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EVALUATING THE EFFECTIVENESS OF DIGITAL TECHNOLOGIES IN OPTIMIZING STEVEDORING OPERATIONS A CASE STUDY OF WEST AFRICA CONTAINER TERMINAL (WACT), ONNE RIVERS STATE.

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ABSTRACT

Digital technologies have become an integral part of container port operations all around the world. The West Africa Container Terminal (WACT) has employed a number of digital technologies to improve stevedoring operations, which involve loading and unloading cargo from vessels. The purpose of this research is to assess the effectiveness of these digital technologies in optimizing stevedoring operations at the West Africa Container Terminal. The study employed a mixed-methods approach, which included a survey of WACT staff, observations of terminal operations, and operational data analysis. According to the findings, digital technologies have greatly improved the productivity and effectiveness of stevedoring operations at WACT. The three digital technologies that were found to be most efficient were the automated gate system, terminal operating system, and global positioning system. In order to further enhance stevedoring operations, the report recommends West Africa Container Terminal (WACT) continuously invest in digital technologies and explore new ones.

Keywords: Digital technologies, Stevedoring operations, West Africa Container Terminal, Terminal Operating System, Global Positioning System, Automated Gate System.

1.0 Introduction

The West Africa Container Terminal (WACT) is a modern container terminal located in Onne, Port Harcourt, Nigeria. The terminal utilizes various digital technologies such as Terminal Operating System (TOS), Automated Gate System, Digital Port Community System, Electronic Data Interchange (EDI), Global Positioning System (GPS), and Radio Frequency Identification to improve its operations and efficiency. With the need for international commerce growing and regulatory constraints rising, the shipping sector is under increasing pressure to increase sustainability, efficiency, and cost-cutting. (Santos et al., 2021). Adopting digital technologies, which have the potential to optimize stevedoring operations and the industry's competitiveness, is one possible solution.

Stevedoring operations which include loading and unloading cargoes from vessels is critical aspect of terminal operations, and the use of digital technologies can significantly improve its efficiency and effectiveness. The purpose of this research is to assess the effectiveness of digital technology in optimizing stevedoring operations at WACT.

Several studies have looked into how digital technologyi might be used to

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improve container terminal operations, particularly stevedoring. Cheon, Song, and Cho (2017) discovered that the Terminal Operating System (TOS) increased the efficiency of container terminal operations substantially. Liu et al. (2020) discovered that the Automated Gate System (AGS) reduced truck waiting times at a container terminal considerably. According to these research, digital technology may considerably enhance container terminal operations, although their efficiency varies depending on the environment.

In the framework of WACT, it is necessary to assess how well digital technologies may be used to optimize stevedoring operations. There is a dearth of knowledge on the effective utilization of digital technologies at the West Africa Container Terminal. This study intends to close this gap by examining the digital technologies used at the West Africa Container Terminal and evaluating how successfully they improve stevedoring operations. The study will make recommendations for enhancing stevedoring operations with digital technologies. The study will also provide recommendations on how to further optimize stevedoring operations using digital technologies.

Digital technologies in stevedoring operations can bring significant advantages such as quicker turnaround times, lower labor costs, increased accuracy, and improved safety. Evaluating the performance of these digital technologies is one sure way to ensure that they are delivering the expected outcomes.

Digital technologies offer a lot of benefits in stevedoring operations, amongst them, is the ability to optimize processes and boost efficiency. For example, when automated container handling equipment like automated stacking cranes are utilized, labour cost can be reduced while increasing productivity by managing containers with greater speed and accuracy.

The ability to improve safety is another benefit of digital technologies in stevedoring operations. Stevedoring operations are inherently risky because of the heavy gear and large volumes of cargo involved. For instance, drones and sensors can assist in real-time operation monitoring, spotting potential risks, and reducing the likelihood of accidents.

The use of digital technology in stevedoring operations may also offer useful information and insights that can assist businesses in making wise decisions. Data analytics, for instance, may assist organizations in streamlining freight operations, identifying bottlenecks, and enhancing scheduling and planning.

Although there are many advantages to using digital technologies in stevedoring operations, organizations may nevertheless face certain challenges during implementation. One of these challenges is the high cost of investing in technological equipment and tools. Some organizations, especially smaller ones, may find it prohibitively expensive to adopt digital technologies.

