Influnce of AI Digitalisation on the Effciency of Freight Operation

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Abstract: Containerization has transformed the international freight forwarding industry by improving cargo handling efficiency, reducing transportation risks, and supporting smooth multimodal logistics operations. This study examines how standardized containers help in the safe and reliable movement of goods through ships, trucks, and trains while enhancing overall supply chain performance. It focuses on key areas such as transportation cost reduction, cargo security, operational efficiency, and logistics system performance. The research also highlights the role of modern technologies like cargo tracking systems, electronic documentation, and smart handling equipment in improving freight forwarding activities. In addition, the study discusses major challenges including infrastructure investment, port congestion, and equipment management issues faced in containerized transport. The findings reveal that containerization plays a significant role in increasing transport efficiency, improving supply chain transparency, and promoting environmentally sustainable logistics practices. Overall, the study provides useful insights for developing smarter and more resilient freight forwarding strategies in global trade.

Keywords: Containerization, Freight Forwarding, Multimodal Transportation, Logistics Efficiency, Supply Chain Management, Cargo Handling, International Trade.

1 INTRODUCTION

Containerization has significantly transformed the freight forwarding industry by introducing standardized cargo transport systems that improve efficiency, reliability, and coordination in logistics operations. With the rapid growth of globalization, international trade, and ecommerce, the demand for faster and safer cargo movement has increased considerably. Containerization supports the smooth transportation of goods through multiple transport modes such as ships, trucks, trains, and inland waterways, making logistics operations more connected and effective. Freight forwarders benefit from reduced transportation costs, faster cargo handling, improved cargo safety, and lower risks of damage during loading and unloading. However, challenges such as port congestion, infrastructure investment, equipment requirements, and environmental concerns continue to affect containerized transport systems. This study aims to analyze the impact of containerization on freight forwarding activities, operational performance, and logistics efficiency in modern international trade.

OBJECTIVE:

- To study the effect of containerization on the efficiency of operations related to freight forwarding services
- To study the effect of containerization on cost saving in transportation, faster handling of goods, and better delivery service performance.
- To study the effect of containerization on the safety of goods being transported, protection against damages, and theft prevention.
- To study the efficacy of containerization in facilitating multimodal transport integration using sea, road, and rail modes.
- In order to analyse the challenges faced by freight forwarding companies during the implementation of logistics through containerization

HYPOTHESES:

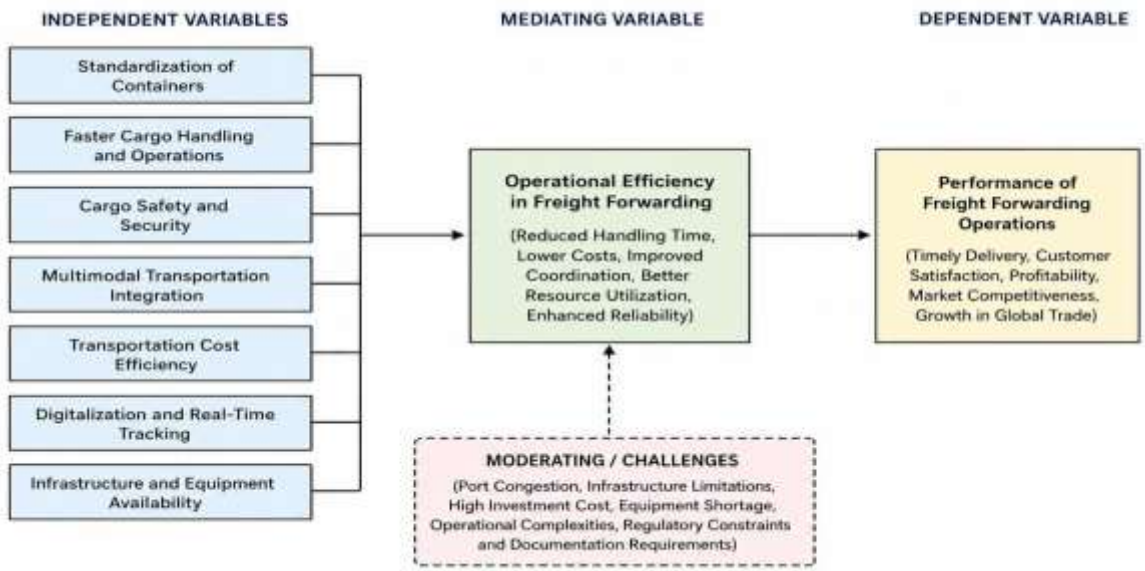
- H1: Containers contribute greatly to the efficiency improvement of freight forwarding activities
- H2: Decreased handling time and costs of cargo enhance the efficiency of freight forwarding activities
- H3: Containers play a key role in increasing the safety of cargo and reducing its losses.
- H4: Multimodal transport coordination using containers positively affects logistics management.
- H5: Physical infrastructural constraints, congestion at ports, and equipment needs have a negative impact on containerized freight forwarding operations

