



FRAMEWORK FOR INTEGRATED MULTISECTOR SMART LOGISTICS

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FRAMEWORK FOR INTEGRATED MULTISECTOR SMART LOGISTICS

1. INTRODUCTION

This paper is second in a series of five papers on integrated multisector smart logistics. The first paper introduces the diverse players in the smart logistics ecosystem with case studies from some of the players on how they have contributed to and impacted the smart logistics ecosystem. This second paper delves deeper into the challenges and gaps in ensuring a resilient and sustainable smart logistics ecosystem, and proposes an integrated multisector smart logistics framework to address these challenges and gaps. An integrated multisector smart logistics framework will be critical for the sustainable growth of the logistics industry, and in turn for commerce and trade, and for the achievement of the sustainable development goals (SDGs).

The logistics system is a complex system that involves the management of the flow of goods, resources, and information between the point of origin and the destination. It requires an integrated process of planning, optimizing, and implementing the multimodal transportation of goods by air, rail, road, and/or sea, as well as warehousing, which includes receiving and recording goods from different suppliers, storing goods at appropriate locations, retrieving and picking goods when they are needed, and preparing shipment to buyers. The food, pharmaceutical, and vaccine supply chains require careful temperature control across a cold chain, which adds to the logistics complexity.

The challenges and gaps in the smart logistics ecosystem, and strategies for addressing them can be divided into eight interrelated pillars: (1) critical infrastructure; (2) core logistics; (3) industries; (4) digital economy; (5) policies, regulations, and standards; (6) human capacity building; (7) startup ecosystem; and (8) cooperation and collaboration.

Section 2 discusses the challenges and gaps in each pillar of the logistics ecosystem and looks at how an integrated, multisector, and smart approach can help address them. As concluded in the first paper, while digital technologies form the backbone of a smart logistics ecosystem, links to reliable and sustainable power sources, water supply and the digital infrastructure for end-to-end tracking and tracing are vital for preventing spoilage and wastage, and ensuring that products are safe for consumption when they reach the end users.

Digital transformation serves as an impetus to address the various challenges and gaps, but it must also include the reskilling and upskilling of human resources, as well as considerations for their safety, security, and well-being. An enabling policy, regulatory, and standard environment and available human resources are crucial to ensuring resilient logistics systems. Digital transformation must also be inclusive of startups, micro, small, and medium enterprises (MSMEs), and gig workers in the logistics ecosystem.

As all sectors and industries rely on the logistics supply chain to store and transport materials and products developed for businesses and consumers, and the demand for logistics services is increasing, which calls for an integrated multisector framework that considers the logistics needs of all sectors and industries, which can only be achieved through multistakeholder cooperation and collaboration.

2. CHALLENGES AND GAPS IN LOGISTICS AND POTENTIAL EFFECTS OF DIGITAL TRANSFORMATION

2.1. CRITICAL INFRASTRUCTURE

Access to reliable infrastructure such as railways, roads, ports, airports, warehouses, information and communications technology (ICT), and energy sources is fundamental and foundational for a resilient and sustainable logistics supply chain.

The logistics supply chain generally involves three main types of infrastructure flows: (1) the **physical** flow of goods by air, sea, and road; (2) the **information and data** flow along the ICT infrastructure; and (3) the **financial** flow associated with supply chain transactions and operations that are increasingly going digital with increasing adoption of mobile and online payments. Fundamentally, the logistics supply chain also requires a robust **energy** infrastructure to power these flows. However, in many rural and remote areas, there is a shortage of such infrastructure. Globally, there are still 733 million people without reliable access to electricity.¹

¹ United Nations, "SDG Goal 7: Progress and Info 2022," <https://sdgs.un.org/goals/goal7>.

2.1.1. PHYSICAL INFRASTRUCTURE

Globally, 1 billion people still lack access to an all-weather road and adequate transport services, especially in rural parts of developing countries. In Africa alone, 450 million people (more than 70% of the total rural population) remain unconnected to transport infrastructure and systems.²

Transportation is a critical part of logistics systems, especially road transportation for reaching the last mile. Innovative ways to finance and build the infrastructure networks in rural and remote regions are needed. At the same time, it is important that the transport sector leverages the potential of digital technologies to enhance efficiency, optimize operations, and reduce carbon emissions through the implementation of **intelligent transportation systems**. These systems have been implemented in some countries to reduce travel time and fuel consumption, improve road safety, monitor air quality, and realize future autonomous driving. Intelligent transport systems, using the Internet of Things (IoT), artificial intelligence (AI), and big data can be used to provide real-time data in mobile apps to help drivers determine the quickest and safest traffic routes. Intelligent transport systems with the exchange of real-time traffic data can also enhance the tracking and tracing of the movements of goods and transactions along the logistics supply chain.

