



SSATP
Working Paper

TOWARD A DATA-DRIVEN UNDERSTANDING OF TRADE AND TRANSPORT CORRIDORS

An Assessment of the Potential of the Existing Transport
Corridor Monitoring Systems to Foster Policy Dialogue and to
Strengthen Corridor Management Institutions in Africa



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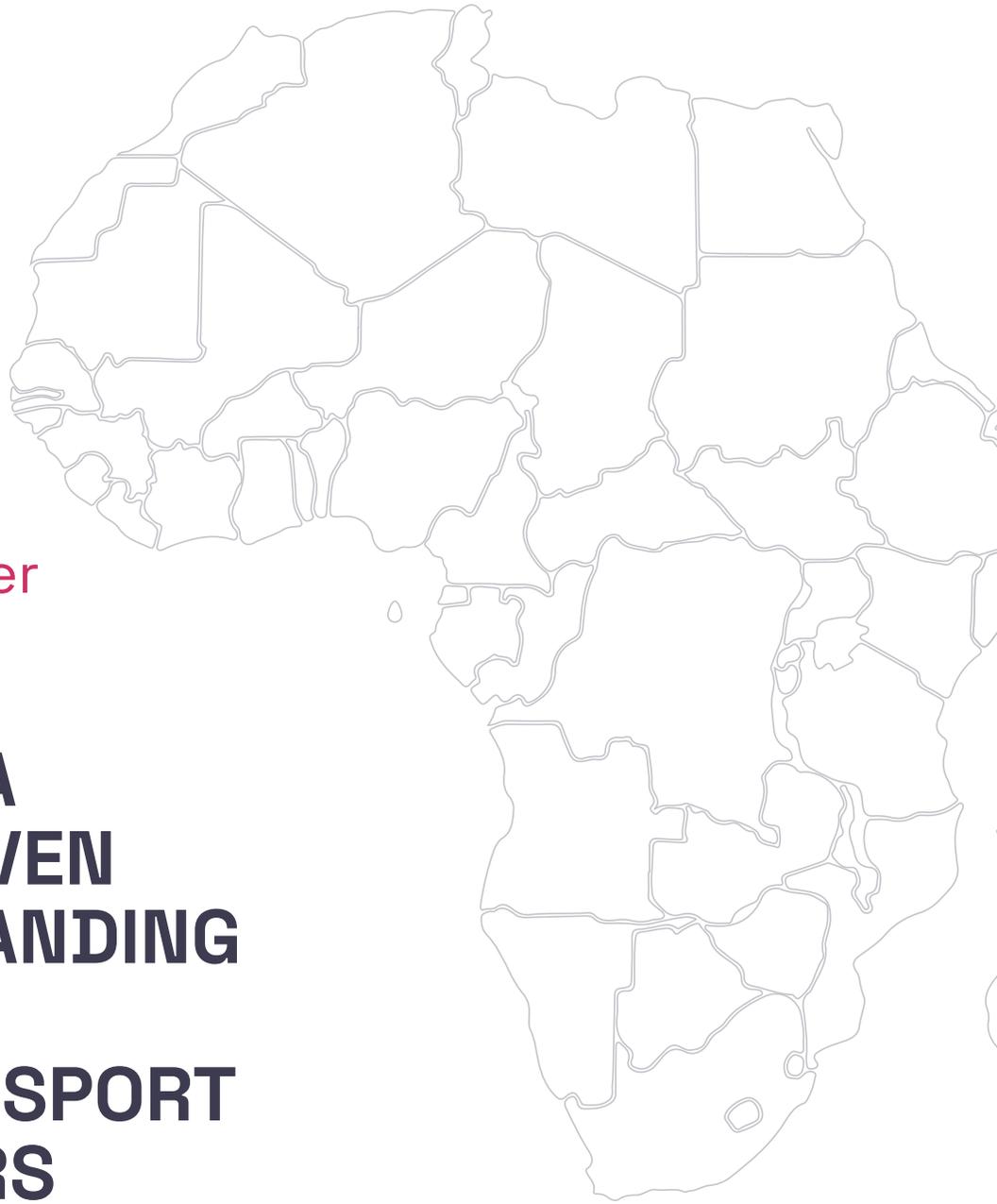
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Acronyms

AI	artificial intelligence
CCTFA	Central Corridor Transit Transport Facilitation Agency
CCTO	Central Corridor Transport Observatory
CMI	corridor management institution
CTMS	Corridor Trip Monitoring System
CTO	corridor transport observatory
EAC	East African Community
EU	European Union
DBOT	design-build-operate-transfer
FESARTA	Federation of East and Southern African Road Transport Associations
HMV	heavy motor vehicle
IBA	International Bar Association
ISO/IEC	International Organization for Standardization/ International Electrotechnical Commission
LMS	Logistics Monitoring System
MCBRTA	Multilateral Cross-Border Road Transport Agency
MCLI	Maputo Corridor Logistics Initiative
NCTCA	Northern Corridor Transit and Transport Coordination Authority
NCTO	Northern Corridor Transport Observatory
NSC	North-South Corridor
SADC	Southern African Development Community
SCEA	Shippers Council of Eastern Africa
TMA	TradeMark Africa
TMS	Truck Monitoring System
TRIPS	Transport Registers and Information Platform System
TTTFP	Tripartite Transport and Transit Facilitation Programme

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Foreword

Developing guidance and tools to assess and monitor regional transport corridors performance is among the priority activities of the Africa Transport Policy Program Fourth Development Plan (SSATP-DP4) strategy.

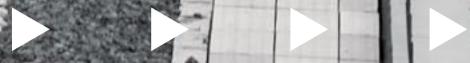
Corridor performance monitoring systems can be of significant value to corridor management institutions (CMIs), offering quick insights into the critical components that influence progress and transport within the corridors.

In this paper, the advantages and limitations of three corridor monitoring instruments are examined. The study indicates that while all three monitoring systems have valuable data collection capabilities that are essential for supporting the sustainability and credibility of CMIs, the preference lies with a system capable of real-time data collection and immediate analysis of key corridor activities on a daily basis.

Overall, this report highlights the potential benefits for CMIs if they integrate data analytics as a fundamental part of their activities.

Mustapha BENMAAMAR
SSATP Program Manager





Executive Summary



There is no debate on the need to monitor corridor performance and to collect data to support that process. Corridor management institutions (CMIs) in the southern African region, despite their long existence in some cases, are hamstrung by the lack of credible, real-time, or near-real-time data to inform their interventions. Without reliable data, not only is the credibility of the CMIs compromised: They are limited in their impact in lobbying, advocacy, monitoring, and evaluation, and in the introduction of evidence-based strategic and operational interventions to reduce costs and improve efficiencies along corridors.

Leveraging logistics platforms and port digitalization and developing guidance and tools to assess and monitor regional transport corridors performance are among the priority activities of the Africa Transport Policy Program Fourth Development Plan (SSATP-DP4) strategy. These activities aim to promote regional connectivity and economic integration by leveraging digital solutions and improving the monitoring and management of transport corridors in Africa.

To this end, two activities were undertaken under the SSATP Regional Connectivity and Economic Integration (RCEI) pillar: (1) a study on the Africa port digitalization assessment and policy recommendations, and (2) an assessment of the potential of the existing transport monitoring systems and the collection of data to support corridor management performance in Africa. This working paper assesses the benefits and shortcomings of three corridor monitoring instruments: (a) the corridor transport observatories (CTOs), (b) the Tripartite Transport and Transit Facilitation Programme's Corridor Trip Monitoring System (CTMS), and (c) the Logistics Monitoring System (LMS). The paper examines the concept of big data and its value in supporting the work of CMIs and provides insight into the possibilities that exist for CMIs should data analytics be integrated into their activities.

The findings of the study reveal that the particularity of the information required differs, in essence, very little from corridor to corridor but that detailed, relevant, real-time, or as near as possible

real-time data are essential to strengthen the capacity, credibility, and sustainability of CMIs. The primary purposes of data collection are, first, the effective evaluation and monitoring of corridor trade and transport, and second, improving the efficiency of cross-border trade. The ultimate objective is to reduce the cost of doing business on a continent where transport costs are anything between 30 percent and 100 percent higher than elsewhere in the world.

The CTOs of the Northern Corridor Transit and Transport Coordination Authority (NCTTCA) and the Central Corridor Transit Transport Facilitation Agency (CCTTFA) are examined in the light of their contribution to the analysis of data along a range of specific indicators that both assess performance and identify barriers to trade and transport facilitation. Both agencies have developed online observatories with dashboards intended to provide weekly monitoring of selected performance indicators, including maritime, port, and inland or corridor indicators (measures of transit time, efficiency, volumes, and cost). While the observatories contribute to improved efficiency in the corridors, they are not, on their own, solely responsible for the improvements. They do, however, play a crucial role in providing the evidential basis for informing decision-making around the improved performance of transport corridors and their value is without question.

The CTMS was designed to monitor compliance by cross-border travelers in order to manage COVID-19 and prevent contagion. Despite COVID-19 no longer being seen as a threat, the system is, nevertheless, equipped to respond rapidly should another pandemic arise. It is an electronic surveillance system designed to monitor and manage the registration of cross-border trips, driver and crew wellness, vehicle tracking, load tracking, tracking of drivers and crew, and management of queues at ports, border posts, and other facilities on the corridors. These activities are then used to generate statistical analyses and reporting to be implemented in the Tripartite region.

The CTMS has been piloted in Botswana, Malawi, Mozambique, and Namibia, and while there is improvement in the uptake of the CTMS by Tripartite member states, within the SADC, South Africa and the Democratic Republic of Congo have

not implemented the system. The major benefit of the CTMS is the digitalization of the road transport logistics supply chain. Once registered online, a hard copy of the Trip Registration Certificate (TRC) is available, but it is also available in digital format on the driver's mobile device. The certificate is signed digitally and is authenticated by the relevant border agencies via electronic scanning, as are the driver's license barcodes, vehicle license discs, and health certificates.

Early indications are that data will only be made available to CMIs historically, in which case the dire need for real-time and near-real-time information may prove to be a challenge. However, as the implementation of the CTMS is in its initial stages, and the countries within which the CTMS has been piloted do not have operational CMIs, it is still too early to determine the value, impact, and availability of the CTMS data for CMIs.

The LMS is structured to collect significant volumes of raw data from GPS-based trucking and shipping management systems in near real time across 51 borders in 15 countries in southern and eastern Africa. The anonymized trucking data are supplied at five-minute intervals by the tracking service providers contracted by the truck owners/operators. The data equate to approximately 100,000 vehicles, which is sufficient for a statistically representative analysis of the extent of delays experienced along a corridor, except for some of the more remote border posts in the extreme north. In short, 100,000 elements of data are collected every five minutes.

The shipping data are obtained from Vessel Tracker at a frequency of every 15 minutes, covering 11 ports in the region. Data relating to more than 300 vessels are typically collected continually, as any vessel entering anchorage areas is monitored across the parameters. The primary purpose of this data, once processed, is to provide an understanding of the interactions between various supply chains—within countries, across borders, and through ports. In addition, the data highlight the factors influencing the performance of supply chains and their impact on local and regional economies. The purpose of the LMS is to provide a trusted, near-real-time monitoring platform that provides visibility across supply chains in the region.

It is immediately apparent that all three of these systems come at a substantial cost. However, without data a CMI has little to no credible impact, and the formulation of data “products” suited to stakeholder requirements may provide a compelling motive for monetization of these data products. This requires considerable effort and intentionality to determine exactly which data are most apposite for different stakeholders. Some suggestions are provided that could lay the foundation for the development of sophisticated reports and publications, which could contribute significantly to the detailed understanding of corridor transport activities and, in turn, provide a source of income for the organization.

No ideal transport and logistics monitoring or management system is in place yet. While the systems assessed all provide excellent data collection capabilities, which are essential for enabling CMIs to support their sustainability, from both a financial and a credibility perspective, the main value for CMIs is in a system that can collect

real-time data and provide an almost immediate analysis of key elements of the corridor activities on a daily basis. The CTOs are comprehensive and have been instrumental in informing policy and regulatory changes and improving efficiencies. The LMS is currently the only system that can provide a near-real-time analysis and has the agility required to provide CMIs with powerful insights into the functioning of a corridor.

The analytical ability of the three approaches can prove to be extremely valuable for CMIs, and together they can give a swift grasp of essential components that affect progress and transport through the corridors. At present, the abundance of data, versatility, and quickness of the LMS puts it at the top of big data analysis in corridors. As rail capacity in southern Africa is unlikely to meet demand in the near to medium term, the need to collect data to improve the management, monitoring, and greater efficiency of corridors and border trade will become greater and critical.



Introduction and Background

This section compares various transport corridor monitoring systems, highlighting their roles in optimizing the efficiency, operational effectiveness, and sustainability of corridor management institutions across Africa.



Enhancing Corridor Management with Data Insights



This working paper examines three transport corridor performance monitoring instruments: (1) the corridor transport observatories (CTOs) of the Northern Corridor Transit and Transport Coordination Authority (NCTTCA) and the Central Corridor Transit Transport Facilitation Agency (CCTTFA); (2) the Tripartite Transport and Transit Facilitation Programme's Corridor Trip Monitoring System (CTMS), and (3) the Logistics Monitoring System (LMS). In doing so, this paper explores how the establishment of such regionwide systems can impact the operations, efficiency, and sustainability of corridor management institutions (CMIs). Furthermore, it compares the effectiveness, costs, scope, and efficiency of the different systems to create an informed basis for policy discussion. It is envisaged that the findings from this paper will be used as a basis for encouraging policy dialogue focusing on an operational framework for the sustainability of CMIs.

The paper evaluates the structure, role, and impact of the CTOs on the Northern and Central Corridors. The CTO approach as an instrument for improved efficiencies has provided value to these institutions; although this performance management instrument is expensive to maintain and not ideally responsive and dynamic, it provides key inputs into the government institutions supporting them, and as such there is value seen in adding this instrument to secure long-term funding for the institutions. The CTOs provide understanding of the efficiencies or otherwise of the various elements of corridor operations, that is, the port, terminals, border crossings, weigh bridge compliance, and the like. The CTOs have proved to be an outstanding mechanism for data collection and have innate value in the short, medium, and long term. The detailed reporting provided by the Northern Corridor Transport Observatory and the Central Corridor Transport Observatory is testament

to the efficiency of data collection and the value of this data for enabling derivation of comparative data, year-on-year trends, and the important role that this data has played in supporting CMI interventions.

In respect of the Corridor Trip Monitoring System (CTMS), which is being piloted by the Tripartite Transport and Transit Facilitation Programme (TTTFP), the benefits, cost, and functionality are examined in some detail, as is the Logistics Monitoring System (LMS; previously named Truck then the Transport Monitoring System), which has some areas of overlap and complementarity with the CTMS. The LMS is examined from the point of view of providing CMIs with accurate, verifiable data. The paper also examines if the benefits of the big data analytics can provide some level of sustainability to CMIs, which face the perennial challenge of sustainable operating models. Some proposals are made regarding the possible monetization of data-based products and services and how this will help CMIs raise their technical profile, strengthen their roles, build highly technically proficient teams, and greatly enhance their capacity and credibility with corridor stakeholders.

Corridor management institutions are pivotal cross-border trade, transport, regional integration, and economic development. Where these institutions have been established by the corridor governments, the consensus is that there have been considerable benefits accrued to all aspects of trade and development. The improvement in the trade, transport, export, import, and regional integration environment has been substantial, albeit not perfect, but in many cases still beset by significant challenges.

Some attention is given to the role of the CMI as the repository for the processed data and to how this supports the CMI's ability to examine the efficiency of service providers on the corridor and make evidence-based deductions about the actual performance as opposed to assumptions based on limited information that are not corridor specific. The demise of the Maputo Corridor Logistics Initiative illustrates the importance of verifiable data, let alone the national statistics agencies. There are little corridor-specific data on volumes moving, origin and destination information, values

of exports and imports, numbers of vehicles, types of vehicles, points of congestion, reasons for congestion, or analysis of peak periods, in any formal sense. When the Logistics Monitoring System was piloted on the Maputo Corridor in 2017, the insights from the big data analysis were game changers in their ability to highlight and inform the understanding of choke points and delays.

