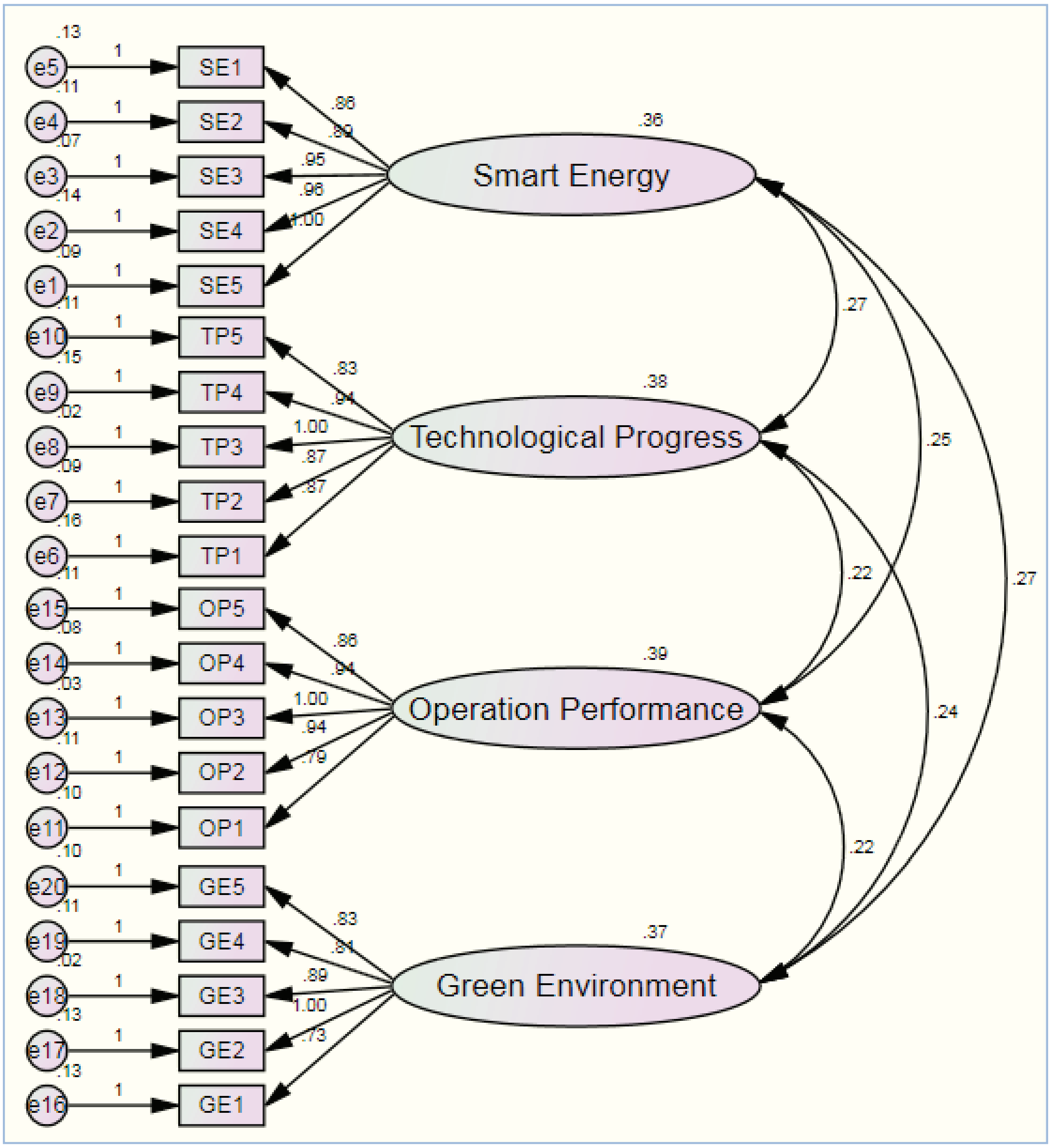

Fig. 3: CFA for the measurement model

Table XII shows that all factor loadings (FL), which represent the size of the loadings of items on their corresponding variables, are greater than or equal to 0.40, implying the fact that the constructs under study have adequate validity. Also, all the P-values are less than 0.05, showing the significance of the corresponding statements to their constructs.

