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Energy Resources, Greenport, and Modern Technology in the Port Terminal Operational Business Efficiency

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ABSTRACT

Purpose: This study aims to determine the effect of energy resources, greenport, and modern technology on the efficiency of port terminal operational business.

Design / methodology / approach: This study uses a quantitative approach with multiple linear regression analysis techniques.

Findings: The research was carried out at the Gresik port terminal.

Research limitations / implications: Limitations in this study using three independent variables and one variable. The independent variables are energy resources, greenport and technology. The variable in question is business efficiency.

Practical Implications: The population in this study were all operators and employees in the operational division with a total sample of 57 respondents.

Originality / Value: This research was conducted at the Port of Gresik

Paper type: Research paper

Keywords: *Business Efficiency, Energy Resources, Greenport, Modern Technology*

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I. INTRODUCTION

The digital era and the industrial revolution have a positive impact on business efficiency. The process of exchanging data is fast leading to a paradigm shift from physical to non-physical such as paperless and digital transformation. Climate change brings port business prospects towards sustainable port development. Terminal infrastructure that fulfills the concept of maximizing business objectives in obtaining profits is wrong with operational efficiency in operational processes. Several factors are taken into consideration, namely related to clean energy with low emissions, green port, and the use of modern technology.

The transition from fossil fuels to clean energy will force port authorities to find suitable and reliable energy sources to increase the increase in electricity consumption in ports in the future and prove that other clean energy sources may be useful at ports (Cascajo et al., 2019). In addition to reducing carbon emissions, electrification of port equipment reduces emissions and its negative impact on society (Notteboom et al., 2021). According to Notteboom et al. (2021) Natural gas is considered the cleanest fossil fuel to be used, especially for energy generation, and has become the main fuel for power generation. Gas turbine technology allows natural gas to generate electricity cheaper than using coal, implying that the global power generation market that relies on fossil fuels is shifting to natural gas supply chains. Low energy use efficiency is expected to have an impact on port cost efficiency (Rizaldy et al., 2018).

Anastasopoulou et al. (2011) The concept of greenport is to integrate environmentally friendly methods in port operations, operations and management. The purpose of greenport is to increase the efficiency of existing resources, reduce the negative impact of the surrounding environment, to increase the level of environmental management and improve the quality of the natural environment around the port. According to Pavlic et al.

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(2014) the application of the greenport concept that goes beyond investing in specific technologies. That the application of the greenport concept is a continuous process that must create conditions for a sustainable transformation of port operations. According to Anastasopoulou et al. (2011) There are many measures to build a greenport such as reducing air pollution, designing ports by planting trees to absorb and pollute. In addition, the use of energy that can be used for port operations and activities, as well as recycling materials that can be reused for operational needs and port activities.

According to Orive et al. (2020) Ports are subject to new requirements in terms of cost, safety and efficiency. In order to meet these requirements and maintain their competitiveness, they must evolve and move towards the Port 4.0 concept. This conversion involves, among other things, of the automation process. According to Vaggelas & Leotta (2019) The adoption of new technologies like Big Data, Internet of Things (IoT), Blockchain along with the adoption of digitization and automation, is the current port challenge. These technological and operational developments have made it possible to obtain better results in terms of port productivity, labor productivity as well as improved work process structures, in the quality of port products, such as activities carried out at ports, and in safety and security standards. According to María Martín-Soberón et al. (2014) Automation has been shown to ensure standardization of operations and greater levels of efficiency, productivity and quality in port processes. According to Scott (2012) When used and integrated with terminal operating systems, this automation technology can support and increase terminal capacity, optimize equipment utilization, and improve overall container handling performance at the terminal.

There are six general activities in loading and unloading operations at Indonesian ports that affect efficiency. Among them are shipping, stevedoring, cargodoring, stacking, acceptance, and delivery (Sitorus & Nahry, 2017). According to Kim et al. (2012) In container terminals, there are three types of handling operations: ship operations related to container ships, hinterland operations which include operations by truck, rail, empty container management, and operations related to warehousing or storage (container stacking).

PT. Terminal Teluk Lamong is a multipurpose port that carries the concept. This can be obtained through the support of environmentally friendly energy supplies or low emissions for the needs of terminal port operations. PT. Terminal Teluk Lamong is a pioneer port that carries the greenport concept in Indonesia. Supported by operating equipment with modern technology and semi-automatic.

