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# The Exploration of Smart Port Concept to Improve Efficiency and Productivity of the Port: Case study Port Elizabeth

*Vuyolwethu Ndoda, Mhlalisi Mndzebele, Zenzile Mbinza*

(Vuyolwethu Ndoda, University of Johannesburg, Dept. of Town and Regional Planning, Johannesburg, South Africa, ndodavuyolwethu@gmail.com)
(Dr Mhlalisi Mndzebele, University of Johannesburg, Dept. of Town and Regional Planning, Johannesburg, South Africa, mhlalisim@uj.ac.za)
(Dr. Zenzile Mbinza, University of Johannesburg, Dept. of Town and Regional Planning, Johannesburg, South Africa, zmbinza@uj.ac.za)

## 1 ABSTRACT

The aspect of transitioning traditional port operations into a smart port is more than just not merely a technological improvement; it is considered as a contingency plan that addresses the various challenges faced by South African ports in a rapidly evolving global trade environment. This research paper stresses that the adoption of smart port concepts is essential for enhancing operational efficiency, reducing congestion, and fostering economic growth. The concept of integrating advanced technologies that encompass automation, the Internet of Things (IoT), and data analytics,allows the Port of Port Elizabeth to overcome the current challenges associated with the old infrastructure and inefficient methods.

This study argues that even though smart port concept is a vehicle for the port that drives productivity and sustainability at the port of Port Elizabeth, there are concerns regarding job losses due to a lack of skilled labour force and this can be addressed through upskilling of the workforce. The successful transition of this port into a smart port model requires not only focusing on the technological investment but also considering the policy frameworks that prioritize human capital development to successfully implement automation. There has been a tremendous increase in global growth port competition and changing maritime dynamics, and this research paper intends to evaluate the potential benefits as well as the challenges of adopting the concept of smart port at the Port of Port Elizabeth. The ultimate goal is to contribute to the broader discourse on the strategic ways in which South African ports can provide for future development, as well as the requirement for inclusive socioeconomic and sustainability.

The Port of Port Elizabeth is facing critical challenges, including outdated infrastructure, poor maintenance practices, and logistical bottlenecks, which have resulted in inefficiencies, long turnaround times, and reduced competitiveness in global trade. These issues threaten the port's ability to support South Africa's economic growth. This study was motivated by the urgent need to modernize the port's operations and explores the adoption of smart port concepts as a solution. The paper argues that transitioning to smart technologies, such as automation and data-driven decision-making, is essential to address these challenges, improve productivity, and position the port as a key player in the global maritime industry.

Keywords: Smart port, Port development framework plan, Efficiency, Productivity, Intelligent infrastructure

## 2 INTRODUCTION

South African seaports are regarded as the main components facilitating trade to ensure economic growth across the world. A seaport is regarded as a maritime facility that is predominantly well-equipped with operational equipment and considerable space necessary for loading and unloading shipments or cargo (Sarkar & Shankar, 2021). Modern ports do not operate as early ports, which were primarily simple harbors for exporting goods to other countries. Mlambo(2021) delineates that the demand for international trade has increased tremendously and propelled modern ports to venture into technologically advanced infrastructure, which requires multimodal intersections for the transportation of goods from various ports that encompass integrated transportation networks such as railway, road, air, and seawater.

The study is based on the port of Port Elizabeth, which is one of the nine state-owned ports in South Africa facing issues of underperformance due to dilapidated infrastructure and a lack of equipment to accommodate more vessels (Transnet National Port Authority, 2019). The research dissertation takes into consideration the in-depth analysis of restructuring the dilapidated infrastructure for the port of Port Elizabeth and explores the possibility of adopting the smart concept to ensure improved efficiency and productivity in the port system. Mcetywa (2021) outlines that the current existing dilapidated port infrastructure, such as rail and road transport, needs constant renovation, the research further outlines the current port performance and the

expected performance after the implementation of the smart port concept. To alleviate port inefficiency and unproductivity in the port system, it is essential to understand the integrated approaches that can be used to improve port performance. Through this research, gaps in port efficiency in the local ports and the international ports can be identified.