Table XII : Factor loadings (FL)

			Estimate	S.E.	C.R.	P
SE5	<---	Smart Energy	1.000			
SE4	<---	Smart Energy	.955	.091	10.459	***
SE3	<---	Smart Energy	.953	.075	12.681	***
SE2	<---	Smart Energy	.892	.082	10.879	***
SE1	<---	Smart Energy	.862	.085	10.112	***

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TP1	<---	Technological Progress	.871	.080	10.837	***
TP2	<---	Technological Progress	.872	.062	13.994	***
TP3	<---	Technological Progress	1.000			
TP4	<---	Technological Progress	.935	.078	12.068	***
TP5	<---	Technological Progress	.831	.068	12.138	***
OP1	<---	Operation Performance	.792	.066	12.035	***
OP2	<---	Operation Performance	.939	.070	13.460	***
OP3	<---	Operation Performance	1.000			
OP4	<---	Operation Performance	.944	.062	15.245	***
OP5	<---	Operation Performance	.863	.069	12.532	***
GE1	<---	Green Environment	.727	.085	8.540	***
GE2	<---	Green Environment	1.000			
GE3	<---	Green Environment	.886	.069	12.854	***
GE4	<---	Green Environment	.806	.085	9.542	***
GE5	<---	Green Environment	.829	.083	9.998	***

Research Discussion and Conclusion

This study aims to investigate the role of the use of smart energy in logistics companies to increase technological progress, improve operation performance and lead to green environment. Therefore, this research has three main hypotheses: the first hypothesis, there is a significant relationship between the use of smart energy and technological progress of corporation; the second hypothesis, there is a significant relationship between the use of smart energy and operation performance, and the third hypothesis, there is a significant relationship between the use of smart energy and green environment.

H_1: There is a significant relationship between the Use of Smart Energy and Technological Progress of Corporation

The correlation matrix for the relationship between the use of smart energy and technological progress of corporation proved a significant relationship between them, where P-value is less than 0.05. It is also proved that there is a positive relationship between them, as the correlation coefficient is more than 0.

The regression model for the relationship between the use of smart energy and technological progress of corporation showed that there is a positive significant relationship between them, as the regression coefficients are more than 0 and P-values are less than 0.000.

These results are consistent with some previous studies such as, Ferreira et al., (2014), Connolly

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et al. (2016), Vijai and Sivakumar (2016), Biresselioglu et al. (2018), and Wang et al. (2019). Therefore, according to the above results, the first hypothesis, which is "**There is a significant relationship between the use of smart energy and technological progress of corporation**" is fully supported.

H_2: There is a significant relationship between the Use of Smart Energy and Operation Performance

The correlation matrix for the relationship between the use of smart energy and operation performance proved a significant relationship between them, where P-value is less than 0.05. It also proved a positive relationship between them, as the correlation coefficient is more than 0.

The regression model for the relationship between the use of smart energy and operation performance showed that there is a positive significant relationship between them as the regression coefficients are more than 0 and P-values are less than 0.000.

These results are consistent with some previous studies, such as Noppers et al. (2016), Chasin et al. (2020), Bhattacharya et al. (2020), and Liang et al. (2020). Therefore, according to the above results, the first hypothesis, which is "**There is a significant relationship between the use of smart energy and operation performance**" is fully supported.

H_3: There is a significant relationship between the Use of Smart Energy and Green Environment

The correlation matrix for the relationship between the use of smart energy and green environment proved a significant relation between them, where P-value is less than 0.05. It also proved a positive relationship between them, as the correlation coefficient is more than 0.