II. LITERATURE

A. Business Efficiency

According to Martin (2012) at its core, business efficiency means making choices and adopting tools and processes that produce the best results and the least costs. While technical efficiency is described as the conversion of physical inputs (such as employee services and machines) into outputs relative to the best practices. In other words, given today's technology, there is no waste of input at all in producing a given amount of output. An organization that operates on best practices is said to be 100% technically efficient. If operating below the best practice level, the organization's technical efficiency is expressed as a best practice percentage. Managerial practices and the scale or size of operations affect technical efficiency, which is based on engineering relationships but not on price and cost (Mokhtar, 2013). Terminal operational business efficiency is the result of time speed, increased productivity, and minimal costs incurred by the company.

B. Energy Resources

According to Novakovic & Nasiri (2016) Energy resources are all forms of fuel used in the modern world, whether for heating, generating electrical energy, or for other forms of energy conversion processes. Energy resources can be roughly classified into three categories: renewable, fossil, and nuclear.

Fossil energy resources are obtained from dead plant and animal deposits created over the long history of the planet. This resource is extensive, but limited, and cannot be activated. Until now, fossil fuels have met most of mankind's energy needs. These resources mainly include coal, oil and natural gas (Novakovic & Nasiri, 2016).

Energy resources at PT. Terminal Teluk Lamong is a power plant or fuel to supply and meet operational needs, especially terminal equipment. Low energy use efficiency is expected to have an impact on port cost efficiency (Rizaldy et al., 2018). Energy resources are an important factor in supporting terminal operational activities. The mobility of equipment in loading/unloading activities will have an impact on the demand for energy resources. increased mobility of equipment will have an impact on increasing consumption of energy resources.

Proper energy consumption analysis provides additional information in the typical business cycle from which stakeholders can obtain more reliable and accurate information about performance and efficiency

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efficiency in general, not only regarding energy efficiency but also from an operational and cost perspective (Pavlic et al., 2014). So the first hypothesis in this study is:

HI : The energy resource variable has a partially positive effect on the efficiency of the terminal's operational business.

C. Greenport

The issue of climate change in combination with the competitiveness of port operations is a key element of future development challenges (Adolf, et al, 2013 and Li, et al 2011 in Pavlic et al. (2014). Production and operation activities of airports, air pollution, soil pollution, habitat destruction, traffic jams, and others, which have a negative impact on the ecosystem and public health of the port. Due to the huge impact of ports on cities, ports have become key to the sustainable development of the entire urban system. The sustainable development of port cities requires ports to incorporate into their overall development goals and policies (Lam & Yap, 2019).

The concept of Greenport is to integrate environmentally friendly methods in activities, operations and port management. The aim of Greenport is to increase the efficiency of existing resources, reduce the negative impact of the surrounding environment, to increase the level of environmental management and improve the quality of the natural environment around the port. Greenport's concept includes protection of the environment in all work infrastructure, as well as improving sustainable policies regarding protection of the environment, and all activities and operations carried out at the port. There are many measures to build a Greenport such as reducing air pollution, port design by planting lots of trees to absorb pollution. In addition, the use of energy that can be used for port operations and activities, as well as recycling materials that can be reused for operational needs and port activities (Anastasopoulou et al., 2011).

The concept of Greenport is to integrate environmentally friendly methods in activities, operations and port management (Anastasopoulou et al., 2011). The use of equipment that uses environmentally friendly energy will have an impact on operational cost efficiency. According to (Pramesti, 2015) Operational costs, maintenance costs and emissions for unloading equipment are cheaper using electric tools. So the second hypothesis in this study is:

H2 : The greenport variable has a partially positive effect on the efficiency of the terminal's operational business.

D. Modern Technology

According to Volti (2009) in Carroll (2017) Technology is defined as a system created by humans that uses knowledge and organization to produce objects and techniques for specific purposes.

According to Ngyah (2014) there is no specific definition for the term modern technology, but the idea coincides with product improvement in the application of science. It may be similar to the previous technology but designed to make the job easier. Technology itself is defined as the study, development and application of devices, machines, and techniques for manufacturing and productive processes.