A cost-effective way to build the physical infrastructure and implement intelligent transportation systems is through the **“codeployment”** of infrastructure in which infrastructure sectors (road, rail, energy, ICT) collaborate to jointly construct and share infrastructure, which has proven to reduce construction costs by half and accelerate rollout.³ Fiber-optic cable codeployment along infrastructure such as major roads, railways, power transmission lines, and pipelines can save significant costs and resources as it allows one-time investment in land acquisition and construction. Most of the cost savings in codeployment are derived from eliminating overlapping civil works. Other benefits of codeployment include the ease of obtaining rights of way and various other permits and approvals, minimization of disruptions to road traffic or the functioning of utilities as a result of repeated civil works, and streamlining of maintenance and repairs.

2.1.2. SMART HIGHWAYS AND SMART MOTORWAYS

Highways and motorways are critical links for robust transportation systems, particularly for landlocked countries, for connecting ports with cities and villages, and for operationalizing regional free trade agreements such as the African Continental Free Trade Area (AfCFTA). Smart highways and motorways involve adopting an

² United Nations, “Sustainable transport, sustainable development: Interagency report for second Global Sustainable Transport Conference,” 2021, https://sdgs.un.org/sites/default/files/2021-10/Transportation%20Report%202021_FullReport_Digital.pdf.

³ ESCAP, “ICT Infrastructure Co-Deployment with Transport and Energy Infrastructure in North and Central Asia,” February 2020, <https://www.unescap.org/sites/default/d8files/knowledge-products/ICT%20Infrastructure%20Co-Deployment%20Transport%20Energy%20NCA.pdf>.

integrated and holistic approach in designing and deploying technology systems across sectors in transportation, energy, and ICT, allowing seamless connection of critical infrastructure and services to the people.

Smart highways and motorways combine physical infrastructures such as sensors and solar panels with software infrastructure like AI and big data. These technologies are embedded in smart highways and motorways to improve visibility, monitor road conditions, and communicate with autonomous and connected vehicles. This requires exchanging and sharing real-time traffic information among different transport modalities across borders to enhance the tracking and tracing of the movement of goods and services from ports to warehouses.

The benefits of smart highways and motorways include improved traffic management, integrated police security using CCTV cameras, and recognition systems for face, vehicle, license plate, etc., and fleet management through access to real-time traffic information on highways and motorways. Smart highways and motorways can also improve energy efficiency and reduce carbon emissions. Some European countries are using solar cells embedded in tempered glass panels to pave roads. These panels contain snow-melting heating devices and inductive charging capability for electric vehicles while driving. Moreover, glass is renewable and can be engineered to be stronger than steel and allows cars to stop safely even when traveling at high speeds.⁴ While this technology has gained widespread support, scalability is a challenge as it remains expensive.

In addition, smart technologies can help automate and improve the performance of recurrent logistics operations such as roll-on/roll-off where loaded road vehicles are driven on a ferry or ship, and off at the port of destination. It involves using sensors to detect obstacles and AI to dynamically learn the required operations including lane-following, obstacle avoidance, and rolling cargo placement.⁵ Major benefits of automated roll-on/roll-off operations are reduced handling of the actual goods and packages, thus reducing the time and cost to successfully deliver goods and services.

In Europe, smart highways and motorways are key components of the Strategy for Cooperative Intelligent Transport Systems (C-ITS) adopted in 2016 by the European Commission. In 2017, Italy approved a framework document for infrastructure development (“Connettere Italia”) that included 108 priority infrastructure projects with the aim to promote accessibility to territories, Europe and the Mediterranean; support sustainable and safe mobility; improve the quality of life and competitiveness of urban and metropolitan areas; and support industrial supply chain policies. One of the projects is the ANAS Smart Road that aims to invest an estimated €1 billion to

⁴ Viro, “Smart Road Technology: Digital Highways Of The Future,” <https://vrioeeurope.com/en/smart-road-technology-digital-highways-of-the-future/>.