The study aimed to assess the impact of smart port concepts on restructuring the dilapidating infrastructure to improve port efficiency and productivity. The literature review has outlined the international ports that have successfully implemented smart port concepts and the local ports in developing countries that are moving towards smart port concepts. A vast majority of the studies are of the view that port efficacy is equivalent to port productivity; in cases where the port is deemed ineffective, customers lose confidence and tend to cease any business with South Africa. The concept of a smart port ensures that there is connectivity between the port and the surrounding infrastructure, and this will ensure the easy flow of traffic throughout the whole connectivity system network (Grimett,2022). The improved port efficiency and productivity will allow South African ports to better compete with well-performing world ports, which further attracts more business opportunities in the port system while propelling the growth of the South African economy.

## 3 RESEARCH BACKGROUND

The world's economic growth is increasing at an exponential rate through global trade, and that has been reshaped by The world's economic growth is increasing at an exponential rate through global trade, and that has been reshaped by transportation connectivity networks and the port system (Notteboom, 2013). Seaports are the main link that ensures the smooth operation of logistic supply and international trade between two different countries. The ports are predominantly provided with infrastructure and necessary facilities that optimize the cargo to be handled, stored, and moved inland through the use of an integrated system that encompasses trucks or railways (Isaacs, 2020). Isaacs (2020) further outlines that ports require deep entrance channels and berths so that larger vessels can be docked in the port.World trade propels the growth of seaborne trade. South Africa is one of the African countries that is dominant in the maritime sector, considering the wide variety of oceans and the international trade patterns across the global system (Othman et al., 2022). The country is strategically situated on one of the busiest international routes, and its geographical location caters to more opportunities for increased levels of trade as well as a thriving maritime industry (Dube, 2020). The maritime transport industry is increasingly growing, more specifically considering containers and dry bulk services, which are the main commodities that contribute greatly to the South African economy. Molavi (2020) alluded to the fact that the main fundamental challenges that are hindering the progress of ports consist of traffic congestion, which causes major delays in the transshipment of cargo within the port limits.