This working paper suggests that data-driven management supports the role of the CMIs, particularly in their overarching role in lobbying, advocacy, and economic analysis—and because of their focus on the impact of congestion, delays on the international supply chain predictability, efficiency, and competitiveness. For reasons mainly of value added, integrity of information, the need for valid and neutral data, and insight into the logistics supply chains and the movement of vehicles on the corridor and at its key nodes, big data in the context of trade and transport corridors is key. This paper looks at this from various perspectives to determine the functionality, advantages, and disadvantages. It examines the various questions of the importance of quality, neutrality, and accessibility. It also illustrates how the role of the CMI is integral to supporting this and making the data available to the various stakeholders requiring it.

Big data analytics are crucial to the development of more relevant and agile CMIs. The analytics allow the CMIs to understand the nuances and dynamics of their corridors in sufficient detail to be able to achieve the much-needed goals of predictability, efficiency, and competitiveness of southern Africa's trade and transport corridor network.

The objective of this working paper is then to investigate the potential of big data in the form of the Logistics Monitoring System to monitor corridor performance and to provide comparable assessment of other, similar systems. This objective forms the framework within which policy dialogue can be encouraged and initiated in two key areas: (a) the LMS in the operations, efficiency, and sustainability of CMIs, and (b) employing big data to support the establishment, operation, efficiency, and sustainability of CMIs.



Corridors and Corridor Management Institutions

The main trading corridors in Eastern and Southern Africa are identified and illustrated in this section, along with a summary of each corridor's key features and whether or not there is a corridor management institution (CMI).



Main Transport Corridors



The **North-South Corridor (NSC)** extends some 3,900 kilometers from Dar es Salaam port in Tanzania to Durban port in South Africa. The corridor encompasses both road and rail networks and maritime ports, and it is the key strategic trade route. The NSC actually comprises two distinct subcorridors: (a) the northern part of the North-South Corridor (known as the Dar es Salaam Corridor in Tanzania, or more generally the Northern NSC), which extends for 1,768 kilometers from Dar es Salaam in Tanzania to Kapiri Mposhi in Zambia, of which 904 kilometers is in Zambia, 864 kilometers is in Tanzania, with branches to Malawi, northern Mozambique, and the Democratic Republic of Congo; and (b) the southern half of the North-South Corridor (hereafter the Southern NSC), from Durban port heading straight north to the Democratic Republic of Congo via Botswana, Zimbabwe, and Zambia. The Southern NSC, connecting South Africa

(including the Gauteng region) to the rest of the eastern Southern African Development Community (SADC) region, is the most heavily used corridor in the SADC region.

The east-west **Trans Kalahari Corridor (TKC)** connects the Gauteng region in South Africa to the west coast port of Walvis Bay, Namibia, via the Pioneer Gate/Skilpadshek border crossing point on the Botswana–South Africa border (near Lobatse) and the Mamuno/Buitepos border crossing point on the Namibia–Botswana border. It also serves as a major connector between eastern Botswana, where the bulk of the country's population lives, and western Botswana. The Trans Kalahari route is currently being proposed for investment in a new railway alignment to the Port of Walvis Bay for containers and new vehicles from Gauteng and coal from Botswana.

FIGURE 2.1: Main Transport and Trade Network of the SADC Region



Note: SADC = Southern African Development Community.

TABLE 2.1: An Overview of SADC Corridors

SADC corridors	Countries	Port	CMI	Corridor performance monitoring mechanism
Maputo Corridor	Mozambique, Eswatini, South Africa	Maputo	No (Defunct)	LMS piloted in 2017
North-South Corridor	South Africa, Botswana, Zambia, Zimbabwe, Dem. Rep. Congo, Malawi, Mozambique	Durban (Maputo secondary)	No	No
Walvis Bay Corridor Group (WBCG)	Namibia, Botswana, South Africa	Walvis Bay	Yes	No
Trans Kalahari Corridor	South Africa, Botswana, Namibia	Walvis Bay	Yes	No
Walvis Bay Ndola Lubumbashi development corridor	Namibia, Zambia, Zimbabwe, southern Dem. Rep. Congo	Walvis Bay	(Part of the WBCG)	No
Dar Es Salaam Corridor	Tanzania, Dem. Repub. Congo, Malawi, Zambia	Dar Es Salaam	No (Defunct)	No
Nacala Corridor	Zambia, Malawi, Mozambique	Nacala	No	No
Beira Corridor	Mozambique, Zambia, Zimbabwe, Malawi, southern Dem. Rep. Congo	Beira	No	No
Lobito Corridor	Angola, Zambia, southern Dem. Rep. Congo	Lobito	Yes	No

Note: Only corridors traversing three or more countries are included.
CMI = corridor management institution; LMS = Logistics Monitoring System; SADC = Southern African Development Community.

The **Walvis Bay Corridors** also serve as north-south routes, connecting the Southern African Customs Union (SACU) countries to SADC members in the north.¹ The Trans Caprivi Corridor provides an alternative from the Copper Belt, Democratic Republic of Congo, Zambia, and even Zimbabwe and Malawi to the port of Walvis Bay. The Trans Kunene Corridor forms part of the corridor from Cape Town through Namibia to Angola. A rail line also exists from Cape Town to the Angolan border. When Angolan ports were first being rehabilitated following the civil war, much of the Angolan cargo

used the port of Walvis Bay and transited overland as far as Luanda. Now most goods for northern Angola use Angolan ports, but Walvis Bay remains relevant as an access port for southern Angola.

The **Lobito Corridor** (otherwise known as the Benguela Railway Corridor and operated by the Caminho de Ferro de Benguela [CFB]) extends 1,344 kilometers and connects the port of Lobito in Angola with Luau on the Democratic Republic of Congo border, where it links to the SNCC, the national railway of the Democratic Republic of

1. The Walvis Bay Corridors comprise the Trans Kalahari Corridor, Trans Caprivi Corridor, and Trans Kunene Corridor.

Congo. A dry port and logistics center is planned at Luau. Angola, the Democratic Republic of Congo, and Zambia (member states of the SADC) signed the Lobito Corridor Transit Transport Facilitation Agency (LCTTFA) Agreement on January 27, 2023, following negotiations that began 2013. The signatories have agreed to fund the establishment of a secretariat and all institutional organs, to promote infrastructure development along the corridor and ensure that such developments support the present and future needs of users, as well as reduce costs for the movement of cargo and passengers.

The **Maputo Corridor** is widely acknowledged as one of the most important examples of contemporary bilateral cooperation between Mozambique and South Africa. The corridor connects the landlocked Gauteng, Mpumalanga, and Limpopo provinces of northeast South Africa to the port of Maputo, the capital and main port of Mozambique. This major import-export route also serves Swaziland and southwest Mozambique. The main road on the South African side of the Maputo Corridor is the N4, a two- to four-lane national toll road. The N4 highway was the first major infrastructure project completed under the Maputo Corridor agreement. In Mozambique, the N4 becomes the EN4 and leads to Maputo. The N4 and EN4 were completed in 2004 and are operated by Trans African Concessions (TRAC), which is responsible for building, operating, and maintaining the road network under a design-build-operate-transfer (DBOT) agreement until 2028. The project was implemented as a public-private partnership using a DBOT structure. It reached financial closure in 1997 and began operations in 2000. The total capital investment at the time was US\$330 million, with a total construction and operating period of 30 years. The project was funded 100 percent with project finance, with a breakdown of 20 percent equity and 80 percent debt finance from primarily South African banks.

The **Beira Corridor**, or Central Corridor in Mozambique, connects the port of Beira to major towns in central Mozambique, Zimbabwe, and Zambia, including Chimoio, Mutare, and Harare. The route from southern Zambia through Harare to Beira is a major trade route for the transportation

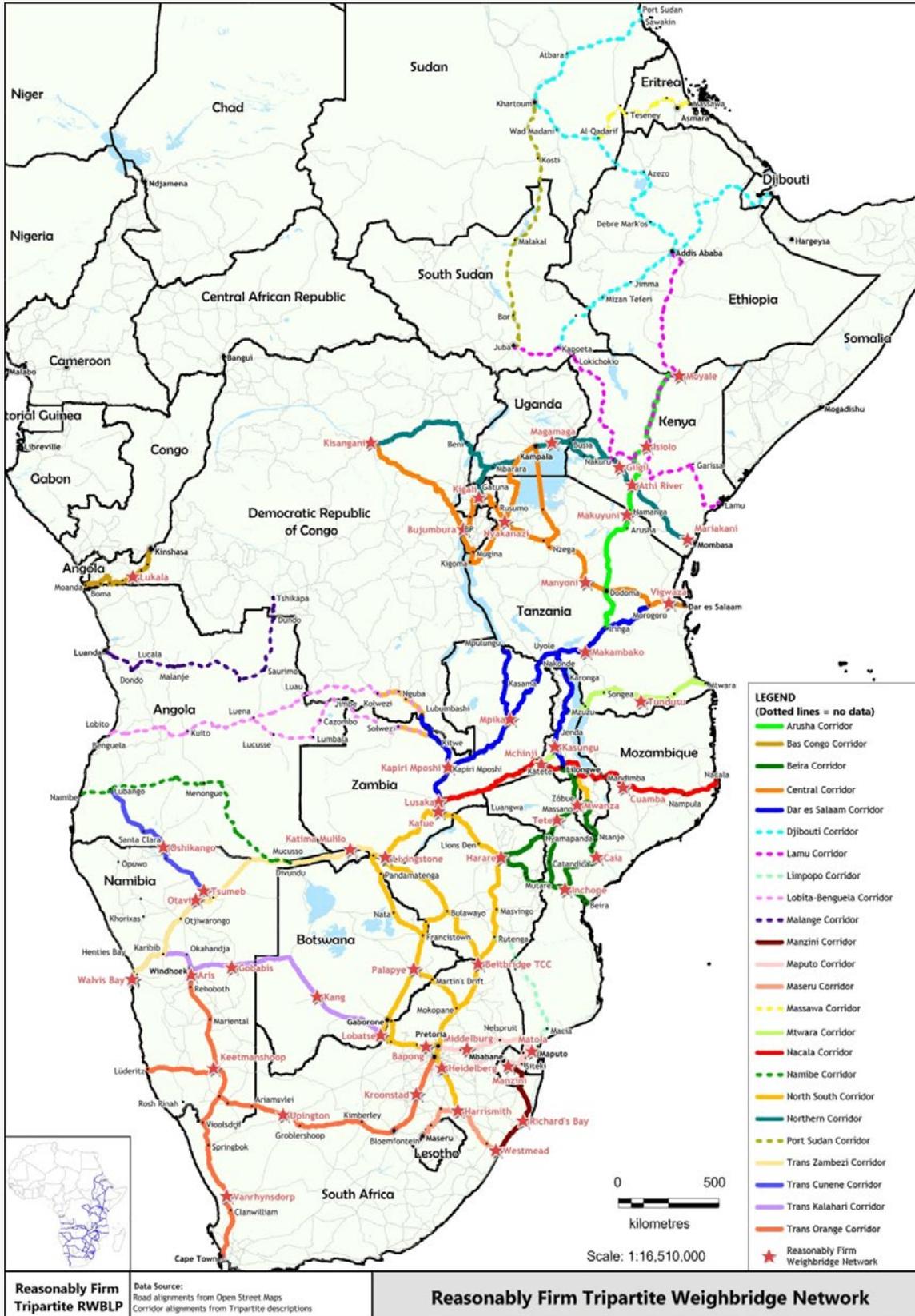
of Zambian and Zimbabwean goods between the major towns and Beira port. The central rail system is part of the Beira Corridor. The system has two main lines: The Machipanda Line extends from Machipanda to the Zimbabwe border (approximately 320 kilometers) and is operated by Mozambique Ports and Railways (Portes e Caminhos de Ferro de Moçambique, CFM); the Sena Line (335 kilometers) runs from Dondo, Mozambique, to Nsanje, Malawi, and continues to Tete province, which is operated by CFM, Jindal, and International Coal Ventures Private Limited (ICVL). The port of Beira is connected by road via the Machipanda border crossing point to the border with Zambia.

The **Nacala Corridor** connects Nacala port to several major towns in northern Mozambique, Malawi, and Zambia, including Nacala, Nampula, Liwonde, Lilongwe, Chipata, and Lusaka. The Nacala Corridor has been an important route for the transportation of coal from Mozambique's Tete province, primarily by rail with services provided by CFM Norte, but also by the CFM Centro service (the Sena Line) to Beira. The spur of the railway line to Lichinga is moribund, and despite its potential, the line is little used for imports and exports for Malawi and Zambia.

The **Northern Corridor** is a principal transport route in the East African Community (EAC) region. It stretches 2,080 kilometers from Mombasa, Kenya, to Uganda, Rwanda, and Burundi. Anchored by the port of Mombasa, this corridor is one of the key trading lifelines for national, regional, and international trade for the EAC countries (Burundi, Kenya, Rwanda, South Sudan, and Uganda).

The **Central Corridor** in Tanzania is served by a 1,244-kilometer road network and a 2,706-kilometer-long railway network. The corridor serves as a key trade route between Tanzania, Uganda, Rwanda, Burundi, and the eastern Democratic Republic of Congo. It connects the riparian countries of Lake Tanganyika and Lake Victoria to the port of Dar es Salaam, providing Rwanda and Burundi with a shorter distance to a maritime port than the Northern Corridor—400 or 600 kilometers shorter, respectively.

FIGURE 2.3: Corridors in the Tripartite Region



Source: Tripartite Transport and Transit Facilitation Programme.



3 Toward Data-Driven Corridor Management

While the benefits of big data analytics for corridors are largely agreed by corridor management institutions (CMIs), a cursory examination of their roles is instructive in strengthening the position of big data analytics for use by CMIs.





Objectives of Corridor Management Institutions



It is helpful to understand the overarching objectives of the corridor institutional structures, and a cursory overview of the CMIs in southern and East Africa reveals several analogous objectives (table 3.1).

All of the institutions raise common objectives:

- Improving efficiencies
- Reduction of delays on corridors
- Reduction of complexity in cross-border trade and transport
- Reduction of the cost of doing business
- Improving the competitiveness of the corridor

TABLE 3.1: Objectives of Eastern and Southern African Corridor Management Institutions

Corridor institution	Overarching objective
Walvis Bay Corridor Group	Increase cargo volumes through the ports of Walvis Bay and Lüderitz, reduce transit time, remove bottlenecks, improve corridor and cross-border efficiency, reduce the cost of doing business in the SADC region. ^a
Northern Corridor Transit and Transport Coordination Authority	Coordinate implementation of the Northern Corridor Transit Agreement and the objectives to promote cooperative transport policies and efficient and competitive transit transport on the corridor; contribute to sustainable economic growth; foster regional integration; minimize delays; integrate simplified documentation and procedures; improve infrastructure and facilities; enhance information exchange, cargo movement, and monitoring along the corridor. ^b
Central Corridor Transit Transport Facilitation Agency	Develop integrated trade and transport networks that create competitive and sustainable trade routes, infrastructure, and services; minimize delays in transport and cross border facilitation; improve competitiveness and predictability of trade routes; harmonize procedures on the corridor and across borders; contribute to an environment of sustainable economic growth and alleviation of poverty. ^c
Maputo Corridor Logistics Initiative (defunct)	Ensure a cost-effective, seamless, and reliable logistics route, creating an enabling environment for further investment and growth, bringing positive returns for all stakeholders; support the development of a highly efficient, sustainable, transport route; support a favorable investment climate. ^d
Trans Kalahari Corridor	Work with regional organizations to develop transport development corridors, to reduce transport costs and transit time and to increase competitiveness of trade within SADC and to operationalize the trade facilitation instruments of the World Customs Organization. ^e

a. Walvis Bay Corridor Group website: https://www.wbcg.com.na/?page_id=22.

b. Northern Corridor Transit and Transport Coordination Authority website: <http://www.ttcanc.org/page.php?id=13>.

c. Central Corridor Transit Transport Facilitation Agency website: <https://centralcorridor-ttfa.org/mission-vision/>.

d. Maputo Corridor Logistics Initiative website: <https://www.mcli.co.za/about-us/>.

e. Trans Kalahari Corridor website: <http://www.tkcmc.com/index.php/about-us>.