⁵ Rachid Ouicheikh et al., “Rolling Cargo Management Using a Deep Reinforcement Learning Approach,” *Logistics*, vol. 5, no. 1 (2021), <https://www.mdpi.com/2305-6290/5/1/10/html>.

make 3000 km of roads “smart” by 2030.⁶ The project is taking a three-pronged approach consisting of ICT connectivity, autonomous driving capability, and sustainable energy. The highway will be 5G-enabled for real-time monitoring of road infrastructure, traffic and freight transport, and the environment and weather conditions. This will allow highway users to stay informed about hazards, slowdowns, accidents, constructions, etc., and be provided with alternative routes. The ANAS Smart Road will also allow vehicles to interact directly with each other and with the road infrastructure for autonomous driving. The electricity required to manage the highway’s technology systems will come from renewable energy sources, including solar and wind power.⁷

To enable cross-border logistics and trade, it is critical that smart highways and motorways are interoperable across localities. The C-roads platform is a cooperation of European Union (EU) member states and road operators working on the deployment of harmonized and interoperable C-ITS services in Europe. The aim is to test innovative traffic technologies, including connected vehicle technologies, using traffic simulation software to provide a digital twin to help understand the impact of a massive rollout of C-ITS services across a huge range of hypothetical scenarios. This platform has been tested in Spain and has successfully sped up C-ITS large-scale deployment in Spain and Europe by analyzing the scalability and replicability of results. The simulation of C-ITS services was able to not only predict future problems but also reduce the cost of implementation.⁸

These examples of integrated transportation systems from Europe can be applied as good practices to leapfrog critical infrastructure for physical infrastructure.

2.1.3. ICT INFRASTRUCTURE

Although 4G network coverage has reached 88% of the world’s population,⁹ almost half are not connecting to mobile internet services for various reasons, including lack of affordability and digital skills.¹⁰ A reliable fixed-broadband infrastructure is essential for building a smart logistics system that leverages digital technologies to enhance operations and coordination among logistics stakeholders. In addition, the utilization of a mix of digital technologies to connect the unconnected, including Wi-Fi and satellite broadband, is important for smart logistics systems.

Various global positioning, navigation, and tracking systems, together with IoT technology and predictive analytics using AI and machine learning (ML), enable logistics stakeholders to monitor operations in real-time,

⁶ Global Infrastructure Hub, “ANAS Smart Road project,” 26 January 2021, <https://www.gihub.org/quality-infrastructure-database/case-studies/anas-smart-road-project/>.

⁷ Enrico Punsalang, “Salerno-Reggio Calabria In Italy Set To Be Europe’s Longest Smart Road,” Ride Apart, 11 March 2022, <https://www.rideapart.com/news/572791/salerno-reggio-calabria-longest-smart-road-europe/>.

⁸ Aimsun, “C-ROADS Spain,” <https://www.aimsun.com/research-projects/ccam/c-roads-platform-spain/>.

⁹ United Nations, “SDG Goal 9: Progress and Info 2022,” <https://sdgs.un.org/goals/goal9>.

¹⁰ GSMA, “The Mobile Economy 2021,” 2021.

predict arrival times, calculate estimated delivery times for improved logistics planning, optimize transport routes for faster transit times and reduced transport costs, and forecast changes in shipping demands and supply for better decision-making.

In Africa, for example, the Regional Electronic Cargo Tracking System, launched in 2017, integrates tracking platforms in the Democratic Republic of Congo, Kenya, Rwanda, and Uganda to help reduce transit time, enhance cargo safety, and better predict the arrival of goods, which are particularly critical for perishable goods. This is achieved with tracking devices that use radio frequency identification (RFID), global positioning system (GPS), and general packet radio service (GPRS) technologies. The system allows the countries to jointly track in real time the movement of goods from the port of entry to the final destination, reduce the number of manual inspections required, and enable better planning upstream and downstream. The system has reduced transit time between Mombasa and Kampala from an average of 21 days in 2017 to an average of five days in 2020.¹¹ With IoT, the system can also monitor other ambient conditions such as pressure, temperature, and humidity in real time and check the status of goods' security as they move along the supply chain.

In addition, digital technologies have been used for smart warehousing. Solutions include autonomous forklifts to load and unload goods, and stocktaking robots for inventory monitoring in large storage spaces. The IoT technology can be used to detect and communicate open spaces in a warehouse for transportation systems and manage energy use in warehouses, including lighting, heating, and cooling to conserve energy.