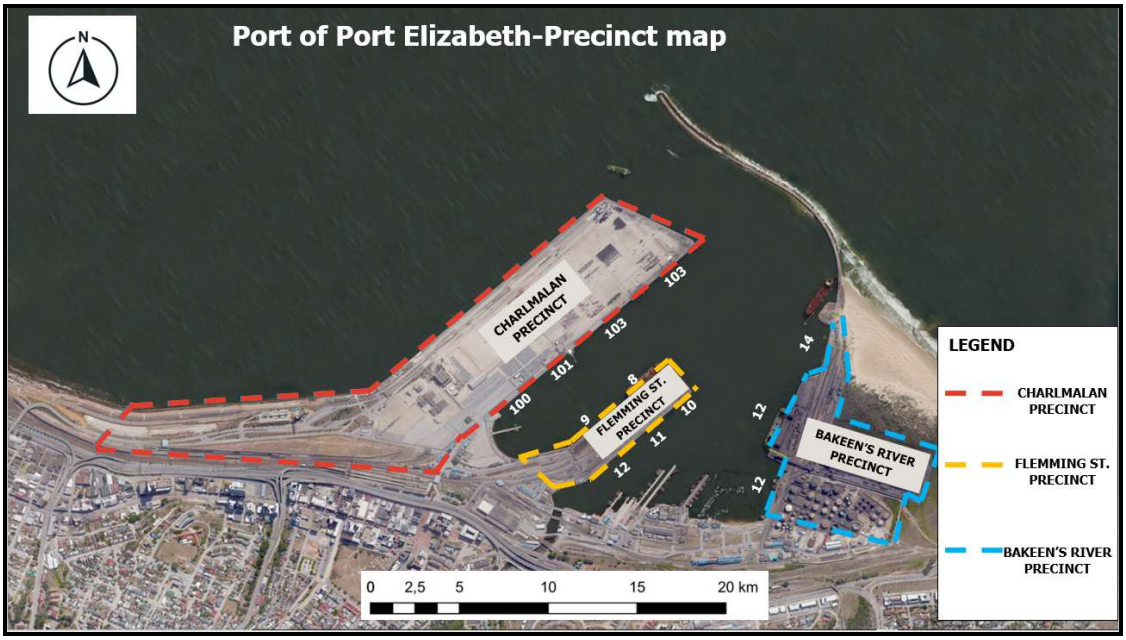


Figure 1: Port of Port Elizabeth precinct map

The port of Port Elizabeth was first established in 1933 and rapidly became one of the main ports facilitating trade. It is located in the central region of South Africa (Isaacs, 2020). The port of Port Elizabeth is regarded as one of the three specialized container-handling facilities along the South African coastline. The port of Port Elizabeth is connected to the city and the coastline of Port Elizabeth to serve the surrounding business hubs. port mainly specializes in automotive, vehicle, container, and agricultural products, offering valuable services such as storage facilities, packing and unpacking of containers, and logistics management (Transnet National Port Authority, 2019). Port Elizabeth is one of the nine operating ports in South Africa that is located within the jurisdiction of Nelson Mandela Metropolitan Municipality and largely supported by the economic zones. The figure below outlines the precincts where different commodities are accommodated in the port of Port Elizabeth.

The Port of Port Elizabeth is regarded as an established port in the central region that predominantly handles containers, manganese ore, vehicles, liquid bulk, general dry bulk, as well as break-bulk cargo (Transnet National Port Authority, 2019). This is one of the South African ports that experiences a catastrophe of traffic congestion, which causes unproductivity and inefficiency. The exploration of smart ports comes as an integrated solution that predominantly reduces truck congestion within the port system. The smart port concept encumbers the cargo delays in the road network to the interlinked business hub from the ports (Mazibuko, 2020). The adoption of the smart concept is essential to addressing these challenges of poor performance because, if they are not addressed, they result in underlying transportation costs and inefficiencies that gradually grow at an exponential rate.

## 4 RESEARCH PROBLEM

South African seaports are currently faced with a catastrophe of underperformance and a lack of efficiency and effectiveness to compete with other international ports such as the port of Barcelona and the port of Rotterdam. The lack of integration in the port system, when there is a decline in port productivity and efficiency, automatically implies a decline in economic growth in the country (Mcetywa, 2021).

The main problem leading to this research is understanding how the smart port concept can address the issues of inefficiency and unproductivity in the port of Port Elizabeth. According to recent statistics, the Port of Port Elizabeth has faced significant challenges that hinder its operational effectiveness. For instance, the port's container throughput has decreased by approximately 15% over the past five years, reflecting inefficiencies in cargo handling and logistics (South African Revenue Service, 2024). Additionally, the average turnaround time for vessels at this port is reported to be around 48 hours, which is considerably longer than the global average of 24-30 hours seen in more efficient ports (World Trade Organization, 2023) The concept of smart port has been adopted in international ports and is working successfully to improve efficiency and productivity. These inefficiencies not only affect the port's operational capacity but also have broader economic implications.

South African ports are no exception in this regard, as they are also under immense pressure to optimize port performance. It is imperative to outline that there is also a lack of thorough and comprehensive research studies conducted over the years to improve efficiency and productivity in this port. In tackling the prevailing issues in the port system, Port Elizabeth needs to explore the aspect of adopting the smart concept, which will address the underlying issues of unproductivity.

### 4.1 Research Objective

The main research objective of the study is to assess the impact of the smart port concept on restructuring South African ports that are faced with port inefficiencies and unproductivity.

### 4.2 Research Question

What is the main impact of the smart port concept to restructure South African ports that are faced with port inefficiency and unproductivity?

## 5 UNPACKING THE SMART PORT CONCEPT

The concept of the smart port is that the port relies heavily on modern technology, which acts as a service in the transportation sector of the port system (Frazzon et al., 2019). This encompasses any service, including processing, collecting, and analysing any relevant information that has been provided (Sari & Pamadi, 2019).

The concept of smart port is based on the full automation of infrastructure, which is mainly connected to the Internet of Things (Yang et al., 2018). Smart ports are regarded as a new generation where ports are designed to be more efficient and innovative as compared to traditional ports. The international ports have mainly adopted advanced technologies, which encompass artificial intelligence, IoT, big data, and automation, to improve port operations and the port economy. According to Grimett (2022), smart ports are integrated in terms of design to ensure connectivity in the logistics sector and industrial environments.

Advanced technology is essential in improving the flow of goods and the information between the cargo and the terminal operators in the port system. They also have an open innovation mindset, which allows them to continuously improve their operations through the use of new technologies and ideas (Liao et al., 2023). "The smart port concept entails the use of technologies to transform the different public services at ports into interactive systems with the purpose of meeting the needs of port users with a greater level of efficiency, transparency, and value" (Ozturk et al., 2018). The smart port can only be successful when there is alignment between collaboration, digital strategy, and port strategy.