Functions of Corridor Management Institutions

CMIIs are responsible for managing cross-border transport and trade routes and for the movement of goods, people, and information across regions and countries. Their role is to ensure the efficiency, safety, and sustainability of trade and transportation corridors, and their functions are largely aligned around the following:

1. **Coordination:** In the management and development of transportation corridors, CMIIs coordinate the efforts, activities, and engagement with the various stakeholders, including government agencies, state-owned entities, transport operators, cargo owners, service providers such as clearing and forwarding agents, and shipping agents, among others.
2. **Planning:** CMIIs are integral to the long-term planning of transport and trade corridors, and for ensuring that both hard and soft infrastructure development and improvements are ongoing. Most often it is the integration of infrastructure planning for roads, railways, ports, and border posts that is required, which involves the development of strategies and operations to optimize the use of existing infrastructure and services and to support the development of new infrastructure.
3. **Implementation:** CMIIs are pivotal in supporting the domestication and implementation of regional agreements. Because of their multilateral nature and their activities, CMIIs are well placed to drive the domestication of regional agreements—one of the critical challenges expressed by the Southern African Development Community (SADC), for example. Their role is similarly crucial in implementation of national trade and transport policy and bilateral or multilateral agreements.
4. **Performance monitoring and continuous evaluation:** Monitoring the performance of the corridor's traffic flows, border crossings, trade flows, and transport mode efficiencies is a primary task of the CMI. This goes hand in hand with their evaluation of the effectiveness of transport and trade policy, and both aspects are central for enabling the implementation of improved performance. This includes regular

evaluation of the effectiveness of policies and strategies as well as adjusting as and when required. Without good data and data analytic capabilities, this function is dramatically undermined.

5. **Stakeholder engagement:** A central role of CMIIs is engagement with the entire range of stakeholders, which includes transporters, government agencies, service providers, and cargo owners, to optimize logistics and supply chain management along the corridor. Strong partnerships with relevant public and private entities are essential for promoting collaboration and cooperation, which, in turn, better enable collaborative efforts and builds the credibility of the CMIIs.
6. **Communication:** A major element of all the functions of a CMI—that is, coordination, planning, implementation, monitoring and evaluation, and stakeholder engagement—is consistent communication across the public and private sectors, which is both targeted, relevant, and beneficial to all stakeholders. Big data analytics has the potential of greatly enhancing the value, content, and relevance of communication to strengthen the operations of the CMI and ensuring continued credibility and applicability.

CMIIs add significant value by leveraging their specific intellectual capital for advocacy for infrastructure investment, promoting economic growth, enhancing safety, and improving trade and transport efficiencies.





The Data Challenge: Accessing Corridor-Specific Data

A key challenge for corridor organizations is the availability and accessibility of corridor-specific data that enable a thorough understanding of all aspects of trade and transport activities on the corridor. This includes data and analysis of all transport modes, full supply chain information, “pit to port” data (in the mining context), border crossing data, and port and shipping data, among others. In the absence of big data analytics, CMIs are most often making assumptions in order to understand the dynamics of corridor operations.

While various trade- and transport-specific data exist, these are often not within the ambit of the CMIs and are often difficult to access, and then only by means of lengthy bureaucratic processes, particularly where data are not in the public domain. Should the data indeed be easily accessible, it is not uncommon for them to be incomplete and inconsistent with the needs of the CMI. Studies done on corridors abound; however, the fundamental information required by the CMI is often pieced together by the institution to produce a retrospective assessment of the status of the various components of the corridor. This has limited value for both the CMI and the corridor stakeholders.

Detailed data specific to corridors in southern Africa are not readily available and neither are they necessarily reliable. This is particularly true where there is no CMI in place, or if no corridor transport observatory (CTO) or Logistics Monitoring System (LMS) data system is in place. The major challenges often relate to the limited resources within the institutions to dedicate to data gathering and analysis, the cost of information technology (IT) systems to do this, the availability of verifiable and accurate information, and, more importantly, the availability of measurement and/or evaluation data that can be translated into economically relevant data for the CMIs to utilize for lobbying and advocacy purposes.

The primary operational issue that all CMIs raise is the cost of cross-border delays for cargo movement on the corridor and the impact of these factors on the cost of trade and supply chain and country competitiveness. It is a persistent issue across the continent despite numerous interventions over many years, and by utilizing data-based evidence, the appropriate lobbying, advocacy, and interventions can be put in place to change the status quo and address the economic cost to the corridor regions.

4 Analysis of the Transport Corridor Monitoring Systems



The analysis of the existing transport management systems in the Southern African Development Community (SADC) and the East African Community (EAC) will focus on the corridor transport observatories of the Central and Northern Corridors, the SADC Corridor Trip Management System, and the Logistics Monitoring System operational in southern and East Africa.



Corridor Transport Observatories



Per Hartmann (2013), the objective of a corridor transport observatory (CTO) is to help reach a “thorough understanding of the obstacles (on the corridor) so that remedial actions (can) be identified and implemented.” This description of the CTO is relevant to the objectives and roles of corridor management institutions (CMIs), particularly those in southern Africa that do not have a mechanism for data collection via a CTO, the Logistics Monitoring System (LMS), or any other facility. Without data it is impossible to assess, with any accuracy, the efficiencies, or challenges of the corridor and to

enable an evidence-based approach to dealing with these where they occur. Hartmann rightly states that the complexities and challenges of corridor functionality makes a single solution for data collection unrealistic.

The common factor and principal tenet are that for any transport management system to be effective, the acquisition of the “right information at the right time” is pivotal. It follows, then, that the analysis should also be able to be provided as speedily and accurately as possible.



4.1.1 Central Corridor Transport Observatory

The Central Corridor Transport Observatory (CCTO) is housed within the Central Corridor Transit and Transport Facilitation Agency (CCTTFA), which is the permanent secretariat for the corridor, based in Dar es Salaam, Tanzania. The CCTO was established through an agreement by the corridor member states and it covers the Central Corridor running from the port of Dar es Salaam in Tanzania to Uganda, Rwanda, Burundi, and the Democratic Republic of Congo. Eleven protocols in the agreement inform the work of the CCTTFA: Port facilities, transport routes, customs controls and operations, documentation and procedures, rail transport, road transport, inland waterways, pipelines, multimodal transport, dangerous goods, and transit agencies, traders, and employees.

The CCTO was established in 2013 to provide a continuous monitoring tool to evaluate the efficiency of the Central Corridor and to disseminate this information to corridor stakeholders. As with its establishment, the observatory's latest upgrade in 2018 was made possible by a funding of US\$1.3 million from TradeMark East Africa (renamed TradeMark Africa in 2023) following the signing of an agreement between them and the CCTTFA. The CCTO's primary purpose is to assess the efficiency of the corridor's logistics supply chains. It is built on five categories of indicators: volume of transactions, transit times, cost of services and transport, efficiency and productivity, and emissions. Each category consists of several sub-indicators that disaggregate the category into the required level of detail. The CCTO is supported by GIS data, which enable access to the location and status of infrastructure on the corridor.

TABLE 4.1: Central Corridor Transport Observatory: Categories and Indicators

Category	Indicator
Efficiency and productivity	TPA average transit container dwell time
	TICTS average transit container dwell time
	TPA average local container dwell time
	TICTS average local container dwell time
	Percentage of imports per entry border
	Ship turnaround time
	TICTS truck turnaround time
Overall TRA release time	
Volume of transactions	Overall export per country through Dar es Salaam port
	Overall imports (with liquids inclusive) through Dar es Salaam port
	Percentage of imports per customs destination
	Volume of imports per destination border and per entry border
	Overall imports per commodity, volume of imports per border
	Distribution of imports per commodity
Transit times	Transit time to destination
	Toolkit journeys and journey stops
	Weigh bridge crossing time at Kyamyorwa, Lukaya, Mutukula, Mwendakulima, Nala, and Kihonda
Cost of services and transport	Transport costs and rates
Emissions	Total greenhouse gas emissions (onward and return)
	Total pollutant emissions
	Particulate matter emission
	Nitrogen oxide, carbon monoxide, volatile organic compounds, emission, methane in carbon dioxide emissions, nitrous oxide in carbon dioxide emissions, carbon dioxide emissions

Source: Central Corridor Transport Observatory website.

Note: TICTS = Tanzania International Container Terminal Services; TPA = Tanzania Port Authority; TRA = Tanzania Revenue Authority.

4.1.2 Scope of the CCTO

Over several years, improvements have been made to the CCTO to ensure the incorporation of data and observatory functions across all modes of transport, important nodal points on the corridor, and across public and private sector transit and transport features. The CCTO covers a significant portion of corridor operations, having been improved over time to provide data and observatory functions for intermodal operations on railway, road, and water transport, borders, ports, and weigh bridges. The data recorded apply to the performance of all the corridor member states, and key performance indicators apply to all relevant transport nodes,

modes of transport, and key points on the corridor. The dashboard, a weekly monitoring tool, provides data for selected performance indicators, including measures of transit time, efficiency, volumes, and cost indicators. Table 4.1 outlines the full range of indicator categories and their sub-indicators.

Of the indicators outlined, only two relate to corridor efficiency: (a) efficiency and productivity, and (b) transit times. The other indicators gather cargo volume data and type—that is, import and export—and provide detailed information on emissions.



4.1.3 Cost of the CCTO

The initial transport observatory system was developed by the CCTTFA with support from TradeMark East Africa. Funding for the development was provided by the donor agencies of the United States, the United Kingdom, Norway, Denmark, and Ireland. TradeMark East Africa provided an additional US\$1.3 million for upgrade work in 2018. This work enabled inclusion of additional features, the upgrading of the hardware and server room for

the observatory, an update to the GIS component of the observatory, and additional publications based on improved collection, processing, and analysis of data. The CCTTFA reported improved resolution of issues facing traders on the corridor and over 14 documents/reports published since 2018. This enabled additional support of \$419,500 for the three-year period 2020–2022 as outlined in table 4.2.

TABLE 4.2: Contributions to Central Corridor Transport Observatory, 2020–2022

Item	Cost (US\$)
CCTO upgrade – data collection, processing, reporting	70,000
Infrastructure support for the CCTO – support upgraded toolkit	80,000
Communication expert – technical assistant	67,500
CCTO field supervisor – technical assistant data collection and processing	72,000
CCTO database specialist – technical assistant database management	72,000
CCTO statistician	18,000
Conferences and other related meetings	40,000
Total 2020–2022	419,500

4.1.4 Northern Corridor Transport Observatory

The Northern Corridor Transit and Transport Coordination Authority (NCTTCA) facilitates the development of the trade and transport corridor from the port of Mombasa, Kenya. The corridor runs through six countries: Kenya, Uganda, South Sudan, Rwanda, Burundi, and the Democratic Republic of Congo. The NCTTCA was established in 1985 with the signing of the Northern Corridor Transit and Transport Agreement. The multilateral agreement was revised in 2007, and South Sudan was included in 2012. The agreement facilitates trade to the landlocked hinterland and the corridor secretariat is responsible for the implementation of the 12 protocols of the agreement, and for supporting a coherent framework and standardized transit trade procedures across the corridor member

states. The agreement covers the following components: port facilities, routes and facilities, customs controls and operations, documentation and procedures, rail transport, road transport, inland waterways, pipelines, multimodal transport, handling of dangerous goods, and measures of facilitation for transit agencies, traders, and employees.

The Northern Corridor Transport Observatory (NCTO) was established in 2011 with initial funding from the Africa Transport Policy Program (SSATP), after which funding support was provided by TradeMark East Africa. The NCTO is integral to the mandate of the CMI to monitor performance of the corridor and identify areas needing improvement and interventions.

4.1.5 Scope of the NCTO

The scope of the NCTO mirrors much of that of the Central Corridor Transport Observatory, with close similarities in approach and application and a focus on identifying issues requiring intervention to improve the efficiency of trade and regional integration for corridor member states. It covers provision of services of private and public service providers across the corridor and assesses the performance of the corridor to identify barriers to trade and transport facilitation and to address these through proposing policy, process, and operational changes to improve the efficiency of the corridor.

A significant element of the NCTO is the focus on monitoring the port of Mombasa and the framework for engagement on port efficiency through a port charter, which is signed between the port and members of the Mombasa Port Community.² Progress towards the goals of the charter is tracked via the Northern Corridor

Performance Dashboard on a weekly basis, which monitors the performance of the agencies who are signatories to the port charter. Here, the private sector role comes into play, with the Shippers Council of Eastern Africa (SCEA) chairing the port charter meetings, and this mechanism monitors the success of the agencies who are signatories to the port charter. The value of the port charter is in its role as an active performance measurement, which is continuously reported on in partnership with the NCTTCA and the NCTO. It is a vital element of the public-private engagement and monitoring of port and corridor performance, led by the SCEA.

Table 4.3 outlines the NCTO's five main categories of indicators, of which only the first two—transit times and delays, and productivity and efficiencies—deal with corridor efficiency measurement. The other indicators gather data on cargo volumes, costs, and regional trade.

TABLE 4.3: Northern Corridor Transport Observatory: Categories and Indicators

Category	Indicator
Transit times and delays	Average cargo dwell time in Mombasa port Dwell time at Rwanda ICD (Magerwa) Time for customs clearance at the document processing center (DPC) Time taken at Mombasa one-stop center before customs release Transit time in Burundi, Kenya, Rwanda, Uganda Transit time in port after customs release URA customs processing time and delay after customs release
Productivity and efficiencies	Ship turnaround time Vessel waiting time before berth Weigh bridge traffic and compliance
Rates and costs	Road freight charges in Burundi, Dem. Rep. Congo, Kenya, Rwanda, Uganda
Volume and capacity	Imports and exports through Mombasa port Licensed fleet of transit trucks per country (TF) Rate of containerization of transit traffic (RCTT) at the port of Mombasa (percentage, annual basis) Total cargo imports of the port of Mombasa versus transit traffic (tons) Volume of containerized and non-containerized traffic handled annually at the port of Mombasa Volume per country of destination (TC)
Intra-regional trade	Trade between Burundi, Kenya, Rwanda, South Sudan, Uganda, and other Northern Corridor member states

Source: Northern Corridor Transport Observatory website.

Note: ICD = Inland Container Depot; TC = Total Cargo; URA = Uganda Revenue Authority.

2. https://www.ssatp.org/sites/ssatp/files/document/Annexure%201%20-%20%20Mombasa%20Port%20Community%20Charter_SIGNED-compressed.pdf

4.1.6 Cost of the NCTO

Table 4.4 provides an overall picture of the costs associated with the NCTO, including expenditures for both technical and human resource support provided to the observatory.

The ministries of foreign affairs of Belgium, Denmark, Finland, Netherlands, and Norway, and development partners UKAid, USAID, Irish Ai, and the European Union Commission provide financial support to the NCTO to varying degrees.

TABLE 4.4: Cost of the Northern Corridor Transport Observatory, 2013–2022

Item	Cost (US\$)
Initial establishment of observatory in 2013 - server infrastructure	1,050,000
Technical assistance, 2018–2022	1,050,000
Statistician	
Database expert	
Communications expert	
Data collection staff	
Data collection exercises	
Validation workshops	
Total	2,100,000

4.1.7 Effectiveness of the Corridor Transport Observatories

Discussions with users of the observatories and with the CMIs indicate that the CTOs have been effective in providing information relating to corridor performance while being an effective repository for comprehensive information on corridor trade. Stakeholders and users consider the CCTO to be an effective performance measurement mechanism, and there appears to be considerable demand for the publications emanating from the NCTTCA and CCTTFA based on the toolkit. The CTOs' online dashboards are used by stakeholders on an ongoing basis, and this data form the basis of the CTO publications.

Much support is evident for the ability of the CTOs to retrospectively pinpoint congestion, bottlenecks, and barriers to trade, with analysis of performance data enabling the implementation of improvements to general operations, infrastructure, and processes. The CTOs have also been instrumental in informing policy and regulatory changes along the corridors and making improvements in efficiencies within the ports of Dar es Salaam and Mombasa. Trade and transport-related nontariff barriers have been reduced by the ability of the CTOs to provide

insight into the various barriers. CTO data are also used to monitor developing nontariff barriers and deal with them in a timely manner.

Reports and updates emanating from the data analysis are used by corridor stakeholders, policy makers, corridor member states, universities, researchers, development partners, government and private sector agencies, and investors, with the latter keen to measure the impact or otherwise of their investment and/or interventions at borders and ports and on roads and railways. The weekly, monthly, biannual, and annual reports are used by government and private sector institutions for diverse types of analytical research.

Stakeholders have expressed the need for the creation of greater awareness of the instrument and its use and suggest that wider application would assist in continuous improvement of the toolkit. This would, in turn, strengthen the role and credibility of the CMIs and would enable still more effective, focused, evidence-based problem-solving and interventions.