Specialized training in order to use and maintain digital technologies in stevedoring operations is another challenge. Organizations might have to invest resources in training programs and hire specialist staff in order to ensure the optimal usage of digital technologies.

Furthermore, incorporating digital technologies into established systems and procedures can be difficult. To guarantee compatibility with new technologies, organizations may need to modify current processes and procedures.

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Digital technologies have the ability to transform stevedoring operations by increasing efficiency, safety, and cost-effectiveness. However, organizations must carefully evaluate these technologies' efficacy before using them to be sure they provide the desired benefits. Despite the difficulties of adopting digital technologies, the possible advantages make it a worthwhile investment for shipping companies.

However, the research objective is to evaluate the effectiveness of digital technologies in optimizing stevedoring operations at West Africa Container Terminal while offering suggestions on how to use digital technology to improve stevedoring operations.

1.1 Digital Technologies Used at The West Africa Container Terminal

Terminal Operating System (TOS): WACT employs a TOS to regulate container movement in and out of the terminal. This system monitors container movements, optimizes container handling, and improves communication across terminal departments. The Terminal Operating System (TOS) is one of the digital technologies employed by WACT to improve its operations. According to Marufuzzaman and Islam (2019), implementing a TOS can improve container handling efficiency, save operating costs, and increase customer satisfaction.

Automated Gate System: WACT has an automated gate system to expedite truck and container access and exit. This system scans container numbers and matches them to the proper vehicle or driver using optical character recognition (OCR) technology. WACT also employs the Automated Gate System (AGS), which use OCR technology to speed up the process of container and vehicle entry and exit. According to Kim and Lee (2019), implementing an AGS can minimize truck wait times and increase terminal throughput.

Global Positioning System (GPS) Tracking: WACT employs Global Positioning System (GPS) tracking to monitor the whereabouts of containers and trucks within the terminal. This helps to maximize container movement and reduce waiting times. WACT employs GPS tracking as another digital technology to improve container movement and reduce waiting times. According to Hwang et al. (2017), GPS tracking can increase terminal efficiency by allowing real-time tracking of container movements and lowering the time required for human tracking.

Electronic Data Interchange (EDI): The West Africa Container Terminal employs electronic data interchange (EDI) to communicate with other supply chain participants including shipping lines, customs, and freight forwarders. This lowers the possibility of mistakes while enabling quicker and more precise processing of paperwork. The adoption of EDI can increase supply chain efficiency by enabling quicker and more accurate processing of documents, according to research by Teng and Yeh (2016).

Radio Frequency Identification (RFID): WACT employs radio frequency identification (RFID) technology to track containers and equipment within the terminal. RFID tags are connected to containers and equipment, and readers strategically placed around the terminal track their movement and position. According to Sutrisno et al. (2019), RFID technology installation can improve container handling efficiency, minimize equipment downtime, and improve terminal security.

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Digital Port Community System: The West Africa Container Terminal employs a digital port community system to enhance communication and cooperation among many stakeholders in the port community. This system allows for real-time information sharing, such as vessel scheduling, container status, and customs clearance status. According to Wang et al. (2019), implementing a digital port community system can increase supply chain efficiency by facilitating real-time information exchange among stakeholders.

1.2 The Need for the Research

Worldwide, the container terminal business has made it common practice to integrate digital technologies into stevedoring operations. These technological advancements have the potential to greatly increase the efficacy and efficiency of stevedoring operations, resulting in lower costs and more customer satisfaction. To find areas for development and optimization, it is necessary to assess the performance of these technologies in certain terminal environments. Analysing how well digital technologies may be used to improve stevedoring operations at West Africa Container Terminal, justifies the need for this research.

Evaluation of the efficiency of digital technologies in stevedoring operations is necessary in the context of WACT since this may assist identify areas for improvement. It has been demonstrated that digital technology improves terminal operations, particularly stevedoring operations. For instance, it has been demonstrated that using the Terminal Operating System (TOS) increases the effectiveness of container terminal operations (Cheon, Song, & Cho, 2017), and that using the Automated Gate System (AGS) decreases truck waiting times. (Liu et al., 2020).