The smart port concept is a phenomenon that predominantly integrates and ensures productivity in port operations by promoting port competitiveness and efficiency (Jović et al., 2019). The essence of the smart port concept is that it propels the integration of the city and the port in a restrictive municipality (Othman et al., 2022). In addition, the concept of smart port is a fundamental overview that predominantly outlines that there is a need for technological port development that is cost-effective while promoting the economy of the country. The smart port utilizes technology to enhance innovation by accessing current existing resources to improve port operations (Belmoukari et al., 2023).

## 6 PORT PRODUCTIVITY AND EFFICIENCY

The concepts of port productivity and port efficiency are two elements that are inexplicably linked, even though they are different. According to Motau (2015), the concept of port productivity is regarded as the combination of results pertaining to the available resource utilization as inputs to be transformed into outputs, while efficiency can be defined as the relative productivity necessary to achieve a desired output over a period of time or space. The concepts of productivity and efficiency in the port are therefore the two important concepts that mainly measure port performance, expressing different ranges of parameters and variables, to be further unpacked in this dissertation.

According to Booi (2022), the concept of port efficiency is essential in attracting investments in the port system while at the same time enhancing the port's competitiveness. The utilization of technology plays a fundamental role in the port system to achieve the volumes that are needed to meet the required financial targets (Dlamuka, 2022). Booi (2022), citing Wang et al. (2014), defines productivity as occurring when port assets increase through increasing utilization or operating efficiency. Equipment productivity can be increased by increasing the number of hours that are utilized on a specific day.

## 7 SIGNIFICANCE OF THE PORT

Ports are critical infrastructure facilities for maritime trade and logistics, serving as key transportation hubs for cargo and people. According to Bichou (2021), from a public policy standpoint, seaports are regarded as the economic engines for the markets and regions they serve. Bichou (2021) further outlines that ports are predominantly viewed as the main catalyst for generating socio-economic benefits, which encompass tax income, the creation of job opportunities, the generation of business, the inter-sector multiplier effect, and the spatial dimension for the agglomeration of different business entities. According to Trujillo (2008), seaports play fundamental roles in a country's trade and logistics efficiency. As controllable aspects of global supply chains, they require particular attention. The efficiency of port operations significantly reduces transport and trade costs, while port delays and inefficiencies lead to excessive costs in logistics and supply chains (Cullinane & Wang, 2006).

In South Africa, ports predominantly act as the gateway in terms of facilitating the functions of the country's trade and logistic activities (Bichou, 2021). The majority of trade in the country is conveyed by the seaports, which consequently ensures the reliance on ports. Furthermore, the reliance on seaports is emphasized by the country's economic trade based on its geographical location, which is heavily characterized by long distances to trade markets and extensive hinterlands and transit corridors. The aspect of maritime seaports does not only contribute to the urban economy; it also encompasses certain interdependent urban spaces (Li et al.,

2023) The primary integration of different modes of transport within the ports and the city predominantly ensures the easy movement of goods from port to port through either rail or road transportation.

## 8 RESEARCH METHODOLOGY

The researcher has opted for a qualitative research approach to unpack that research problem from the perspective of a third party. According to Brannen (2017), qualitative research is regarded as an approach that aims to understand the research problem from the perspective of the participants. The concept of the qualitative research approach is based on human behaviours, which also encompass the opinions, beliefs, emotions, and relationships of the affected individuals (Onwuegbuzie et al.,2012). The data was collected through the administration of survey questionnaires via email to the respondents.

The response rate was 100%, based on a sample size of 24 employees who had a broad understanding of the port operation. Questions were formulated, and they were made simple, concise, and specific to the research objective while ensuring there were no ambiguities in the research study. Port jargon was simplified to ensure people who are not familiar with the port operation understand this jargon. The potential participants were approached by the researcher at the port and were issued an approval letter from the organization detailing the essence of the study.

Participants were given time to complete the questionnaire at their own comfort and pace, and the researcher followed up after five (5) days to collect the completed questionnaires. If not completed, a second chance was given, and a follow-up was done. The main advantages of using a survey questionnaire that is of sound construction include convenience, encouraged anonymity, and varied data from closed-ended and open-ended questions (Griffee, 2012). The thematic analysis allows the researcher to determine precisely the relationships between concepts and compare them with the replicated data (Braun &Clarke, 2006). The aspect of applying thematic analysis ensures that there is a link between the various concepts and opinions of the study and compares these with the data that has been gathered in different situations at different times during the project. This is a method that is predominantly widely used in the aspect of analyzing experiences and the opinions of the participants, as well as behaviours.