Modern technological advances in ports have introduced several operational solutions, such as automation, to increase terminal productivity (Ghiara & Tei, 2021). Equipment automation technology as a way to increase efficiency (Scott, 2012). Modern technology supports terminal operational activities which are limited to loading and unloading activities, transportation, Container Yard. So that the third hypothesis can be proposed as follows:

H3 : Modern technology variable has a partial positive effect on the efficiency of terminal operational business.

From relationship and hypothesis stated above then he research model can be proposed as follows:

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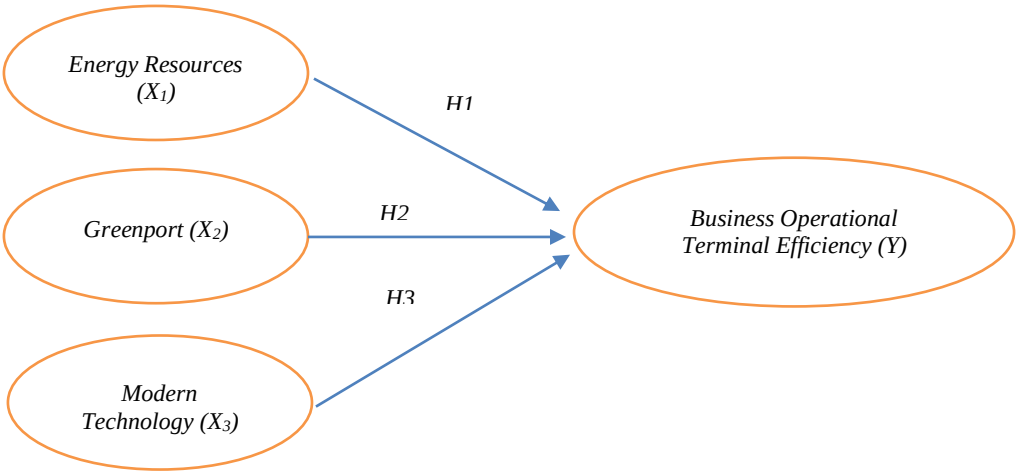

Figure 1. Conceptual Framework

Source: Processed Data (2022)

III. METHODOLOGY

This type of research is a type of quantitative research with data collection methods through distributing questionnaires to all operators of Automatic Stacking Crane (ASC), Ship to Shore (STS), Combine Tractor Terminal (CTT), Straddle Carrier (SC) and operational staff of PT. Terminal Teluk Lamong with a sample size of 57 respondents. The analytical technique used is multiple linear regression analysis, by testing the quality of the data to measure the research instrument obtained by using validity and reliability tests. Using the classical assumption deviation test and hypothesis testing. The operational definition in this research is:

Table 1. Operational Definition of Variables

Independent Variable	*Energy Resources (X1)*	*The indicators consist of:* *Alternatives are clean or low-emission fossil energy (Rodrigue, et al 2021 and Rizaldi, 2018);* *Energy transition from fossil fuels to the use of clean energy to reduce the impact on the environment (Cascajo, 2019);* *Electrification of equipment by using electric power to support operational equipment (Rodrigue, et al. 2021);* *Natural gas to produce electricity is cheaper than coal (Rodrigue, et al. 2021);* *Environmentally friendly energy efficiency regarding energy consumption and environmental impact (Pavlic, et al. 2014).*
	Greenport (X2)	*The indicators consist of:* *Resource consumption (Energy use, etc.) and environmental quality (exhaust emissions, etc.). (Sydney harbor corporate greenport guidelines, 2006 and Ahmadi, 2016);*