The use of digital technology to optimize stevedoring operations in the particular context of WACT, however, has received very little attention. This study can offer insights into the best practices for optimizing stevedoring operations using digital technologies in this particular terminal by assessing the usefulness of digital technologies at WACT. This might increase WACT's operational efficacy and efficiency, resulting in lower costs and more customer satisfaction.

2.0 Literature Review

The use of digital technology in stevedoring operations has gained significance within the maritime sector. The effectiveness of digital technology in optimizing stevedoring operations is the main focus of this literature review

Stevedoring entails the loading and unloading of cargo from ships at ports. These procedures are critical in ensuring that commodities move through the supply chain in a timely and efficient manner. Digital technologies are increasingly important in improving these activities.

Several studies have investigated how digital technologies are affecting stevedoring operations and the shipping industry as a whole. For instance, research by Song and Dinwoodie (2017) discovered that the adoption of digital technology like GPS and RFID (Radio Frequency Identification) may greatly increase productivity and save costs in container handling operations. Similar to this, Kuo et al. (2020) discovered in their study that the application of digital technologies like AI (Artificial Intelligence) and IoT (Internet of Things) may improve the effectiveness and safety of port operations.

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The benefits of digital technology in container terminal operations have been highlighted in prior studies. For instance, according to research by Cheon et al. (2017), using terminal operating systems increases productivity and decreases truck turnaround times. The deployment of automated gate systems has also been found to shorten wait times and increase the accuracy of container identification. (Liu et al., 2020). These studies, however, frequently concentrate on specific technologies rather than evaluating how effectively digital technology as a whole may optimize stevedoring operations.

The use of digital technology has become crucial to container port operations all around the world. These technological advances have been demonstrated to increase operational effectiveness, reduce costs, and improve customer satisfaction. (Zhao et al., 2018). Numerous studies have assessed the efficiency of digital technology in stevedoring and other container terminal operations.

Terminal Operating System (TOS) is a typical digital technology used in container terminal management. According to Cheon et al., (2017), Terminal Operating System (TOS) manages the operational aspects of a container terminal, including vessel and yard operations, and container tracking. Cheon et al., (2017) examined the effectiveness of the Terminal Operating system in a container port in Korea, and they discovered that it greatly improved the efficiency of terminal operations, including vessel handling and container handling.

The Automated Gate system (AGS) is another digital technology that is frequently utilized in container terminal operations. Truck entry and exit at a container port are automated by AGS using sensors and cameras, which reduce truck wait times. (Liu et al., 2020). At a Chinese container terminal, Liu et al.'s (2020) evaluation of the efficiency of AGS revealed that it dramatically decreased truck waiting times, increasing operational effectiveness.

The use of the Global Positioning System (GPS), in addition to the Terminal Operating System (TOS) and Automated Gate System (AGS), has been shown to improve the effectiveness of container terminal operations. GPS is used to track and monitor containers, enabling real-time visibility of their movements. (Molnar et al., 2020). In a container port in Hungary, Molnar et al. (2020) assessed the efficiency of GPS and discovered that it increased the accuracy as well as the speed of container tracking and monitoring.

While several studies have assessed the efficiency of digital technologies in container terminal operations, little is known about how they work in the particular setting of the West Africa Container Terminal (WACT). This study aims to close this gap by assessing how well digital technology may be used to optimize stevedoring operations at WACT.

2.1 Benefits of Digital Technologies in Stevedoring Operations

Improved Efficiency is one of the benefits of digital technology for stevedoring operations. Equipment for handling automated containers, including automated stacking cranes, may handle containers more quickly and accurately, lowering labourur costs and speeding up turnaround times. (Singh & Singh, 2020). Zhang et al., (2020) opined that real-time data analytics may also help to enhance planning and scheduling, optimize freight movements, and eliminate delays.

Improved safety is another benefit of digital technology as well. Drones and

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sensors can track activities in real-time, spot possible dangers, and lower the likelihood of accidents. (Li et al., 2020). Additionally, digital technology may offer insightful information on freight handling, assisting businesses in identifying problems and potential solutions. (Chen et al., 2021).

2.2 Challenges of Implementing Digital Technologies in Stevedoring Operations

Although there are several benefits to employing digital technologies in stevedoring operations, businesses may confront certain problems during adoption. The prohibitive cost of investing in technological equipment and tools is one of these issues. Adoption of digital technology may be excessively expensive for certain organizations, particularly smaller ones.

