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TECHNOLOGICAL TRANSFORMATION AND INNOVATION STRATEGY AS A KEY PILLAR IN IMPROVING SUSTAINABILITY EFFICIENCY IN THE MARITIME INDUSTRY

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Abstract

This research aims to analyze the impact and benefits of innovation strategies, investment in technology, and technological transformation in the maritime industry in facing global challenges and increasing profitability. The main focus of this research includes three key aspects: first, how implementing innovation strategies can help maritime companies overcome global competitive challenges and exploit new opportunities; second, the contribution of investment in technology and innovation to increasing the profitability of maritime companies in the long term; third, the impact of technological transformation, including digitalization, the Internet of Things (IoT), and big data analytics, on the changing landscape of the maritime industry with a focus on improving operational efficiency, supply chain management, and demand prediction. The method used in this research is descriptive qualitative, where the author conducted an in-depth literature review by following the existing steps. The results of this research are expected to provide in-depth insight into the effectiveness and potential of technology and innovation. These insights are crucial for understanding and navigating the increasingly complex global market, thereby increasing the competitiveness and performance of maritime companies. Innovation strategy is the primary key for the maritime industry in facing the challenges of increasingly fierce global competition, changes in international regulations, rapid technological developments, and changes in customer preferences. To remain competitive, maritime companies must adapt through innovation in products, services, and operational processes. Investments in technology and innovation can increase the profitability of maritime companies through operational efficiency, cost reduction, increased safety, service diversification, and competitive advantage. Therefore, the Internet of Things (IoT) and big data analytics have profoundly changed the maritime industry in various fields.

Key words: Technological, Technological Transformation, and Innovation Strategy

1. Introduction

Technological transformation and innovation strategies are two key elements that play an essential role in improving the efficiency and sustainability of the maritime industry business in this digital era. The maritime industry, which includes all activities related to the sea, such as transportation, logistics, natural resource management, and tourism, has undergone significant

changes in recent decades. Technological transformation in the maritime industry is pivotal. It can enhance operational efficiency, reduce costs, improve safety, and support environmental sustainability. More importantly, the application of new technologies can be a game-changer, expanding the capabilities and competitiveness of maritime companies in a fiercely competitive global market. Furthermore, the maritime industry has significantly contributed to the global economy, with ports as the primary international trade and transportation nodes. However, the increasing complexity of port operations, coupled with the growing demand for efficient and sustainable practices, has necessitated the adoption of innovative technologies (Evyana Kusumawati, et al, 2023).

Technological transformation in the context of the maritime industry often refers to the use of information and communication technology (ICT), automation, digitalization, and system integration to improve efficiency, security, and sustainability in the maritime sector. This definition may vary depending on the research focus and the application of the technology being discussed. (Carlos Guedes Soares, 2014). Technological transformation refers to the process of profound changes in how an industry, organization, or system operates by applying new technologies. This transformation involves using technology to improve efficiency, effectiveness, and value, as well as to meet challenges and capitalize on emerging opportunities in the digital age.

Besides, information and communication technology development has drastically changed the maritime industry's landscape. Innovations like the Internet of Things (IoT), big data analytics, artificial intelligence (AI), and blockchain technology have enabled maritime companies to optimize their operations, improve resource management efficiency, and improve security and sustainability.

On the other hand, the right innovation strategy is also key to answering the industry's new challenges, including climate change, environmental regulations, and increasing consumer demand for sustainability standards. Companies in the maritime industry that can adapt quickly to these changes through the use of innovative technologies and strategies will have a significant competitive advantage.

This approach identifies various opportunities and challenges that must be faced in implementing this transformation effectively. The research will also highlight practical examples from leading

companies in the maritime industry that have successfully implemented these innovative technologies and strategies to achieve their goals. affecting various operational and strategic aspects. The main challenges faced by the maritime industry today are increasing global competition, fluctuations in fuel prices, strict environmental regulations, and changing market needs. Some of the critical challenges the maritime industry faces today include Intensive Global Competition. The maritime industry operates in a highly competitive global environment. Competition for shipping contracts, cost cuts, and more efficient services is increasing, especially with the emergence of large shipping companies and super-large container ships.

