

Contribution of digitalization initiatives in African ports to the sustainable development

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Abstract

Purpose – African ports play a vital role in the continent’s economy and international trade. While African ports are essential for the competitiveness of African countries, their low level of digitalization presents significant challenges. This study aims to explore how digitalization initiatives implemented by African countries since 2018 are contributing to addressing the sustainable development goals (SDGs).

Design/methodology/approach – A qualitative analysis approach is adopted by exploring 19 case studies identified by the World Ports Sustainability Program. It explores how African ports have contributed to addressing the 17 SDGs, the positioning of these initiatives according to sociotechnical systems theory and the role these initiatives can play in reducing asymmetries in performance between African countries.

Findings – The results indicate that the most strongly addressed SDGs are 8, 9 and 17. The technical dimension stands out as the main objective of these projects to the detriment of the social and organizational components. Finally, the findings reveal that these initiatives have not significantly reduced performance gaps between African countries.

Originality/value – This study explores the under-researched nexus between digitalization and sustainable development. It uniquely contextualizes digital initiatives within the SDGs. The value lies in its potential to guide policymakers, port operators and stakeholders in leveraging digital transformation. Moreover, the relevance of this study is amplified as Africa seeks to integrate more fully into the global trade system while addressing pressing challenges related to resource management, sustainable development and socio-economic disparities.

Keywords Digitalization, Smart ports, Sociotechnical systems theory, Sustainable development

Paper type Research paper

1. Introduction

Digitalization has emerged as a critical solution for addressing the challenges faced by ports in a global context. As recognized by the International Maritime Organization, ports that embrace digital transformation are better positioned to handle growing trade volumes and adapt to market disruption (IMO, 2024). At the same time, digital transformation is important for ports to remain competitive in the evolving global supply chain landscape. Studies from other developing regions provide valuable insights into how digital technologies can enhance ports’ competitiveness. A study conducted on Indian ports by Sajith *et al.* (2024) demonstrates that the implementation of digital technologies, including blockchain and Internet of Things (IoT)-enabled tracking systems, significantly improves cargo handling efficiency and reduces congestion. These findings are particularly relevant to African ports, which often struggle with long dwell times and inefficient customs processes. Furthermore, research on Latin American ports, such as the work of Wilmsmeier and Sanchez (2017), underscores the impact of port

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digitalization on reducing logistical bottlenecks and increasing competitiveness. In countries like Brazil and Colombia, the adoption of port community systems and electronic documentation has facilitated smoother trade flows, reducing delays and minimizing corruption risks (Miller and Hyodo, 2022; Umbelino de Souza *et al.*, 2021). This is especially pertinent to Africa, where similar challenges persist due to bureaucratic inefficiencies and limited infrastructure.

In addition to digitalization efforts, ports need to address sustainable development goals (SDGs). Integrating sustainable development principles into port operations is essential to balance economic growth with environmental and social responsibilities. It is expected that the adoption of sustainable practices by ports is important to better equip them to handle emerging challenges such as stricter environmental regulations and shifting market demands (Behdani, 2023). Ports play a pivotal role in Africa's economic development, serving as gateways for international trade and vital hubs for regional integration (Mlambo, 2021). Given the continent's reliance on maritime transport, which handles around 90% of its trade, African ports are essential for connecting countries to global markets and fostering economic growth (Institute for Security Studies, 2020). However, the role of African ports extends beyond economic development. As recognized by Mohamed-Chérif and Ducruet (2016), they also play a crucial role in regional integration and infrastructure development. Despite their significance, African ports face challenges that limit their full potential. Many ports suffer from outdated infrastructure, congestion and inefficiencies in customs processes, which can result in delays and higher costs for shippers (Ayesu and Boateng, 2024). Therefore, investments are necessary in modernizing port facilities, digitalizing operations and enhancing connectivity with other transportation networks to unlock the full benefits of ports for the continent's growth.

Studies addressing the digitalization of African ports are very scarce. Most of the works in this sector are technical reports carried out by economic and development associations and entities on a regional scale, which aim to explore the current state of economic and technological development of African ports. At this level, the work carried out in 2022 by the African Development Bank Group indicates that ports have made efforts and interactions in sustainable development; however, these collaborations are the result of isolated efforts not supported by national governments, and they are typically limited to port companies, excluding other actors such as civil society (AFDB, 2022). Another study carried out by the Africa Transport Policy Program in 2024 on digitalization processes in ports, considering a panel of 31 African countries and 39 ports, concluded that digital maturity in African ports is very asymmetrical (SSATP, 2024). Furthermore, although some ports have recorded high levels of digitalization, their productivity levels are lower than would be expected, which indicates that other factors, such as working conditions and equipment availability, may affect their performance (SSATP, 2024). Finally, the only scientific study identified in the field was conducted by Sakita *et al.* (2024), and based on 13 semi-structured interviews, they identified 5 groups of impediments to the digitization processes of African ports (i.e. system ownership issues, sabotage and corruption, human dependence, cultural constraints and political influence). In this sense, there is a gap in the identification of digitization initiatives promoted by African ports and in the exploration of their role as a contribution to the SDGs. This study takes on the challenge of exploring the complexities of how projects initiated by African ports address the 17 SDGs, examining the specific characteristics of these projects, especially the digitization strategies employed, as well as the disparities that exist among African ports.