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		Reducing and polluting operational activities (Despina et al., 2011); *Environmentally friendly unloading equipment (Pramesti, 2015);* *Use of environmentally friendly energy to support operational equipment (Nikitakos, 2012);* *Energy and environmental management system (Pavlic, et al. 2014).*
	Modern Technology (X3)	*The indicators consist of:* *Using modern port terminal equipment (Vaggelas, 2019);* *The use of modern and automated equipment shows faster business process times, thereby increasing productivity (Sitorus and Nahry, 2017);* *The use of equipment automation technology for more efficiency and greater productivity (Martin, et al., 2014 and Ghiara and Tei, 2021);* *Automation has an impact on improving operational performance (Scott, 2012);* *Operational costs of automated equipment are decreased/more efficient (Chu, et al., 2018).*
Dependent Variable	*Business Operational Terminal Efficiency (Y)*	*The indicators consist of:* *Efficiency in terms of loading and unloading containers can be expressed by the ratio of the number of TEUs during operational time and costs (Sitorus and Nahry, 2017);* *Energy resources in electricity supply and new technologies have a significant impact on operational costs (Wibowo, 2020);* *The use of electric power tools shows energy savings and can reduce carbon dioxide emissions (Yang and Chang, 2013);* *Ports with the greenport concept are more efficient in terms of operational costs, productivity, and emission costs (Pramesti, 2015 and Roosanty, 2015);* *Total CAPEX(cost for investment purposes) The cost is more expensive considering the equipment is more automated and modern. However, the faster business processes, the greater the productivity and profits (Sitorus and Nahry, 2017 and Chu, et al., 2018).*

Source: Processed Data (2022)

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IV. DATA COLLECTION

The following shows the frequency distribution of respondents based on position :

Table 2. Characteristics of Respondents by Position

No.	*Position*	*Quantity*	*Percentage (%)*
1	*Operator STS*	*12*	*21.1%*
2	*Operator ASC*	*10*	*17.5%*
3	*Operator SC*	*7*	*12.3%*
4	*Operator CTT*	*24*	*42.1%*
5	*Staff Operational*	*4*	*7%*
	Total	*57*	*100%*

Source: Processed Data (2022)

Based on table 2, it can be seen that respondenwith CTT position has the largest quantity value, namely 24 respondents with 42.1%.

V. RESULTS AND DISCUSSION

In this study, questionnaires were distributed to 57 respondents of employees from PT. Terminal Teluk Lamong, in order to obtain primary data. The data being tested need to be tested with several tests. The first test is a questionnaire test which includes validity and reliability tests. The second test is the classic assumption test which consists of normality test, multicollinearity test, and heteroscedasticity test. The third test is multiple linear regression analysis and the fourth test is the hypothetical test. The test results are as follows:

A. Validity test

Table 3. Validity Test Result of Energy Resources (X1)

Statement	*r-count*	*r-table*	*Remarks*
X1.1	*0,869*	*0,2609*	*valid*
X1.2	*0,847*	*0,2609*	*valid*
X1.3	*0,802*	*0,2609*	*valid*
X1.4	*0,768*	*0,2609*	*valid*
X1.5	*0,905*	*0,2609*	*valid*

Source: Primary Processed Data with SPSS (2022)

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Table 4. Validity Test Result of Greenport (X2)

Statement	*r-count*	*r-table*	*Remarks*
X2.1	*0,931*	*0,2609*	*valid*
X2.2	*0,938*	*0,2609*	*valid*
X2.3	*0,942*	*0,2609*	*valid*
X2.4	*0,951*	*0,2609*	*valid*
X2.5	*0,807*	*0,2609*	*valid*

Source: Primary Processed Data with SPSS (2022)

Table 5. Validity Test Result of Modern Technology (X_3)

Statement	*r-count*	*r-table*	*Remarks*
X_3.1	*0,815*	*0,2609*	*valid*
X_3.2	*0,933*	*0,2609*	*valid*
X_3.3	*0,945*	*0,2609*	*valid*
X_3.4	*0,957*	*0,2609*	*valid*
X_3.5	*0,723*	*0,2609*	*valid*

Source: Primary Processed Data with SPSS (2022)

Table 6. Validity Test Result of Business Operational Terminal Efficiency (Y)

Statement	*r-count*	*r-table*	*Remarks*
Y.1	*0,918*	*0,2609*	*valid*
Y.2	*0,891*	*0,2609*	*valid*
Y.3	*0,925*	*0,2609*	*valid*
Y.4	*0,951*	*0,2609*	*valid*
Y.5	*0,833*	*0,2609*	*valid*

Source: Primary Processed Data with SPSS (2022)

Based on tables 3 to 6, it can be seen that variable energy resources, greenport, modern technology and business efficiency are valid so that they can be used as instruments in research.