Another emerging technology being used in the logistics industry is the digital twin for simulations and real-time tracking. Digital twins pull relevant data that are captured across the supply chain through IoT sensors and other technologies for representation in virtual or simulation environments.¹² For example, warehouses and facilities can use the technology to create 3D models of their centers and experiment with layout changes or the introduction of new equipment to see their impact, risk-free. Logistics hubs can create digital twins to test out different scenarios and increase efficiency. Delivery networks can use the technology to provide real-time information that will improve delivery times and aid autonomous vehicles in their routes.¹³

Countries and localities without access to reliable fixed-broadband infrastructure will not be able to leverage the benefits of these digital technologies and risk being left further behind.

¹¹ United Nations, "Sustainable transport, sustainable development: Interagency report for second Global Sustainable Transport Conference," 2021, https://sdgs.un.org/sites/default/files/2021-10/Transportation%20Report%202021_FullReport_Digital.pdf.

¹² Mike Walker, "Top 10 Digital Ecosystem Trends In Supply Chain And Logistics," Forbes, 8 February 2021, <https://www.forbes.com/sites/forbestechcouncil/2021/02/08/top-10-digital-ecosystem-trends-in-supply-chain-and-logistics/?sh=5196e9e3f738>.

¹³ Transmetrics, "Guide to Supply Chain and Logistics Technology," 7 January 2022, <https://www.transmetrics.ai/blog/supply-chain-logistics-technology-trends/>.

2.1.4. PORTS AND TERMINALS

At ports and airport terminals, high dwell times (the amount of time that cargo or ships spend within a port or terminal) add to the high logistics costs. The main reasons for high dwell times include delays in customs clearance and border control, and inefficiencies in multimodal transitions between vessels, planes, trains, and trucks. Digital technologies have helped to increase real-time end-to-end visibility, allowing logistics companies to plan ahead in automating the preparation of paperwork online for customs clearance and arranging downstream distribution. Digital technologies have also enhanced efficiencies and supported collaborative border management and customs clearance through one-stop shops or single-window systems.¹⁴

The establishment of digital systems such as single windows in Ghana and Rwanda, for example, has improved their logistics performance. The Ghana National Single Window has reduced the time and cost of import procedures per consignment by 40 h and \$50, respectively. In Rwanda, the introduction of the single window system has reduced the time needed to clear goods from 11 days in 2010 to 34 h in 2014.¹⁵

Angola implemented the Automated System for Customs Data World (ASYCUDAWorld) system in 2017 using CargoXML standards defined by the International Air Transport Association that allowed digital communication between airlines, shippers, freight forwarders, customs, and security agencies. Customs were streamlined and digital payments were introduced. As a result, the customs clearance process of goods was reduced from 30 to 7 steps, paperwork for goods clearance was reduced by 70%, and revenue increased by 44% in 2018 and by a further 13% in 2019.¹⁶

2.1.5. LAST MILE

At the last mile, there are a number of significant challenges. As much as 53% of the logistics costs are incurred in the last mile, making it the most expensive leg of logistics operations.¹⁷

Challenges related to the last mile include **congestion and delays**, especially on roads. According to a World Bank study in Bangladesh, data from GPS devices fitted on delivery trucks indicates that the average speed is

¹⁴ Logistics companies engaged in international trade must submit large volumes of information and documents to terminal operators, port authorities, and other public sector bodies, in order to comply with regulatory and port entry requirements. These include, among other things, maritime agencies, customs, health, border police, immigration, agriculture, and defense authorities. Often information must be submitted through several different authorities, each with its own specific system, and/or paper forms. These requirements, together with the associated compliance costs, constitute a burden both to governments and to the business community. The inefficiencies and resulting increase in costs represent a major barrier to the development of international trade. A single window or one-stop shop environment is a system that allows the submission and handling of all data and documents on a single platform to fulfil regulatory requirements, customs clearance, etc.

¹⁵ United Nations, "Sustainable transport, sustainable development: Interagency report for second Global Sustainable Transport Conference," 2021, https://sdgs.un.org/sites/default/files/2021-10/Transportation%20Report%202021_FullReport_Digital.pdf.

¹⁶ World Economic Forum, "Growing Intra-African Trade through Digital Transformation of Border and Customs Services," May 2022, https://www3.weforum.org/docs/WEF_Regional_Action_Group_for_Africa_2022.pdf.

¹⁷ Soham Chokshi, "Five ways an efficient supply chain and logistics management system can boost business," Business World, 19 May 2022, <https://www.bworldonline.com/technology/2022/05/19/449334/five-ways-an-efficient-supply-chain-and-logistics-management-system-can-boost-business/>.