



**THE IMPORTANCE
OF INFRASTRUCTURE
FOR LANDLOCKED
DEVELOPING
COUNTRIES**



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FOREWORD



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The Vienna Programme of Action (VPoA) identifies the challenges that Landlocked Developing Countries (LLDCs) face and aims to provide guidance for their regional integration and advancement. Infrastructure development is identified as one of the six priorities of the VPoA.

With the explicit mandate within the UN to implement infrastructure, UNOPS is committed to supporting LLDCs gain a better understanding of how they can improve their infrastructure planning, delivery and management practices to support achievement of the Agenda 2030.

Infrastructure plays a critical role in society as it is the foundation for development and, because it is built to last, can have positive or negative impacts far into the future. This is why evidence-based decision-making is vital in developing and managing sustainable, resilient and inclusive infrastructure that can enable good development.

This publication highlights the critical role of infrastructure in helping LLDCs combat some of their specific development challenges and protect their development gains. It also aims to provide some insight into potential solutions to ensure they reap the long-term benefits from infrastructure investment.

We are proud to present this report and to reaffirm our commitment to helping people build better lives and countries achieve sustainable development through sustainable, resilient and inclusive infrastructure.

EXECUTIVE SUMMARY

LLDCs face particular development challenges. Their geographical constraints limit their access to international markets and intensify their vulnerability to climate change. Due to these issues, the UN Office of the High Representative for Least Developed Countries, Landlocked Developing Countries and Small Island Developing States (UN-OHRLLS) has estimated that, on average, the development levels of LLDCs are approximately 20 per cent below their non-landlocked peers. In order to improve their social, environmental and economic development, LLDCs need to break away from the current silo-based approach to infrastructure development and move towards a more holistic approach. Development partners need to work with LLDCs to support them to increase their capacity to effectively plan, deliver and manage sustainable and resilient infrastructure systems utilizing relevant data and applied analysis.

The VPoA for LLDCs focuses on the development of efficient transit systems; improved competitiveness and trade; regional cooperation; the promotion of inclusive economic growth; and sustainable development. Although LLDCs have made development progress from the adoption of the VPoA – including moderate economic growth, regional integration policy reforms and increased development assistance investments – there are still significant barriers to their international competitiveness and sustainable development. These barriers result in LLDCs spending twice as much and requiring nearly double the time to import and export goods and services when compared to transit countries.

Of the five main infrastructure system sectors, the three sectors with the greatest impact on improving the regional integration and trade competitiveness of LLDCs are transport, digital communications and energy. Actions to advance the sustainable development of LLDCs include:

- Developing transit corridors by improving the quality of existing road and rail networks and by increasing the efficiency of intermodal facilities (for the transfer, handling, storage, inspection and customs clearance of goods);

- Developing digital communications systems by expanding fiber-optic broadband cabling and reducing the cost of access, which will lead to increased trade competitiveness and enhanced international integration; and
- Implementing cost-effective solutions to energy infrastructure, for example, by replacing diesel-powered generation with renewable energy sources (hydropower, bio-energy, solar and wind energy), which will result in decreased reliance of LLDCs on energy sources subject to political instability and shortages, and increased independence and reliability in international markets.

Implementing sustainable and resilient infrastructure requires an approach which relies on a detailed understanding of the context and is evidence-based. This is particularly important to avoid risks and realize opportunities. The failure to consider this complexity can result in costly and ineffective infrastructure solutions.

UNOPS has been working with partners to provide governments with the evidence needed to plan and finance infrastructure that is essential to grow the economy, protect the environment, and improve the lives of their populations. The Evidence-Based Infrastructure (EBI) Initiative is a holistic approach that includes the processes and, where appropriate, the tools for successful infrastructure planning, delivery and management. These tools and methodologies are rooted in the system-of-systems approach, with a focus on long-term, integrated planning and development, and with consideration for the entire lifespan of infrastructure systems and assets.

To create this evidence-based approach, UNOPS has harnessed decades of experience in designing and implementing infrastructure projects in some of the world's most challenging environments, to find ways of better supporting governments with their infrastructure development.

To improve understanding of the enabling environment and the capacity of governments (at a national, regional,



UNOPS works with partners in South Sudan to improve infrastructure and enhance connectivity – via roads and bridges – helping to facilitate humanitarian access and economic development. ©UNOPS

or municipal level) to plan, deliver, and manage their infrastructure systems in a sustainable and resilient manner, the Capacity Assessment Tool for Infrastructure (CAT-I) was developed.

