

SMART PORTS: IS SADC POSITIONED FOR TRANSITION?

LA GRIMETT

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ABSTRACT

Whereas international trade was previously the preserve of organised business, the digital revolution and the increased popularity of online purchases through the internet, has meant that international trade is now easily accessible at an individual level. At both a domestic and international level, the Covid-19 crisis has amplified the pressure placed on businesses and consumers to adopt digital technologies and been catalytic in moving the public towards greater reliance on online transactions and the movement away from traditional purchasing practices. Increased global trade at an individual level has put greater pressure on global supply chains, with every link in the supply chain being called upon to perform more effectively and efficiently. Ports, as gates of entry into domestic markets and transshipment routes, have been under increased pressure to conform to the needs of the international trading community.

Greater trading volumes have put ports at risk of higher levels of crime by international and domestic criminal syndicates, as monitoring and evaluation of cargo is more difficult. The changing environmental landscape has meant that ships are being transformed for compliance purposes. Increased concern about water quality and impacts on sensitive habitats has put additional pressure on port authorities. These pressures have led to the creation of smart ports, which are fully automated, taking advantage of the latest technologies, blockchain and artificial intelligence (AI), state of the art monitoring software and processes while adhering to and promoting compliance with both the latest environmental protocols and the United Nations (UN) 2030 sustainable development goals (SDGs).

In this contribution to the Conference, the discussion centres on the challenges facing ports within the Southern African development Community (SADC) region, in the light of the latest global developments. Smart ports and the drivers towards greater changes are discussed and analysed. Finally, the state of ports within the SADC region are evaluated in the light of the latest global developments in order to determine whether our ports are prepared to transition and changes that can be made to facilitate the process.

1. INTRODUCTION

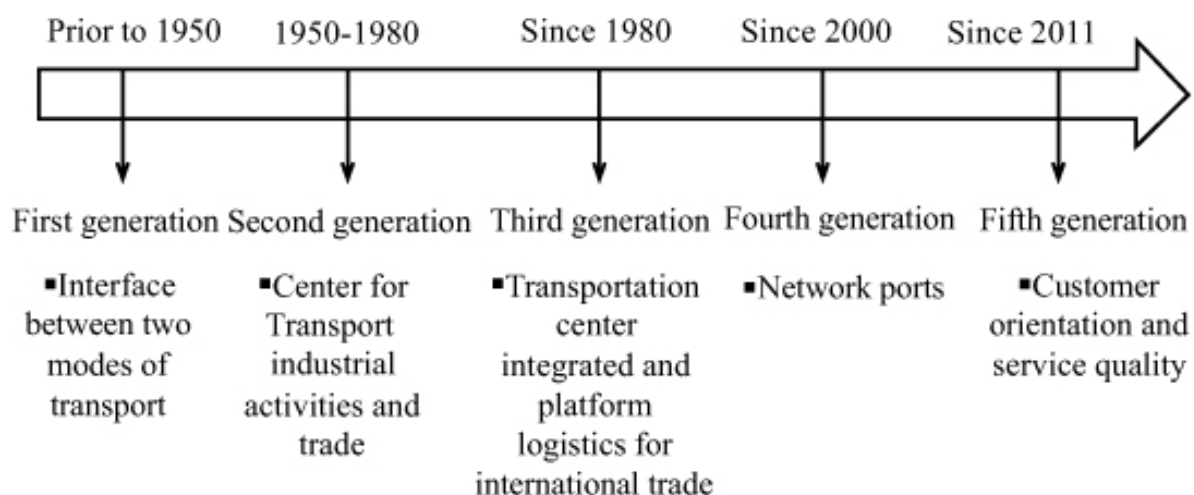
Change is often driven by need and inescapable circumstances, and the movement towards the establishment of smart ports is no exception. Global trade has been both a catalyst and a beneficiary of increased technological breakthroughs. It has also, unfortunately been a major contributor to the climate change crisis. Increased global trade has led to greater pressure on ports as more and bigger ships are required to meet customer demand. As shipping is the preferred logistics method, the fuels required to power these vessels have contributed towards climate change. Shipping companies are known to contribute towards increased carbon dioxide (CO₂), nitric oxide and greenhouse

gas (GHG) emissions, spillage of fossil fuels and hazardous waste as well as waste matter, thus polluting the marine environment (Chircop *et al.*, 2018: 5). Ships at port are also responsible for air pollution which affects both the surrounding communities and the sensitive marine ecosystems surrounding the ports (OECD, 2022). The needs of multinational companies have facilitated the speedy development of both the supply chain sector, risk management policies and legislation. They are also responsible for information technology (IT) and data management breakthroughs and the use of AI to expedite manufacturing processes and secure data management systems, amongst others.