## 9 RESULTS, INTERPRETATION, AND DISCUSSION

The essence of the research objectives is based on bridging the gap between the best-performing international ports and the underperforming ports in South Africa through the exploration of smart ports to improve port performance. The study has shown that the port of Port Elizabeth is faced with issues of inefficiency due to a lack of equipment and skilled workers, which has led to poor port performance.The overall aim of this study was to assess the impact of the smart port concept on improving port productivity and efficiency in the port system. The questionnaires that were applied in this study analysed carefully to ensure that the data gathered was presented clearly with the use of tables and graphs, where possible. Data was collected from the study questionnaires, which were completed by a total of 24 employees who participated. Concerning the readiness of the port to adopt the smart port concept, the response rate was positive for 79% of the employees who stated that the port is ready to adopt the smart port concept to improve port efficiency and productivity. The data was analysed to outline the causes of port inefficiencies and unproductivity and the possible interventions that can be applied to alleviate such challenges.

### 9.1 Challenges of adopting the smart port concept at the Port of Port Elizabeth

The adoption of smart port technologies at the Port of Port Elizabeth presents several challenges that need to be addressed for successful implementation.The research has portrayed that there are many challenges associated with the adoption of the smart port concept, including the lack of maintenance of infrastructure in the port and the consistent breakdown of equipment, which causes more delays. The main challenge is the outdated infrastructure, congestion from trucks entering the port, as well as long turnaround times and marine delays.The port's facilities are unable to accommodate larger vessels or handle increasing cargo volumes efficiently. Expanding and modernizing infrastructure requires significant investment and poses environmental risks, such as disrupting marine ecosystems and surrounding communities. The port currently uses a manual booking system for trucks entering the port, which causes more traffic in the port while overloading the road system. One of the main fundamental issues that causes port inefficiencies is the poor implementation of capital projects and the poor terminal oversight.