However, changes in market needs in global trade patterns, changing market demand, and economic uncertainty can affect the demand for shipping services and the types of ships needed. The industry must adapt quickly to these changes to remain competitive. The maritime industry needs help in recruiting and retaining a skilled workforce. Limitations in specialized skills, such as ship experts and licensed seafarers, can affect operations and maintenance. Technology and Innovation: Despite technological improvements to operational efficiency and security, the maritime industry still faces challenges in adopting new technologies quickly and making optimal use of them.

Maritime Industry Technology Transformation refers to adopting and integrating new technologies changing how the industry operates, innovates, and improves overall efficiency. The maritime industry involves everything from freight forwarding, passenger transportation, and exploration of marine resources to port management. This transformation arises from improving safety, operational efficiency, asset management, and environmental sustainability. Some of the main aspects of technological transformation in the maritime industry include Digitalization and the Internet of Things (IoT).

The Internet of Things (IoT) application to monitor and manage ships, cargo, and port infrastructure in real time allows for better operational optimization and maintenance. (Nurfadholi, 2019). Digitalization and the Internet of Things (IoT) have changed how the maritime industry manages ships, cargo, and port infrastructure. (Panel, A, B, et al., 2021). The application of IoT in this context enables real-time data collection and analysis from various

connected devices and sensors, such as temperature, humidity, pressure, and GPS sensors on ships and cargo.

Rapid technological changes have caused social and economic disruptions whose impact is not yet fully known. The convergence of new technologies such as artificial intelligence (AI), robotics, and blockchain is driving radical changes that require new policies and actions to ensure they will support the SDGs. (Schwab, 2017). This requires great awareness and adaptability from the government. Digital technologies will play an essential role in achieving the SDGs, taking into account the need to accelerate progress in achieving the goals by 2030. Decision-makers need to be aware and understand technological changes as much as possible to make sustainable use of technology and reduce its side effects. As stated in the Ministerial Declaration, "the introduction of new technologies must not make us forget the promise to leave no one behind" (Hege, 2018)

The formulation of the problem that can be taken from the results of this study is:1). What are the potential benefits of innovation strategies in helping maritime companies overcome globally competitive challenges and seize new opportunities?, 2) How can investment in technology and innovation improve the profitability of maritime companies in the long run? 3) What technological transformations, such as digitalization, IoT (Internet of Things), and big data analytics, can change the landscape of the maritime industry by improving operational efficiency, supply chain management, and demand forecasting. Therefore, the objective of this study is to to investigate the significant role that investment in technology and innovation can play in the long-term profitability of maritime companies, providing a promising outlook for the future.

2. Method

This type of research uses a qualitative approach, a method used to understand the characteristics of a phenomenon of the object being studied so that the main problems that arise can be identified and analyzed and alternative solutions can be taken. Nassaji (2015) states, "Descriptive research is a method used to describe and interpret research objects or subjects systematically. This type of research is descriptive, namely a method that examines the status of a group of people, an object, a condition, or a system of thought at the time. This research aims to create a systematic, factual, and accurate description of the facts based on observations efforts to improve the technological transformation and innovation strategies.

There was no expansion of problems that would not be by the objectives of this research. The stages in this research include:

a. Identifying the extent of technological transformation and innovation strategies.
b. Carrying out an in-depth literature study or literature review (collecting and analysing information that is already available in various written sources) regarding the implementation of technological transformation and innovation strategies.
c. Processing data based on the results of observations on efforts to improve the technological transformation and innovation strategies.
d. Analysing the extent of technological transformation and innovation strategies.

3. Result and Discussion

3.1 The Potential Benefits of Innovation Strategies in Helping Maritime Companies Overcome Globally Competitive Challenges And Seize New Opportunities.