The remainder of the manuscript follows this structure. First, we provide a theoretical background on the themes of digitalization and sustainable performance, followed by an exploration of the African port context. Next, we present the study's adopted methodology and the data used for qualitative analysis. A presentation and discussion of the results, grouped by the three listed research questions, follows. Finally, we conclude the study by exploring its theoretical and practical contributions and offering some suggestions for future work.

2. Background

2.1 Digitalization and sustainable development

The nexus of digitalization and sustainable development is multifaceted, with digital technologies playing a crucial role in advancing sustainability across the triple bottom lines. Through the adoption of a systematic review and conceptual framework, [Gradillas and Thomas \(2025\)](#) characterize digitalization as the process of integrating digital technologies into all aspects of business, society and daily life to improve efficiency, productivity and innovation. Accordingly, the goal of digitalization is not only to enhance processes but also to facilitate new business models, better customer experiences and more informed decision-making ([Nauhaus et al., 2021](#)). As pointed out by [Varriale et al. \(2024\)](#), digitalization can play a transformative role in addressing the SDGs by enabling more efficient, inclusive and sustainable processes across various sectors. Therefore, it can be assumed that digitalization can accelerate progress towards the SDGs by fostering innovation and enhancing global collaboration. While digital technologies have a transformative impact across many areas, their influence is more pronounced in certain goals compared to others. Some SDGs are more directly aligned with digitalization due to the nature of the challenges they address, while others benefit indirectly or to a lesser extent. Digitalization is deeply connected with goals related to economic growth and sustainable development, while its impact is less important in areas where individual and social behavior is more relevant. Anyway, it can support progress across all SDGs, but its role varies depending on the nature of the challenge and the extent to which digital technologies can address the specific issues within each goal. Furthermore, the relevance of the SDGs to port infrastructure emerges from the need to balance economic growth, environmental sustainability and social inclusivity within the complex operational landscape of maritime logistics. As recognized by [Jayarathna et al. \(2024\)](#) and [Twrdy and Zanne \(2020\)](#), sustainable infrastructure planning is essential to ensure that growth does not come at the expense of environmental degradation or social inequities. Using sustainable development concepts to lead a comprehensive approach to port infrastructure guarantees that operational plans incorporate social well-being, environmental responsibility and economic efficiency. To explore the role of sustainable development initiatives promoted by African ports in specifically addressing each SDG, the following question was formulated:

RQ1. What are the main SDGs addressed by the digitalization initiatives promoted by African ports?

Digitalization in ports can be explored through various theoretical lenses. Sociotechnical systems theory (SST) is considered by [Iden and Bygstad \(2024\)](#) as a central lens for exploring digitalization due to its focus on the interplay between social and technical dimensions. SST posits that organizations are composed of both social and technical elements that interact and influence each other. When exploring digitalization, this lens helps to analyze how technology affects social structures, behaviors and processes within organizations and society. It emphasizes that successful digital transformation requires not only the adoption of new technologies but also the alignment of organizational culture, processes and human factors. This perspective is crucial for understanding the challenges and benefits of digitalization in various contexts, particularly in ports. Literature, such as [Kraus et al. \(2021\)](#) and [Omol \(2024\)](#), suggests that successful digital transformation in any organization, including ports, necessitates a comprehensive approach that goes beyond merely adopting new technologies. It requires a deliberate alignment of organizational culture, processes and human factors to ensure that digital initiatives are effective and sustainable. In the context of ports, which are complex ecosystems involving various stakeholders (e.g. shipping companies, logistics providers, customs authorities and local communities), this alignment is particularly critical. When digital technologies are introduced into ports, it is not merely a matter of implementing new tools; rather, it necessitates a comprehensive transformation of both the social and technical aspects of the system. Moreover, SST underscores the significance of processes in shaping the effectiveness of digital initiatives. In ports, workflows