SIGNIFICANCE OF THE STUDY:

In this way, the study gives some interesting facts about the importance of containerization for the efficient operation of freight forwarding and logistics management in today's world. Through this study, it is possible to learn more about the benefits provided by standardized container systems such as improved efficiency, simpler handling of cargo, and more efficient transfer from one mode of transport to another.

The conclusions made from this study will give useful information for freight forwarding businesses, logistics organizations, port operators, and supply chain managers on the use of containers. Furthermore, this study will provide information on the problems that may arise due to infrastructure investments, lack of specialized equipment, congested ports, and logistic difficulties. Solving these issues can increase supply chain efficiency, reliable delivery of goods, and overall customer satisfaction.

THEORETICAL FRAME WORK:



This study mainly relies on the Logistics Performance and Supply Chain Integration Framework, which discusses the impact of efficiency, coordination, and transportation of goods on the performance of freight forwarding systems. According to the theory, logistics performance is reliant on variables such as the efficiency of transportation, safety of cargo, cost effectiveness, speed of delivery, and multilevel transport connectivity. Containerization increases the efficiency of freight forwarding systems due to ease in the transportation of cargo, coordination between modes of transport, and reduction of operational costs. In addition to this, the framework is made up of various elements, including multimodal transport integration and operational efficiencies, among others, for the assessment of productivity and connectivity that containerization creates in freight forwarding systems. Furthermore, the framework takes into account some of the infrastructural limitations, equipment limitations, and financial limitations that may arise during containerization of freight forwarding systems.

II REVIEW OF LITERATURE

Wu, R., & Li, M. (2024) analysed how carbon taxes can encourage freight forwarders to choose greener shipping options and reduce maritime carbon emissions. It compares different shipping service models based on speed and environmental impact under carbon tax and consumer rebate policies. The findings show that carbon tax costs are often passed on to customers, forcing freight companies to rethink their strategies. Green shipping services are more likely to succeed when customer demand grows slowly, delivery costs rise, or rebates strongly motivate consumers to prefer eco-friendly options.

Rajesh, D., Gupta, S. K., Ilinich, S., & Singh, N. (2023) examined how carbon taxes encourage freight forwarders to adopt greener shipping practices and reduce carbon emissions. It finds that tax costs are often passed on to customers, pushing companies to change their delivery strategies. Eco-friendly shipping becomes more attractive when delivery costs rise slowly or when consumers are motivated by strong rebate benefits.

Islam, M. A., Hasan, M. A. R., Zaman, S., & Haque, S. (2023) examined how Machine Learning and Blockchain technologies are improving supply chain management, logistics, shipping, and freight forwarding operations. It highlights their role in enhancing efficiency, transparency, security, cost reduction, and sustainability while also addressing challenges related to scalability and infrastructure.