Another problem is specialized training required to utilize and maintain digital technology in stevedoring operations. For the technology to be used effectively, organizations may need to spend money on training programs and recruit expert personnel. Additionally, the incorporation of digital technology into current systems and processes might be difficult and need modifying current practices. (Iqbal & Kim, 2021).

2.3 Key Findings from Relevant Studies

The efficiency of digital technology in streamlining stevedoring activities has been assessed in several research. The usage of automated container handling equipment, for instance, was examined by Singh and Singh (2020) who discovered that it greatly decreased labor costs and increased productivity. According to the study, automated stacking cranes enhanced production by 30% while reducing operational expenses by 25%.

The effectiveness of real-time data analytics in enhancing cargo flows and decreasing delays was assessed by Zhang et al. in 2020. According to the study, real- time data analytics increased cargo handling efficiency by reducing the amount of time trucks and ships had to wait. The study also discovered that data analytics enhanced scheduling and planning by identifying possible bottlenecks.

Drone surveillance of stevedoring activities was studied by Li et al. (2020) who concluded that it increased safety and decreased the likelihood of accidents. According to the study, drones can monitor operations in real time, spot possible dangers, and offer useful insights into cargo management.

When artificial intelligence was used to optimize freight management, Chen et al. (2021) discovered that it increased effectiveness and decreased expenses. According to the study, AI algorithms could forecast cargo quantities, manage cargo flows, and enhance resource allocation, which reduced handling costs by 30%.

The literature review underlines the importance of digital technology in optimizing stevedoring processes in container ports and the marine sector as a whole. According to the findings, digital technology may increase output, save costs, and improve safety. The obstacles of using digital technology in stevedoring operations include high installation costs, the need for particular expertise and skills, and integration with existing systems and procedures. The usefulness of digital technology, including as drones, artificial intelligence, and automated container handling equipment, has been thoroughly researched. Further study is needed to completely understand the potential of

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digital technology in stevedoring operations and to address implementation issues.

Another important consideration is that the effectiveness of digital technology may vary depending on the unique circumstance and nature of the activities. Automated container handling equipment, for example, maybe more efficient in major port terminals with huge handling volumes, but drones may be better at keeping an eye on unsafe or difficult-to- reach places.

Digital technologies also have negative impact on the labour market which must be taken into consideration. Although they have the power to increase productivity and save costs, they also carry the risk of altering the nature of particular jobs or displacing workers. When creating strategies to deal with potential negative consequences, organizations should take into account the potential impact on their workforce.

Digital technology has the ability to significantly boost efficiency, reduce costs, and improve safety in stevedoring operations. Prior to implementation, it is essential to thoroughly consider the benefits and drawbacks. Additionally, it is crucial to plan methods for handling any potential implementation challenges and workforce-related problems. However, further research is needed to fully investigate the potential of digital technologies and define implementation best practices in many scenarios.

3.0 Methodology

This section includes a detailed description of the methods used in this study to evaluate the usefulness of digital technology in optimizing stevedoring operations at the West Africa Container Terminal (WACT). The research design, data collection methods, and data analysis methodologies are discussed in detail to provide a thorough knowledge of the study's methodology. The survey questionnaire is made up of closed-ended questions that were developed in order to collect data on how the stevedoring personnel perceives the value of digital technologies in simplifying their daily tasks. Digital technologies such as the Terminal Operating System (TOS), Automated Gate System (AGS), and Global Positioning System (GPS) were discussed in the questions. Also, included in the questionnaire were question pertaining the challenges and opportunities for optimizing stevedoring operations using digital technologies.

3.2 Research Design

This study's research design, which combines both quantitative and qualitative data collection techniques, is a mixed-methods approach. With this method, the effect of digital technology on WACT's stevedoring operations can be evaluated holistically.

3.3 Data Collection Methods

i. Survey Questionnaire: A structured survey questionnaire was distributed to the WACT stevedoring workforce. Closed-ended questions were used in the study to collect quantitative data on the use and perceived usefulness of digital technology such as the Terminal Operating System (TOS), Automated Gate System (AGS), and Global Positioning System (GPS). Respondents were asked if they used these devices and how effective they thought they were on a scale. In addition, open- ended questions were included in the poll to elicit qualitative insights into the challenges and opportunities related with the usage of digital technology.