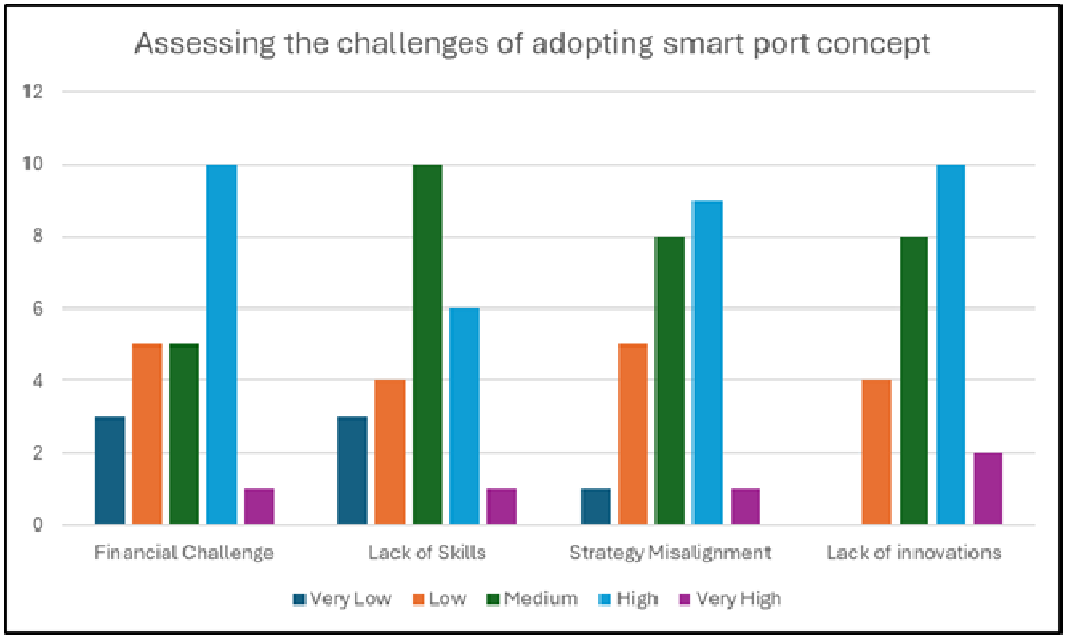


Figure 2: Challenges of adopting smart port concepts

The Port of Port Elizabeth is currently facing issues of breakdowns that cause considerable delays in operations. The geographic location of the port is integrated with the city, which, while essential for the integration of city planning and the port, has an adverse effect on port efficiency because any disruption in the city causes more delays in port operations.The concept of implementing smart port technologies requires substantial funding from investors, which is challenging for a port with limited resources such as the Port of Port Elizabeth. Inefficiencies in current operations increase operating costs while reducing productivity. The lack of financial capacity to invest in automation systems, and IoT devices limits the port's ability to modernize into a smart port.

The transitioning of an ordinary port to a smart port requires advanced digital systems for the real-time data tracking of cargo, predictive analytics, and automated operations. However, the Port of Port Elizabeth still lacks these systems which makes it difficult to optimize logistics and remain competitive globally. The research participants' recommendations on how the city can resolve the smart governance challenges they encounter in the process of being smart were given by the respondents.

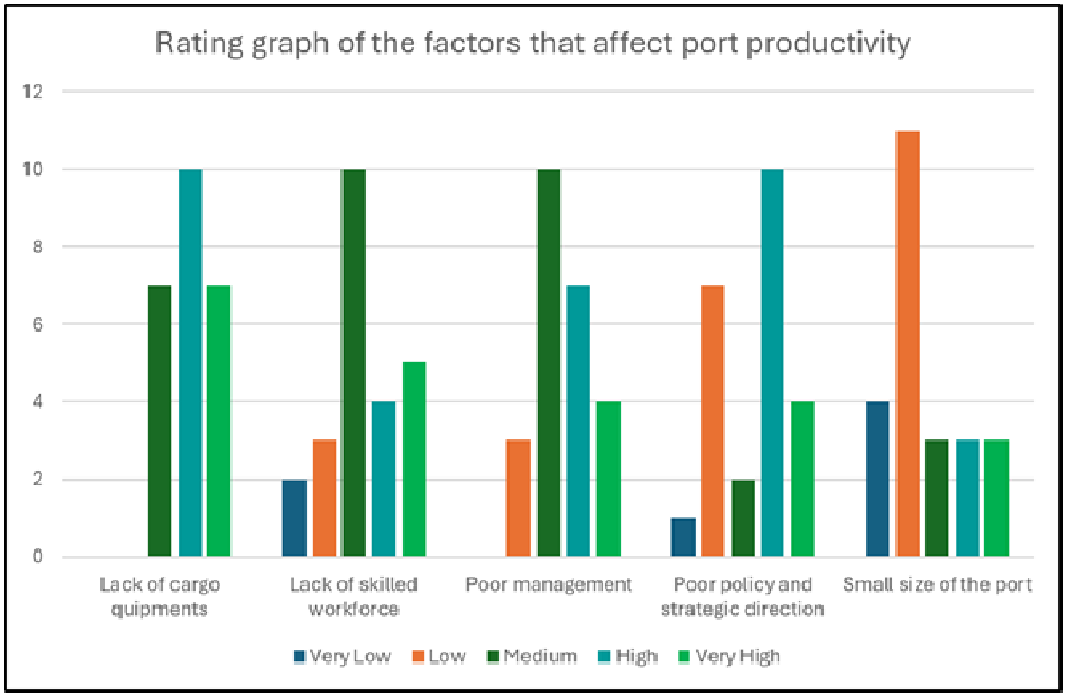


Figure 3: Rating of the factors that affect port productivity

### 9.2 Integrated approaches to improve the performance of the port through the smart port concept

The implementation of smart port systems is essential in monitoring the condition of the infrastructural elements, which consist of quays, cranes, and rail systems, through the use of Internet of Things (IoT) devices. In this manner, it becomes easier to analyze big data and port operators by predicting maintenance needs and scheduling repairs or replacements before infrastructure reaches a critical state of disrepair. The strategic approach is based on the implementation of a port system to alleviate the current inefficiencies and unproductivity by exploring the smart port concept. The aspect of smart port systems is essential in monitoring the condition of the infrastructural elements, which consist of quays, cranes, and rail systems, through the use of Internet of Things (IoT) devices. This plays a fundamental role in analyzing big data while at the same time predicting maintenance needs and scheduling repairs or replacements before infrastructure reaches a critical state of disrepair. The port serves as a vital hub for South Africa's automotive and agricultural sectors, emphasizing the necessity for improved infrastructure to accommodate increasing trade demands.