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B. Reliability Test

Table 7. Reliability Test Results

Variables	*Cronbach's Alpha*	*Criteria*	*Remarks*
Energy Resources (X_1)	*0,891*	*0,6*	*Reliable*
Greenport (X_2)	*0,950*	*0,6*	*Reliable*
Modern Technoology (X_3)	*0,924*	*0,6*	*Reliable*
Business Operational Terminal Efficiency (Y)	*0,942*	*0,6*	*Reliable*

Source: Primary Processed Data with SPSS (2022)

Based on table 7, it can be seen that all variables have reliable results, which means that the questionnaire can be used in research.

C. Classic assumption test

1. Normality Test

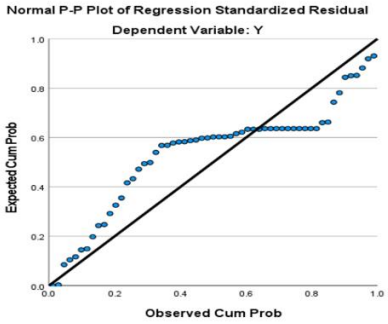

Figure 2. Normally Test Results

Source: Primary Processed Data with SPSS (2022)

Based on Figure 2, it can be said that the graph is normally distributed.

2. Heteroscedasticity Test

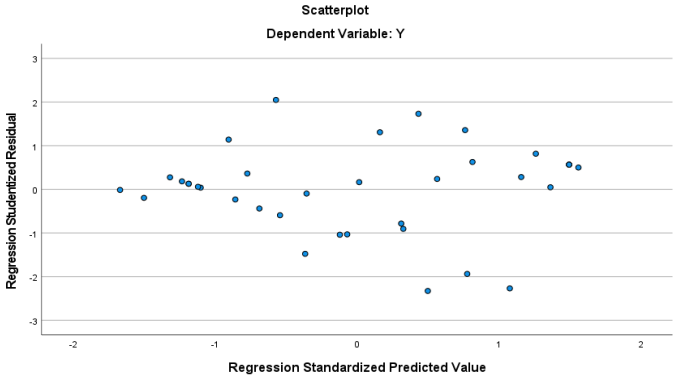

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Figure 3. Heteroscedasticity Test Results

Source: Primary Processed Data with SPSS (2022)

Based on Figure 3, it can be ascertained that there is no heteroscedasticity because the scatterplot does not form a certain pattern and spreads above and below the number 0 on the Y axis.

3. Multicollinearity Test

Table 8. Multicollinearity Test Results

Variable	*Collinearity Statistics*		*Remarks*
	Tolerance	*VIF*	
X_1	*0,830*	*1,205*	*Multicollinearity does not occur*
X_2	*0,618*	*1,619*	*Multicollinearity does not occur*
X_2	*0,610*	*1,639*	*Multicollinearity does not occur*

Source: Primary Processed Data with SPSS (2022)

Based on table 8 it can be said that there is no multicollinearity between X variables.

D. Multiple Linear Regression Analysis

Regression analysis is used to measure the relationship between variables X and Y. The results of the regression in this study are:

Table 9. Results of Linear Regression Analysis

	B Value	*T-Count*	*Significance*	*Conclussion*
Constanta	*2,029*	*0,577*	*0,568*	*-*
X1	*0,106*	*0,796*	*0,432*	*Not Significant*
X2	*0,136*	*0,893*	*0,378*	*Not Significant*
X3	*0,646*	*3,778*	*0,001*	*Significant*
F Count		*11,987*	*0,001*	*Significant*
	R		*0,727*	
	Adjusted Rsquare		*0,485*	

Source: Primary Processed Data with SPSS (2022)

Energy Resources (X_1), Greenport (X_2), Modern Technology (X_3) at PT. Terminal Teluk Lamong can be said as one of the ways in the efficiency of port terminal operational business. Without Energy Resources (X_1),

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Greenport (X_2), Modern Technology (X_3), the efficiency of the port terminal operational business at PT. Terminal Teluk Lamong will not be reached properly.

E. Relationship of Energy Resources (X_1) to Terminal Operational Business Efficiency (Y)

The results show that Energy Resources (X_1) has an insignificant relationship to Terminal Operational Business Efficiency (Y) with a t-count value of 0.796, which is smaller than a t-table of 2.036, with a significance level greater than 0.05. so this study shows that there is a positive but not significant effect on the efficiency of the port terminal operational business at PT. Terminal Teluk Lamong.