4.1.8 Areas Requiring Strengthening

Stakeholders have highlighted five areas where the CTOs need strengthening:

1. Efficient and timely publication of data
2. Broader engagement with stakeholders and greater awareness and accessibility of the data analysis
3. Options for tailoring analytics to suite sector or audience-specific needs
4. Linking the identification of problem points to implementation of solutions
5. Real-time or near-real-time monitoring of road traffic

4.1.9 Efficient and Timely Publication of Data

The CCTO dashboard, currently online at <https://centralcorridor-ttfa.org/>, shows an inconsistency in the CTO's presentation of reports and newsletters, with newsletters last updated on the dashboard on December 23, 2021. The 2021 annual report of the CCTO was uploaded in July 2022. The joint reports were last uploaded in July 2022. Greater benefit would be gained from annual reports being published as soon after the financial year ends as possible, as opposed to six months or longer as is currently the case.

Weigh bridge data on the CCTO appear to have been last updated in 2017. Transport associations maintain that public weigh bridge data are the data most relevant to transporters as they provide clear indications of levels of compliance or otherwise with weigh bridge standards and are crucial to the operations of their members. Other transit and travel time indicators are available only until March 2022.

4.1.10 Broader Engagement with Stakeholders

There is acknowledgement of the need to improve stakeholder engagement, particularly with and between service providers and users of the toolkits, and to make a concerted effort to widen the awareness and access to the data by stakeholders. This is essential for monitoring and evaluation and for ensuring continuous improvement of the data collection, analysis, and dissemination.



The broadening of stakeholders will ensure increased awareness of the toolkits and the value of the analysis. Suggestions have been made that easier access to analysis could be facilitated by more regular production of printed material, regular newsletters, and the like, additional to the online platforms. Reports presented in Swahili would greatly benefit the truck drivers, who are a primary target group for certain data.

4.1.11 Options for Tailoring Analytics to Sector- or Audience-Specific Needs

To support the sustainability of the CTOs and their continued relevance, it has been suggested that analysis should be tailored to the needs of stakeholders based on their activities within the transport and/or cross-border trade sector, customized to address sector-specific interests and functionality. This may also support the broadening of stakeholder interest and participation in the objectives, collection, and outcomes discussed above.



4.1.12 Linking Analysis Outcomes to Implementation

The CMIIs for both the Northern and Central Corridors—NCTTCA and CCTTFA, respectively—require a more robust system or mechanism of ensuring that agreed improvements are implemented at the country level, as there is frequently a lag in implementation of changes and improvements within the corridor member states. Validation reports commonly outline issues requiring implementation and/or improvement, but this does not guarantee implementation within the member state concerned. It is critical that the analysis emanating from the CTOs be accessible and sufficiently detailed to enable decision-makers to make informed decisions that improve the efficiency of transport infrastructure and logistics performance, and that this is followed up by implementation of the recommendations.

4.1.13 Real-Time or Near-Real-Time Data

The CTOs do not appear to gather real-time or near-real-time data. An emphasis on timeliness of data sharing could be strengthened by a component that includes this element in the activities of the corridors in their entirety. Adding real-time or near-real-time data to the existing capacity of the CTOs would enable rapid response times to natural disasters such as flooding as well as congestion and delays. It would enable a more dynamic and responsive tracking functionality in addition to that suggested in section 4.1.14 below to provide an understanding of time lost along a corridor's towns and rest stops.

Utilization of tracking data of heavy vehicles as well as shipping, as is the case with the Logistics Monitoring System, may also provide an incentive for operators to use vehicle tracking systems to improve their own performance, and to contribute to the improved data collection, and ultimately, to the improved collection of corridor trip and port data.

4.1.14 Additional Areas for Inclusion in the CCTO

Six areas are seen as needing inclusion in the CCTO:



1.

Real-time or near-real-time tracking of trucks. Where a vehicle stops and reasons for the stops—for example, at towns and rest stops en route—are not currently measured. Real-time or near-real-time tracking would enable direct operational assistance to the operators and a clearer understanding of delays and what interventions are required. It would also provide insight into driver behavior patterns, which would be valuable for assessing issues such as road safety, uptake of roadside station use, parking and stopping habits, and the like.



2.

Real-time monitoring of ships in the ports would provide powerful benchmarking across Africa and in near real time assist in the understanding of constraints and setting of standards.



3.

Trade data, which include the type, volumes, value, origin, destination, and transport mode, are crucial for an accurate understanding of (a) the needs and potential growth of the corridor, and (b) the trade flows and the economic impact of the corridor for the corridor member states and the region.



4.

There is growing pressure for greening of supply chains and monitoring of emissions and impact on climate change. Both policy and practice can benefit from integrating environmental factors into the CCTO and ensuring benchmarking with best practice and delivering on national and regional economic community (REC) policy imperatives related to climate change.



5.

The evidence from the ECTS could then be extended along the corridors, which would have a significant impact on understanding the cost and regularity of police roadblocks on the corridors. This would provide an economic case for the reduction of roadblocks, which would enable the CMI to work with the relevant government agencies to eliminate unnecessary stops on the corridors.



6.

The introduction of real-time or near-real-time cargo and vehicle tracking would provide the observatories and the CMIs with leverage to work with the revenue authorities and trucking associations to fast-track the uptake of electronic cargo tracking systems (ECTSs), which currently is little used in the region. This alongside the need for electronic vehicle tracking may encourage operators to consider increasing the use of vehicle tracking systems in their vehicles. This would, in turn, enable a greater sample of data to be gathered and would strengthen the veracity of the data analysis.

4.1.15 Upgrading the Corridor Transport Observatory

TradeMark Africa (TMA, formerly TradeMark East Africa) has been instrumental in providing financial and technical support to the functioning and upgrading of the CTOs. In the past three years, the upgrading has included a mobile app to assist with data collection, GIS mapping of key infrastructure on the corridor, and for the CCTO, a

business intelligence toolkit to assist with analysis and processing of collected data, a data warehouse to assist with collection and storage of data, and an enterprise service bus to assist with integrating the toolkit with data providers. TradeMark Africa's recommendations have included the following as key for ensuring the CTOs remain relevant and impactful:

1.

Include environmental indicators to track and report greenhouse gas emissions. This will set the foundation for the creation and implementation of future green corridor benchmarks.

2.

Increase the numbers of stakeholders with whom the CMIs can engage to access additional relevant data, such as the rail companies, shipping lines, port terminal services, and rail and roads agencies, among others. The formalization of data collection via memorandums of understanding will secure collection of data from existing systems, stakeholders who have automated systems, urban authorities, and weigh bridge management, for example. Most of the agencies, including the revenue authorities of the corridor member states, have been integrated with the data providers on the platform so that they speak to each other. This has significantly reduced the cost of data collection and contributed to the efficiency and accuracy of the data. The broadening of automated data sharing is an ongoing activity within the CTOs.

3.

Both the CCTTFA and NCTTCA have been challenged with the sustainability of their CTO, and the funding support of TMA has been central to their continued operation and strengthening. The CCTTFA has been enabled to focus on sustainability options for the CMI by the permanent appointment of TMA technical assistants, who have established key skills and experience over the past six years. The NCTTCA has begun to put in place measures to ensure that there is continuity, and the CMI will absorb some of those costs. This is largely because the CMI has been able to demonstrate the value of the observatory, which is considered one of the organization's success stories, and the CMI will use this as leverage to secure funding in future.

As recommended previously, the need for continuous assessment of the data, collection mechanisms, and analysis is applicable here to ensure that data quality is continuously improved. Improvement to the way statistical measures are used within the toolkit will be essential. Benchmarking and regular performance

assessments against other corridors will be helpful in laying a sound foundation for benchmarking of the selected indicators. Continuous monitoring and evaluation of the toolkit will also ensure that the indicators keep pace with the needs and functions of the corridor as it evolves. This will be integral for reporting and stakeholder engagement.

4.1.16 General Observations on the CCTO and NCTO

The CCTO and NCTO are designed to monitor and evaluate the performance of their respective transport corridors. They are efficient data collection points for transport activities and infrastructure capacity and provide insight into the factors affecting the efficiency of the corridors. By providing accurate, up-to-date information on corridor performance, the observatories are useful for identifying where improvements are needed, such as reduction of transit times, improving the safety, efficiency, and reliability of freight transport, and understanding infrastructure requirements. Ultimately, these improvements can lead to the increased efficiency and competitiveness of the transport corridors. The CTOs are important for providing information to policy makers, transport operators, and other stakeholders who can use the data to make informed decisions about investments in infrastructure, regulations, and other interventions.

It is difficult to determine with any certainty from the reports emanating from the CTOs, and from discussions with the CTO representatives on both corridors, whether improvements in certain indicators are a direct result of the activities of the observatories or if they are the result of a combination of factors, which include the development and learning of the CMI

as organizations, the growing awareness and improvement in a range of factors such as customs modernization, introduction of a single customs area, or improved road and port infrastructure and the like; as well as the presence of a monitoring mechanism such as the observatories. It is likely a combination of these factors.

For the NCTO, the presence of a port charter as a mechanism for driving operational efficiency within the port service and user community, and its presiding over the port charter committee, is central to the effectiveness of stakeholder dialogue and driving the resolution of, and improvement in, operations. While a port charter exists in the port of Dar Es Salaam, it is a statement of service intent rather than an active and functioning mechanism for improving port efficiency and operations in partnership with the private sector, as is the case with the NCTO.

While the observatories contribute to improved efficiency in the corridors, they are not, on their own, solely responsible for the improvements. They do, however, play a crucial role in providing the evidential basis for informing decision-making around the improved performance of transport corridors and their value is without question.



Corridor Trip Monitoring System



The Tripartite Transport and Transit Facilitation Programme (TTTFP) was developed to enhance the overall competitiveness, integration, and liberalization of the road transport market in the eastern and southern African regions. The program supports the objectives of the African Continental Free Trade Area by facilitating the harmonization of road transport policy, law, regulation, standards, and systems.

The TTTFP has four pillars:

- Harmonized vehicle load management
- Harmonized vehicle and driver regulations and standards
- Integrated transport registers and an integrated information platform system
- Improved efficiency of regional transport corridors

The legal framework for the TTTFP is underpinned by the Multilateral Cross-Border Road Transport Agreement (MCBRTA) and the Vehicle Load Management Agreement (VLMA). These two agreements are the basis for the harmonization of the legal frameworks applicable to all aspects of vehicle, driver, and fleet operations; they are geared toward limiting overloading and safeguarding the longevity of the road infrastructure in the Tripartite region.

The development of the TTTFP was funded by the European Union through the end of March 2023, with SADC as the lead coordinator on behalf of the Tripartite member states.

During the COVID-19 pandemic, the TTTFP developed the Corridor Trip Monitoring System (CTMS) to limit the disruption to trade and to ensure the safety of cross-border travelers and reduce the possibility of infection.

4.2.1 CTMS Focus Areas

The CTMS was designed to monitor compliance by cross-border travelers in order to manage COVID-19 and prevent contagion. Despite COVID-19 no longer being seen as a threat, the system is, nevertheless, equipped to respond rapidly should another pandemic arise. It is an electronic surveillance system designed to monitor and manage the registration of cross-border trips, driver and crew wellness, vehicle tracking, load tracking, tracking of drivers and crew, and management of queues at ports, border posts, and other facilities on the corridors. These activities are then used to generate statistical analyses and reporting to be implemented in the Tripartite region.

The CTMS is integral to the TTTFP and the development and implementation of harmonized road transport laws, regulations, policies, systems, and standards, and it is intended to improve cross-border trade and road transport efficiencies and to reduce transport costs across the Tripartite region.

The CTMS has four areas of focus:

- Implementation of the Tripartite Vehicle Load Management Strategy
- Harmonization of vehicle and driver regulations and standards
- Implementation of Transport Registers and Information Platform System (TRIPS) and CTMS to gather and disseminate data between Tripartite member states
- Improved efficiency of regional trade and transport corridors

The CTMS operates on a web-based trip registration system, which enables operators to register a trip and link the driver or crew with the vehicle(s) and cargo. The application ensures driver compliance with health requirements, such as vaccination status of the driver or crew, and uploads test results and health records. Verification of the authenticity of the health and vaccination records is achieved by a management-level web application to which relevant government officials have access, and which is conducted entirely electronically. This not only eliminates the customary paper process but also drastically reduces the possibility of fraudulent documentation and declarations. The management-level web application is also used to monitor routes used by vehicles and enables alerts should deviations occur.



4.2.2 Objectives of the CTMS

The longer-term objectives of the CTMS align with the objectives of the TTTFP: reduce travel and trip times and reduce the costs of goods and services in the region. Additionally, the CTMS provides the basis for the implementation of SMART corridors, with SMART standing for “Safety, Mobility, Automated, Real-time Traffic” management. The African Union defines SMART corridors as:

“surface transport corridors with quality infrastructure and logistic facilities, between two or more countries, used to carry intraregional and international cargo and passengers facilitated by the latest trade facilitation tools and conducive policies; the corridor includes innovative Intelligent Transport Systems (ITS) aimed at facilitating trade through simplification of transport administrative processes and providing real-time information to the key corridor stakeholders to monitor cargo clearance and movement”



(NTU/Louis Berger Consortium 2016)





4.2.3 Security, Ownership, and Utilization of the CTMS

The CTMS is ISO/IEC 27001 compliant and fully compliant with the Center for Internet Security (CIS) level 1.1.0. In addition, privacy of personal information is regulated by Article 16 of the Multilateral Cross-Border Road Transport Act. The SADC has indicated that the provisions of Article 16 are “compliant with generally accepted international requirements regarding privacy and protection of personal.”

The CTMS is owned by the Tripartite member/partner states and managed by the SADC as the contracting authority on behalf of the Tripartite (SADC, Common Market for Eastern and Southern Africa (COMESA), and the EAC). As such, the SADC Secretariat is the custodian of the hardware, system software, and source code of the CTMS application software, as well as all data recorded on the CTMS. The CTMS is hosted by Namibia on behalf of the Tripartite member states.

All member states, CMIs, users, operators, travelers, and service providers on the corridors in the Tripartite region have access to the CTMS. At present, with the functionality deployed to date, there is full access to all data relating to the trips crossing the territories of the Tripartite member states.

Member states have yet to approve the guidelines for data management, processing, and dissemination in ways other than the various modules of the CTMS, and they still need to clarify these through the hosting agreement. This is both crucial and urgent if the ethical and legal issues surrounding protection of personal information and privacy are to be upheld and trust in the system is to be developed.

4.2.4 CTMS Cost and Sustainability

The European Union funded the development of the CTMS, with the funding ending in the first quarter of 2023; it is expected that the Tripartite member states will contribute to sustaining the platform after that. Namibia’s hosting costs will be covered for the first five years, that is, 2023 to 2028. Deployment of the CTMS at the border posts and ports of the countries used for the pilot—Botswana, Namibia, Zambia, and Zimbabwe—and for the rollout in Malawi and Mozambique is funded by the German Development Cooperation through GIZ.

A viable, self-sustaining institutional model for the management and governance of the CTMS was to be decided by May 2023. A public-private partnership is being considered for the joint management and operation of the CTMS, as are other options.

4.2.5 Overall Benefits of the CTMS

The major benefit of the CTMS is the digitalization of the road transport logistics supply chain. Once registered online, a hard copy of the Trip Registration Certificate (TRC) is available, but it is also available in digital format on the driver’s mobile device. The certificate is signed digitally and is authenticated by the relevant border agencies via electronic scanning, as are the driver’s license barcodes, vehicle license discs, and health certificates. Digitalization has benefits in several areas, which are outlined in table 4.5.

