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IMPACT OF TECHNOLOGICAL TRANSPORTATION ON EFFECTIVENESS OF MARITIME COMPANIES IN RIVERS STATE

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Abstract

This study investigated the impact of technological transportation on effectiveness of maritime companies in Rivers State. Technological transportation is the predictor variable, and effectiveness is the criterion variable. The predictor variable was used as a one-dimensional variable while the criterion variable was measured in terms of operational efficiency and environmental sustainability. Adopting a positivist philosophy, the study adopted an explanatory research design and a quantitative. The population of the study comprised 16 maritime companies. A total of 73 respondents from the 16 maritime companies provided valid data for the study through a 20-item questionnaire. Simple Regression Analysis was used to analyze the data with the aid of Statistical Package for Social Sciences (SPSS) version 22.0. The study found that technological transportation has positive significant impact on operational efficiency and environmental sustainability of maritime companies in Rivers State. Thus, the study concluded that technological transportation determines effectiveness of maritime companies in Rivers State; and recommends that maritime companies in Rivers State that desire to improve their effectiveness should invest in, and adopt technology in transportation operations in order to enhance their operational efficiency and environmental sustainability.

Keyword: Environmental sustainability, organizational effectiveness, operational efficiency, technological transportation

Introduction

The maritime industry plays a pivotal role in global commerce, particularly in regions where port activities significantly influence the economic landscape. Technological advancements in transportation have reshaped the industry, leading to substantial improvements in operational efficiency and cost management. These innovations range from automated cargo handling systems to advanced navigation technologies, all of which aim to optimize resource allocation and reduce operational overhead. This shift towards technologically advanced systems directly impact the effectiveness of firms and influence local and global competitiveness (Kalu, 2020).

The integration of technology into maritime transportation requires high initial investment, particularly in acquiring and maintaining cutting-edge equipment (Alake & Wokocha, 2021); but result in significant cost savings by reducing labor costs, minimizing delays and improving fuel efficiency on the long term. This is particularly important for companies operating where high cost of manual labor and infrastructural challenges often eat into profit margins (Adegbite, 2019).

Furthermore, the adoption of digital platforms in transportation has streamlined operations, by allowing companies to monitor shipments in real-time, improving scheduling accuracy and reducing demurrage fees. This mostly results in more predictable and manageable overall cost of maritime companies (Ugochukwu, 2022). Despite these gains, there remain significant challenges, including high costs associated with adopting these technologies and the need for skilled labor to operate them effectively (Nkwocha & Onyeador, 2023).

But, while technological innovations have brought about increased effectiveness for maritime companies in Rivers State, the benefits are accompanied by substantial initial costs and operational challenges. Understanding the balance between these costs and the long-term savings is crucial for maritime companies aiming to remain competitive in an increasingly technology-driven global economy. Thus, this study investigated the impact of technological transportation on effectiveness of maritime companies in Rivers State.

This study is founded on instrumental technology theory, and is conceptualized in Fig. 1. Technological transportation is the treatment variable, and is used unidimensionally; while effectiveness is the outcome variable, and is measured as operational efficiency and environmental sustainability.



Fig. 1: Conceptual framework of impact of technological transportation on effectiveness.

Theoretical Foundation: Instrumental Technology Theory

Instrumental theory (Duhme, 1906) is based on the idea that technologies are tools standing ready to serve the purposes of their users. That is, technology is neutral, and does not have evaluative content of its own. The neutrality of technology implies at least four points. Firstly, technology is indifferent to the ends it is employed to achieve (Kenneth & Laudon, 2007). Secondly, technology is indifferent to politics, at least in the modern world, and especially with respect to capitalist and socialist societies. A hammer is a hammer, a steam turbine is a steam turbine, and such tools are useful in any social context (Macharia et al., 2015).

Thirdly, the neutrality of technology is attributed to its "rational" character and the universality of the truth it embodies. Technology, in other words, is based on verifiable causal propositions. Insofar as such propositions are true, they are not socially and politically relative but, like scientific ideas, maintain their cognitive status in every conceivable social context. Hence, what works in one society can be expected to work just as well in another. Lastly, the universality of technology means that the same standards of measurement can be applied in different settings (Bitner et al., 2000). Thus, technology increase the productivity of labour in different countries, different eras and different civilizations.