must be re-engineered to incorporate digital tools, ensuring that they align with the broader organizational objectives and the needs of various stakeholders. Additionally, the sociotechnical approach promotes collaboration among stakeholders, recognizing that the success of digitalization in ports depends on the collective efforts of all parties involved. Compared to other theoretical perspectives, such as the technology acceptance model (TAM) or the diffusion of innovation (DOI) theory, SST provides a more comprehensive framework for understanding digital transformation. TAM focuses primarily on individual user acceptance of technology, assessing factors like perceived ease of use and usefulness (Davis, 1989). While useful for analyzing frontline adoption of digital tools, TAM does not fully capture the broader organizational and systemic challenges that digitalization entails, and DOI explains how innovations spread throughout a population, highlighting key factors such as compatibility and trialability (Rogers, 1962). However, DOI tends to emphasize the characteristics of technology itself rather than the dynamic interplay between technology and organizational structures. Accordingly, a key advantage of SST over these alternatives is its ability to address the complexity of digitalization by recognizing that technological advancements alone do not guarantee success (Pasmore *et al.*, 2018; Thomas, 2024). This is particularly critical in developing regions, such as Africa, where digitalization efforts often face structural challenges. SST suggests that for digitalization to be effective, ports must adopt a sociotechnical approach. Therefore, another research question was established to explore how the initiatives address the SST.

RQ2. How do digitization initiatives promoted at African ports address the dimensions identified in the SST?

2.2 African context

The landscape of African ports is influenced by a distinctive mix of opportunities and challenges that mirror the continent's economic conditions, infrastructure developments, geopolitical factors and social dynamics. African ports function as essential conduits for global trade, enabling the transfer of goods and resources both within the continent and to international markets. Nonetheless, extant literature reveals that African ports encounter various challenges that impact their effectiveness and ability to satisfy the increasing requirements of international trade. Additionally, African ports exhibit significant diversity. According to SSATP (2024), this diversity reflects the continent's intricate geography, economic conditions, historical developments and differing levels of investment in port facilities and services.

Significantly, African ports differ widely in terms of infrastructure and capacity. Some major ports, like the Port of Durban in South Africa and the Port of Tanger Med in Morocco, have relatively advanced facilities and can handle larger volumes of cargo (Global Trade, 2024). These ports have modern container terminals, deep-water berths and extensive hinterland connections, allowing for efficient operations. In contrast, smaller and less developed ports, such as Bonny Port and Calabar Port (Nigeria), Kamsar and Conakry Port (Guinea), Banjul Port (Gambia), the Port of Dar es Salaam (Tanzania) and the Port of Maputo in Mozambique, all struggle with inadequate facilities, limited capacity and outdated equipment (Ugboma and Oyesiku, 2021). The structural capacity of the ports is also a determining factor that allows us to understand the lower operational performance of some ports in Africa. Some ports have implemented best practices in logistics, cargo handling and customs procedures, which help minimize turnaround times and streamline processes (Kaliszewski *et al.*, 2020). Conversely, other ports face challenges such as bureaucratic bottlenecks, inefficient customs processes and labor disputes, which can lead to delays and increased costs (Mazibuko *et al.*, 2024). These differences in operational performance can create uneven competitive advantages among ports in the region.

The governance structures and regulatory frameworks governing ports in Africa differ considerably. Trujillo *et al.* (2013) point out that some countries have established robust

frameworks that facilitate investment, promote transparency and encourage public-private partnerships. In contrast, others struggle with weak governance, corruption and inefficiency, which can deter investment and hinder port development. The varying degrees of political stability and economic policies across the continent further contribute to the heterogeneity in port governance. Furthermore, the socio-economic contexts surrounding African ports also contribute to their diversity. Some ports serve as critical gateways for highly developed urban centers, with well-established supply chains and access to international markets. In contrast, ports in less developed regions, as documented by [Mlambo \(2021\)](#), may face significant challenges (e.g. poverty, access to financing and workforce skills). These socio-economic factors influence the role of ports in regional and national economies, shaping their potential for growth and development. Accordingly, a new research question was formulated to identify the contributions that digitalization initiatives promoted by African ports have made to mitigate these asymmetries.

RQ3. How have digitalization initiatives helped to reduce performance gaps between African ports?