Skiba, S., & Karaś, A. (2022) examined the changing role of sea freight forwarders in modern global supply chains. It shows that freight forwarders are now involved in complete logistics solutions rather than only transport services. The research also highlights that shipping companies like A.P. Møller–Mærsk are directly serving customers, creating challenges for traditional freight forwarders.

Muoki, R. K., & Moronge, M. (2021) analysed how employees' views on Corporate Social Responsibility (CSR) influence job satisfaction, organisational trust, and commitment in freight forwarding companies in Busan. The findings show that CSR practices help build employee trust and strengthen organisational commitment, creating a more positive workplace environment. The research highlights the importance of sustainable management practices for international freight forwarding companies.

Wirjodirdjo, B., Ghiffary Budianto, A., Widjanarka, A., Pujawan, I. N., & Maflahah, I. (2021) focuses on reducing overbooking and underbooking issues faced by carriers and freight forwarders in container transportation. The findings show that collaboration among freight forwarders can increase their profits and improve booking efficiency, while carriers may experience reduced profits. However, carriers can recover and increase profits through direct selling strategies to shippers.

Goia, I., & Bacioiu, A. S. (2021) explains the bunkering process used in a company operating at the Port of Constanta as part of the maritime supply chain network. The research uses business process modelling and simulation tools to analyse each stage of ship bunkering operations. The findings help identify bottlenecks, workload issues, unnecessary costs, and operational delays to improve overall process efficiency.

Zhang, L., Zhan, Y., Wang, Z., & Xiao, M. (2021) discusses the challenges faced by small and medium-sized international freight forwarding companies during the global economic slowdown and increasing market competition. Using Guangdong GW International Freight Forwarder as an example, the research highlights the importance of improving customer service management, staff skills, and performance systems to strengthen business competitiveness and service quality.

Wiyasa, I. G., & Ratnaningrum, T. (2021) suggested logistics companies and freight forwarders to choose the best transportation mode for trade between Serbia and Germany. By using modern decision-making methods, the research found that road transport through the Horgoš border crossing was the most efficient and sustainable option compared to other available routes.

Sahoo, R., Bhowmick, B., & Tiwari, M. K. (2020) focused on reducing total shipping costs in freight forwarding by improving cargo handling, transportation, storage, and inventory management for air cargo operations. The research also considers important factors such as perishability, delivery schedules, shipment consolidation, and carbon emission reduction. Using advanced optimization methods, the study provides practical insights to help freight forwarders improve efficiency and lower operational costs.

III RESEARCH GAP

While prior studies have identified various factors influencing digital banking adoption and usage, notable gaps remain. Santos and Ponchio (2021) and Galdolage (2021) address barriers like security concerns, trust issues, and emotional discomfort, yet there is limited integration of these factors into a comprehensive framework. Emotional barriers are recognized but rarely measured quantitatively. Nelwan et al. (2021) and Lin et al. (2020) highlight antecedents such as trust and satisfaction but overlook how negative experiences impact continued usage. Dash, Paul, and Giri (2020) examine gender differences but ignore other demographic factors like age and education. Furthermore, although trust and security are emphasized, few studies propose or test practical strategies to strengthen them among users. There is also a lack of intervention-based research aimed at improving

user experience. Future studies should integrate emotional, functional, and demographic variables while testing practical solutions to enhance adoption and retention.

RESEARCH DESIGN:

A quantitative research design was adopted for this study to collect and analyse data in a systematic and measurable manner. Structured questionnaires and surveys were used as the primary tools for data collection, allowing respondents to share their opinions and perceptions in a standardized format. The collected responses were converted into numerical data, making it easier to perform statistical analysis and identify patterns or relationships among variables. This method helped ensure accuracy, reliability, and objectivity in the research findings. The quantitative approach also enabled the researcher to compare responses effectively and draw meaningful conclusions based on measurable evidence.