To support a government's ability to plan and manage infrastructure, it is important to improve their understanding of what infrastructure assets they own, and what condition it is in. For this reason, UNOPS is developing the Database for Evidence-Based Infrastructure (DEBI) and FieldSight.

In partnership with the University of Oxford-led Infrastructure Transitions Research Consortium (ITRC), UNOPS has also developed the National Infrastructure Systems Model International (NISMOD-Int), which supports countries that already have basic information on their assets, with upstream planning. NISMOD-Int enables decision makers to understand the performance of existing and future infrastructure systems, and to develop and access alternative strategies for achieving sustainable development.

These evidence-based approaches – combined with its extensive experience in designing, developing and implementing infrastructure projects in diverse and challenging environments – enable UNOPS to support LLDCs in the challenges they face on the path to sustainable growth and resilience.

INTRODUCTION

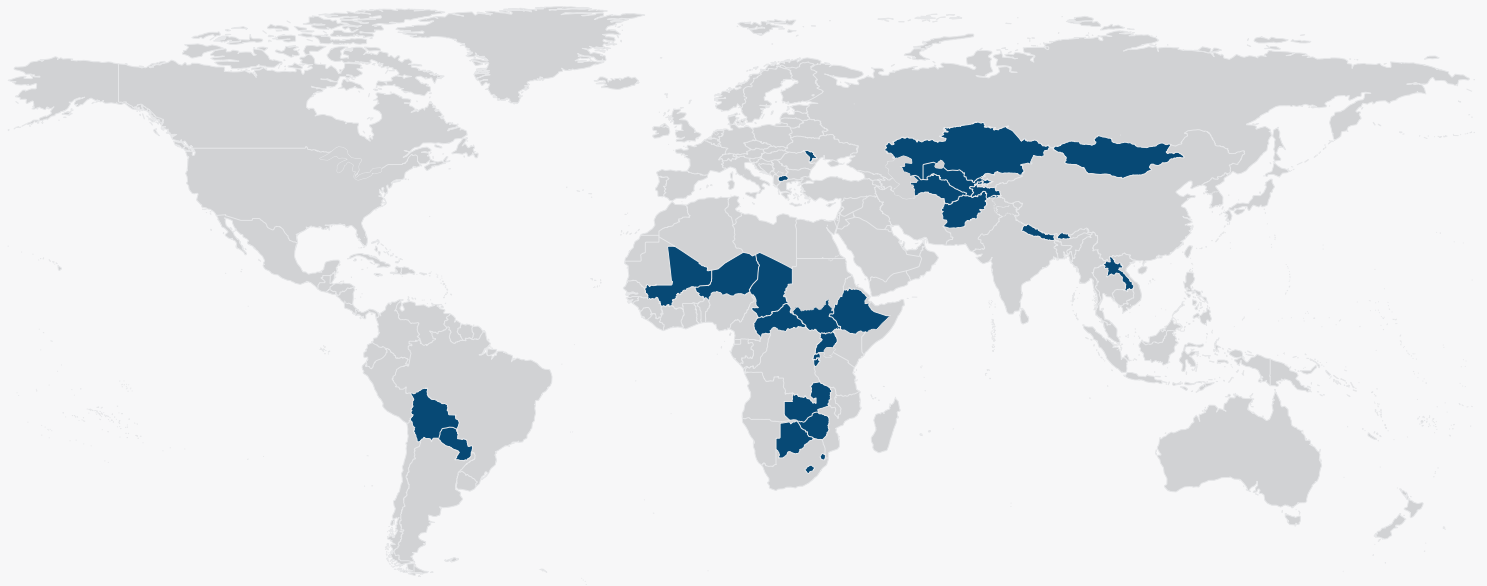


A lack of sustainable and resilient infrastructure is holding back landlocked developing countries from achieving their full potential, reducing their international competitiveness and integration. Geographical constraints, weak infrastructure systems management, and reliance on unsustainable resources are at the base of the existing development divide between LLDCs and the rest of the world. Given the importance of sustainable and resilient infrastructure for development, new solutions and tools have to be used in order to support LLDCs in the planning, delivery and management of infrastructure systems, and to support them in their efforts to close the development gap with the rest of the world.