With the need to adapt in the face of global competition, maritime companies face rapidly changing dynamics, including international regulations, technological developments, and customer preferences. An innovation strategy allows companies to adapt quickly to these changes, either through developing new products/services or improving operational processes. One of the most complex and globally integrated sectors, the maritime industry is vital in innovation strategies. This is mainly due to the industry's dynamic nature, which faces challenges and rapid changes in various aspects.

Some of the main factors driving this need for adaptation include:

Tabel 1. Main factors for adaptation

No	Adaptation	Proven	Meaning
1	Intense Global Competition	√	**Innovation can help companies create added value that differentiates them from competitors, both through new products and services.**
2	Changing international regulations	√	allows companies to be proactive in facing change
3	Technology development	√	**With an innovation strategy, companies may catch up with these technologies, which could result in a competitive disadvantage.**

4	Changes in Customer Preferences	√	**able to meet customer needs, increase satisfaction, and build customer loyalty**

From the above table it could be elaborated that:

a. **Addressing Global Challenges of Operational Efficiency**

Innovations in operational processes, such as implementing automation and digitalization technologies, can help maritime companies increase efficiency, reduce operational costs, and improve supply chain management. Apart from that, if companies comply with regulations, maritime companies can more easily meet increasingly stringent international regulatory standards, such as regulations related to carbon emissions and maritime safety, and Increased Competitiveness: Companies that successfully integrate innovation into their business strategies are better able to compete with other global companies through improving service quality and product differentiation.

Taking advantage of new opportunities by taking advantage of business opportunities creatively and innovatively involves several strategic steps that require creativity and the ability to see opportunities where others may not see them. On the other hand, this means taking advantage of situations or conditions that arise in the business environment, in new, unique and unconventional ways. This certainly involves using creativity to identify, develop, and implement new ideas. Here are some ways to do it:

1) Identify Unmet Needs and Problems by Conducting In-Depth Market Research: Conduct research to understand consumers' unmet needs and problems. Pay attention to social trends, technology, and economic changes. Use an Empathetic Approach: Empathetically understand consumer problems from their perspective. This can inspire more original and relevant ideas.
2) Cross-Industry Inspiration: Foster innovation by seeking inspiration from other industries and applying these concepts to your business. For instance, the methods used in technology can be adapted to the food industry. Use brainstorming and mind-mapping techniques to explore ideas without limitations, and don't shy away from ideas that may seem unusual or strange.
3) Using New Technology, Digital Innovation: Use the latest technology, such as AI, IoT, or blockchain, to create new solutions or increase business efficiency.

4) Experiment with Prototypes, Rapidly Iterate: Create a prototype or minimal version of your product/service and test it in the market. This lets you get quick feedback and refine the product before the big launch.

3.2 The investment in technology and innovation improves the profitability of maritime companies in the long run

Increasing investment in the maritime sector needs to be developed because the development, construction, and modernization of maritime infrastructure require sustainable investment and funding support, both from the APBN and through increasing the participation of the private sector. The limited financial resources of the APBN, which can only finance around 40 percent of infrastructure projects, have encouraged the government to look for other alternatives to realize and finance investment plans in the infrastructure sector.

With limited APBN funds, the government must collaborate with private investors to develop infrastructure projects through an investment scheme in the form of a public-private partnership (Government/Public-Private Partnership). This scheme is the primary strategy for realizing the development, construction, and modernization of maritime Infrastructure by increasing the participation of private investors.

Government/Public-Private Partnerships are regulated normatively in Presidential Regulation Number 67 of 2005 concerning Government Cooperation with Business Entities in Providing Infrastructure (from now on referred to as Presidential Decree 67/2005). The availability of adequate and sustainable Infrastructure is urgently needed to support the implementation of national development and improve the economy, social welfare, and Indonesia's global competitiveness. To accelerate infrastructure development, comprehensive steps need to be taken to create a conducive investment climate, encouraging the participation of private business entities in providing maritime Infrastructure based on sound business principles.