Increased trade volumes have placed greater pressure on ports to perform more efficiently and effectively (Munim *et al.*, 2018). In addition to their gateway function, ports are also customs access and exit points, with government agencies facing additional pressures to their normal customs functions. As the 9/11 terrorist attack clearly indicated, increased global trade has provided more opportunities for criminal syndicates and terrorist cells to move contraband, weapons and illegal animal and human cargoes (Peterson *et al.*, 2006:2). The endogenous and exogenous pressures placed on ports and the competition faced by governments, with the fast-changing balance of power between western and eastern ship owners, together with more stringent trade, shipping and supply chain regulations, has led to the rise of the smart port (PPIAF: 2007:5) In this paper smart ports will be defined and the many elements influencing their adoption, explained. Against this backdrop, the development of the ports of Maputo in Mozambique, Walvis Bay in Mozambique and Durban in South Africa, will be discussed and analysed to determine whether they are positioned to take the next step and transition successfully as Smart ports.

2. THE TRANSFORMATION OF PORTS

The Collins Dictionary defines ports as a harbour where goods or passengers are loaded or unloaded. Although this definition describes the basic activities at a port, it can hardly be relied upon to adequately describe the many aspects of modern ports. With time, the functions of ports have changed and evolved, with each successive generation fulfilling a new role.



Source: <https://benthamopen.com/FULLTEXT/TOTJ-11-120/FIGURE/F2/>

Figure 1: The five generations of ports (Bentham Open: 2011)

The World Bank Toolkit on Port Reform (2007:4-8) referred to three main forces driving port reform. These are:

- External forces of competition and technology from the shipping industry.
- The acknowledged financial and operational benefits of private participation in infrastructure development and service delivery.
- The diversification and globalization of investors and operators in the port industry.

The first force has driven the need to restructure port operations to deal with the external factors affecting port viability. These include national competition for global markets, changes in port and transport technology, and increased competition among ports (World Bank, 2007:5). The impacts of technology on ports has become a powerful differentiating force between ports and radically increased the ability of ports to perform. The fourth industrial revolution technologies (4IR) such as AI, internet of things (IoT), Cloud, Big data and Blockchain are common modern smart port technologies (UNESCAP, 2021:15).