TABLE 4.5: Benefits of the Corridor Trip Monitoring System

Area	Benefit
Journey management	<p>Visual trip monitoring for operators, which flags deviations from routes registered on the online application</p> <p>Applies to:</p> <ul style="list-style-type: none"> ■ Health management and monitoring of crew ■ Required border crossing documentation ■ Trip summary reports ■ Map-based visual reports registered by operators
Mobile Crew Application (commercial traffic)	<p>When data connections are available, and as part of the journey management function:</p> <ul style="list-style-type: none"> ■ Uploads location tracking data, which supports consignment information and vehicle tracking ■ Can be used for disease contact tracing and verification of health documentation requirements
Tripartite Traveler Application & Lab integration	<p>Provides World Health Organization (WHO)–compliant digital certification and verification of test results and vaccination status for travelers</p>
Contactless verification	<ul style="list-style-type: none"> ■ Scanning of QR code of electronic travel and cargo documentation scanned by handheld devices at border posts ■ Zero physical contact provides a level of safety to border officials and drivers/crew/travelers ■ Route deviation warnings enable health officials to undertake contact tracing through deviated versus registered route comparisons
Access to disease and vaccination certificates	<ul style="list-style-type: none"> ■ Facial recognition and/or live picture verification of passport, ID documents, or driver’s licenses ■ Protection of health officials at border posts
Customs integration (still to be developed)	<p>CTMS integrates customs management systems and law enforcement for contactless inspection and release of vehicles. The benefits of the customs integration for operators are:</p> <ul style="list-style-type: none"> ■ Prevention of delays due to capturing inaccuracies ■ Reduction of capturing and processing time ■ Reduction of transit times ■ Information exchange will assist in addressing bottlenecks at border posts that contribute to high transport costs. <p>Where release orders are integrated into the CTMS, this will expedite immediate electronic access to the release order for compliance requirements.</p>
Corridor performance management	<p>Enables monitoring of:</p> <ul style="list-style-type: none"> ■ Corridor efficiency ■ Border congestion ■ Travel and transit times on specific sections of the corridor ■ Utilization of wellness centers ■ Corridor utilization and planning when operators use alternative routes
Transit guarantees	<p>The intention is to integrate the CTMS with existing transit guarantee systems, which will ensure that transit guarantees have been paid and are subject to the integration options of the transit guarantee schemes. This will obviate the requirement for operators to pay bonds to multiple transit guarantee schemes.</p>
Corridor management institution	<p>CTMS data will be available to corridor management institutions to enable reporting on travel and transit time for cargo movement within the region. It also enables:</p> <ul style="list-style-type: none"> ■ Implementation of interventions to address the non-tariff and technical barriers to trade ■ Data consolidation and comparable performance metrics for all corridors ■ Reporting on travel and transit times for cargo moving within the region

Note: CTMS = Corridor Trip Monitoring System.

4.2.6 Potential Benefits for Stakeholders

For operators:



- A single consolidated bond payment for all countries.
- Reduced complexity as digital documentation is accessible across the region.
- Fast-tracking of clearance.
- Certificates of Origin available digitally, which negates the requirement of a hard copy document.

For drivers:



- Documentation is available electronically prior to departure or arrival at a border post.
- Vehicle clearance is conducted by border officials using a handheld device, so crew/drivers have no need to exit the vehicle.

For officials:



- Country administrators can manage the officials specific to their member/partner state who are authorized to use the Officials Mobile Application to:
 - » View statistical information regarding trips on the corridors running through their specific linked country.
 - » Monitor trip progression and reporting of vehicles or drivers/crew deviating from the registered route.
- Enables vehicle tracking through geofenced routes and geocoded border posts, weigh stations, and fixed check points.
- Certificates of origin are accessed via the handheld device, which reduces clearing time.

Immigration integration:



- All documentation is available prior to departure/arrival at a border post and integrated across the Tripartite member states.
- Officials access details and clear via a handheld device.
- e-Commerce and digital logistics, consignor and consignee documentation are linked to the CTMS, which facilitates ease of movement of the goods.
- Trade in goods and services is enabled electronically.
- Enables more efficient planning for loading and/or off-loading of cargo.
- Access to the port is enabled via the CTMS.
- Imports and exports are uploaded on the CTMS.
- Tracking enables estimated date of arrival and departure times of vessel(s) in ports.

4.2.7 CTMS Functionality and Required Technology

Table 4.6 presents the technological requirements to undertake each functionality and Table 4.7 describes the CTMS Portal Access and Functions. From trip registration to health compliance management, the CTMS ensures seamless cross-border travel operations while optimizing efficiency and transparency.

Trip Registration Certificates, Vaccination Certificates, and Traveler Certificates were used during the pilot, with public sector officials having access to the CTMS web application to obtain information relevant to the performance of their duties. The entry point for all interaction on the CTMS is www.CTMS.africa.

TABLE 4.6: Functionality and Technology of the Corridor Trip Monitoring System

Operator/Operation	Functionality	Requirements
Trip Registration	<ul style="list-style-type: none"> ■ Vehicles, drivers/crew members select the waypoints of the route and customs classification of the cargo. ■ Enables cargo and/or vehicle tracking. 	Laptop or desktop computer and printer
Traveler Registration (noncommercial)	<ul style="list-style-type: none"> ■ Online or offline vaccination and/or health compliance. ■ Vaccination and test results imported from the national health systems. ■ Medical test and vaccine documentation digitally signed and can be accessed on www.CTMS.africa. 	Accessible from laptop, desktop, any smart device (that is, phone or tablet)
Crew Application	<ul style="list-style-type: none"> ■ Location tracking on a cross-border trip by road. ■ Verification of compliance with the rest, stop, and refueling points in the host country. 	Android mobile phone
Officials Mobile Application (Customs, Health, Immigration)	<ul style="list-style-type: none"> ■ Trip and vehicle verification. ■ Driver/crew health and health compliance verified through QR code scanning on TRC or traveler mobile device. ■ Digital certificates less susceptible to forgery and virus spreading. <p>Pending implementation of Customs and Immigration integration, the Officials Mobile Application may currently also be used to:</p> <ul style="list-style-type: none"> ■ Record and upload a COVID-19 test result or COVID-19 vaccination when a traveler was tested or vaccinated. ■ Record an incident or accident with the option to upload photographs taken at the scene of the incident. 	Android mobile device
Healthcare Capture	COVID-19 test results or vaccination details if travelers were tested or vaccinated prior to starting a journey.	Web based; laptop, phone, or tablet
Officials Management	<ul style="list-style-type: none"> ■ Authorized officials can access statistical trip information within their country corridors. ■ Monitor trip progression and deviations from registered routes. ■ Track vehicles on geofenced routes and geocoded border posts, weigh stations, and fixed check points. 	Web based; laptop, phone, or tablet www.CTMS.africa

4.2.8 Implementation of the CTMS

Currently, there are several challenges with the use of the CTMS in the pilot program because all the modules have not yet been deployed and there is some uncertainty as to when they will be available. The CTMS has been piloted in Botswana, Malawi, Mozambique, and Namibia, and while there is improvement in the uptake of the CTMS by Tripartite

member states, within the SADC, South Africa and the Democratic Republic of Congo have not implemented the system. South Africa, for instance, has indicated that the information required from its eNaTIS (National Traffic Information System) is protected by the country's Protection of Personal Information Act, which makes it unavailable for sharing.



TABLE 4.7: Corridor Trip Monitoring System Portal Access and Functions

Portal access	Functions
Operator portal	Operators register routes, vehicles, crew members, and COVID-19 test results and vaccinations to register trips and generate a Trip Registration Certificate (TRC).
Traveler portal	Travelers register and generate WHO-compliant Vaccination and Travel Certificates for cross-border travel across the Tripartite region.
Country administrator portal	Registered authorities (government officials, corridor, and border management agencies) view and report on the data and trips. Portal is used to manage the official users registered for their linked countries but has no access to tracking information of an operator's trips. Tracking information is made available in a historic, de-personalized format for corridor performance management purposes.
Healthcare capturer portal	Captures administered tests and vaccinations and test results. Test results and vaccinations certificates are made available to travelers and operators for Vaccination Certificate, Travel Certificate, and TRC generation. The Healthcare Capturer portal was developed specifically to allow laboratories without WHO/CDC-compliant electronic systems to interface with the CTMS.
Officials' portal	Available on the Officials Mobile Application to access information relevant to trips that pass through an official's station. Includes access to trip queries, crew members, vehicles, operators, and test result and vaccination capture.
Officials' Mobile Application*	Officials stationed at land border posts/ports of entry such as port health, customs. In conjunction with TRIPS, verifies details relating to operators, drivers, and/or vehicles.
Crew Member Mobile Application	Enables location tracking of crew, health information, results of COVID-19 checklist. Scanning of the TRC enables selection of the driver from a list of crew on the trip so that tracking can be initiated.

Note: CDC = Centers for Disease Control and Prevention; TRA = Tanzania Revenue Authority; TRIPS = Transport Registers and Information Platform System; WHO = World Health Organization.

* The integration of Customs and Immigration has yet to be developed; it will be a single window application to accelerate border crossings for both commercial and private travelers.

Despite these challenges, several modules have been deployed by the CTMS for rollout of the pilot program. Most of these are web applications, such as Trip Registration, Traveler Application, Healthcare Capture, and Officials Management; the Crew Application and Officials Mobile Application are only available on Android mobile devices.

Because of the recent launch of the pilot program, a full report on the stakeholder uptake and the effectiveness of the CTMS is not available. However, general observations are that the system will be an effective tracking tool for road freight and will provide significant assistance in the event of a pandemic situation. There are reservations, however, regarding the following issues:

1. The integrity of data in the hands of government officials via the android device.
2. The safety of devices used by the CTMS.
3. The level of data required at registration, which may be construed as onerous and invasive, even somewhat heavy-handed in terms of the personal information and facial recognition requirements. It appears not to consider periods in which a pandemic is not a threat. It may be worthwhile to “downsize” the requirements during non-pandemic periods and reintroduce these should a pandemic become a concern.

It is critical that the current Logistics Monitoring System (see section 4.3) and the CTMS engage in depth to pursue areas of potential collaboration. At this point, however, it may be a starting point for the LMS to provide a level of verification for the CTMS data and to provide near-real-time support data analysis for corridor management institutions.

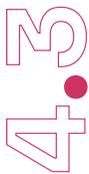
4.2.9 CTMS and Data Benefits for Corridor Management Institutions

From available information, it is confirmed that CMIs will have access to the functions of the CTMS and be able to use it for moving toward the establishment of SMART corridors and providing corridor performance monitoring and comparison of corridor performance. Data will be available to the CMIs to enable reporting on cargo transit and travel time. CTMS also enables the following:

- Identification of interventions to address the tariff and technical barriers to trade
- Data consolidation and comparable performance metrics for all corridors
- Reporting on travel and transit times for cargo moving within the region
- Communication with operators to reduce vehicle congestion within the ports

Early indications are that data will only be made available to CMIs historically, in which case the dire need for real-time and near-real-time information may prove to be a challenge. However, as the implementation of the CTMS is in its initial stages, and the countries within which the CTMS has been piloted do not have operational CMIs, it is still too early to determine the value, impact, and availability of the CTMS data for CMIs.





Logistics Monitoring System



The LMS³ is structured to collect significant volumes of raw data from GPS-based trucking and shipping management systems in near real time across 51 borders in 15 countries in southern and eastern Africa. The anonymized trucking data are supplied at five-minute intervals by the tracking service providers contracted by the truck owners/operators. The data equate to approximately 100,000 vehicles, which is sufficient for a statistically representative analysis of the extent of delays experienced along a corridor, except for some of the more remote border posts in the extreme north. In short, 100,000 elements of data are collected every five minutes.

The shipping data are obtained from Vessel Tracker at a frequency of every 15 minutes, covering 11

ports in the region. Data relating to more than 300 vessels are typically collected continually, as any vessel entering anchorage areas is monitored across the parameters.

The primary purpose of this data, once processed, is to provide an understanding of the interactions between various supply chains—within countries, across borders, and through ports. In addition, the data highlight the factors influencing the performance of supply chains and their impact on local and regional economies. The purpose of the LMS is to provide a trusted, near-real-time monitoring platform that provides visibility across supply chains in the region. The LMS is currently expanding its focus along seven pillars of interest (figure 4.1).

3. <https://www.ssatp.org/sites/ssatp/files/document/Annexure%20%20-%20LMS%20Brochure.pdf>

F **FIGURE 4.1: Seven Pillars of the Logistics Monitoring System**

Source: Crickmay & Associates.

4.3.1 Logistics Monitoring System and Big Data Collection

Part of the benefit of the LMS data collection is that, unlike the majority of big data collection, which is as the United Nations (2020) suggests, collected “passively” or “inferred via algorithms,” the LMS data collection is approved for collection and is entirely anonymous, which is somewhat comforting for those uneasy with the collection of personal information whose use is seldom properly communicated or managed to provide any levels of trust or confidence in its use or safety.

As the United Nations mentions, critical data for global, regional, and national development policy making is still lacking, and the challenge is the sustainability of big data collection in the longer term. However, first, clear frameworks must be established to clarify roles and expectations for all those involved. This is true of the regional information systems and has been part of the development of this working paper in the discourse with the SADC Secretariat as lead coordinator of the TTTFP Corridor Trip Monitoring System.

The LMS traces its origins to the Truck Monitoring System (TMS), which was conceptualized as a trade facilitation tool and was initiated by COMESA, EAC, and SADC under the UK DfID-funded TradeMark Southern Africa–supported Comprehensive Trade and Transport Facilitation Program circa 2012. The TMS development was supported by the Africa Transport Policy Program (SSATP) from approximately 2016, and subsequently by the World Bank in 2017–2022, during which time the need was identified for accurate data to monitor transport efficiencies and bottlenecks to provide a data-based approach to monitoring corridor performance. The TMS was piloted on the Maputo Corridor with the then Maputo Corridor Logistics Initiative (MCLI), and the system was a game changer even in its early iterations, providing unambiguous evidence of the dynamics of the road transport activities on the corridor—something that had, hitherto, been absent. The absence of evidence-based data had severely hamstrung the ability of the MCLI to support its lobbying and



advocacy efforts, and its inputs into policy and legislation. Until the TMS pilot, the MCLI had used information sources from a myriad of government departments, which were seldom available in a timely manner, and which lacked a corridor-specific focus. This limited the credibility, use, and application of the data.

The real-time data provided by the LMS are critical for efficient and timely interventions and for ensuring that the lobby and advocacy efforts of CMIs are relevant and credible. In the past two years, the addition of the Vessel Tracker data, and the detailed geofencing of the entire Maputo Corridor, has provided significant value. More recently, the World Bank, the South African Association of Freight Forwarders, and the Western Cape government have invested in the customization of some of the platform's capability to suit their specific requirements, which speaks to the adaptive nature of the platform.



4.3.2 Benefits and Ownership of the LMS

The LMS provides independent and objective information, which enables stakeholders to identify common problems, bottlenecks, and their causes. In addition, where poor driver behavior is responsible for damaging infrastructure, these hot spots can be located and addressed, ensuring the accountability of stakeholders. The LMS also provides as near as possible real-time information on road congestion and expected arrival times at ports, which enables more efficient planning of vessel loading and off-loading operations.

The LMS enables the industry to anticipate the impact of changes in trade flows, both within and across regional boundaries. Importantly, the LMS data form the basis for determining how transport flows impact economic indicators and how transport flows are impacted by commodity price changes. This information is valuable to both

financial institutions and insurance companies in their assessment of risk. Both businesses appear to be interested in measuring their clients against a benchmark. The information has also been assisting companies that participate in the planning of infrastructure.

These benefits can be used by stakeholders in both a national and a regional context, and the data analysis can inform the development of interventions and remedial actions and may also be useful to inform strategy and policy within the CMIs and within SADC member states. More importantly, the analysis enables a clear understanding of the performance of transport corridors and how they are affected by the internal flow of goods within a country as well as provides an understanding of the flow of goods across the entire corridor region.

The availability of clean, verified data analysis provides several overall benefits to the economy of the region:

1. Enabling of evidence-based dialogue and analysis
2. Access to a dashboard containing nonconfidential data and trends
3. Enabling the specific requirements of stakeholders to be addressed effectively
4. Evolving with the latest best practice and enhancing the skill set in the private and public sectors
5. Bringing maturity and development to the process of big data analytics and technology as applicable to cargo movement
6. Tracking cargo movement patterns in line with a country's roads and demonstrated port capacity
7. Ability to identify shortfalls and inefficiencies along the corridors, and with the data, find feasible solutions for improvement
8. Fostering resilient supply chains, extending growth and economic development by providing solid information for strategic and operational planning

The functionality and application of the LMS is constantly developing and improving to bring more data layers into play. However, some limitations are important to note:



Sustainability:

The cost of the platform is substantial in terms of outlay and maintenance. While it is likely that the data analysis has potential to produce revenue for the CMIs, there is an equal likelihood that technology requirements may increase, and with it, the costs.



Industry-specific requirements:

Differing regulatory, security, and cost pressures apply to different industry sectors in the supply chain. Where big data analytics is concerned, these may prove diverse and difficult to manage. Data, systems, and security are the service provider's responsibility, and that responsibility encompasses managing and protecting the data, systems, and security of their clients' businesses. This includes ensuring that the data are stored securely and backed up regularly, and that the systems are as protected as is possible from potential threats and unauthorized access.



Single source service provision:

There is some risk involved with having upgrades to systems and software being the exclusive remit of a single service provider, which is the case with Crickmay & Associates, the developer and service provider of the LMS. This is a risk both to the service provider and to the user and may prove problematic in the longer term where upgrades, development, and repair and troubleshooting are dependent on one company country wide.



The LMS is owned by Crickmay & Associates, an independent, private company that developed the system with the support of the World Bank. It manages the collection and scrubbing of data on behalf of its clients, which include public and private sector entities across Namibia, Mozambique, and South Africa.