The regression model for the relationship between the use of smart energy and green environment showed that there is a positive significant relationship between them as the regression coefficients are more than 0 and P-values are less than 0.000.

These results are consistent with some previous studies, such as Liu et al. (2012), Pan et al. (2020), Shi et al. (2020), Fenton (2020), and Zhu et al. (2021). Therefore, according to the above results, the first hypothesis, which is "**There is a significant relationship between the use of smart energy and green environment**" is fully supported.

Accordingly, the study provides some recommendations to the decision makers. It is recommended to depend on the corporation between both of the private and the public sector regarding the adoption and the application of smart energy projects. This step will help in establishing big projects of smart energy that is characterized by its high costs as well as it enables better risk sharing. The researcher also recommends the government to increase the awareness of the importance of replacing traditional energy with smart one through making awareness campaigns as well as facilitating obtaining loans that are needed for smart energy projects.

Additionally, the research recommends that logistics companies should rely on the adoption of smart energy projects in their industry, which helps them to improve their performance and increase their efficiency. However, these projects need to be well planned and established so that companies can implement them effectively and with the lowest costs.

Secondly, it is recommended that future research studies investigate the impact of the independent variable, which is smart energy, on the dependent ones, which are technological progress, operation performance and green environment, as prior studies only focus on examining the smart energy projects or cities without testing their influence on other dimensions.

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Furthermore, the researcher also recommends that the future research add new dependent variables to the framework in order to see whether smart energy has an effect on them, as well as searching for other variables that could affect the efficiency of the projects of smart energy.

Finally, as any other research study, this research has many limitations. First, the limitation of the sampling as the study sample was a random sample of 80 employees working at supply chain department at logistics companies located in Alexandria, Egypt. Therefore, the researcher suggests increasing the sample size and conducting more research on the logistics industry, in order to see whether the results of this study can be generalized inside this sector. The researcher also suggests making other studies on different sectors to see whether the same results can be reached.
The study also limited its research on Egypt as there is a lack in studies that took Egypt as a case study. Therefore, the researcher suggests conducting more studies in Egypt. The researcher also recommends making comparative studies between Egypt and other developing countries. The study also had a limitation regarding the timing, as the data collected for the study include a limited duration of time, so the study recommends for the future research to include a wider period of time. Finally, the research suggests for the future research to include more variables that may be affected by smart energy, as well as to try to examine factors that could affect the adoption and usage of smart energy.

Appendix 1

This questionnaire aims to measure the study dimensions; smart energy, technological progress, organizational performance and green environment, where they are measured through a 5-point Likert-scale, which shown as follows:

Table XIV : Research Variable Operationalization

Variables	Statements	References
Smart Energy	1. Is smart energy usage considered as a cost reductive than the usage of traditional resources?	**Kahma and Matschoss (2017)**
	2. Does your company maintain the electricity displays at the real time in order to monitor the consumption of energy?	
	3. Does your company maintain and install the electricity guiding equipment (technical equipment)?	
	4. Do services for the purchase or installment of equipment lead to energy saving (as heat pumps)?	
	5. Does your company utilize services related to micro-production technology for energy production (such as solar panels or small-scale wind power plants)?	

Technological progress	1. Does your company use standard technical systems?	**Cohen and Olsen (2013)**
	2. Does your company use scalable technology systems?	
	3. Does your company deal with multiple technological applications?	
	4. Does your company use agreed standard technology systems?	
	5. Does your company have high degree of application integration?	
Operation Performance	1. Does your company provide service that is clean and pleasant?	**Sylva (2020)**
	2. Do the employees handle complaints quickly and effectively?	
	3. Does your company have an effective supply chain network?	
	4. Is your company ahead of its competitors in the introduction of new services offerings?	
	5. Do the adopted technologies in your company harm the environment?	
Green environment	1. Does your company follow certain environmental criteria before offering any service?	**Yacob et al. (2019)**
	2. Are the provided services designed in a way that minimizes the harmful impact on the environment?	

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