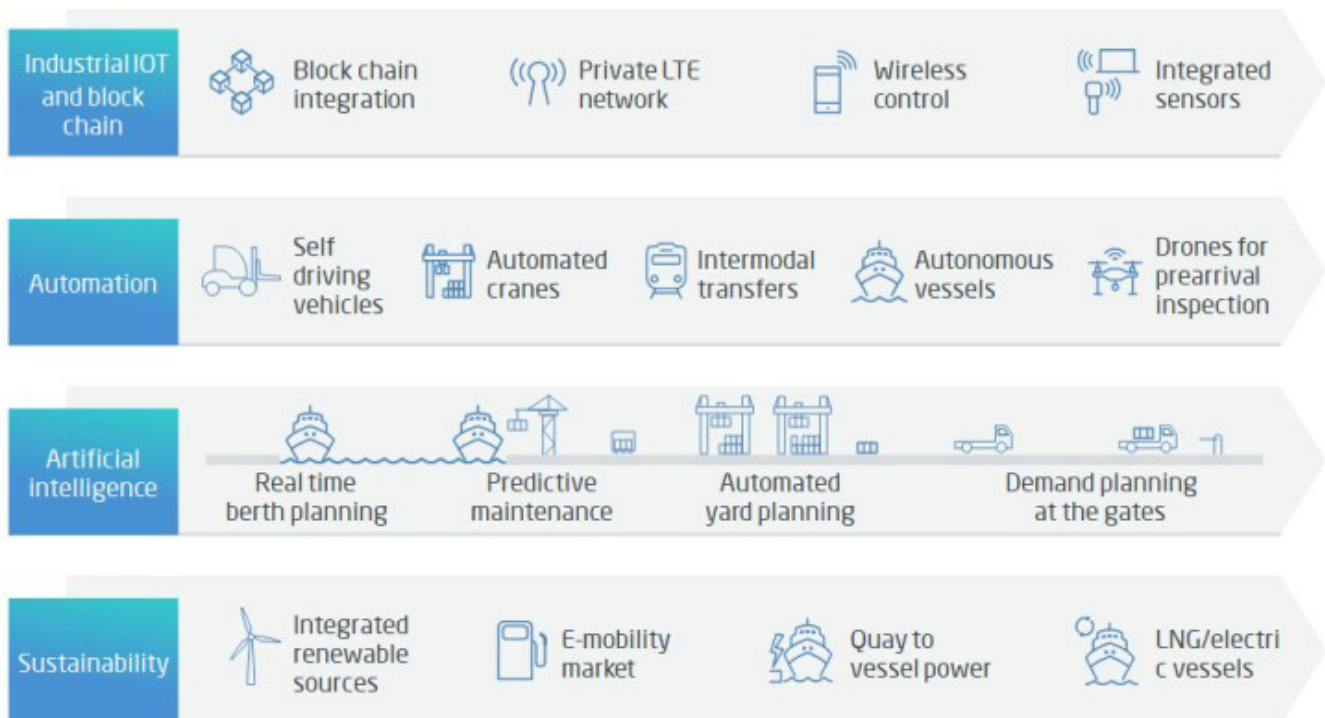


Figure 2: The future of ports: how to stay competitive (ALG Newsletter, Shaping Future)

The costs of these technologies have increased the cost of efficient performance, rapidly altering the competitive landscape. Port models developed in the 19th and early 20th century were simpler and had many drawbacks (World Bank, 2007). They significantly constrained ports from competing effectively on a service quality basis, limited their agility and market responsiveness in mobilizing resources, and constrained their ability to share risks with private sector partners. As many of the challenges facing modern ports had not been envisaged, the models of port development were appropriate for the period in which they were developed. In planning how responsibility for future port development and operations will be divided, policy makers now have the option of both public sector and private sector participation. In deciding on desired levels of investment to be funded or guaranteed from public sources, policy makers must increasingly weigh the competitiveness of their port(s) in relation to other ports in their region, and in comparison, to the supply chain alternatives available to their users. These alternatives are now more abundant than they were 15 plus years ago. The port business is therefore more

competitive now than it was prior to the 4IR. New institutional models are therefore needed for this new era of increased competition (World Bank, 2007).

The second force generating momentum for reform is private sector participation in infrastructure and superstructure. In this era of decentralization, many sectors which were protected by governments have been outsourced to the private sector. Governments and lending agencies have come to acknowledge that private sector participation can be a powerful force for enhancing the performance of port assets, as with other infrastructure assets. National and regional seaports have accepted that they cannot compete effectively without the efficiencies offered by private operators and without access to capital provided by private investors. There has thus been a steady increase of private sector participation in port operations around the world. Countries with recent experience of port reform include Argentina, Brazil, Canada, Chile, China, Colombia, Egypt, Estonia, Germany, India, Indonesia, Japan, the Republic of Korea, Latvia, Lithuania, Malaysia, Mexico, Mozambique, Nigeria, Oman, Panama, the Philippines, Poland, Russia, Tanzania, Thailand and the United Kingdom. In addition, the pace of private investment in the sector is accelerating (World Bank, 2007).

The third force affecting reform is the development of a global market for port development services. Each specialized niche contains several international companies that offer specialized service capabilities. The sector contains four groups of operators:

- 1) The first wave of “global stevedores”, the first to have expanded their operations internationally from a strong home base.
- 2) The second wave, comprising regional operators now entering the international market following the success of their predecessors.
- 3) Shipping lines, investing in terminals.
- 4) Niche investors, looking more specifically at small- to medium-scale facilities (PPIAF:7).