Because the LMS is modular, ownership of specific modules can be assigned to funders where practical, but to date funders have tended to build upon the legacy of previous funders to strengthen the tool for those who use it.

▶ ▶ ▶ ▶

Vehicle data are obtained from GPS tracking service providers, are owned by the source, and can be withdrawn at any time, which does provide a level of risk for continuity of data collection. There is, however, some security in that a substantial portion of the data is paid for. Vessel data are obtained from Vessel Tracker and are used by Crickmay & Associates, under specific stipulations, while port data are obtained from Portnet. However, the data used are processed in a manner that is understandable and accessible.



4.3.3 Utilization and Functionality of LMS Data

The LMS is hosted by Crickmay & Associates and the data are accessible to a wide range of private and public sector subscribers to the service, who use the developed features of the LMS application to help build understanding across the region. The functionality of the LMS is best understood via the following example:

Corridor traffic is affected by internal movement of cargo within a country. The LMS has investigated the Durban port bottlenecks and has assumed that they are caused by the following:

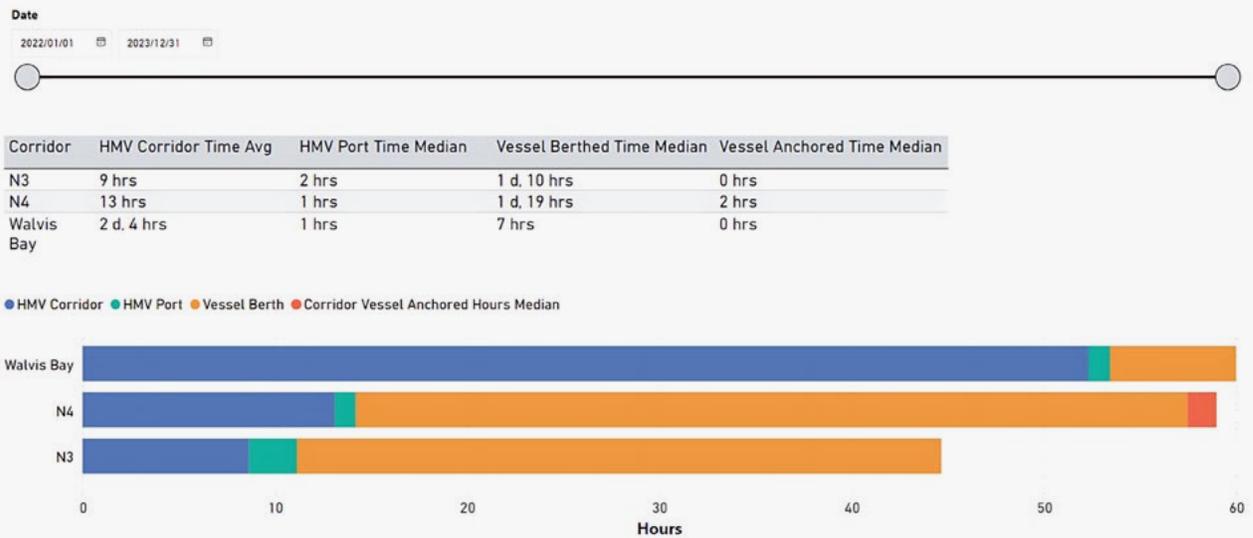
1. The increase in minerals into Durban by tipper trucks, causing increased congestion and blocking trucks carrying fruit exports into the Durban container terminal, which is a major concern as fruit products are more time sensitive since part of the ripening process is controlled in transit
2. Poor coordination of export traffic and shipping schedules
3. Poor loading and off-loading performance at the ports

4. Poor adherence to off-loading schedules by truckers

Using vehicle GPS, geozones, and shipping traffic data, the LMS can use big data analytics to identify the bottlenecks and provide stakeholders with the information to engage the various parties in the supply chain and to monitor if the management systems put in place have the desired effect. LMS data provide exporters with better information on shipping so that they may better anticipate, plan, and predict flows of traffic.

The LMS currently has valuable data dating from January 2018 available on its system. It covers a wide range of reporting functions that provide detailed information on border arrivals, border activities, routes, trip times within the region, median border crossing times, and the like. This is crucial information that enables a clear understanding of corridor activities and performance. Examples are provided in figures 4.2 through 4.12.

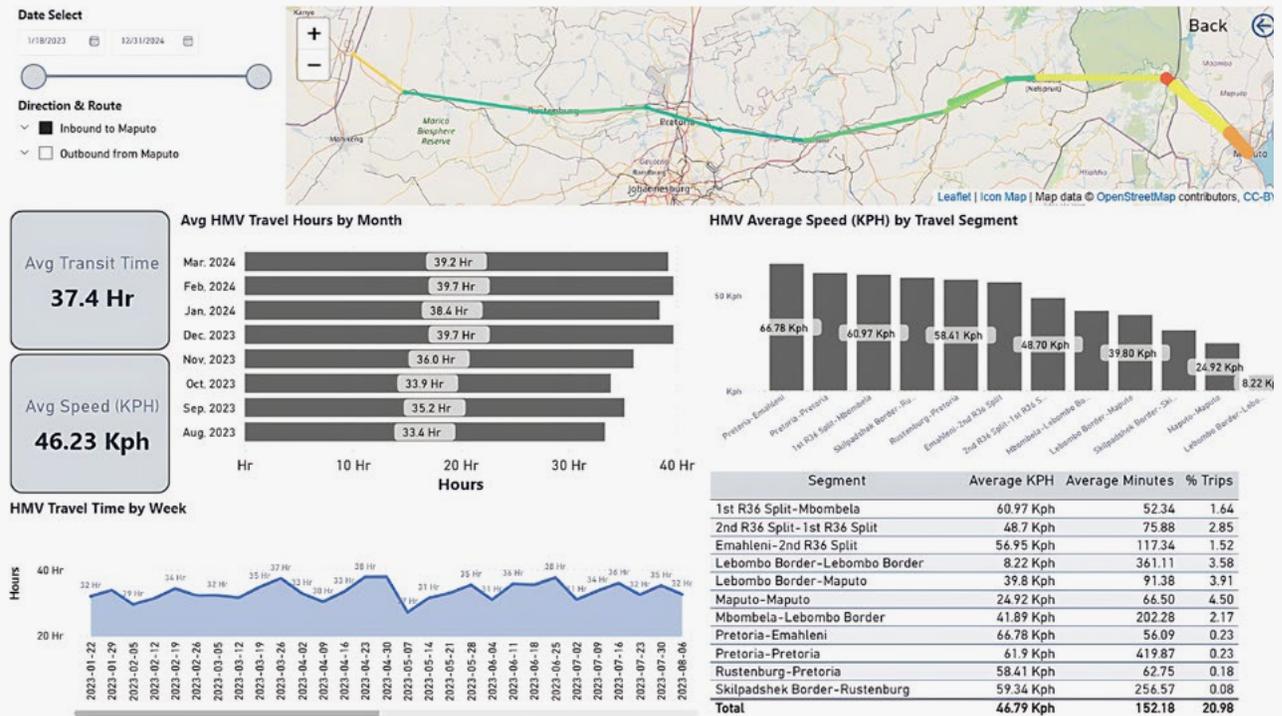
F FIGURE 4.2: Pit to Port Analysis



Notes: Corridor data is the summed time of 50km corridor segments from Gauteng to port, with average times grouped at a monthly level for 2022. HMV port time includes HMV time spent within the port area. Includes visits within the last 10 weeks only. Vessel data is median time at berth for all port visits.

Source: Crickmay & Associates.

F FIGURE 4.3: Inbound Trip Analysis-Port Maputo



Source: Crickmay & Associates.

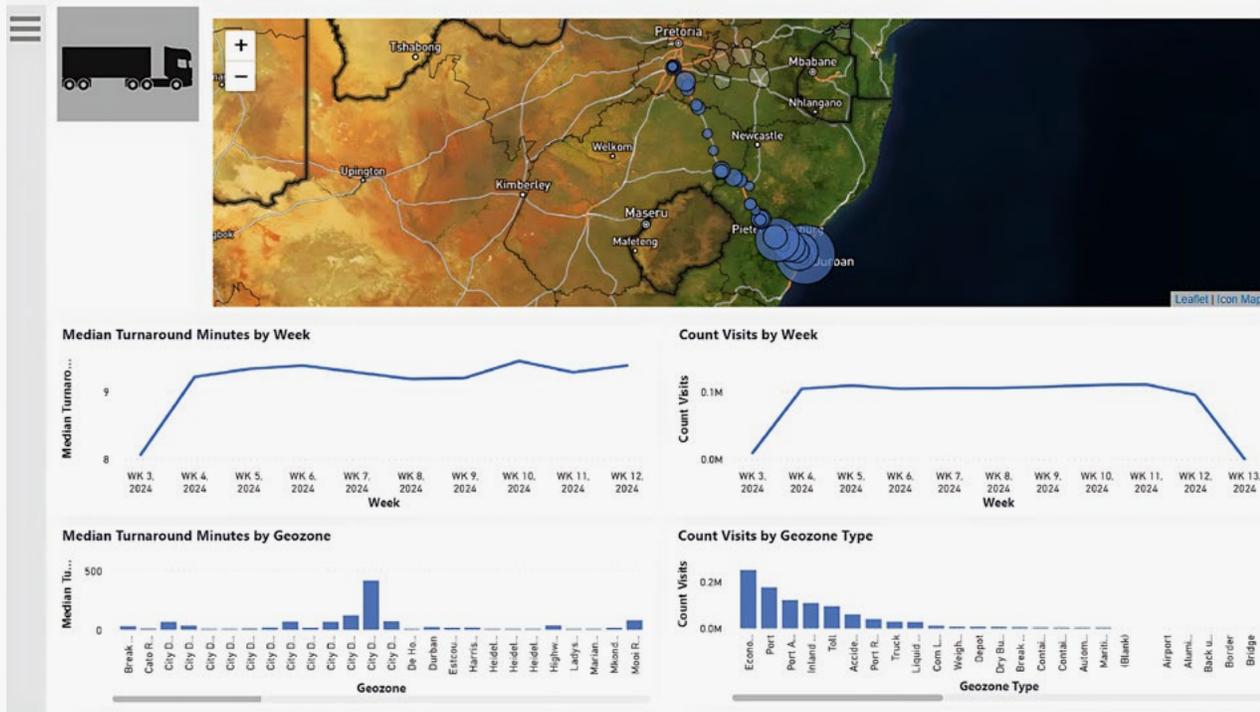
Figure 4.2 gives median time analysis of the vehicle corridor travel, time within the port, as well as the median time taken for vessel berthing within the port.

The data can create a visual analysis of the number of trips per band (Figure 4.3), the sections indicated on the map, where thinner lines indicate quicker travel and lower density, and thicker lines indicate density and related travel time. Details of time and average kilometers per hour are also provided for each band. This enables rapid assessment of critical choke points on the corridor and can provide excellent analysis for operators, terminals, CMIs, port operations, and mines.

Figure 4.4 provides a weekly picture of density of travel per geozone and key corridor points, as well as an indication of median turnaround times and number of visits. This analysis is also valuable to stakeholders, particularly CMIs, terminals, service providers (tolls, weigh bridges, border posts), and the like.

Time spent at borders is currently still the major cost and inefficiency factor in cross-border trade (Figures 4.5–4.6). This information is invaluable for analysis, particularly for CMIs and other government agencies. It provides diagnostics for addressing the causes and effects of delays, including near-real-time information and weekly, monthly, and annual analyses that can inform interventions, planning, and strategy across the range of corridor stakeholders.

FIGURE 4.4: Analysis of Key Corridor Points



Source: Crickmay & Associates.

F

F **FIGURE 4.5: Inbound Trip Analysis-Port Maputo**



Source: Crickmay & Associates.

F **FIGURE 4.6: Border Crossing Detail**



Source: Crickmay & Associates.

The significant detail provided in the above analysis (see Figure 4.6) is crucial for insight into the service provision of government agencies at the border post and provides an excellent basis for a refined understanding of where the major chokepoints occur during the border crossing. Again, CMIs, other government agencies, and a range of corridor stakeholders would benefit from this analysis for addressing inefficiencies and for developing benchmarks when crossing times can be measured consistently for efficiency.

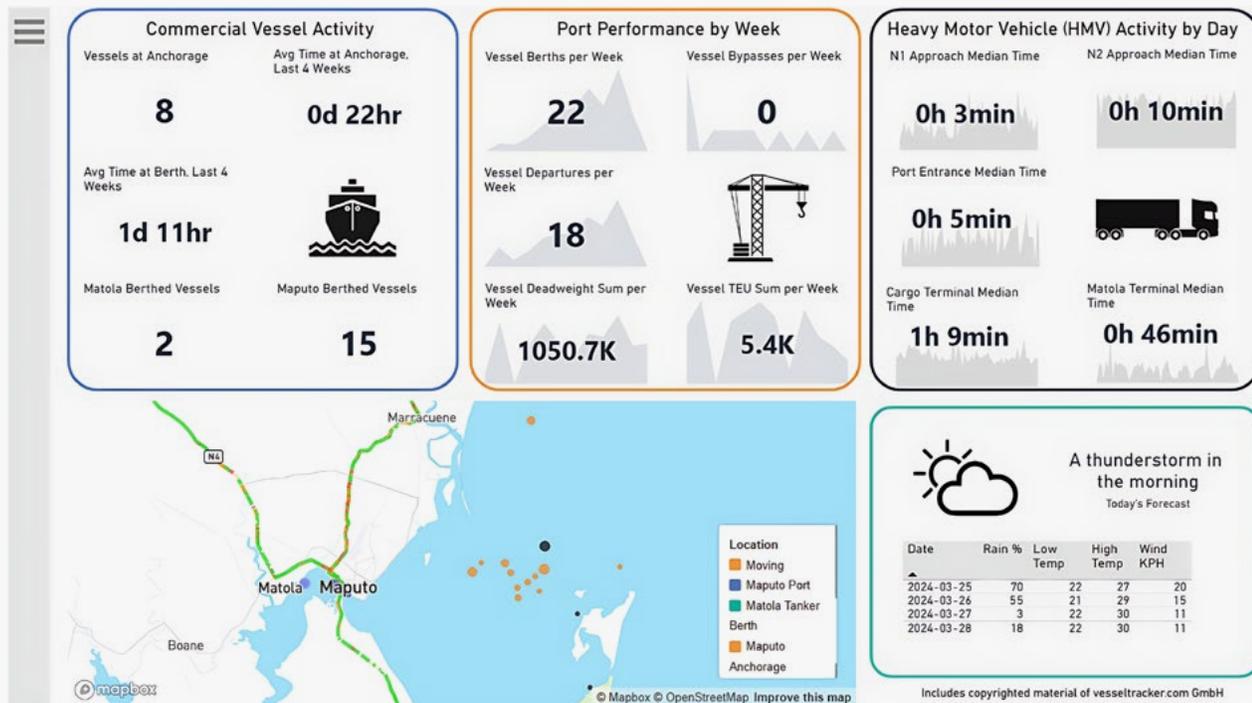
Figures 4.7, 4.8, and 4.9 deal with port data that enable a clear picture of vessel activity, port performance, heavy motor vehicle (HMV) turnaround within the port, vessel behavior, capacity, functionality, and efficiency. Figure 4.10 provides a comparison of regional ports, which enables benchmarking.

Analysis emanating from data in Figure 4.11 is crucial for understanding port and HMV behavior, efficiency, and capacity. It is of critical importance for all stakeholders and is invaluable for understanding immediate challenges and efficiencies, and for planning of infrastructure and digitalization interventions.

The LMS monitors disruptions of traffic across South Africa and has been actively used by the Western Cape government to understand, in greater detail, flows into Cape Town port (figure 4.12).