The maritime industry is very strategic for development because Indonesia's geographical location is an archipelagic country, located between two continents and two oceans, and borders many neighboring countries by sea. Maritime security is one of the government's essential targets.

Investments in technology and innovation can significantly increase the profitability of maritime companies in the long term in several ways: (1) Operational Efficiency, The application of advanced technology such as automation, digital-based logistics management systems, and IoT (In-

ternet of Things) sensors allows maritime companies to optimize their operations. This can reduce waiting times and fuel consumption and optimize vessel utilization, reducing operational costs and increasing profit margins. (2) Cost Reduction: Innovation in technologies such as alternative fuels (e.g., LNG, hydrogen fuel) or more efficient ship designs can help reduce fuel costs, one of the most significant cost components in the maritime industry. Using sophisticated weather prediction and navigation software can also help avoid inefficient routes and minimize the risk of damage from bad weather. (3) Improved Safety and Regulatory Compliance: Investments in safety technology and monitoring systems can improve operational security and reduce the risk of accidents or incidents. In addition, technological innovation can help companies comply with increasingly stringent international maritime regulations, such as carbon emissions regulations. This compliance avoids potential fines and can improve the company's reputation, which in turn can increase competitiveness and profitability. (4). Diversification of Services Technology also enables maritime companies to offer new or improved services, such as real-time cargo tracking, integrated logistics services, or more effective supply chain management solutions. This diversification can open new sources of revenue and increase the added value provided to customers, which positively impacts profitability. (5) Competitive Advantage: Companies that adopt technology and innovation early tend to have a competitive advantage over competitors who still use traditional technology. These advantages can include better cost efficiency, higher quality of service, and faster response to market changes. In the long run, this will strengthen the company's position in the market and allow them to earn higher profit margins.

3.3 technological transformations, such as digitalization, IoT (Internet of Things), and big data analytics, can change the landscape of the maritime industry by improving operational efficiency, supply chain management, and demand forecasting

Technology has played a critical role in improving supply chain visibility and efficiency. Some of the primary roles of technology in increasing supply chain visibility: (1). IoT and AI Integration that Revolutionizes Supply Chain Management; in the ever-evolving digital era, the integration between the Internet of Things (IoT) and artificial intelligence (AI) has fundamentally changed the way companies manage their supply chains. This transformation is not just a technological revolution but also creates significant changes in the company's interactions with customers, speeds up the product delivery process, and increases overall operational efficiency. Integrating these technologies not only opens up new opportunities but also demands a paradigm shift in traditional approaches to supply chain management. (2). Real-time Visibility and Tracking: Supply chains are at the heart of modern business operations. In a dynamic and

increasingly complex environment, real-time visibility and tracking are essential to increase efficiency and accuracy in supply chain management. Integrating IoT and AI allows companies to understand, monitor, and optimize every real-time supply chain process step.

IoT enables real-time data collection from multiple sources, including delivery vehicles, warehouse devices, and products. Installed sensors provide critical information regarding location, temperature, humidity, and other conditions. This data is then processed by AI systems quickly and accurately, providing deep insight into the movement of goods in the supply chain. Companies can make smarter decisions regarding inventory management, shipping, and production with a better understanding of the whereabouts and condition of goods. One of the main benefits of real-time visibility is the ability to track goods from factory to customer with high timeliness. (3). Prediction (Forecasting) Demand One of the most significant advantages of IoT integration in demand prediction is accurately collecting real-time data. IoT sensors installed on products, storage shelves, and other devices generate continuously updated data about inventory, product movement, and environmental conditions. This information becomes a vital resource for AI systems to perform intelligent analysis.