All infrastructure systems are important for development. However, there are five key systems which enable and support the development and functioning of society, namely: water, solid waste, energy, transport and digital communications.¹ From these, the three most important systems for the development of LLDCs are transport, energy and digital communications. These three sectors have a significant impact on trade and market performance, business competitiveness, and regional and international connectivity, and support improved transparency and governance.² These focus areas also represent concrete direct and indirect intervention opportunities for LLDCs, and other development partners, including the private sector and civil society. Creating sustainable and resilient infrastructure fosters the economic, environmental and social development of LLDCs, which currently lags behind other developing and developed countries. According to UN-OHRLLS, the development levels of LLDCs are approximately 20 per cent lower than they would be if these countries were not landlocked.³

The significant role of infrastructure in enhancing the sustainable development of LLDCs is strongly related to the current paradigm shift that UNOPS encourages. There is a need to take a holistic approach to infrastructure to enhance the way it is planned, delivered and managed. This requires establishing a dialogue between LLDCs, UNOPS and other development partners to understand what aspects of infrastructure system development must be prioritized, and the opportunities that arise from considering transport, energy and digital communications infrastructure as part of an integrated and interdependent system-of-systems.

UNOPS has developed – and is currently implementing – a series of methodologies supported by tools, to be used where appropriate, and based on the EBI approach to helping governments assess and improve their capacity to plan, deliver and manage infrastructure systems. This includes identifying priority areas for intervention and assessing the level of sustainability, efficiency and resilience of existing infrastructure assets and systems. The tools and methodologies that have been developed to support the EBI approach are: the Capacity Assessment Tool for Infrastructure; the Database for Evidence Based Infrastructure; FieldSight; and the National Infrastructure Systems Model. This approach and related tools are discussed in detail in the final section of this report.



■ Landlocked developing countries

*This map is for illustrative purposes and does not imply the expression of any opinion on the part of UNOPS concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

BACKGROUND

There are 32 landlocked developing countries in Africa, Asia, Europe and South America, with a combined population of roughly 440 million people. These countries face significant development challenges due to their lack of territorial access to the sea and resulting isolation from international markets. VPoA for landlocked developing countries (2014–2024) renewed commitments to improving the connectivity and regional integration of LLDCs. This process began in 2003 with the Almaty Programme of Action (APoA), which reflected the goal to create partnerships to address the specific challenges of LLDCs.

The geographical constraints of LLDCs hinder their ability to advance economic development, environmental sustainability, and human and social progress. Some LLDCs are among the least developed countries in the world, and only five LLDCs are included in the group of countries with a high human development index rating.⁴ In general, LLDCs are characterized by higher levels of vulnerability. For example, they are more exposed to volatile food prices and resource dependency which can result in increased food insecurity.⁵

LLDCs are also more seriously affected by climate change due to the majority of their agricultural land being located in arid and semi-arid areas, with an estimated 54 per cent of their land classified as dryland.⁶ Desertification – the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture and land use – disproportionately affects LLDCs, along with flooding, landslides and loss of biodiversity.⁷ At the same time, according to the UN's Sustainable Development Goals Report 2018, the proportion of land area covered by freshwater bodies in LLDCs has declined by 4.7 per cent over the last decade (2005–2016).

Lack of abundant surface water and progressive desertification has considerably impacted people's livelihoods and agricultural productivity in many LLDCs. UN-OHRLLS highlights that between 2005 and 2015, the loss of crop and livestock production for LLDCs due to natural-hazard induced disasters amounted to \$11.6

billion, or approximately 8 per cent of their potential crop and livestock production.⁸ These conditions also result in higher undernourishment levels (76 per cent higher) and mortality rates for children under five-years-old (46 per cent higher) than averages in other developing countries.⁹

Climate change induced natural disasters also contribute to the deterioration of many infrastructure types, including roads, rail, hydropower plants, schools and other public buildings. These negative effects result in increased costs on maintenance, transit and trade, and consequently affect the competitiveness of LLDCs in the global market.¹⁰

Key issues that impede LLDCs' competitiveness in international trade include the following:

- Additional border crossings and border procedures;
- Longer distances and inadequate transport infrastructure;¹¹
- Climate change related shocks and disasters;¹² and
- Reliance on transit countries' political stability.¹³