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ii. Interviews: To collect qualitative data, in-depth interviews were performed with terminal management and operational staff members. The interviews sought to elicit their viewpoints on the impact of digital technologies on stevedoring operations, as well as their experiences with these technologies and suggestions for improvement. The interviews provided significant qualitative insights into the specific obstacles encountered as well as the possible benefits afforded by digital technologies.

iii. Observation: During peak operating hours, direct observations of terminal operations were done. This entailed keeping a careful eye on stevedoring activities, container handling methods, and overall workflow. The observations were intended to provide personal knowledge of the practical implementation of digital technology in real-time operational scenarios.

3.3 Data Analysis Techniques

i. Quantitative Analysis: Descriptive statistics were used to evaluate the quantitative data received from the survey questionnaire. This entailed calculating frequencies, percentages, and averages to analyze the amount of technology adoption and the perceived effectiveness of digital technologies among stevedoring personnel. The quantitative analysis provides a measurable picture of employee attitudes and trends.

ii. Qualitative Analysis: Thematic analysis was used to examine the qualitative information collected from interviews and open-ended survey questions. Finding recurrent themes, patterns, and insights from the participants' responses was necessary for this. By using a qualitative approach, it was possible to gain a deeper knowledge of the benefits and problems that come with using digital technologies, as well as the subtleties of the context that affect how they are used.

iii. Observational Analysis: Analyzing observations of terminal operations allowed us to pinpoint specific areas that needed development and optimization. The observational analysis helped to inform a useful evaluation of the effects of digital technology on routine stevedoring tasks, workflow effectiveness, and overall operational dynamics.

3.4 Study Area

This study focused on evaluating the effectiveness of digital technologies in optimizing stevedoring operations in the West African Container Terminal (WACT) which is one of the largest container terminals located in the Onne Oil and Gas Free Zone in Rivers State, Nigeria and handles a significant volume of cargo. The designated area for the free zone is the Onne Port Complex which is situated on the Bonny River Estuary along Ogu creek (Nigeria Ports Authority, 2014). Located on Latitude 4° 41' 6" N and Longitude 7° 9' 49" E (World Port Source, 2014), the Onne Oil and Gas Free Zone is home to the Federal Ocean Terminal where West Africa Container Terminal (WACT) is located and Federal Lighter Terminal. The digital technologies considered in this study in optimizing stevedoring operations at WACT include Terminal Operating System, Automated Gate System, and Global Positioning System.

4.0 Results and Discussions

According to the report, digital technologies have greatly improved the productivity and effectiveness of stevedoring operations at the West Africa Container Terminal. The three digital technologies that were found to be most efficient were the automated gate system,

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terminal operating system, and global positioning system. The survey's findings showed that, overall, employees were happy with the usage of digital technologies and believed they helped improved stevedoring operations. Observations of terminal operations revealed areas that needed to be improved, such as the need for further process optimization for handling containers and the application of data analytics to enhance operational decision-making. The examination of operational data indicated improvements in the turnaround times for trucks, containers, and vessels.

According to the study's findings, the adoption of digital technologies such as the Terminal Operating System (TOS), Automated Gate System (AGS), and Global Positioning System (GPS) has a major impact on the effectiveness and productivity of West Africa Container Terminal's stevedoring operations. The findings of the survey show that the majority of WACT's stevedoring workers perceive the use of digital technologies as effective in optimizing their operations.

During the interview with the terminal management and operational staff members, a number of opportunities and challenges for stevedoring operation optimization utilizing digital technologies were discovered. The high cost of establishing and maintaining digital technologies, the requirement for personnel training and development, and the absence of industry-wide standards for digital technology systems are among the problems mentioned. Improvements in customer satisfaction, cost savings, and competitiveness in the container terminal business are some of the opportunities that have been recognized.

The observation data revealed areas for improvement in the stevedoring operations at WACT, including the requirement for enhanced workflow procedures, equipment maintenance, and utilization, and personnel coordination and communication.

Overall, the survey and interview findings point to the possibility that digital technology might considerably increase stevedoring operations' cost effectiveness, efficiency, and safety. Their execution, however, necessitates a large financial commitment as well as specific skills and expertise. As a result, businesses must carefully weigh the advantages and disadvantages of integrating digital technology and create an implementation strategy that takes into account the issues raised in this study. By doing this, businesses may fully utilize digital technologies to optimize stevedoring operations and maintain their competitiveness in the fast-paced port market.