Given this understanding of technology, the only rational stance is unreserved commitment to its usage. Of course, one might make a few exceptions and refuse to use certain devices out of deference to moral or religious values. Reproductive technologies are a case in point. Even if one

believes that contraception, abortion, test tube babies are value-neutral in them, and technically considered, can only be judged in terms of efficiency, one might renounce their use out of respect for the sacredness of life (Bitner et al., 2000).

Thus, by understanding the fact that technology is always availability for every organization to boost their business operations maritime companies can leverage technological tools designed for transportation to improve their management processes. Thus, instrumental theory was considered appropriate to underpin this study.

Concept of Technological Transportation

There has been consensus among transport and digital development communities that digital tools transform transportation. They can be leveraged to promote system efficiency in logistics, ensure access for all by mapping travel patterns for vulnerable groups, and reduce transport's environmental impact through technological solutions that alert residents about levels of pollution (Sehmi, 2020). The consensus among the transport and digital development communities came to reality during the corona virus (COVID-19) pandemic.

Innovations in transportation technology are born out of three necessities: efficiency, ease and safety. Scientists and transportation industry professionals work side-by-side to ensure that new technologies get more people (or things) to their destination faster, safer and with the fewest amounts of resources possible. This is the reason for the shift from coal-powered trains to ultra-fast bullet trains, luxurious aircrafts to budget-friendly, cost-saving models and a switch from gas-guzzling vehicles to 100 per cent electric cars (Daley, 2022).

As transportation technology continues to advance, the way we get from one place to another will improve (Daley, 2022), people and goods will move between points faster, and companies and consumers will save valuable time and money. Innovation in transportation technology is at an all-time high with creative solutions that are helping individuals and corporate bodies get down the block, across the country and even into outer space (Daley, 2022).

Organizational Effectiveness

Organizational effectiveness refers to the measure of how well resources (such as time, money, and labor) are utilized to achieve desired outcomes. It evaluates whether a particular course of action or investment delivers maximum value. In other words, a process or decision is considered effective if it achieve its goals while minimizing expenses and optimizing resource use. Effectiveness in maritime operations entail efficient use of resources. This involves balancing costs with expected outcomes of maritime activities, ensuring that each resource expended contributes to overall success (Burgoyne, 2020).

Organizational effectiveness is also the relationship between outputs generated and costs incurred in maritime activities. It emphasizes maximizing output while reducing input, thereby ensuring that operations are efficient and sustainable (Smith & Jones, 2019). This position highlights the importance of evaluating alternative strategies to determine the most economically viable options (Taylor, 2021). In maritime operations, for example, effectiveness may be evaluated by the extent to shipping company delivery on their services, and doing so with lowest possible amount of resources.

Effective maritime operations optimize resources, are efficiency and are eco-friendly. Various factors contribute to effectiveness of maritime operations, including fuel efficiency, vessel maintenance, crew training and compliance with regulations (Wang et al., 2020; Kemp et al., 2019). Notteboom and Vernimmen (2009) states that implementing fuel-efficient technologies and practices reduce overall costs and enhance competitiveness of shipping companies.

Effectiveness of maritime companies can be measured using operational efficiency (Burgoyne, 2020), fuel management (Smith & Jones, 2019), maintenance and reliability (Taylor, 2021), supply chain optimization (Lee & Chang, 2022), and regulatory compliance (Peterson, 2023). Kumar and Singh (2020) adds that supply chain visibility, environmental sustainability and reduced administrative costs as other measures of effectiveness. However, operational efficiency, environmental sustainability were adopted to proxy effectiveness in this study.

Operational efficiency

Operational efficiency refers to the ability of an organization to deliver products in the most costeffective manner without compromising quality. It involves optimizing processes, resources and workflows to achieve the best possible output with the least amount of input. In practice, operational efficiency is achieved by streamlining procedures, reducing waste, improving productivity and ensuring that resources are utilized optimally.

In maritime operations, operational efficiency may be measured by how well a shipping firm manage its fleet, minimize turnaround times, and maximizes cargo throughput, while controlling operational costs. Operational efficiency is critical for maintaining competitiveness and profitability. Several factors contribute to enhancing efficiency, including technology adoption, process optimization, and supply chain integration. The integration of advanced technologies, such as automation and data analytics, significantly enhance operational efficiency (Hsu et al., 2019).