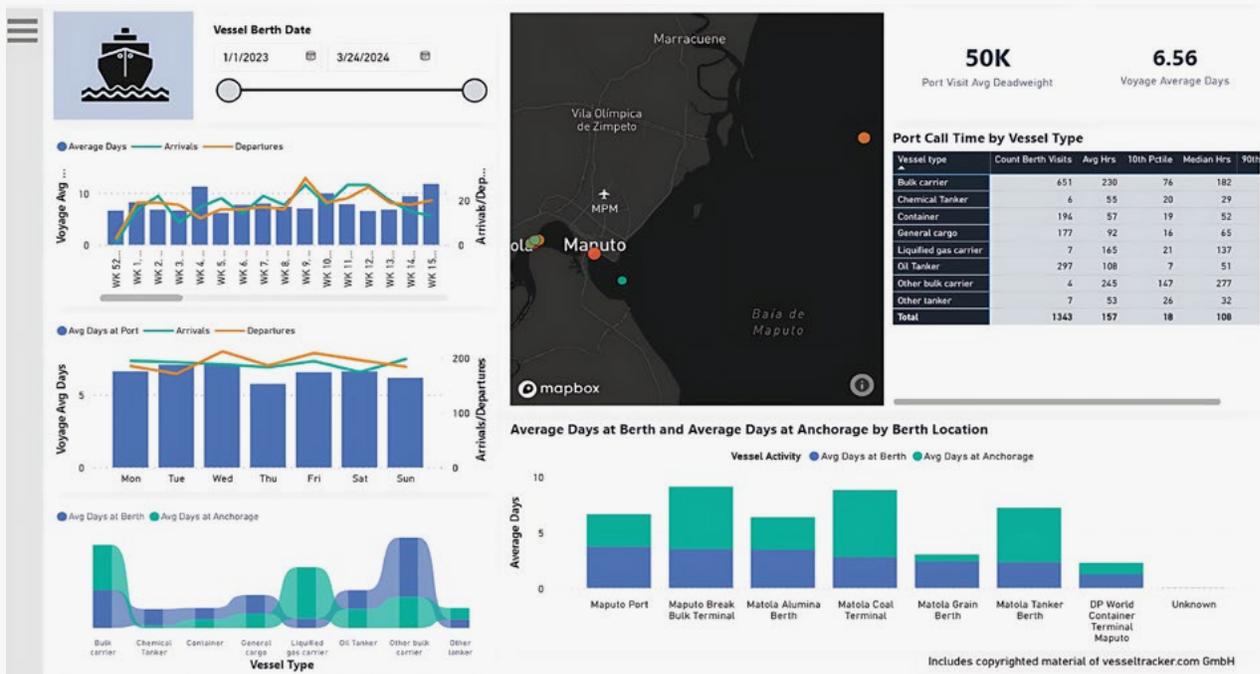
FIGURE 4.7: Port Maputo Overview



Source: Crickmay & Associates.

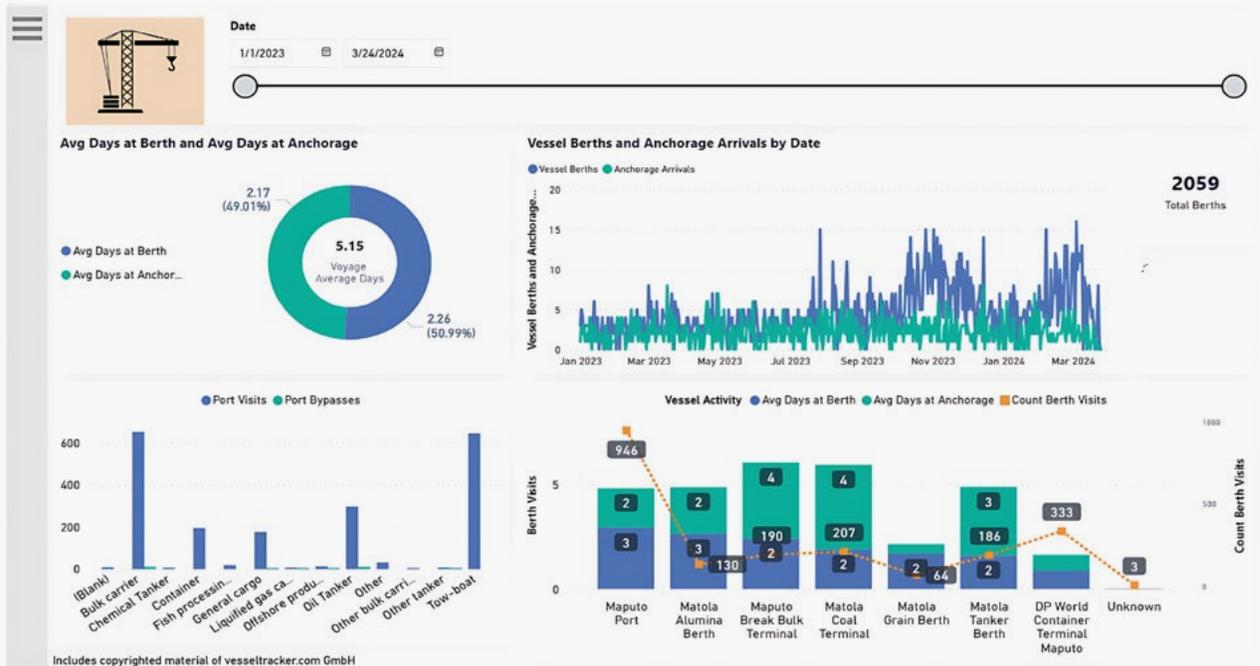
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F **FIGURE 4.8: Vessel Behavior in Port**



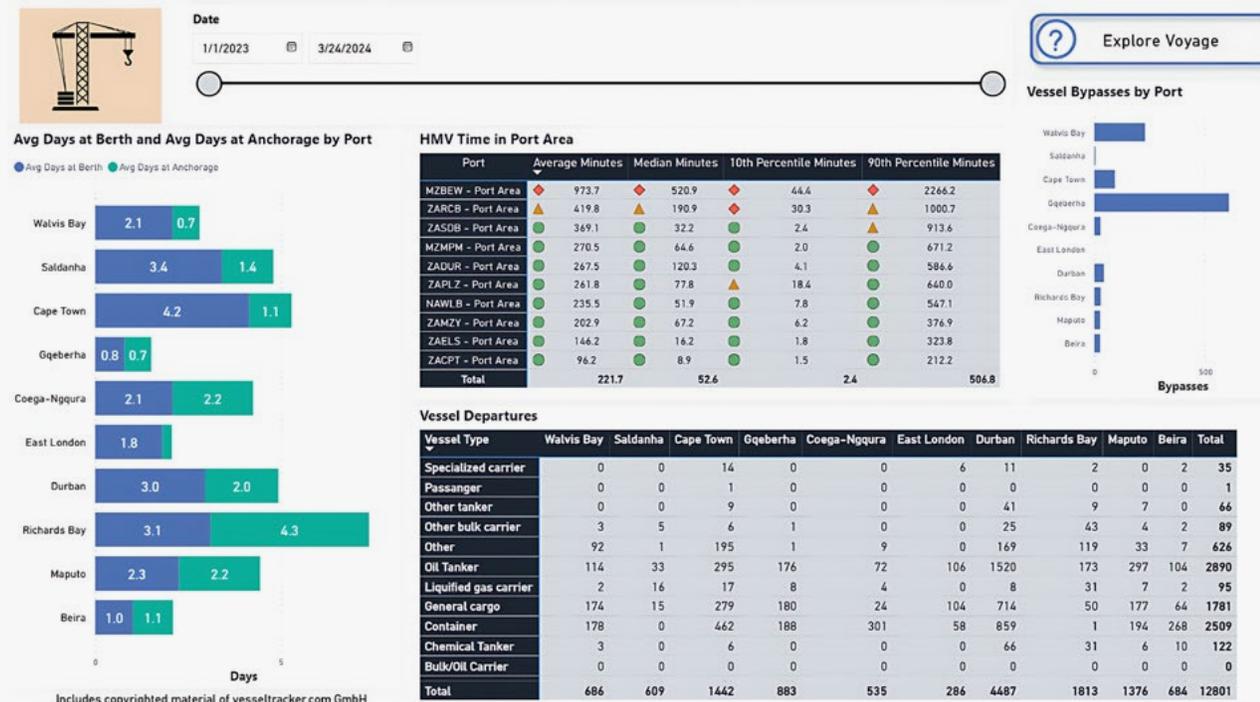
Source: Crickmay & Associates.

F **FIGURE 4.9: Port Activity Analysis**



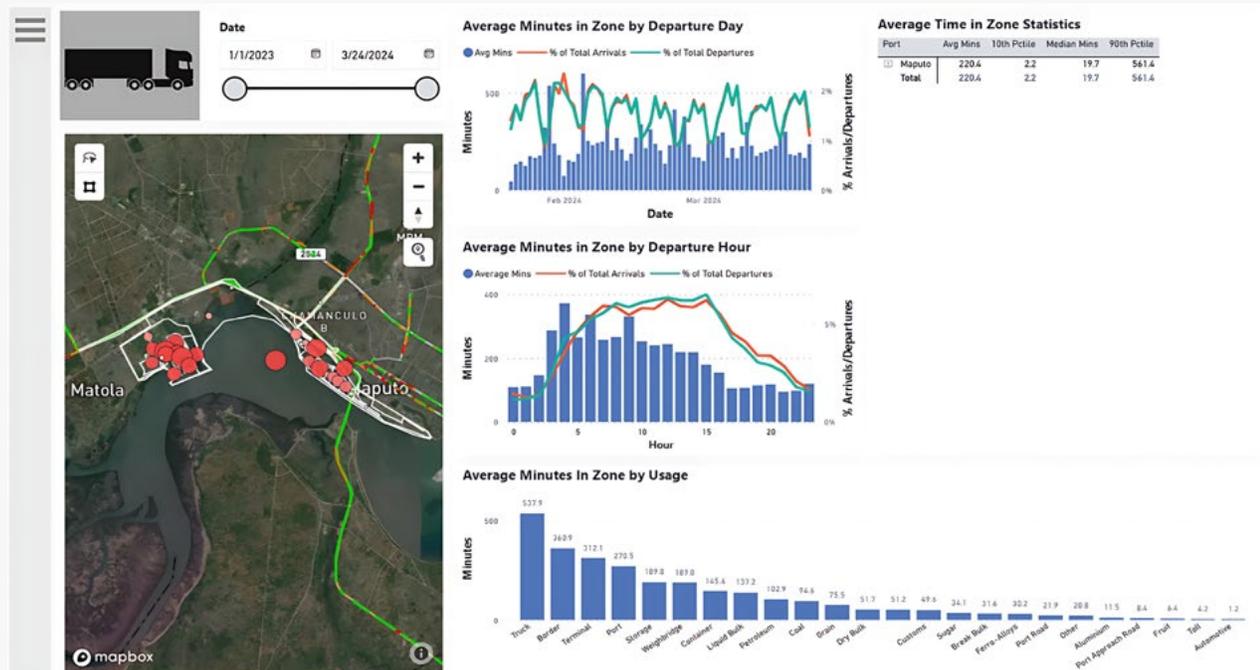
Source: Crickmay & Associates.

FIGURE 4.10: Port Comparison (within region)



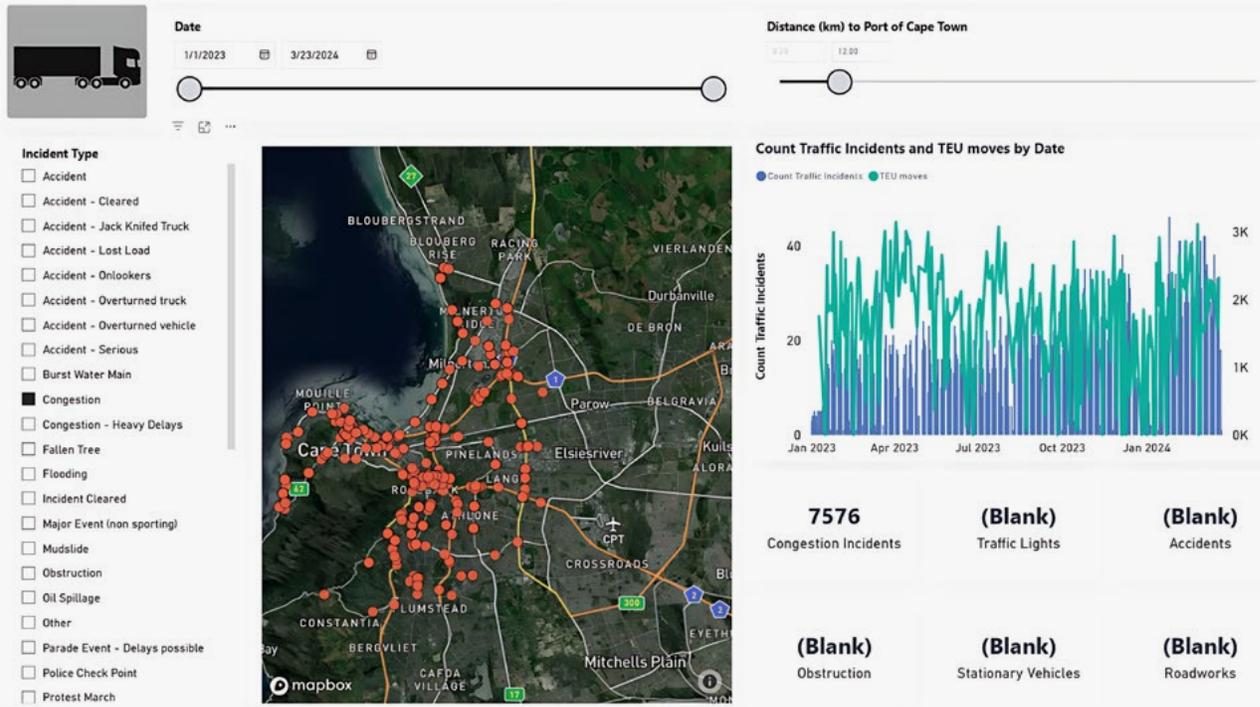
Source: Crickmay & Associates.

FIGURE 4.11: HMV Movement in Port Maputo



Source: Crickmay & Associates.
 Note: HMV = heavy motor vehicle

F FIGURE 4.12: HMV Movement into Port of Cape Town



Source: Crickmay & Associates.
Note: HMV = heavy motor vehicle

4.3.4 LMS Technology

Vehicle data gathered from onboard tracking companies are anonymized before being shared with the LMS. This includes minute-by-minute GPS data from approximately 100,000 vehicles, retrieved every five minutes. Vessel land-based Automatic Information System (AIS) data are sourced from Vessel Tracker. The data are updated every 15 minutes for all vessels at anchorage or in the ports along the coasts of Mozambique as far north as Beira, along the South African coast, and Walvis Bay in Namibia. There are typically more than 300 vessels in this area at any given time, although the number will vary by day and time. Transnet port data covering the number of containers moved and equipment used are received daily by the LMS.

Many data sources such as maps, traffic disruptions, driver WhatsApp groups, weather stations, traffic cameras, vehicle counting, and weigh bridge (private and public) are data sets that are available and easily added to the LMS. Ultimately, the data should, with the use of artificial intelligence, give the system the ability to anticipate bottlenecks and movement times.



4.3.5 LMS Cost and Sustainability

As a means of exploring sustainability options, Crickmay & Associates have categorized potential beneficiaries into 10 different market segments, each of which has specific needs that the LMS could fill. Apposite data products are in various stages of development for dissemination based on a subscription model. Data generated from granular data are available on a near-real-time basis, which has proven attractive to the beneficiaries and has developed considerable capabilities over the recent 18-month period. Twelve months into the strategy, there has been pleasing uptake in the form of subscriptions; however, this does not yet cover running costs in their entirety. Various data

products exist on the LMS that can be used by different stakeholders. Within the context of CMIs and corridor stakeholders, the requirements for setting up a new CMI, or supporting a new CMI with the available data, is summarized in table 4.8.

For a CMI to avail itself of the information and to use it to its maximum benefit, it can be assumed that the cost in the first year would be US\$2,000–\$3,000 per month. Once the LMS is established, the monthly cost would drop to US\$833–\$1,833, depending on whether port system generated data are included or not.

TABLE 4.8: Approximate Cost of the LMS in Support of a CMI

Description	Cost (US\$)
Annual access to port data – per port per annum	5,200
Customized setup per corridor – approximate and dependent on number of routes to the port	14,000
Monthly maintenance of data and reporting, including port-generated data Annualized	16,800
Basic heavy motor vehicle data and Vessel Tracker data only (excluding external port data) monthly (5 user licenses only) Annualized – no port system generated data	4,800

Note: CMI = corridor management institution; LMS = Logistics Monitoring System.

4.3.6 Assessment of the LMS Sample Size

The assessment of the LMS sample size has proved challenging as the actual sample size has not been officially measured. However, alongside the University of KwaZulu Natal's Pietermaritzburg campus, Crickmay & Associates estimates that there are 450,000–500,000 trucks in South Africa. The LMS monitors 100,000 of those, or roughly 20 percent, which is regarded as a fair sample. A minimum sample is set at 4 percent, or 18,000 trucks (particularly where border posts are part of the journey), to get a representative result.