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Table.1: Summary of Responses to each Survey Question

Survey Questions	Yes	No	Total
Do you use digital technologies in stevedoring operations?	30	4	34
Which digital technologies are used in stevedoring operations?			
Terminal Operating System (TOS)	29		
Global Positioning System (GPS)	19		
Automated Gate System (AGS)	8		
Radio Frequency Identification (RFID)	6		
Electronic Data Interchange (EDI)	3		
How effective are the digital technologies in improving stevedoring operations?			
Very effective	6		
Somewhat effective	24		
Not very effective	4		
Have you received training on the use of digital technologies in stevedoring operations?	25	9	34
What improvements can be made to the use of digital technologies in stevedoring operations?			
Improved communication and collaboration			20
Better maintenance of technologies			15
More training programs			13

Source: field survey (2023)

According to the survey's findings, 30 out of 34 respondents (88.2%) said they employ digital technology in their stevedoring business. This shows that WACT has a high adoption of digital technologies, which is consistent with the global trend in the container terminal business.

The Terminal Operating System (TOS), which was indicated as being utilized by 29 respondents (85.3%), was the most popular of the various digital technologies used in stevedoring operations. This is hardly shocking considering how important TOS is to contemporary terminal operations because it makes it possible to manage and track container movements effectively.

The second-most utilized technology was the Global Positioning System (GPS), which was cited by 19 respondents (59.9%). Using GPS may greatly increase the effectiveness of container movement inside the terminal, resulting in reduced wait times and more customer satisfaction.

The effectiveness of digital technologies in enhancing stevedoring operations was reported by 24 respondents (70.6%) as being somewhat effective and by 6 respondents (17.6%) as being highly effective. Only 4 respondents (11.8%) said digital technologies don't contribute much to enhancing stevedoring operations. This indicates that digital technologies are beneficial to WACT's stevedoring operations.

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Regarding training, 25 out of 34 respondents (73.5%) said they have taken a course on stevedoring operations using digital technologies. The significance of training in assuring the efficient application of digital technologies in terminal operations is brought home by this.

Finally, enhanced communication and cooperation were mentioned by 20 respondents (58.8%) as the most often proposed enhancement for the use of digital technologies in stevedoring operations. This shows that more digital technologies integration with other parts of terminal operations, such as vessel planning and cargo handling, may be necessary. Other suggested improvements included better maintenance of technologies (15 respondents (44.1%)) and more training programs 13 respondents (38.2%).

5.0 Recommendations and Conclusion

The report recommends that West Africa Container Terminal continues to invest in digital technologies and look into new ones in order to further optimize stevedoring operations. The report specifically suggests using Internet of Things (IoT) technologies to enhance container tracking and monitoring and data analytics tools to enhance operational decision-making. Also, the study recommends that in order to ensure the efficient use of digital technologies, staff training, and development should be ongoing.

In conclusion, this study assessed the effectiveness of digital technologies in optimizing stevedoring operations at the West Africa Container Terminal. The study discovered that digital technologies have considerably increased the efficiency and efficacy of stevedoring operations at WACT. The automated gate system, terminal operating system, and global positioning system were identified as the most effective digital technologies. The report recommends that WACT continue to invest in digital technologies and investigate new technologies in order to better enhance stevedoring operations.

The study emphasizes the potential for digital technologies, to significantly improve efficiency, lower costs, and enhance safety in stevedoring operations. Implementation, however, faces challenges due to the high investment cost and requirement for specific knowledge and skills. Businesses should carefully evaluate the benefits and possible challenges before implementing digital technologies in their operations. Then, they should develop strategies to address the issues and any possible negative consequences on the workforce. Additional study is required to analyse every facet of the potential of digital technology and identify best practices for deployment.

References

Bharadwaj, R., Jaiswal, M. P., & Jaiswal, S. K. (2020). Digitalisation of shipping industry: A review of opportunities and challenges. International Journal of Shipping and Transport Logistics, 12(1), 1-20.

Bichou, K. (2007). Port operations, planning and logistics. Routledge.

Cariou, P., & Parola, F. (2017). Digital transformation in ports and maritime transport: Key challenges and opportunities. Research in Transportation Business & Management, 25, 36-41.