In addition to providing core port services, ports are increasingly delivering nontraditional services to their customers as well. These nontraditional services have expanded the role of port service providers in the supply chains of shippers and create value for shippers by expanding the scope of markets they can economically access by reducing the delivery cost of products they sell, or by reducing the cost to complete buy/sell transactions. Ports can now participate in specialised port service niches and differentiate themselves from other more traditional ports (World Bank, 2007).

In addition to the changes afforded to the operational port functions, modern ports are under pressure to conform to global operational standards on risk management, supply chain management and environmental standards. The level of pressure depends on the stringency of the regional laws and the level of development of the countries involved, as well as their level of commitment to the net zero targets of the Paris Agreement on Climate change. Countries within the European Union are moving at a faster pace to ensure that both their ports and their ships are environmentally compliant (Ministry of Environment, 2022). Where ports are extremely busy, or situated close to cities, fishing waters, ecologically protected areas or within rivers, there would be greater pressure for them to conform as the risks and pressures facing the ports, rivers and cities are greater.

The development of ports would therefore, to some extent, be related to the pressures which they face and their commitment to change, as well as the access to capital required to ensure that these changes are made and maintained. In addition to regional challenges,

there are the global commitments by governments to the UN Sustainable development goals to which 185 UN Member States bound themselves to implement and uphold in 2015 (UNESCAP:13). These 17 Sustainable Development Goals (SDGs) aim to support environmental preservation, economic development and social integration, and to improve the quality of life for the present and future generations. The International Association of Ports and Harbors (IAPH) launched the World Ports Sustainability Programme (WPSP) in February 2019 to integrate the SDGs into the business strategies and governance by Port Authorities and help align them with global sustainability standards. The five World Port Sustainability Programme themes are climate and energy, community outreach and port city dialogue, resilient infrastructure, governance and ethics, and safety and security. With the inclusion of the SDGs, the development of ports cannot be rejected by any forward-thinking government, as all global players are affected by change and committed to be part of the change (UNESCAP:14).

The World Bank's Port Reform Toolkit (2007:21), provides, in addition, five factors that are expected to affect future ports:

- Intensifying global competition: Trade and the growing trend towards globalization of production, expanding the geographical scale or logistics reach.
- Changing technology: The need for container port productivity improvements, and the growing role of information technology.
- Changing distribution patterns: Looking for strategic hub locations. Generating income of a transshipment hub by the double handling of containers. Inland container terminals replace activities from the port to enhance intermodal efficiency.
- Increasing importance of environment, safety and security concerns.
- Change in the bargaining power of stakeholders due to port changes – consolidation among ocean carriers, and the emergence of a global logistics service provider environment (UNESCAP:15).

In addition, a rapidly changing global trading environment, including increasing vessel sizes and cargo volumes, has made it necessary to revise the business model (service) and introduce technological innovation needed to strengthen port competitiveness. Most ports should therefore try to move towards becoming smart ports in order to maintain productivity, customer-friendliness, efficiency and competitiveness.

While it is tempting to see the Smart Port model as complete, it is important to realise that, together with changing technologies, Smart port development is in its infancy and likely to face even more challenges. The latest 2022 DNV report, *Maritime Forecast to 2050*, looks at the efficiency of alternative fuels and the movement to the use of ammonia as a ship propulsion fuel post 2035 (DNV:55). According to this report, the efficiency of these fossil fuels is much less than that of fossil fuel. Ships will therefore need to refuel more often. In addition, ammonia needs more storage space than traditional fossil fuels. This will impact both the ships which are running on these fuels and the ports receiving them. Greater refueling needs will mean greater opportunities for ports to make themselves available (DNV:57). Ports along global shipping routes which would not normally receive ships in transit may now be within the refueling path of these ships and, if they are equipped, have opportunities to trade afforded them. Because alternative fuel technology is still in its infancy, however, no one can accurately predict the potency of alternative fuels by 2035. In addition to the issue of alternative fuels is that of the technology needed to launch and receive automated ships. This will require the technology, resources and appropriate skills. The movement to smart port status is therefore one of continual change and improvement.