3. Materials and methods

The data for this study were obtained from the World Ports Sustainability Program (WPSP). It is an initiative launched by the International Association of Ports and Harbors in 2018 to promote the sustainable development of ports worldwide. Furthermore, the projects identified by WPSP are aligned with the 17 SDGs (i.e. SDG 1: No Poverty; SDG 2: Zero Hunger; SDG 3: Good Health and Well-Being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 6: Clean Water and Sanitation; SDG 7: Affordable and Clean Energy; SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation and Infrastructure; SDG 10: Reduced Inequalities; SDG 11: Sustainable Cities and Communities; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; SDG 15: Life on Land; SDG 16: Peace, Justice and Strong Institutions and SDG 17: Partnerships for the Goals). WPSP focuses on five main areas of sustainability in ports, which include resilient infrastructure, climate and energy, community outreach, safety and security and governance and ethics. The goal of this program is to highlight the best practices, research and innovative solutions, encouraging collaboration among port authorities, stakeholders and industries. The WPSP has identified and compiled over 400 sustainability projects from more than 160 ports across 65 countries. However, only 19 projects come from the African continent. [Table 1](#) lists the projects identified and analyzed in this study. A unique ID is associated with each initiative. Most of the projects (5 out of 19) come from Kenya. There is also one project involving multiple countries (i.e. PJ7). This is a consortium of seven countries, two of which are African (i.e. Egypt and Tunisia). [Figure 1](#) complements this analysis with a map representation of the initiatives in which the concentration of some projects in limited geographical areas becomes more evident. Many of Africa's key ports are located in the western region, particularly along the West African coastline, which is strategically important for trade routes between Africa, Europe, the Americas and Asia. As recognized by [Olukoju \(2020\)](#), these ports serve as critical gateways for international trade, handling a significant portion of the continent's import and export activities.

The data were collected in September 2024. The following elements were collected: (1) project name, (2) country, (3) year, (4) description of the initiative, (5) SDGs addressed and (6) weblinks with complementary information on this project. The information was collected using the Scrapy tool, which is a Python framework for large-scale scraping tasks. This information was then loaded into NVivo v.14 software to carry out a thematic analysis. Given the small number of projects identified on the African continent, qualitative analysis is the most appropriate and can offer rich insights. Thematic analysis is appropriate for identifying and interpreting patterns of meaning (themes) across qualitative datasets ([Nowell et al., 2017](#)).

Table 1. List of projects implemented in African ports

ID	Title	Country	Year
PJ1	Tanger Med Port – Port Paperless Passage Initiative	Marocco	2023
PJ2	Port Autonome de Cotonou – Sustainable Transformation of Vendor Livelihoods	Benin	2024
PJ3	Collaborative project – Qualifying for Employment	Egypt	2022
PJ4	Kisumu Port – Resilient Infrastructure Project	Kenya	2024
PJ5	Kenya Ports Authority – Shimoni Fish Port project	Kenya	2024
PJ6	National Ports Agency of Morocco – Smart port innovation approach	Marocco	2023
PJ7	Collaborative project – Youth Employment in Ports of the Mediterranean	Multiple	2023
PJ8	TIPSP – Biohut project	Ivory Coast	2022
PJ9	New Owendo International Port – Decarbonization initiatives	Gabon	2022
PJ10	Port of Mombasa – KPA e-Citizen platform	Kenya	2022
PJ11	Mauritius Ports Authority – Feasibility Study for Onshore Power Supply	Mauritius	2022
PJ12	Port of Lamu – KPA Fishermen Compensation program	Kenya	2023
PJ13	Port of Kribi – Socio-economic support program PASEK	Cameroon	2020
PJ14	Port of Kribi – Integrated Renewable Energy Generation Complex	Cameroon	2022
PJ15	Port Authority of Kribi – Kribi Port Eco-sustain Project	Cameroon	2022
PJ16	Port Autonome de Cotonou – Port environmental monitoring platform for invasive species (PPSEs)	Benin	2023
PJ17	Port of Tema – Sea Turtle Conservation Program	Ghana	2018
PJ18	Port of Tema – Clean Coast/Beach Project	Ghana	2019
PJ19	Kenya Ports Authority – Tunahusika Corporate Social Investment program	Kenya	2018

Source(s): Own work

Furthermore, this study has also developed a conceptual map using CMAP v.6.0.4. This approach complements the thematic analysis by visually organizing the relationships between codes and themes, which is important to identify the motivational factors for the establishment of cooperation in digital initiatives addressed by the African ports.

4. Results and discussion

4.1 RQ1. What are the main SDGs addressed by the digitalization initiatives promoted by African ports?

Figure 2 shows how the projects address the SDGs. The SDGs most addressed by African ports are SDG 8, SDG 17 and SDG 9. These SDGs are interconnected, and it is possible to explore synergies between them. Economic growth relies heavily on modern and efficient infrastructure. As recognized by [Verschuur et al. \(2022\)](#), ports are critical to African economies as key gateways for trade, both regionally and internationally. Therefore, upgrading port infrastructure (SDG 9) facilitates smoother logistics, which is vital for African industries that are dependent on import-export activities. Partnerships also emerge as a key element in developing large-scale port infrastructure. African countries often require technical expertise, investment and technology transfers, which are frequently achieved through international partnerships (SDG 17). Partnerships can involve several entities such as multilateral institutions, foreign governments and the private sector, which is vital for building and upgrading port facilities and introducing innovative technologies that enhance port operations. Moreover, also recognized by [Satta et al. \(2024\)](#), collaboration also helps ensure that port projects are aligned with global standards of sustainability.