### 9.3 Strategic initiatives to reconfigure the dilapidating infrastructure to improve efficiency and productivity

The main integrated approach to improving port performance through the smart port concept is the assessment of current port infrastructure and equipment, which is one of the ways to identify and reduce inefficiencies. The acquisition of marine fleets (e.g., tugboats) is another means to address frequent marine-related breakdowns. The research study has highlighted the importance of adopting the smart port concept not only for the port of Port Elizabeth but for the whole port system. The proposed concept has been highlighted as an effective solution to address the deteriorating infrastructure in the port, which has immensely affected port performance and increased inefficiencies that have led to poor port productivity and high transport costs. The port has a strategy to reduce dwell time by increasing rail capacity and reconfiguring the port to implement technology-related interventions. Some of the strategic initiatives in the port system consist of the truck booking system and automated truck work permits. The smart booking system ensures that there is no traffic congestion in the port system, and trucks will be allocated a scheduled time to avoid any port congestion. The port is working towards the implementation of the smart port concept with the current projects that are in the pipeline.

### 9.4 The strategic approach of Smart port South Africa`s economic growth

The notion of smart port technology offers a unique opportunity to solve unemployment in Port Elizabeth by developing new skill development routes and novel employment initiatives. The implementation of Smart port technology represents an integrated strategy for workforce development by recognizing that the 4IR necessitates a significantly altered labor force. The Port of Port Elizabeth requires skill development efforts for present personnel, which include the creation of focused maritime technology certification programs. This will ensure the collaboration between educational institutions and port industries, and implementation of quick upskilling initiatives for the employees who are currently working.

The transition to smart ports represents more than a technological upgrade it is a comprehensive workforce transformation strategy. Proper adoption of the smart port concept at the port will ensure there is reduced unemployment due to the fact that people will be well-informed about how to use the well-advanced equipment that will enhance workforce employability, and this will modernize local workforce capabilities.

## 10 INTERNATIONAL APPROACH OF SMART PORTS AT THE PORT OF ROTTERDAM

The Port of Rotterdam (POR) is regarded as one of the largest ports in Europe, ranked in the top 20 in 2017 in the world port rankings (Isaacs, 2020). The Port of Rotterdam has made significant investments in handling equipment for effective operations and has revolutionized the idea of a new transportation system. The Port of Rotterdam has the benefit of being able to handle larger ships without any problems. The port consists of well-organized infrastructure, deregulation of transportation services, and logistical trends that make up the smart port idea feasible. One logistics mega center that has adopted the smart port concept is the Port of Rotterdam.

### 10.1 The strategies and initiatives for the Port of Rotterdam

The adoption of the smart port concept will mainly entail reduced traffic congestion within the port limits for both road and rail transport, which will promote connectivity within the port (Mswephu, 2020). South African ports are experiencing the catastrophe of traffic congestion; hence, the adoption of smart ports comes as an integrated solution that predominantly reduces truck congestion within the port limits. In addition, the smart port concept alleviates the cargo delays in the road network to the interlinked business hub from the ports. The adoption of the smart concept is essential to addressing these challenges of poor performance, which, if not addressed, result in underlying transportation costs and inefficiencies that gradually grow at an exponential rate.

The essence of digital transformation in the world can be proven to be evident at the port of Rotterdam through the transition from physical operation to digital port. Digital The port consists of a digital twin that mainly intends to track the movements of the ships,the upgrade of infrastructure, changesinweather, and geographic data to enhance the port efficiency and overall operations (Merk, O., &Notteboom,2013).

The port uses various technologies that encompass the IoTto collect and process dynamic data such as the flow ships, and visibility. This data is used in the aspect of predicting the port infrastructuremanatiance to optimize the logistics.The port predominantly capitalizes on fostering collaboration between companiesdeliveredto companies such as tech providers, cargo owners, and financial institutions to develop innovative and sustainable services. Karas (2020) further states that the terminal operators have a real insight into the specific handling of their loads in the terminal. According to Yau (2020), the use of modern devices ensures that customers urgently receive the relevant information regarding the cargo on the train, its destination, and the expected time for it to arrive for unloading. This further encompasses the work progress related to the load at the terminal.