The use of automated cargo handling systems reduce loading and unloading times, leading to faster turnaround times in ports (Notteboom & Vernimmen, 2009). Streamlining operational processes and implementing lean practices helps to eliminate waste and reduce operational costs. Firms that adopt lean principles significantly reduce lead time and improve service quality, thus, enhance their operational efficiency (D'Amato et al., 2020; Wang et al., 2016).

Environmental sustainability

Environmental sustainability refers to the practice of managing and using natural resources in a way that maintains the health of the environment and ensures that it can support current and future generations. It involves minimizing negative impacts on ecosystems, reducing waste and pollution, conserving energy and resources, and promoting practices that preserve ecological balance. In essence, environmental sustainability seeks to meet present needs without compromising the ability of future generations to meet their own needs. It includes efforts to reduce carbon footprints and protect biodiversity.

Environmental sustainability has been an issue of grave concern to policymakers and business practitioners alike. It is however becoming increasingly critical to maritime operations as the global shipping industry seeks to reduce its environmental footprint. Maritime operations are responsible for a significant portion of global greenhouse gas (GHG) emissions, oil spills, ballast

water discharge and other forms of marine pollution, which according to Knatz (2020), have long-lasting negative effects on marine ecosystems and biodiversity.

As a result, maritime companies are under growing pressure from international regulatory bodies, governments and eco-conscious consumers to adopt sustainable practices that minimize harm to the environment while maintaining operational efficiency (Smith et al., 2020). In order to surmount the challenges posed by these demands, maritime companies are adopting cleaner alternative fuels (e.g., liquefied natural gas, biofuels, and hydrogen), energy-efficient vessel designs, and slow steaming (Psaraftis, 2019). Wang and Meng (2021) states that energy-efficient vessel designs, including optimized hull shapes, propeller designs, and air lubrication systems, have the potential to reduce fuel consumption and lower emissions.

Technological Transportation on Organizational Effectiveness

The high level of competition among shipping firms underscore the need to adopt of technological options that enable differentiation in the industry (Ebere & Ateke, 2019). Shipping firms leverage technology to offer services that are structured to be unique with, and which appeal to clients. A shipping firm may effectively attract and retain clients by adopting technologies that differentiates their offerings from those of competitors (Gallouj & Wreinstein, 2011).

Most offerings of shipping firms are similar; thus, individual firms adopt technological options to drive differentiation (Ebere & Ateke, 2019). Effective use of technology in transportation influence competitiveness of shipping firms. Clients view the services of shipping as basically the same. An individual firm that desire to be competitive must strive to differentiate itself and its offerings through the adoption and implementation of transportation technology (Jogaratnam, 2012).

The adoption of transportation technologies can reshape the services of a firm and the structure of competition. Firms that adopt transportation technologies derive economic value through differentiation and operational efficiency, which in turn, inform competitive advantage (Pine, 2011) and superior performance. Johan and Christoffer (2017) investigated the economic impact of autonomous vehicles in Sweden's logistics industry and observed that autonomous vehicles heavily impact the logistics industry.

Similarly, Takumi (2022) argue that automated transportation systems lead to informative signals and improved effectiveness of firms. Also, Idem (2007) revealed that manual labour is costly, and error prone and cannot ensure that inventory accuracy; while Prasanna and Shakila (2020) revealed that, among the many options for improving supply chain performance, warehouse automation is one whose benefits, though potentially great, are in many cases only partly understood, and that, the benefits of warehouse automation are more accessible than in the past, and they can be used to drive value throughout the supply chain and to open up strategic options.

The forgoing reports and arguments suggests that the application of technology in transportation could improve effectiveness of maritime companies in Rivers. Thus, the following null hypotheses were formulated tested:

HA1: Technological transportation significantly impact operational efficiency of maritime companies in Rivers State.

H_{A2}: Technological transportation significantly impact environmental sustainability of maritime companies in Rivers State.

Methodology

This study is rooted in positivist philosophy; hence an explanatory research design and a quantitative methodology was employed. The population of the study comprised 16 maritime companies in Rivers State. Considering the small size of the population, a census was taken. 5 staff (procurement manager, logistics manager, director of finance, marketing managers and directors of communication and technology) from each of the 16 companies. That makes a total of 80 respondents. However, only 73 respondents provided valid data which were used for the analysis.