These findings are only partially aligned with the conclusions reached by [Almeida and Okon \(2024\)](#), who, in addition to these three SDGs, also include SDG 13 in the context of their analysis considering ports on a global scale. Perhaps climate action (SDG 13) could be considered even more important than in many other regions because the continent is highly vulnerable to the impacts of climate change. However, there may be a perception that it is less

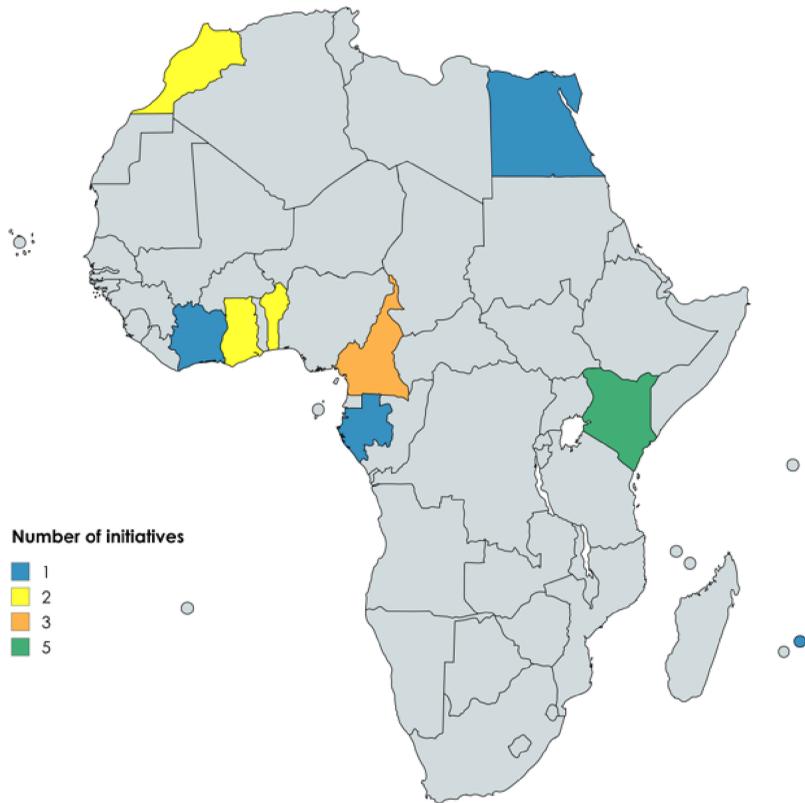


Figure 1. Geographical distribution of initiatives in African ports. Source: Own work

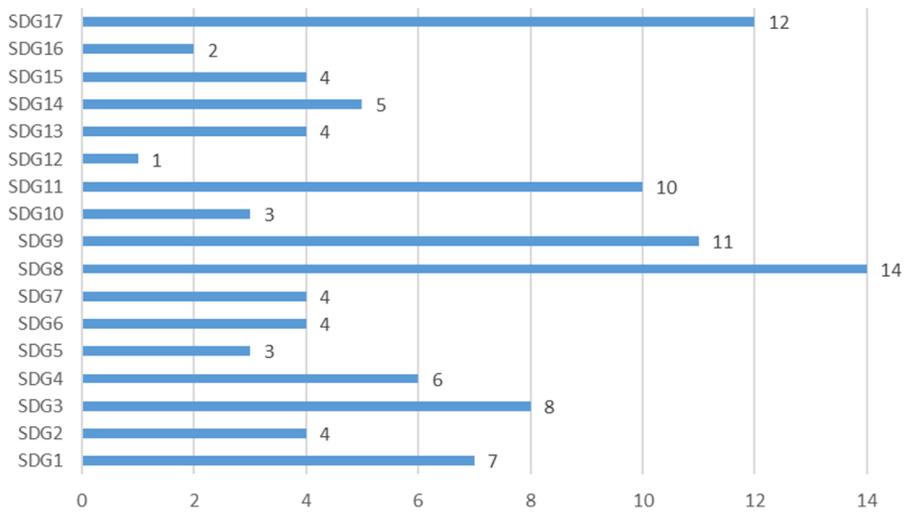


Figure 2. SDGs addressed by African ports initiatives. Source: Own work

prioritized compared to other SDGs, particularly due to Africa’s pressing challenges around economic development, poverty and infrastructure deficits. The results confirm this vision, considering the high relative importance given to SDG 1 and SDG 3, which are related to poverty and health. Therefore, climate action may seem like a longer-term goal in comparison. Furthermore, [Mostefaoui et al. \(2024\)](#) point out that Africa contributes only a small fraction of global greenhouse gas emissions (around 3–4%), and therefore, African countries tend to argue that the responsibility for climate action should fall more heavily on industrialized nations. Accordingly, African leaders may focus more on adaptation than mitigation, believing that wealthier nations should lead the fight against climate change.