### 10.2 Strategic Overview of the Port of Barcelona

The Port of Barcelona is one of the ports that has committed to adopting the concept of smart port that involves the gradual movement towards the aspect of efficient suitability with the main aim of continuous services to improve productivity (Henríquez et al., 2022). The Port of Barcelona is a leading port when it comes to the integration of the city with the port, which has been propelled by smart policies at an international level.The port also utilizes electronic documental interchange (EDI) among the different stakeholders at the port (Yau et al., 2020). The vision of a smart port concept is predominantly based on reliance by the port on the digital system to ensure improved technology while reducing the costs of port operation and the consumption of resources while ensuring that the environment is not adversely affected by the operation.

Nowadays, the cruise tourism sector around the world has progressively shown massive growth and high demand in the market. The Port of Barcelona is a major destination for cruise tourism due to its well-equipped cruise terminals that are in operation (Henríquez et al., 2022). The strategic positioning of the Port of Barcelona makes it among the most advantageous ports in Europe, owing to its closeness to numerous popular tourist destinations in the western Mediterranean. The port consists of cruise liners, the port is anticipated to remain a key port that accommodates cruise ships. The port is a major attraction for tourists thanks to the presence of high-quality architecture coupled with history, food, and good accessibility to the city as compared to the surrounding regions (Yau et al., 2020).

### 10.3 Integration of InternationalPort with South African Port

The port of Rotterdam is one of the best-performing ports in Europe because of its advanced technological equipment. These systems are essential in that they provide the relevant information in real-time, ensuring that there is no unrealistic communication that would cause any delay in the transportation of goods through the sea operation. The smart port concept consists of well-structured infrastructure and the liberalization of transport services and logistic trends. The Port of Rotterdam is classified as a main logistics hub that has implemented the smart port concept. The port of Port Elizabeth can learn a lot from this port and invest in equipment that will eliminate downtime or delays. However, in order to explore technologically advanced equipment, there is a need to have maintenance plans in place. This further encompasses the financial viability of procuring the equipment that is required for smart technology.

The Port of Barcelona is one of the international ports that possesses the qualities ofthe smart port concept based on the utilization of technology to demonstrate an environmental commitment to become a sustainable port, and orientating port activities to the needs of both customers and the port authorities. The Port of Port Elizabeth has the responsibility to uphold through focusing on several elements to align with the strategies of the Port of Barcelona. The port of Port Elizabeth is on the verge of implementing the smart port initiatives which include the expansion of automotives and the development of the waterfront. The port of Port Elizabeth can achieve this by integrating the port with the city to promote ecological transition and accommodate urban life. This involves designing public spaces that improve understanding of port activities and facilitate mobility between neighboring districts.The development of the waterfront not only supports the tourism sector in the port but also grows the economy of the city and the province and the hotels that are in close proximity will immensely benefit. They possess all the qualities that the Port of Port Elizabeth wants to accomplish in order to be a well-developed port in the provision of the tourism sector.

## 11 CONCLUSION

In conclusion, the essence of the study was based on exploring the smart port concept to improve port performance, taking into consideration international ports that have fully adopted the concept. The study has shown the underlying challenges and the strategic approaches that can be used to counteract those challenges by improving port efficiency and productivity. The adoption of the smart port concept will ensure that the South African port system experiences the aesthetic of port planning, taking into account that the ports will become more competitive with lower transportation costs while ensuring the reliability of transportation through integrated planning. The adoption of the smart port concept is expected to drastically reduce truck congestion within the port area. This means that transportation issues will be resolved in the surrounding areas as well because both rail and road will be integrated. If these challenges are not addressed in an orderly manner, the South African port system will continue to face challenges of inefficiency and unproductivity. Eventually, investors will not be keen on doing business with South Africa due to a lack of trust, and that will affect the economy of the country in the long run.

The concept of the smart port model will influence the employees at Transnet to adapt to the change in technology and embrace the planning integration of different land uses that promote the viability of the transportation system. Intelligent infrastructure will be introduced across the port system, which will ensure improved port performance. This will encourage investors to have more confidence to trade with South Africa because of its good performance and reduced transportation costs in the port system. There will be an integrated logistics chain, and the port system will be an integrated gateway for trade. The aspect of leveraging technology and modernizing infrastructure, South African ports can improve their competitiveness in the global market while supporting economic growth.

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