The results of this study are in accordance with previous research conducted by Asshanti (2017); Pramesti (2015); Roosanti (2015) which concluded that operational costs, maintenance costs and emission costs for loading and unloading equipment are cheaper using equipment. electric. And the emission costs of gas-fired power plants are less than those of coal-fired power plants. Electrification affects the service time of containers at the dock, where the service time of containers at the dock becomes faster, so the authors conclude from previous research that energy resources can have a positive influence on the efficiency of terminal operational business and in this study the conclusion that energy resources have an effect positive but not significant on terminal operational business efficiency.

Gas is a clean but non-renewable fossil energy, and currently PT. Terminal Teluk Lamong still has a dependence on gas supply from other parties. It will be more efficient and cost-effective if you switch to using renewable energy that is sustainable or renewable, such as the use of solar panels which are only available for street lighting and warehouse operations. The use of other renewable energies such as wind turbines, wave turbines, etc., even though they require large capital/investments, will be more efficient if they are independent in producing energy for port terminal operations.

F. Greenport's Relationship (X_2) to Terminal Operational Business Efficiency (Y)

The results showed that Greenport (X_2) had an insignificant relationship with Terminal Operational Efficiency (Y) with a t-count value of 0.893, which was smaller than a t-table of 2.036, with a significance level greater than 0.05. then this study shows that there is a positive but not significant effect on the efficiency of port operations at PT. Terminal Teluk Lamong.

The results of this study are in accordance with previous research conducted by Roosanti (2015) which concluded that the cost of a greenport port is less than the cost of a non-greenport port and the operating time of a greenport port is faster than a non-greenport port. So the authors conclude from previous research that greenport has a positive influence on the efficiency of terminal operational business. And this research concludes that greenport has a positive but not significant effect on the operational efficiency of terminal operations. Greenport has a positive influence on port emission costs where the greenport concept can reduce port emission costs lower. But on the other hand, the implementation of greenport creates double handling activities, namely containers transported using trucks with fuel oil (BBM) must be moved to trucks with gas fuel. This happens because the greenport concept restricts fuel trucks from entering the terminal or dock area because fuel trucks have high emissions or exhaust gases. So that the double handling activity in the transfer area is what causes inefficiency.

G. Relationship of Modern Technology (X_3) to Terminal Operational Business Efficiency (Y)

The results show that Modern Technology (X_3) has a significant relationship with Terminal Operational Business Efficiency (Y) with a t-count value of 3.778, which is greater than t-table of 2.036, with a significance level of less than 0.05. then this study shows that there is a positive and significant influence on the operational efficiency of the port terminal business at PT. Terminal Teluk Lamong.

The results of this study are in accordance with previous research conducted by Silalahi et al. (2016); Sitorus & Nahry (2017) which concluded that the faster automated equipment and business processes, the greater the productivity of the terminal, and greater profits. . The use of Automatic Stacking Crane at the port ensures more safety, lower vibration, sound and better emissions, easy to control and monitor. So the author concludes on the previous research that Modern Technology has a positive influence on the efficiency of terminal operational business. And this research concludes that Modern Technology has a positive and significant impact on the efficiency of terminal operational business.

Business process speed and productivity increase. Efficiency can also be seen from the HR side of ASC operators, where 1 operator can handle 3 units of equipment. This proves that more modern technology is able to provide efficient use of 1 operator for 1 unit of equipment.

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VI. CONCLUSION

By using linear regression, it can be said that: (1) the Energy Resources (X_1) has a positive but not significant effect on Terminal Operational Efficiency (Y), meaning that if the Energy Resources use electrical energy and power plants from gas and low emissions then can improve port terminal operational business efficiency but not significantly; (2) The Greenport variable (X_2) has a positive but not significant effect on Terminal Operational Business Efficiency (Y), meaning that if the port is supported by the Greenport concept with environmentally friendly equipment and energy, it can improve port terminal operational business efficiency but not significantly; and (3) Modern Technology (X_3) has a positive and significant effect on Terminal Operational Business Efficiency (Y), meaning that if the port is supported by equipment with modern technology, it can significantly improve the efficiency of the port terminal's operational business.

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