The instrument used to collect primary data was 20-item questionnaire designed in the 5-point Likert scale, whose reliability was determined via a pilot study (pretest) conducted and the data subjected to Cronbach's Alpha reliability test, with a threshold of 0.70 set by Nunally (1978). The construct validity of the instrument was determined through Exploratory Factor Analysis (EFA) (see table 1 for results of reliability and validity tests). To determine the impact of technological transportation on organizational effectiveness (operational efficiency and environmental sustainability) a Simple Regression Analysis was used to test two alternate hypotheses. The Statistical Package for Social Sciences (SPSS) version 22.0 was relied upon for the tests.

Table 1: Reliability and Validity Tests

S/N	Variables	Number of	Cronbach's Alpha	Factor
		Items	Coefficients	Loadings
1	Technological Transportation	5	0.708	0.813
2	Operational Efficiency	5	0.713	0.567
3	Environmental Sustainability	5	0.736	0.773

Source: SPSS Output form field data (2024).

Results of the Cronbach's alpha analysis in Table 1 reveal that all the variables in the study produced high Cronbach's Alpha coefficients. This shows that there is inter-item consistency among the variables in the study. In other words, if this study is conducted again in a similar condition the results will be similar to the results of this study. Again, all the variables have high factor loadings greater than 0.4, indicating that the items and variables in the questionnaire measured what they were supposed to measure. These loadings indicated that there is no cross-loading hence there is discriminant validity.

Data Analysis and Results

Table 2: Model Summary of impact of Technological Transportation on Operational Efficiency

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate						
1	.361ª	.131	.118	1.502						
a. Predictor	a. Predictors: (Constant), Technological Transportation									

Source: SPSS Output form field data (2024).

A simple regression analysis was run to determine the impact of technological transportation on operational efficiency of maritime companies in Rivers State. As shown in Table 2, technological transportation has a weak positive impact on operational efficiency. This is evident in the regression coefficient (R) of 0.361. Furthermore, the coefficient of determination (R Square) is 0.131. This means that approximately 13% of the changes in the criterion variable (operational efficiency) are attributable to the impact of the predictor variable (technological transportation), whilst the remaining 87% changes are due to the impact of external variables not included in the model.

Model		Sum of Squares	df	Mean Square	F	Sig.			
1	Regression	24.044	1	24.044	10.656	.002 ^b			
	Residual	160.202	71	2.256					
	Total	184.247	72						
a. Dependent Variable: Operational efficiency									
b. Predi	ctors: (Constan	t), Technological Tran	sportatio	n					

Source: SPSS Output form field data (2024).

As shown in Table 3, technological transportation significantly predicts operational efficiency of maritime companies in Rivers State. This is indicated by the probability value of 0.000, which is less than the critical value of 0.05. Statistically, technological transportation significantly predicts operational efficiency at F(1, 71) = 10.656, p = 0.002 < 0.05, $R^2 = 0.131$. The results also showed that the regression model is a good fit for the data.

Table 4: Coefficients^a of impact of Technological Transportation on Operational Efficiency

S Coefficients
Error Beta t Sig.
.735 9.723 .000
.361 3.264 .002
-

Source: SPSS Output form field data (2024).

The unstandardized coefficients in the regression model in Table 4 indicate how much the dependent variable – operational efficiency varies with the independent variable – technological transportation. As shown in the Table, before the introduction of the predictor variable, operational efficiency stood at 16.872, but at the introduction of the predictor variable, there is an additional unit. Specifically, as shown in the Table, the intercept B₀ is 16.872, which is the predicted value of operational efficiency without the contributions of the predictor variable. That is, when technological transportation is equal to zero, operational efficiency is 16.872. However, the slope B₁ is 0.260, indicating that 1 percent increase in technological transportation will bring about approximately 0.26 percent increase in operational efficiency.

Table 5:	Model	Summary	of	impact	of	Technological	Transpo	rtation	on	Environm	iental
	Sustair	nability									

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.895ª	.733	.727	1.424
a. Predictors	s: (Constant), Te	chnological Tran	sportation	

Source: SPSS Output form field data (2024).

A simple regression analysis was run to determine the impact of technological transportation on environmental sustainability of maritime companies in Rivers State. As shown in Table 5, Technological Transportation has a very strong and positive impact on environmental sustainability. This is evident in the regression coefficient (R) of 0.895. Furthermore, the coefficient of determination (R Square) is 0.733. This means that approximately 73% of the changes in the criterion variable (environmental sustainability) are attributable to the impact of the predictor variable (technological transportation), whilst the remaining 27% changes are due to the impact of external variables not included in the model.