4.2 RQ2. How do the digitization initiatives promoted at African ports address the dimensions identified in the SST?

Figure 3 shows the thematic analysis carried out for African ports considering the SST framework. The theoretical lens provided by SST emphasizes the interaction between people, technology and the organizational environment in the design and operation of systems. All three of these dimensions are identified in the African ports, but not homogeneously, with the technical component being more predominant than the social and organizational dimensions. A total of 10 first-order codes are identified, which give rise to the 5 themes (i.e. digitalization, customer-centric port services, operational efficiency, sustainability and environment and safety, security and monitoring) in the technical dimension. [Paraskevas et al. \(2024\)](#) highlight that the adoption of digital technologies in ports (e.g. automated cargo handling systems, port management software and smart logistics) is providing contributions to streamline operations, reducing delays and bottlenecks. A good example is provided by PJ4:

Designed to optimize passenger flow, the terminal includes segregated areas for ferry passengers with substantial cargo, local travelers and international/VIP guests. (PJ4, Kenya)

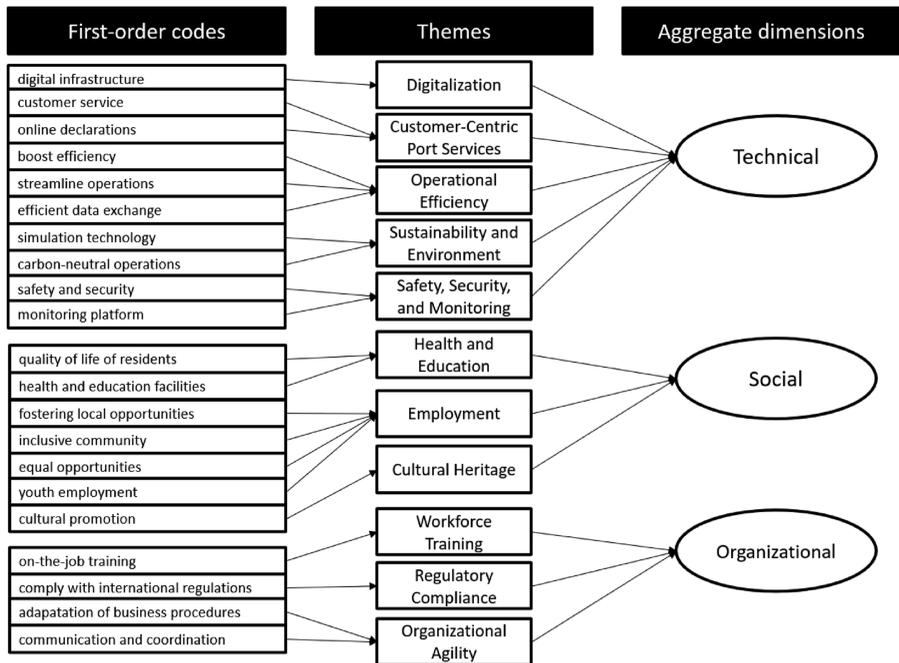


Figure 3. Thematic analysis considering the SST framework. Source: Own work

Another example that shows how it is important to have a flexible infrastructure is provided by PJ5:

The industrial fishing port infrastructure will comprise the construction of a multi-purpose berth that will incorporate fish and conventional cargo handling . . . and a dedicated warehouse that will serve as a fish processing plant. (PJ5, Kenya)

The technical dimension also plays a role in implementing sustainable practices. Technologies such as IoT sensors, renewable energy systems and energy-efficient equipment are important for ports to reduce their carbon footprint and monitor energy consumption. These technologies enabled the National Ports Agency of Morocco to implement two hackathons that were important for the development of new projects, as recognized by PJ6:

. . . various innovative projects addressing challenges such as facilitation of foreign trade processes, reduced waiting times for ships in the harbor . . . and monitoring the level of air, water and sediment pollution in ports. (PJ6, Morocco)

The social dimension is the second most addressed component with seven first-order components and three themes. The social dimension encompasses the human factors that directly influence the successful adoption and implementation of new technologies. As African ports embrace automation and digital systems, certain job roles may evolve, while others may become obsolete. It is critical to manage this transition in a way that provides new employment opportunities, especially for younger workers, aligning with youth employment initiatives. Investing in re-skilling programs and creating jobs are initiatives identified in this study. PJ3 presents an initiative that addresses multiple SDGs for qualifying jobs that promote the employment of women and customized training programs for young graduates.