3. SMART PORTS DEFINED

According to Kok-Lim *et al.* (2020:1-2) the fifth-generation smart port has the following five distinguishing characteristics:

- a) Smart port services and applications such as vessel and container management.
- b) Technologies such as data centre, networking and communication, and automation.
- c) Use of sustainable technology to increase energy efficiency and reduce greenhouse gases emission.
- d) Cluster management such as a shipping cluster that consists of geographically proximate companies and stakeholders with their main activity being shipping.
- e) Development of hub infrastructures to foster collaboration among different ports.

In their definition of smart ports, Molavi *et al.* (2019:9) have identified the following domains and sub domains as being attributed to smart ports:

Table 1: Domains and subdomains attributable to smart ports (Molavi, 2019:10)

No	Domain	Subdomain	Description
1	Operations	Productivity	The extent to which the port operations are carried out efficiently within the limits of time, budget, space, and available facilities
		Automation	Automation is the use of various control systems (set of devices that manages the behavior of other devices or systems) for operating equipment with minimal or reduced human intervention.
		Intelligent infrastructure	Intelligent infrastructure means the use of technologies, both hardware and software, in the port with the aim to increase efficiency and sustainability.
2	Environment	Environment management systems	Environmental management systems (EMS) are means to help organizations to improve their environmental performance. This aim is achieved through observing and controlling port operations regarding their environmental impacts.
		Emissions and pollutions control	Port activities and shipping industry can cause three major types of pollution: emissions to air, noise pollution, and water pollution.
		Waste management	Ports receive a noticeable amount of waste, sources of which are port activities and vessels.
		Water management	Water is a vital resource for both human and other species health, so monitoring and controlling the water quality should be part of port plans and strategies.
3	Energy	Efficient energy consumption	Several factors influence the energy consumption of a port. These elements could be divided into two categories, direct and indirect energy users. For both groups, saving possibilities should be identified.
		Producing and use of renewables	Renewable energy is replenishable energy that is generated from natural processes. There are significant possibilities of renewable energy implementation in the ports. This assists in partially or totally covering the port energy demand and significantly reduces pollutions.
		Energy management	Ports should identify energy management strategies and activities to make efficient use of the available energy.

Table 1: Cont'd

No	Domain	Subdomain	Description
4	Safety and Security	Safety management systems	Safety Management System (SMS) is a comprehensive business management system designed to administer safety principles in the workplace.
		Security management systems	A security management system identifies potential threats to the port and establishes, implements, monitors, reviews, and maintains all appropriate actions to provide assurance for the effective handling of security risks.
		Integrated monitoring and optimization systems	Establishing an integrated monitoring and optimization system based on the most recent software and hardware facilitates achieving enhanced security and safety in the port area.

Molavi *et al.* have subsequently, using all the elements attributed to smart ports, defined a Smart port as” a port having all the elements of a digital port, knowledge port, intelligent port and humane port. In addition, “a smart port gathers better educated individuals, skilled workforces, intelligent infrastructures, and automation to facilitate knowledge development and sharing, optimize the port operations, enhance the port resiliency, lead a sustainable development, and guarantee safe and secure activities.”

The UNESCAP (2021:18) article referred to the Korean Maritime Institute definition of a smart port. This definition provided that a smart port is as a comprehensive concept, aiming at automation, logistics optimization, energy efficiency, eco-friendliness and reinforcement of connectivity with hinter cities through process innovation and the introduction of information technologies (IT) such as IoT, AI, Robot etc. This definition aligns with that of Molavi *et al.* From these definitions and descriptions, we can see that, for a port to qualify as a smart port, it needs to be more than technologically proficient and contain elements relating to all four domains listed above.

In addition, there are levels of technological proficiency or stages which a port must pass through before it can be considered to have reached the level of technological proficiency required of smart ports.

Below are the four phases of technological progress which ports pass through before they attain Smart port status (UNESCAP: 86).

- 1) Phase 1 – port information:
 - Use paper documents, manual processing.
 - Less systematic port procedures.
 - Willingness to transform to computerized port.
- 2) Phase 2 – automatic port:
 - Paperless transactions by e-documents.
 - Use of an information system, such as port-EDI (electronic data exchange) and terminal operating systems (TOS) to handle port operations.
 - Willingness to change semi-automated port operations to fully automated.