Due to these issues, LLDCs spend double the amount on import and export costs per container compared to transit countries,¹⁴ and require nearly twice the amount time for both imports and exports.¹⁵

The World Bank Logistics Performance Index (LPI) rates the quality of trade and transport-related infrastructure by analyzing selected components – customs, infrastructure, ease of arranging shipments, quality of logistics services, tracking and tracing, and timeliness – to come up with an indicator to conduct cross-country comparisons.¹⁶

According to the LPI, there has been a slight improvement in the logistics performance scores of LLDCs from 2016 to 2018.¹⁷ However, the average score for LLDCs of 2.47 is still significantly lower than the world average of 2.84.¹⁸ **Table 1** illustrates that the LPI scores of transit countries have also decreased, while the global scores have increased.

Following the adoption of the APoA, LLDCs have begun to achieve certain development results, including moderate economic growth, regional integration policy reforms and increases in national and international development

assistance investments. However, significant effort is still needed in order to achieve sustainable development and international integration for LLDCs. While the Gross Domestic Product (GDP) growth rate across LLDCs increased from 3.4 per cent in 2000 to 9.3 per cent in 2007, the economic growth rate slowed down to 3.6 per cent in 2015 due to the global financial crisis and the fall of commodity prices.²⁰ Unfortunately, in most cases, economic growth does not translate into redistribution of wealth to the poorest individuals. In 2017, the average per capita GDP in LLDCs was \$1,544; however, it was still lying below \$1,000 in 13 LLDCs,²¹ and the proportion of the employed population subsisting on \$1.90 per day (the international poverty line) was 25.5 per cent in 2017.²²

Infrastructure and transit policy reform is one method used to address the development challenges faced by LLDCs. Some LLDCs have initiated the process to harmonize transport and transit policies, legislation, procedures and practices between transit countries. For example, in Latin America, several countries banded together to form the Southern Common Market, which seeks to generate business and investment opportunities through agreements on border procedures and transit rules, with the final objective of freedom of movement for goods, services and productive factors.

Another example is the Agreement on International Land Transport, which governs rail transport and the transport of goods and passengers among its member countries. Certain institutional frameworks have also been developed to establish free trade areas and regional trade agreements. At the international level, the World Trade Organization Trade Facilitation Agreement made customs and border management procedures more efficient. At the regional and sub-regional level, trade agreements include the Multilateral Agreement on the Lapsset Corridor Development Authority of 2012 between Kenya, Uganda, South Sudan and Ethiopia, and the Intergovernmental Agreement on the Trans African Highway, which includes requirements for the technical standards for roads and signage that members must abide.²³

In an effort to reduce transport time and transaction costs, certain measures have been adopted by LLDCs. In regards to transport time, there has been a decrease in the estimated import/export times from 57/49 days in

	2007	2010	2012	2014	2016	2018
LLDCs	2.19	2.47	2.40	2.19	2.19	2.19
Transit Countries	2.56	2.65	2.73	2.56	2.56	2.56
World	2.74	2.87	2.87	2.74	2.74	2.74

Table 1: Logistics Performance Index (average values calculated based on available country information)¹⁹



Vital infrastructure improvements and better roads throughout South Sudan help drive sustainable development.
©UNOPS/John Rae

2006 to 47/42 days in 2014, which is still nearly double the time used by transit countries.²⁴ One solution to help reduce transport time is the use of cargo air transport. LLDCs have seen an increase in cargo air transport from an estimated 200,000 registered flight carrier departures in 2003 to 362,800 in 2013.²⁵ However, new infrastructure investments for storage and intermodal facilities are needed to make air transport more affordable and competitive, as its average cost is still 4 to 5 times higher than road transport, and 12 to 16 times higher than sea transport.²⁶

In order to address both the challenges and opportunities for sustainable development, the VPoA provides a way forward for LLDCs to expand and develop transit systems and transport development; enhance their competitiveness; expand trade; achieve structural transformation; increase regional cooperation; and work towards inclusive economic growth and sustainable development. The six priorities of action defined by the VPoA will help governments, institutions and development organizations to direct their efforts towards effective development initiatives.