. . . graduates gain the specific skills demanded by the industry, empowering them for successful careers and contributing to economic growth (PJ3, Egypt)

The organizational dimension has less relevance with four first-order codes and three themes (i.e. workforce training, regulatory compliance and organizational agility). Ports need to embrace a mindset of continuous improvement, encouraging innovation and experimentation. In the context of digitalization, this means constantly seeking ways to optimize port processes through digital innovations. Global trade and supply chain dynamics in Africa, as recognized by [Poponcini \(2024\)](#), are constantly shifting, influenced by factors such as geopolitical events, economic fluctuations and changing customer demands. PJ1 gives the example of the port community system (PCS) of Tanger, which facilitates communication and coordination among port stakeholders. Data exchange protocols and systems implemented by PJ1 enabled Tanger Med Port to have real-time sharing of critical information, such as shipment tracking, cargo status, customs documentation and regulatory compliance updates.

4.3 RQ3. *How have digitalization initiatives helped to reduce performance gaps between African ports?*

Collaboration in digitalization initiatives can be an instrumental strategy to reduce performance gaps in ports, particularly in regions such as Africa, where many ports have historically faced challenges in efficiency and competitiveness. To explore the role that collaboration can assume in African ports, we considered the initiatives that address SDG 17. This SDG emphasizes the importance of strengthening global partnerships to achieve the United Nations' 2030 Agenda for Sustainable Development ([UN, 2025](#)). SDG 17 highlights several key areas, including financial resources, technology transfer, capacity building and trade, aiming to create a supportive global environment for sustainable development ([Leal Filho et al., 2024](#); [Stott and Murphy, 2020](#)). It advocates for enhanced cooperation between countries, particularly in terms of sharing knowledge, technology and innovation, to address systemic challenges that individual nations cannot solve alone.

Figure 4 shows a conceptual map of collaboration initiatives between African ports to understand how various elements interact to improve port performance and close development gaps. This conceptual map visually represents the key players, processes and outcomes involved in these collaborations, offering a comprehensive view of how digitalization and cooperation among ports, governments and stakeholders are interlinked. It depicts knowledge transfer and capacity building, emphasizing how collaboration fosters learning and adoption of best practices across regions. Moreover, it highlights the global trade connections, demonstrating how improved collaboration and digitalization initiatives help African ports integrate more efficiently into global shipping routes, improving their competitiveness.

The findings identified collaborations with five types of partners (i.e. shipping companies, logistics providers, regulatory authorities, volunteers and ports). The first three collaborations can involve local or international communities. Volunteer initiatives take place through hackathons, as evidenced by PJ6. As recognized by Kamariotou and Kitsios (2022), hackathons provide an opportunity for capacity building, allowing participants to learn new skills in technology and innovation, which is especially valuable for regions where technological infrastructure may be underdeveloped. In PJ6, it is also noted that the realization of hackathons encouraged a culture of innovation and experimentation within the port sector, which led to the emergence of breakthrough solutions. Furthermore, it is recognized their role as a starting point for larger digitalization initiatives by bringing attention to the potential of technology to improve port operations and competitiveness. Another initiative involving local communities is provided by PJ12 in Kenya.

Through the KPA Corporate Social Investment program “Tunahusika”, the Authority continues to make big investments in education, health, sports and environment sectors (PJ12, Kenya)

“Tunahusika” implements a corporate social investment approach. KPA invests in education by building schools, providing scholarships and donating educational materials that aim to improve literacy rates and skill development, mainly for the youth generation. The health initiatives under “Tunahusika” include supporting local health centers, providing medical equipment and promoting public health campaigns. Furthermore, KPA promotes youth engagement through sports, helping nurture talent and offering platforms for young people to develop skills and discipline that can translate into career opportunities.

International collaboration in African ports primarily focuses on increasing connectivity and efficiency by integrating advanced technologies, improving logistics systems and aligning ports with global trade standards. Increased connectivity is achieved through the adoption of digital platforms such as PCSs and integrated customs management, which streamline communication and data sharing between various stakeholders involved in trade. Efficiency is another central goal of these collaborations through increasing automation and reducing manual processes to minimize human errors. The Port of Mombasa in Kenya (PJ10) is a good example of seeking operational efficiency.