- 3) Phase 3 – digital port:
 - Construct an automated port using radio frequency identification (RFID), sensors, cameras etc.
 - Use port collaboration model such as Single window, port community system PCS etc.
 - Willingness to interconnect with other organizations or countries for information sharing.
 - Prepare a nation-wide logistics masterplan or roadmap for smart ports.
- 4) Phase 4 – smart port:
 - A fully automated port that uses nascent, automation and innovative technologies; Digital transformation with the 4IR technologies.
 - Objective is an optimized, unmanned and autonomous port.
 - Comply with international regulations and/or standards.

4. SMART PORT DEVELOPMENT IN SUBSAHARAN AFRICA

The development of smart ports is not a phenomenon limited to the biggest, busiest global ports. The changes brought about by global trade and the technological adaptations made throughout global supply chains have meant that all ports must adapt or be left behind. In the light of the above requirements and developments, the question of transition of the ports within the SADC region is raised. More specifically, the readiness of the ports of Durban, Maputo and Walvis Bay to participate in the global smart port movement is questioned. The answer to this question lies not with the three main ports under discussion, but with an understanding of the dynamics behind the top ten global smart ports, the majority of which are in Europe. According to the Sinay Hub (2021) the world's top ten ports, in progressive order are the ports of Rotterdam, Hamburg, Antwerp, Singapore, Shanghai, le Havre, Los Angeles, Copenhagen, Valencia and Barcelona. From the list, we can see that Europe is at the forefront of smart port development. What has made these ports unique is their commitment to the SDGs and their incorporation into all aspects of port operations (Sinay Hub, 2021). Be it the Digital Twin at the Port of Rotterdam, complete automation, as in the Singapore Tuas mega port project, or digital sensors and intelligent use of 5G technology and digital systems, the relevant ports have fully integrated environmental and ecological goals into their daily operating systems, ensuring that the cities in which they operate are not affected by port operations.

Commitment to change does not happen in a vacuum, however. The top ten smart ports are amongst the busiest ports in the world, and with increased global trade, have been pushed beyond their normal capacity. They have had to find methods to improve port operations, increase productivity, decrease port congestion and satisfy all their stakeholders, all of whom are operating under tremendous pressure. The proximity of European ports to each other has meant that shippers have many alternatives to choose from, thus increasing the level of inter - port competition. These ports, as portals to global trade within the region, must answer to their customers, many of whom depend upon just - in- time processes to manufacture goods. As vital supply chain partners, port operators have had to align with European and other global multinationals who are already using the most advanced technology to streamline manufacturing, service and administrative processes. The culture of business within these countries has transferred to the port authorities. In addition, the level of skills development and the prevalence of highly skilled labour has assisted the transition and progress of these ports towards their Smart port status.

There are, in addition, structural efficiencies working in the favour of these ports. Rather than playing the traditional landlord role, these port authorities have long worked in partnership with the private sector to ensure efficient port functions. Not only do ship owners and shipping companies own their own berths at these ports, but service providers work autonomously but harmoniously with port authorities to ensure the smooth running of port operations and other services. This arrangement assists with the raising of finances, as port authorities have not had to bear the burden of raising finances, alone. The fact that these ports are amongst the busiest ports in Europe, the USA and Asia, has meant that they are able to maximise their income and raise funds needed to finance change through port operations. This, in turn, does not put a tremendous burden on governments to invest in port development, even though the port authorities work hand in hand with government. At the Antwerp port, the Port house, a unique residence for the governing port authorities, is found on the Port premises. This assists with the public- private partnerships as business and government work closely together.