 Table 6: ANOVA^a of the impact of Technological Transportation on Environmental Sustainability

Model		Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	248.025	1	248.025	122.288	.000 ^b	
	Residual	144.002	71	2.028			
	Total	392.027	72				
a. Dependent Variable: Environmental sustainability							
b. Predi	ctors: (Constar	nt), Technological Tra	nsportation				

Source: SPSS Output form field data (2024).

As shown in Table 6, technological transportation significantly predicts environmental sustainability of maritime companies in Rivers State. This is indicated by the probability value of 0.000, which is less than the critical value of 0.05. Statistically, technological transportation significantly predicts environmental sustainability at F(1, 71) = 122.288, p = 0.000 < 0.05, $R^2 = 0.733$. The results also showed that the regression model is a good fit for the data.

Table	7:	Coefficients ^a of	impact	of	Technological	Transportation	on	Environmental
		Sustainability						

		Unsta Coe	ndardized fficients	Standardized Coefficients			
Model		В	Std. Error	Beta	t	Sig.	
1	(Constant)	3.737	1.645		2.272	.026	
	Technological Transportation	.834	.075	.895	11.058	.000	
a. I	Dependent Variable: Environmenta	al sustaina	bility				

Source: SPSS Output form field data (2024).

As shown in the regression model in Table 7, the unstandardized coefficients indicate how much the dependent variable – Environmental sustainability varies with the independent variable – technological transportation. As shown in the Table, before the introduction of the predictor variable, environmental sustainability stood at 3.737, but at the introduction of the predictor variable, there is an additional unit. Specifically, as shown in the Table, the intercept B₀ is 3.737,

which is the predicted value of environmental sustainability without the contributions of the predictor variable. That is, when technological transportation is equal to zero, environmental sustainability is 3.737. However, the slope B₁ is 0.834, indicating that 1 percent increase in technological transportation will bring about approximately 0.83 percent increase in environmental sustainability.

Discussion of Findings

This study probed the impact of technological transportation on the effectiveness of maritime companies in Rivers State. The results of the test of hypotheses showed that technological transportation has weak positive and statistically significant impact on operational efficiency and a very strong positive impact on environmental sustainability of the maritime companies surveyed. These results support the view that the adoption of technological options that enable differentiation in an industry has become an existential need for firms (Ebere & Ateke, 2019).

The findings also support the position that shipping firms can leverage technology to offer unique services attract and retain clients, as well as differentiates their offerings from those of competitors (Gallouj & Wreinstein, 2011). Similarly, our finding align with the argument that shipping firms can adopt technological options to drive differentiation (Ebere & Ateke, 2019); and that effective use of technology in transportation influence competitiveness of shipping firms (Laws & Jogaratnam, 2012).

Our findings substantiate the conjecture that adoption of transportation technologies can reshape the services of a firm and the structure of competition in the industry, and that firms that adopt transportation technologies derive economic value through differentiation and operational efficiency, which in turn, inform competitive advantage (Pine, 2011) and superior performance (Kumar & Petersen, 2013). In addition, our findings validate the report of Johan and Christoffer (2017) who investigated the economic impact of autonomous vehicles in Sweden's logistics industry and observed that autonomous vehicles heavily impact the logistics industry.

Furthermore, our findings lend credence to the view that technological options reduce manual labour and errors and ensure inventory accuracy, which are essential to organizational effectiveness (Idem (2007). The finding align with the report that revealed technological options facilitate service innovation (Hertog & Bilderbeck, 1999, as cited in Ebere & Ateke, 2019); improve supply chain performance (Prasanna & Shakila, 2020) and competitiveness of firms (Ebere & Ateke, 2019); as well as improve sales performance of firms in omni-channel retailing (Takumi, 2022).

Conclusion and Recommendations

Based on the findings of this study and the large extent to which they findings support the findings of previous studies examined, the study concludes that technological transportation has positive, significant impact on effectiveness of maritime companies in Rivers State. This is because technological transportation strongly impact operational efficiency and environmental sustainability of maritime companies in Rivers State. Therefore, this study recommends that maritime companies in Rivers State should invest more in the integration of technology into transportation in order to enhance operational efficiency and environmental sustainability.

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