KPA has introduced the KPA e-Citizen platform . . . Customers can now track consignments in real-time and make payments directly for invoices through a variety of payment options. (PJ10, Kenya)

However, the results also indicate that addressing only connectivity and efficiency in international collaboration efforts is insufficient to reduce asymmetries between African ports



Figure 4. Conceptual map of collaboration initiatives between African ports. Source: Own work

because these two areas do not fully encompass the broader structural and systemic issues that contribute to the disparities. While enhancing connectivity and efficiency is crucial, deeper challenges must also be addressed for African ports to achieve long-term competitiveness and sustainability. Infrastructure capacity is recognized by [Sahoo et al. \(2024\)](#) as a critical limitation, considering that many African ports suffer from outdated or inadequate physical infrastructure. Without substantial investment in port infrastructure development, improvements in digital connectivity and operational efficiency will have a limited impact. Regional integration is another issue, and therefore, efforts to improve individual port performance may not fully address the broader issues affecting trade flows across Africa. Furthermore, human capital development is mainly focused on local training using digital systems. This kind of training is not enough, as recognized by [Mehner et al. \(2024\)](#). Therefore, it is important to implement comprehensive approaches that include leadership development, technical expertise and long-term workforce planning. Finally, achieving environmental sustainability in African ports is challenging. One major obstacle is the lack of funding and investment. It is recognized by [Agrawal et al. \(2024\)](#) that environmental initiatives, such as green technologies and climate adaptation strategies, often require significant financial resources. While international partnerships can provide some financial assistance, the scale of investment needed to overhaul infrastructure, adopt clean technologies and meet environmental standards is often far beyond what is readily available.

5. Theoretical and practical implications

This study offers several theoretical insights. It contributes to advancing the SST considering the African ports context by showing how the integration of digital technologies in port operations reshapes not only the technical aspects but also the social and environmental dimensions of port functioning. In port operations, digitalization influences efficiency, automation and data management, addressing the technical challenges of African ports. However, beyond technical improvements, the study reveals that digitalization alters social structures by changing the nature of work, requiring new skills and shifting workforce dynamics. It also impacts governance and stakeholder relationships, increasing transparency and accountability through enhanced communication systems.

From a practical perspective, this study provides actionable insights for port authorities and policymakers by identifying best practices in digital technology adoption. Through the analysis of 19 case studies that explore how African ports have effectively integrated digital solutions, this study can serve as a guide for other ports looking to modernize their operations, particularly in aligning their digitalization strategy with the goals of SDG 8, 9 and 17. The case studies revealed that African ports are implementing workforce development programs and investing in automation to enhance productivity while ensuring job security, which is important to address the goals of decent work and economic growth. Furthermore, several ports, such as the Port of Durban and the Port of Mombasa, are expanding infrastructure through digitalization, smart port technologies and green energy solutions to increase efficiency and sustainability. Moreover, partnerships for the goals are achieved through collaborative efforts between governments, international organizations and private sectors to implement capacity building programs.

6. Conclusions

Digitalization initiatives promoted by African ports aim to align with the broader goals of sustainable development, creating long-term benefits for both the economy and the environment. The results of this study indicate that the SDGs most addressed by these initiatives are related to SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals). The initiatives promoted by the African ports are aligned with the theoretical lens provided by SST, but not in a homogeneous way. Initiatives promoted by African ports often focus more on the technical

component than on social and organizational aspects because the technical challenges are seen as the most immediate barriers to competitiveness in global trade. As a result, there is a heavy emphasis on upgrading technology, modernizing equipment and automating processes to address these bottlenecks and improve overall performance. The technical focus also reflects the pressure to meet global standards in port operations. In contrast, social and organizational components, such as workforce development, governance structures and community engagement, tend to receive less attention in the short term. While these are critical for the long-term sustainability and success of port operations, they may not deliver the immediate gains in efficiency and competitiveness that technical upgrades promise.

Future research in this field can look at the contribution of ports to the innovation diffusion theory by analyzing the varying rates and patterns of digital technology adoption across African ports. This may reveal insights into the barriers and enablers of technology diffusion in contexts where infrastructure gaps, regulatory frameworks and socio-economic conditions differ significantly, offering a deeper understanding of how innovations can drive sustainable development under diverse conditions. Furthermore, the role of African ports can also be explored with institutional theory, exploring how different regulatory and governance structures influence the effectiveness of digitalization initiatives in advancing SDGs. Analyzing how regulation settings shape the appropriation and usage of advanced arrangements can shed light on the significance of adjusting approach systems with innovative improvements to achieve sustainable goals.

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