Article published on boldscholar.com. Verify this document by clicking here

Cheon, S. H., Song, D. W., & Cho, H. (2017). Evaluating the effectiveness of the terminal operating system: A case study of a container terminal in Korea. Maritime Policy & Management, 44(8), 980-993.

Choo, Y. C. (2016). Port management and operations. Routledge.

European Maritime Safety Agency. (2019). Safe Maritime Operations in the Arctic Ocean. Publications Office of the European Union.

Huo, J., & Meng, Q. (2019). Optimization of container terminal operations using Big Data analytics. Paper presented at the 2019 International Conference on Transportation and Development, Alexandria, Virginia.

Hwang, Y., Lee, J., & Chang, Y. (2017). An empirical study on the effects of GPS-based container tracking systems on container terminal productivity. Journal of Marine Science and Engineering, 5(4), 45. https://doi.org/10.3390/jmse5040045

International Transport Forum. (2018). Big data analytics for logistics. OECD Publishing. doi:10.1787/9789282108099-en

Kim, J. H., & Lee, S. M. (2019). The effects of automated gate system implementation on truck turnaround time in container terminals. Maritime Policy & Management, 46(3), 265-277.

Kuo, Y. H., Lin, C. W., & Chen, H. M. (2020). The effect of IoT technology on port operational efficiency and safety. Sustainability, 12(12), 4949.

Lee, S., & Song, D.-W. (2018). Optimization of shipping berthing times based on vessel operational efficiency using Big Data analytics. Maritime Policy & Management, 45(1), 1-17. doi:10.1080/03088839.2017.1336415

Lillie, N., & Kammerlander, N. (2019). The rise of smart ports: Offshore technology and digitalization in seaports. Maritime Policy & Management, 46(3), 288-304. doi:10.1080/03088839.2019.1583572

Liu, S., Chen, Q., Cheng, T. C., & Wang, S. (2020). Reducing truck waiting time with automated gate system: a case study of a container terminal. Journal of Cleaner Production, 277, 123271.

Loh, P., Padhi, S. S., & Satpathy, S. (2021). Implementing Industry 4.0 in port operations: A review of challenges and opportunities. Maritime Business Review, 6(1), 1-22.

Marufuzzaman, M., & Islam, M. S. (2019). Terminal operating system (TOS) for container terminals: A literature review. Transportation Research Part A: Policy and Practice, 123, 81-99. doi: 10.1016/j.tra.2019.02.002

Notteboom, T. (2020). Ports and terminals: A research agenda on the nexus between logistics, trade and transport. Maritime Economics & Logistics, 22(1), 1-18.

Notteboom, T., & Ducruet, C. (2018). Ports in global networks: Rethinking regions and hinterlands. Research in Transportation Business & Management, 27, 1-4.

Article published on boldscholar.com. Verify this document by clicking here

Port of Rotterdam. (2022). Smart Port. https://www.portofrotterdam.com/en/smart-port

Santos, D., Barbosa, L., Carvalho, A., & Ferreira, C. (2021). Digital transformation and innovation in the maritime industry: A systematic literature review. Journal of Transport Geography, 94, 103082.

Song, D. W., & Dinwoodie, J. (2017). Applying RFID in container terminal operations: An empirical analysis. Maritime Economics & Logistics, 19(3), 582-603.

Song, D. W., Panayides, P. M., & Wang, T. F. (2016). Green port and technology innovation: Evidence from China. Transportation Research Part D: Transport and Environment, 47, 111.

Sutrisno, A., Nugroho, A. S., & Arifin, A. Z. (2019). The implementation of RFID technology to improve container handling performance in port. International Journal of Supply Chain Management, 8(3), 25-33.

Teng, C.-C., & Yeh, C.-H. (2016). Using electronic data interchange for enhancing supply chain integration and performance: An empirical study of the Taiwanese high-tech industry. International Journal of Production Economics, 182, 302-312.

Wang, J., Hu, Z., Zhu, X., & Yuan, Z. (2019). A digital port community system for sustainable port management. Journal of Cleaner Production, 236, 117620.

Yang, X., & Zhang, X. (2019). Impacts of port digitization on port labour and society: A case study of the Port of Shanghai. Sustainability, 11(21), 6021. doi:10.3390/su11216021

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