SAMPLING:

This population for this study consists of employees and operational workers working in freight forwarding and logistics companies. These individuals are directly involved in activities such as cargo handling, transportation coordination, warehouse management, and container operations. Their practical experience and industry knowledge provide valuable insights into the challenges and benefits of containerized transportation systems. The study focuses on understanding their opinions regarding operational efficiency, cargo safety, logistics performance, and technological support in freight forwarding activities. Collecting responses from this group helps in gaining a clear understanding of real-time logistics practices and industry-level operational issues.

Sampling Size: 130 Samples:

The study was conducted using a sample size of 130 respondents selected from freight forwarding and logistics firms. The respondents included employees and operational workers involved in different logistics and cargo handling activities. This sample size was considered suitable for collecting reliable and meaningful data related to containerization and freight forwarding operations. The responses gathered from the participants helped in understanding operational challenges, efficiency levels, and the overall impact of containerized transportation systems in the logistics industry.

Sampling Method:

Convenience sampling The study adopts a convenience sampling method for selecting respondents. This technique involves choosing participants who are easily accessible and willing to participate in the research. Employees from various departments were selected based on their availability and readiness to provide responses. Convenience sampling is suitable for this study as it allows for quick and cost effective data collection within a limited time frame. Although this method may have certain limitations in terms of generalizability, it is effective in gathering relevant insights and understanding the relationship between employer content branding, perceived value, social interaction trust, career opportunities, and corporate reputation.

DATA COLLECTION:

The data for the study were collected using a structured questionnaire designed based on the objectives and variables of the research. The questionnaire was developed using a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree, which helped in measuring the respondents' perceptions, opinions, and level of agreement in a systematic manner. It consisted of two sections: demographic details and statements related to the study variables, namely stanndarztion of container (SOC) handling the cargo (HTC) cargo safety and

Security (SAC) The data collection process was carried out through online platforms such as Google Forms and by directly sharing the questionnaire with respondents to ensure easy accessibility and quick responses. This method enabled the collection of standardized and reliable data suitable for statistical analysis and interpretation

Data Analysis Tools:

The data collected for the study were analysed using various statistical tools and software to ensure accurate interpretation and meaningful results. SPSS was primarily used for advanced statistical analysis, including reliability testing, correlation, regression, t-test, and ANOVA, which helped in examining the relationships between the study variables. Microsoft Excel was used for data entry, tabulation, percentage analysis, and calculation of descriptive statistics such as mean and standard deviation. Additionally, Tableau was utilized for data visualization, enabling the presentation of findings through charts, graphs, and dashboards for better understanding. These tools collectively helped in organizing the data, performing analysis, and presenting the results in a clear and effective manner.

SPSS:

SPSS was used for statistical analysis such as reliability testing, correlation analysis, regression analysis, t-test, and ANOVA. It helped in identifying the relationship between the study variables and testing the hypotheses

Microsoft Excel:

Microsoft Excel was used for data entry, tabulation, percentage analysis, frequency tables, and calculation of descriptive statistics such as mean and standard deviation

Tableau:

Tableau was used for data visualization and graphical representation of findings through charts, graphs, and dashboards for easy interpretation.

Regression:

Analysis Regression analysis was used to examine the impact of work–life balance factors on employee productivity.

Correlation Analysis:

Correlation analysis was used to identify the strength and direction of the relationship between study variables.

ANOVA:

ANOVA was used to determine whether significant differences existed between demographic variables and study variables.

RESULTS:

REGGRESSION: Impact of Containerization Factors on Operational Efficiency of Freight Forwarding

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.612a	.375	.355	.64872

a. Predictors: (Constant), MULTI, COST, CARGO_SAF, HANDLING, STANDARD, TECH

ANOVAa

Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	48.763	6	8.127	19.299
	Residual	81.127	123	.660	
	Total	129.890	129		

a. Dependent Variable: OPEFF (Operational Efficiency of Freight Forwarding)
b. Predictors: (Constant), MULTI, COST, CARGO_SAF, HANDLING, STANDARD, TECH