If the samples become too small, Crickmay & Associates would be required to buy in additional data to ensure the consistency of sample size. Another 100,000 trucks' data could be accessed with ease in South Africa; however, countries north of the SADC region become more difficult to monitor within the required sample size, for various reasons, chief of which is the significant cost of GPS data. Further investigation is required to determine how representative samples may be accessed across the SADC region, and particularly across borders.

4.3.7 Areas of Commonality between the LMS and the CTMS

The discussion above brings to light the multiple roles played by the CTMS:

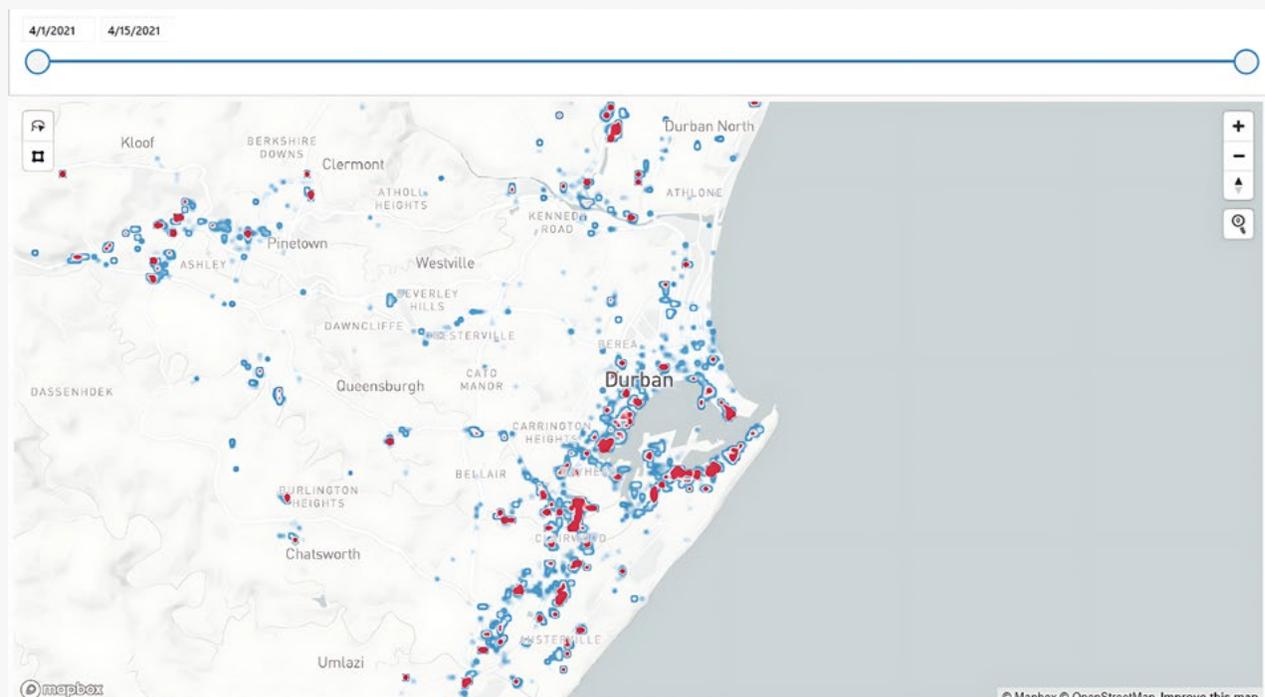
- A data collection system, which gathers data supplied by consignees/consignors, clearing, and forwarding agents, operators, drivers and officials, relating to the range of matters that are verified at border crossing, including health, customs, and immigration, among others, to facilitate smooth and efficient border crossings
- A management tool, which enables queue management at ports, border posts, and other facilities, and identifies vehicles and crew members, their routes, deviations, or emergency signals
- An analytical tool, which utilizes live tracking of vehicles and drivers/crew during a trip and provides statistical analysis of delays at various nodes along a corridor (border posts, weigh stations, check points, and the like), enabling the identification of bottlenecks and facilitating their resolution

Similarly, the LMS is an analytical tool that performs statistical analysis of delays at various nodes along a corridor (border posts, weigh stations, and check points, among others), based on anonymized tracking data, which are used for performance assessment and to enable identification of bottlenecks and their resolution.

The interface between the LMS and the CTMS is the ability of both systems to provide dashboards and statistical information, albeit from different perspectives. This may provide an important support and verification function.

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FIGURE 4.13: Heat Map of the Durban Port Area



Source: Crickmay & Associates.

4.3.8 Potential Areas for Collaboration with the CTMS and CTO

The difference between the LMS and the CTMS is that the CTMS concentrates on cross-border movement and deviations from registered routes, while the LMS monitors in-country traffic that affects traffic flow. The LMS includes port monitoring and tracking of the entire corridor and provides a macro picture of the logistics supply chain. As such, the LMS could potentially provide significant complementarity to the CTMS by providing an understanding the impact of ports and internal country logistics on the borders, and vice versa. Should it be possible for nonconfidential data from the CTMS to be used by the LMS, an additional layer of analysis could be added.

The vehicle and driver tracking data are continually recorded on the CTMS in real time. To protect the privacy of operators and drivers/crew members, the real-time tracking is not made available to officials on a continual basis unless the vehicle deviates from the registered route and timetable. In addition to the supply chain analysis, the LMS may be able to provide insights into the peculiarities and behavior of drivers. For example, the LMS's heat maps of the Durban port area clearly indicate the use of noncommercial parking facilities by drivers while waiting to enter the port for loading and/or off-loading (figure 4.13).

The LMS evaluates the activity of unidentified vessels that are anchored in lay-by or already docked. It also analyzes the anonymous vehicle tracking data received from the tracking service provider. In addition, the LMS uses daily port data to analyze the number of containers moved and the ratio of equipment (such as cranes and straddle carriers) to stack occupancy. This analysis provides critical insight into the productivity and capacity of the port and assesses wasted and/or cancelled slots.

This functionality complements the monitoring features of the CTMS, although the specific technical details and further areas of collaboration must be explored in greater detail once the CTMS uptake increases, the data become available, and a broader uptake of the system and its functionality is in place.

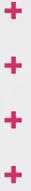
Collaboration between the LMS and CTOs is also worth examining. The CTOs gather significant data from the range of indicators and enable a retrospective understanding of corridor logistics movement and port activity. With the need for access to real-time reporting on the Northern and Central Corridor observatories, this is a possible area for additional focus, and the LMS possibly could provide support in view of the existing capacity and framework within which the data are collected and analyzed. The LMS may be able to assist because the rules required to work with the data, and the framework for dissemination of the information, are already well established, which would simplify the introduction of additional layers and analysis to the existing data.

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5.

Recommendations



The conclusions that follow are addressed from their analysis in this working paper, and from the position of the strengths of the system, the value of data, and the impact or potential impact on the ability of the corridor management institutions (CMIs) to (a) utilize big data to improve operations on the corridor, (b) be more responsive to the needs and challenges faced by corridor stakeholders, (c) broaden the application of the data to measure corridor performance, and (d) leverage the volume and relevance of the data and ensure regular communication with all stakeholders to strengthen the sustainability of the CMIs.





Corridor Transport Observatories



The corridor transport observatories (CTOs) on both the Northern and Central Corridors have proven to be outstanding data-gathering instruments, essential both for the purposes of understanding the performance of the corridors and for enabling an effective retrospective examination of corridor performance. In addition, the value of consistent data gathering has enabled a meaningful contribution to the understanding for member states of the technical and nontariff barriers affecting trade on the corridors. The annual, biannual, and quarterly reports are detailed, comprehensive, well presented, and of considerable value to the work of the government agencies and departments responsible for infrastructure, trade, and cross-border operations and to public sector service providers on the corridor. The value to all stakeholders is due to the comprehensiveness, scope, depth, and range of the data collected, which enable an understanding of the efficiencies and activities of the corridors.

The CTOs on the Northern and Central Corridors have been operational for a decade or more—approximately 12 years for the former and 10 years for the latter. However, the CTO websites yield little up-to-date information. The Northern Corridor’s dashboard indicates that it is a weekly monitoring tool for certain maritime, port, and corridor indicators. However, the weekly benefit of current, up-to-date information is lost as some data are a month out of date, and others are more than 18 months out of date. The indicative value of the data is in its currency, and the outdatedness of the dashboard summaries is counterproductive and lessens trust in the priority and credibility of the information.

The CTOs are costly to staff and operate, and both organizations depend to a greater or lesser extent on donor funding for their operation,

although the Northern Corridor CMI has indicated that it is moving toward self-funding its CTO. Documentation and reports are somewhat outdated and inconsistent in their production, with the most recent documents dating from July 2022. The Central Corridor’s dashboard is not entirely clear as to its currency; the indicators for efficiency, productivity, and transit times do not indicate dates and it is unclear as to which period the dashboard analysis refers. These factors detract from the value of immediacy in the assessment of indicators and are detrimental to the credibility of the CMIs. Some reports appear to be more current, and in the past two years, annual and quarterly reporting has been published jointly. Annual reporting is comprehensive, but the value would be considerably enhanced by more regular, shorter, more focused reporting on specific sections and/or sets of data in addition to the comprehensive annual reports.

In the case of the Central Corridor, an annual validation workshop is insufficient to build traction and understanding with private sector stakeholders. This is not an uncommon challenge for wholly public sector–run agencies; however, it would be of benefit to both the CMI and to stakeholders to have more regular communication and engagement on the reporting. The Northern Corridor’s annual validation workshops are strengthened by ongoing and direct engagement with the Shippers Council of Eastern Africa (SCEA) and the operational efficiencies that are managed in cooperation with the SCEA under the port charter. This is a dynamic and ongoing engagement on the operational efficiencies of the port and the impact of inland logistics on port efficiency, and it directly engages with the port and CMI on efficiencies.



Corridor Trip Monitoring System



The CTMS remains largely untested apart from the pilot project in four SADC countries—Botswana, Namibia, Zambia, and Zimbabwe. The number of transporters involved in the pilot program is also limited, and limited uptake of the CTMS makes an accurate assessment of the system impossible. Table 5.1 outlines the uptake of the CTMS pilot project run in the four pilot countries.

Based on its capabilities, the CTMS would provide excellent, in-depth information on regional corridor movement. The key benefit is in the real-time monitoring and reporting. Unfortunately, the same information is not available to the CMIs in real time; it is only available retrospectively, which is not ideal. In addition, not all the information provided to the CTMS is available to the CMIs, the format of the information is also not yet available, and there are concerns about the level of personal information required by the system. Both truckers and the Federation of East and Southern African Road Transport Associations (FESARTA) voice concern that the information required from drivers is intrusive and is not justified when a pandemic is no longer a threat. There is clear acknowledgment of the value of the tracking and tracing of drivers and travelers during pandemics such as COVID-19, but the extent of personal information required

is concerning when the safety and security of the information is not required in a normal trading environment and where much of the information could be easily accessed by government officials. The possibilities of manipulation certainly exist, and there is little information available to determine how a breach of the system would be managed. Such a breach would be disastrous for the system and for those whose information is compromised.

As the CTMS is still in its infancy, and the uptake has been limited, recommendations are premature. However, an area that may be worth reexamination is the retrospective access by CMIs of the trip information. It would be ideal for data to be accessible to CMIs in real time, to increase the impact and effect of the data analysis on the ability of the CMI to carry out interventions and provide timely data.

It is recommended that the LMS and the CTMS collaborate extensively to explore potential opportunities for strengthening and provide the best possible solution for improving the efficiency of transport corridors. The LMS should also offer verification for CTMS data and supply near-real-time data analytics to CMIs.

TABLE 5.1: Uptake of the CTMS Pilot Project

Country	Trips registered	Crew members registered	Vehicles registered	Routes registered
Botswana	4	15	31	4
Namibia	4	2	3	1
Zambia	76	1,272	2,073	45
Zimbabwe	50	1,832	2,708	110
Total	134	3,121	4,815	160

Source: Source: SADC: Fischer Consulting CTMS Trip Registration Data.
Note: CTMS = Corridor Trip Monitoring System.



Logistics Monitoring System



The LMS has been proven to provide excellent data for border-crossing statistics and for the operation of the port of Durban. It has been instrumental in providing an understanding of ship turnaround times, container terminal efficiency, truck movements into and out of the port of Durban, as well as of the waiting times of trucks at borders on the Beira, Dar Es Salaam, Maputo, Nacala, Northern Southern, Trans Caprivi, Trans Cunene, and Trans Kalahari Corridors.

The LMS sample size has been cited at 20 percent of the total heavy vehicles in South Africa (in the region of 450,000 registered heavy vehicles). At present, the LMS is the only system that provides near-real-time data in sufficient volume and with appropriate parameters, and it is the only system that additionally collects and analyzes port and shipping data in near real time. However, of concern is the cost of the outlay for the system and the cost of additional layers as the system develops. The possibility for expansion of the system is immediately available (that is, in terms of the sample size, and the possibility of doubling of the sample is currently available at little extra charge). The speed at which this can be done is a very positive factor that makes the LMS still more attractive. A major factor in support of the LMS is the various iterations of the data that can be made available at short notice for reporting, and which would strongly support the possibility of monetization of the data to strengthen the sustainability of the CMIs.

The data are of significant value to government departments that have services and functionality on corridors. For departments of public works, for example, the ability to understand the behavior of trucks in parking has provided insight into the damage caused by trucks parking over underground drainage lines, which enables interventions to be made to prevent the issue. The shipping data have been presented at the port of Durban and used to provide a dashboard that gives clear insight into ship behaviors and efficiencies within the port. In terms of the preparation and planning that could be

derived from corridor truck data, this is a significant gain for all corridor stakeholders. Mine loading can be monitored, and customs, immigration, port health, and similar departments can be alerted to prepare for the arrival at the border post and ports. In addition, the information is critical to informing policy and provides evidence for policy amendment, which enables greater safety and efficiency measures to be implemented.

It is recommended that clear frameworks be established that clarify roles and expectations for all involved in data collection and analysis of the LMS data, to create the conditions necessary for sustainable big data collection in the longer term. This is in line with the United Nation's recommendation for the availability of critical data for regional and national development policy development.

The most important recommendation for the sustainability of the LMS is for the corridor management institution to have a specific strategy to draft and implement a marketing plan to cover the outlay of the LMS and to gain sufficient buy-in from corridor stakeholders to cover the initial costs. Once the LMS is up and running, the CMI should do the following:

1. Determine what information the stakeholders require.
2. Develop a meaningful pricing strategy for the various data products.
3. Build specific products for monetization of the data.
4. Market the data products to stakeholders.
5. Evaluate and review and revise.

This will enable the CMI to build on the value of the LMS data to strengthen the organization's credibility while providing data that can be used to support improved efficiencies, lobbying and advocacy, policy and process amendments and improvements, and, importantly, to provide a legitimate and credible basis for this work.



Conclusion



As the CTMS develops and adds significant numbers of transport operators to the system, it will be possible to assess the impact of the system. The data analysis format of the CTMS is also unclear at this point and would require further assessment. The marketing of the benefits and the application of the CTMS to the transport sector will need to include significant comfort regarding the concerns on the integrity and safety of the information. These are an unknown factor at this stage, and until these security concerns are addressed, it remains unlikely that significant numbers of transporters will be incentivized to participate in the CTMS. The development of the CTMS should be monitored to assess its effectiveness.

Should these concerns be resolved, it is possible that the CTMS could satisfy most of the needs of data for CMIs, although the essential port operations data are not included. The LMS could play an important role in filling this gap and ensuring that the full corridor data are provided to CMIs in near real time.

No ideal transport and logistics monitoring or management is in place yet. All the systems provide excellent data-collection capabilities, which are essential for enabling CMIs to support their sustainability, from both a financial and a credibility perspective. However, the main value for CMIs is in a system that can collect real-time data and provide an almost immediate analysis of the key elements of corridor activities on a daily basis. For CMIs, this positions the LMS as the most appropriate system at present.

The significant data collection and analysis capacities of the CTOs, CTMS, and LMS are greatly beneficial to CMIs, and utilized in concert, these three systems would enable an almost immediate understanding of critical factors impacting trade and transport on the corridors. However, at present, the volume, flexibility, and responsiveness of the LMS data place the LMS at the forefront of big data analysis on the corridors. As rail capacity in the southern African region appears unlikely to meet demand in the near to medium term, the need for data collection to enable the management, monitoring, and increased efficiency of corridors and cross-border trade will become more pressing than ever.





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