The dynamics of the SADC ports are very different. Within the South African context, the Transnet Port Authority, (TNPA) is a government entity in charge of port operations. In addition, the South African port system still works on the landlord system. From the websites of the ports of Walvis Bay in Namibia and Maputo in Mozambique, it is clear that our ports are still government entities under control of quasi -governmental authorities. Development is therefore part of strategic government growth planning initiatives rather than a synergy between the public and private sector planning. From the different port websites, all three ports are positioning themselves as modern ports. The Port of Walvis Bay has positioned itself as a very modern port while the Port of Maputo has embarked on modernisation projects with private sector partners to position itself as a global competitor. Within the Durban port, digitalization of processes has already begun, as the port authorities seek to align with the needs of their global customers and global legislative requirements. While these developments are encouraging, the ports of Maputo and Mozambique are not currently working at maximum capacity. They are, instead, in the process of positioning themselves for greater trade, competing amongst themselves for trade from South America, China and Europe. From the European and Asian examples, we have seen that increased competition is a driver of development, and that smart port development was largely driven by inter-European and inter- Asian competition, in addition to the needs of businesses within the regions.

While the Southern African governments have been proactive in transforming their ports, port development cannot happen in a vacuum. Development of the ports will be dependent upon the following:

- 1) **The development of the South African business sector and the speedy change to a 4IR enabled economy:** Problems with the supply of energy, the drop in the cost of airtime and data, fibre and fibre speeds and other basic energy and communication infrastructure will need to be addressed. Currently, the urban areas are beneficiaries, but the rural areas are still dead zones. To ensure that digital technologies become mainstream, the movement towards alternative fuels and energy sources will have to be prioritized by government.
- 2) **Alignment with global supply chain trends and legislative requirements:** This will mean that there will be more education of the business community of these requirements and the importance of alignment for the development of the South African Economy and port development.

- 3) **Alignment with the greening of global trade initiatives:** This will have serious impact on the readiness of the SADC ports to receive and service new generation ships. As global shipping moves to full automation, this is a priority area, as smart port development has been driven by the greening of Europe and climate change undertakings. Environmental initiatives, from a development perspective, have been viewed with suspicion, as they are often seen as conflicting with development goals. With the adoption of the UN SDGs, there will need to be both a shift in the culture and the business mindset.
- 4) **A major impediment to change is government employment goals and the need for skills development:** Traditionally, state - owned enterprises were used to absorb labour, especially unskilled labour, where there are activities which require more physical labour. Within the ports, automation will require a complete restructuring of labour, with a movement towards more skilled labour. Given that the largest pool of unemployed labourers is young and unskilled, the movement towards automation and digitalization of the port and business will create a short- or medium-term skills shortage. There will therefore be a need to rapid upskilling initiatives. The speed at which the labour force and the school system can be transformed and repurposed will therefore affect the speed at which the ports within the region can transition. The ability of the Southern African region to transition will depend on the speed at which current literacy and skills issues are addressed. There is also a need to change the mindsets regarding automation and digitalisation, which is often wrongly perceived to lead to job losses and decreased need for labour. Speedy transition is not likely within the South African context, however. Until structural educational deficiencies and imbalances are addressed, progress may be slow.
- 5) **Another major issue is that of sourcing finances:** The current landlord system does not serve the region and there will need to be a complete rethinking of the governance structures of ports within the SADC area. Going forward, there will need to be a greater commitment by government to public-private partnerships and the way in which partners and service providers are chosen. The global trend towards international port service providers can assist with both finances and increasing performance standards if utilized strategically. What is clear, however, is that government cannot shoulder the financial burden of digitalisation alone and will need to surrender a degree of authority and ownership to both domestic and international private sector stakeholders.

5. CONCLUSION

The adoption of the smart port methodology cannot be avoided and is required, if ports are to survive. The speed at which change occurs is dependent on the current status of the business community, the policies of the various governments and their willingness to align with current and future global business and administrative legislative requirements and processes as well as their willingness to relinquish administrative power to the private sector, where required, for funding of port development initiatives. At present, within the context of transition of ports, our governments are still dealing with major structural issues which affect the rapid transition of domestic economies and hence, the development of the ports. The transition of our ports towards smart port status will therefore depend on the speed at which both the public and private sector can adapt to the new global trading climate and make the required internal changes. With new technologies come new opportunities and while transition will require changes within the labour force, a radical repurposing and skills development program can assist with the transition and create job

opportunities within new sectors. This is a very important aspect, as port development occurs together with the business community and adjusts to the needs to the business community. The speed at which the business community develops will therefore impact on the demands made on the port authorities. Without these demands, transition will be much slower.

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