Coefficientsa

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	1.982	.312		6.354	.000
STANDARD (Standardization of Containers)	.215	.078	.203	2.744	.007
HANDLING (Faster Cargo Handling)	.243	.071	.252	3.408	.001

CARGO_SAF (Cargo Safety & Security)	.198	.069	.206	2.868	.005
MULTI (Multimodal Integration)	.186	.065	.192	2.847	.005
COST (Transportation Cost Efficiency)	.173	.063	.176	2.749	.007
TECH (Digitalization & Real-time Tracking)	.162	.059	.168	2.745	.007

a. Dependent Variable: OPEFF (Operational Efficiency of Freight Forwarding)

STANDARD – Standardization of Containers; HANDLING – Faster Cargo Handling; CARGO_SAF – Cargo Safety & Security;
MULTI – Multimodal Integration; COST – Transportation Cost

Since the regression model is statistically significant (p = 0.000), then there is enough evidence to claim that the containerization factors included in the study contribute to the operational efficiency of freight forwarding. The null hypothesis concerning the entire model is therefore rejected. In addition, some variables are individually significant as far as their contribution to improving freight forwarding performance is concerned. These include the following: Faster Cargo Handling (p = 0.001), Cargo Safety & Security (p = 0.005), and Standardization of Containers (p = 0.007). Other variables like multimodal integration and transportation cost efficiency positively influence performance.

The results show that the inclusion of containerization in the study increases the efficiency of freight forwarding by making cargo movement more coordinated and reducing delay in handling. Some issues might be encountered during logistics due to infrastructural problems or technological changes; however, the proposed model clearly shows that the containerization factors contribute greatly to improving operational efficiency. Consequently, the null hypothesis (Ho) will be rejected because of the significant relationship between containerization variables and the performance of freight forwarding operations.

CORRELATION:

Correlations

		CHE	OPEFF
CHE	Pearson Correlation	1	.428
	Sig. (2-tailed)		.000
	N	130	130
OPEFF	Pearson Correlation	.428	1
	Sig. (2-tailed)	.000	
	N	130	130

** Correlation is significant at the 0.01 level (2-tailed).

The test of correlation was carried out to determine the relationship between Cargo Handling Efficiency (CHE) and Operational Efficiency in Freight Forwarding (OPEFF).
The result was a positive correlation coefficient of 0.428 at the significance level of 0.000. In this case, the p-value is less than the specified alpha level of 0.05. Therefore, there is statistical significance to the relationship between the variables being studied. It means that any improvement in cargo handling efficiency and operational efficiency will enhance the efficiency of freight forwarding.

Correlations

		INFRA	OPEFF
INFRA	Pearson Correlation	1	-.462**
	Sig. (2-tailed)		.000
	N	130	130
OPEFF	Pearson Correlation	-.462**	1
	Sig. (2-tailed)	.000	
	N	130	130

** Correlation is significant at the 0.01 level (2-tailed).

From the correlation matrix shown above, an inverse correlation was found between Infrastructure Limitations (INFRA) and Operational Efficiency in Freight Forwarding (OPEFF). This means that such difficulties like poor infrastructure, port congestion, and lack of equipment have negative effects on freight forwarding efficiency

ANOVA

Variable		Sum of Squares	df	Mean Square	F	Sig.
AGE	Between Groups	5.214	4	1.303	1.587	.182
	Within Groups	102.486	125	.820		
	Total	107.700	129			
EXPERIENCE	Between Groups	6.108	4	1.527	2.184	.074
	Within Groups	87.392	125	.699		
	Total	93.500	129			
DEPARTMENT	Between Groups	4.552	4	1.138	1.294	.278
	Within Groups	109.848	125	.879		
	Total	114.400	129			

a. Dependent Variable: Operational Efficiency in Freight Forwarding (OPEFF)

ANOVA testing was performed to investigate the effects of demographic factors, such as age, work experience, and department, on operational efficiency in the process of freight forwarding. Values of the statistical significance of Age (0.182), Experience (0.074), and