By leveraging the integration of IoT and AI, companies can create more accurate and responsive demand forecasting. They can predict demand fluctuations quickly, enabling better production, raw material procurement, and distribution adjustments. By reducing uncertainty in demand predictions, companies can optimize inventory, reduce carrying costs, and increase customer satisfaction through on-time delivery. Integrating IoT and AI opens opportunities for more innovative and responsive demand predictions.

Additionally, by leveraging real-time data and deep AI analysis, companies can optimize their supply chains, increase efficiency, reduce costs, and increase customer satisfaction. (4) . Optimizing Supply Chain Route Selection, Efficient route selection in the supply chain is the key to reducing costs, increasing efficiency, and meeting customer expectations. In this context, the integration of IoT and AI has opened up new opportunities for smarter and more efficient route optimization. Smart sensors installed on delivery vehicles collect valuable real-time data on traffic conditions, roads and vehicle performance. This information allows companies to map optimal routes, avoid traffic jams, and choose faster and safer paths. 5). Improving Warehouse Operations One of the biggest challenges in warehouse management is inventory optimization. With IoT sensors installed on storage shelves, companies can collect real-time data regarding stock. AI then analyzes this data to identify demand patterns and optimize item placement. The

result is more efficient inventory management, which reduces the risk of overstocking or understocking, and minimizes waste. The integration of IoT and AI enables real-time tracking of goods entering and leaving the warehouse. Based on this information, the AI system can plan the fastest route to collect goods from storage locations and determine optimal placement of goods within the warehouse. Efficient routing and placement of goods not only saves time, but also reduces the risk of damage to goods during the handling process. This integration also allows for more efficient workforce management.

Data regarding warehouse staff activities, such as time spent picking or loading goods onto delivery trucks, can be captured and analyzed by AI systems. This analysis helps identify efficient work patterns and allocate human resources more intelligently, reducing labor costs and increasing productivity. (6). Supply Chain Risk Mitigation: Modern supply chains face various risks that can disrupt the company's smooth operations, ranging from natural disasters to production disruptions. These risks require an intelligent and responsive approach for effective mitigation. Integrating IoT and AI opens up new opportunities in supply chain risk mitigation. IoT sensors can monitor various conditions in the supply chain, including temperature, humidity, vibration, and noise levels. The data collected helps companies identify potential risks, such as damage to goods due to inappropriate temperatures or excessive vibration during transportation. Companies can plan more effective mitigation measures with a deep understanding of field conditions.

Conclusion

From the explanation above, innovation strategies are essential in the maritime industry to face increasingly fierce global competition, constantly changing international regulations, rapid technological developments, and changes in customer preferences. Maritime companies must adapt through innovation in products, services, and operational processes to remain competitive and meet regulatory standards. Additionally, taking advantage of business opportunities creatively and innovatively, taking calculated risks, collaborating with other parties, and learning and adapting are essential to increase competitiveness and business success. Creative marketing through storytelling and viral campaigns is also vital in attracting attention and building customer loyalty. In an effort to improve Indonesia's maritime sector, we need to encourage investment and modernization of maritime infrastructure. This can be achieved with the support of various funding sources, including public-private partnerships. These partnerships are crucial for the success of

our initiatives. Investments in technology and innovation can increase the profitability of maritime companies in several ways: Operational Efficiency, Cost Reduction, Improved Security and Regulatory Compliance, Service Diversification, and Competitive Advantage. Overall, investment and adoption of technology in the maritime sector is key to increasing efficiency, reducing costs, and strengthening Indonesia's position in the global market.

Technological transformation, including digitalization, the Internet of Things (IoT), and big data analytics, has profoundly changed the maritime industry. The integration of these technologies, especially IoT and artificial intelligence (AI), has revolutionized supply chain management in the following ways: Supply Chain Management Revolution, Real-Time Visibility and Tracking, Demand Prediction, Route Selection Optimization, Improved Warehouse Operations, Global Risk Mitigation Overall, this technological transformation increases visibility, efficiency, and responsiveness in supply chain management, which can improve operational performance and customer satisfaction in the maritime industry.

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