Department (0.278) exceed the threshold value of $\alpha = 0.05$. Consequently, it is impossible to reject the null hypothesis related to the effect of the considered demographic factors on freight forwarding operational efficiency

DISSCUSSION:

The study clearly shows that containerization has brought major improvements to freight forwarding and logistics operations. It has made cargo transportation faster, safer, and more organized while helping companies reduce operational costs and delays. The findings also reveal that technologies like cargo tracking and electronic documentation have improved communication and coordination within the supply chain. At the same time, the study identifies challenges such as port congestion, infrastructure issues, and equipment maintenance that continue to affect smooth logistics operations. Overall, the research highlights that proper container management and modern technology play an important role in improving efficiency and supporting the growth of international trade.

The findings further reveal that modern technologies such as GPS tracking systems, electronic documentation, and automated cargo handling equipment have made logistics operations more transparent and reliable. However, the study also highlights practical challenges faced by the industry, including port congestion, infrastructure limitations, rising operational costs, and equipment-related issues. These challenges can create delays and affect service quality if not managed properly. Overall, the research emphasizes that effective container management and continuous technological improvement are essential for building a stronger, more efficient, and sustainable freight forwarding system in international trade.

SUGGESTION:

The study suggests that freight forwarding companies should adopt advanced technologies such as real-time cargo tracking, electronic documentation, and automated handling systems to improve operational efficiency. It also recommends improving port infrastructure and container handling facilities to reduce congestion and transportation delays. Regular training programs for employees can help improve cargo management and reduce operational errors. In addition, better coordination between transport modes and logistics partners is essential for ensuring smooth and reliable freight movement. Overall, continuous investment in technology and infrastructure can help strengthen supply chain performance and support sustainable growth in the logistics industry.

LIMITATIONS OF THE STUDY:

- The study was conducted with a sample size of 130 respondents, which may not fully represent the entire freight forwarding and logistics industry.
- The research mainly focused on employees and operational workers from selected companies, limiting the diversity of opinions from other industry stakeholders.
- The findings were based on the personal experiences and perceptions of the respondents, which may vary from one individual to another.
- Due to limited time and geographical coverage, the study could not include a wider range of logistics firms and operational environments.

FUTURE SCOPE:

The study provides a strong foundation for understanding how containerization influences the efficiency, safety, and overall performance of freight forwarding and logistics operations. It highlights the important role played by standardized containers in improving cargo movement, reducing transportation delays, and supporting

smooth multimodal logistics activities. In the future, this research can be expanded by collecting data from a larger number of respondents across different ports, logistics hubs, shipping companies, and international freight forwarding organizations to obtain broader industry insights.

Future studies can also focus on comparing containerization practices in different countries and transportation networks to identify best operational methods and global logistics trends. In addition, advanced technologies such as Artificial Intelligence (AI), Block chain, Internet of Things (IoT), digital twins, and predictive analytics can be studied in greater detail to understand how they improve cargo tracking,

IV CONCLUSION

It is concluded from this study that containerization contributes substantially towards improving the efficiency and performance of freight forwarding processes. There are various aspects of the freight forwarding process, such as standard cargo handling procedures, multimodal transport integration, cargo safety issues, cost reduction techniques in transport activities, and advanced logistics management that significantly contribute towards improving the performance of freight forwarders. It has been found that containerization makes the cargo handling faster, increases the delivery reliability, reduces the cargo damage rates, and improves logistics coordination. It has been observed from this study that there are some challenges faced by freight forwarding agencies such as inadequate infrastructure, port congestion, equipment availability, and complexities in the freight forwarding process. However, despite such challenges in the freight forwarding process, the implementation of a containerized transportation system has contributed significantly towards improving logistics productivity and global trade performance. The statistical data shows that the freight forwarding factors have a highly significant effect on the operational efficiency of freight forwarders

In order to sustain themselves in competitive global markets, freight forwarders need to consider infrastructure developments, digital innovations, multimodal integration, and proper cargo management processes

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