The priorities are as follows:

Priority 1: Fundamental transit policy issues

Priority 2: Infrastructure development and maintenance

- a. Transport infrastructure
- b. Energy and information and communications technology infrastructure

Priority 3: International trade and trade facilitation

- c. International trade
- d. Trade facilitation

Priority 4: Regional integration and cooperation

Priority 5: Structural economic transformation

Priority 6: Means of implementation

The VPoA has reinforced the commitment of national governments and development partners to address the unique challenges of LLDCs. Investments and development assistance to LLDCs more than doubled from \$12.2 billion in 2003 to \$25.9 billion in 2012, of which \$5.9 billion represents the aid-for-trade disbursement to improve trade facilitation and trade-related infrastructure development.²⁷

The main infrastructure challenges of LLDCs identified by UN-OHRLLS are further analyzed in the next section of this report.



COMMON INFRASTRUCTURE ISSUES FOR LLDCs

Networked and non-networked infrastructure systems play a key role in economic growth and sustainable development. In the case of LLDCs, transport, digital communications and energy infrastructure are essential for improving access to markets and resources, as well as for improving the movement of raw materials, commodities, data and knowledge.

As highlighted in the report “Infrastructure: Underpinning Sustainable Development”,²⁸ infrastructure plays a critical role in achieving sustainable development – that is, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.²⁹ The research underlying the report found that 155 out of the 169 targets (92 per cent) of the 17 Sustainable Development Goals (SDGs) are influenced by infrastructure development in different sectors.

Numerous infrastructure projects have been developed following both the APoA and the VPoA, but many issues still require attention to help LLDCs attain greater regional integration and enhanced trade competitiveness. Some of the challenges for the achievement of these goals, as identified by UN-OHRLLS, include: the lack of links within the regional road and rail systems; the need for maintenance of roads; faster intermodal (multiple modes of transport) transfers; the provision of digital communications, and, specifically, access to the internet; and finally, the improvement of sustainable energy resources and reliability.³⁰

Transport infrastructure

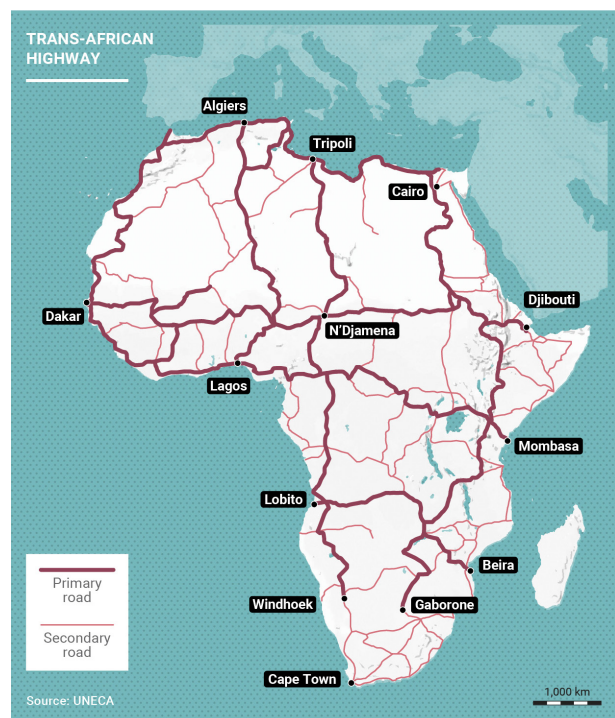
In order to achieve efficient and integrated mobility of goods and people between LLDCs and their neighbouring countries, there is a need to create the missing connections within existing transportation networks and corridors. Creating the missing links entails different actions that range from paving and asphaltting existing roads, to creating new ones, and from the harmonization of border procedures, to the construction of intermodal transfer facilities.



Most LLDCs are currently working toward the development of international and regional transit corridors. A transit corridor is defined as the geographic area between two points, linking multiple centers, and moving people and freight. This definition includes both the transportation infrastructure (e.g. the roadbed, rails and stations) and the new and existing development that surrounds that infrastructure. A successful case is the National Road 81 in Argentina, which was restructured and now connects the ports of Iquique in Chile and Asunción in Paraguay. Investments in these corridors have provided consistent benefits for both countries, with increases in exports from Paraguay to Chile from \$63,821 in 2005, to \$669,556 in 2014. The East-West Economic Corridor (EWEC), connecting Vietnam and Myanmar via Laos and Thailand, is another successful example of developing transit corridors. The EWEC significantly reduced travel time; contributed to Cambodian access to healthcare, education, markets and other public service facilities; and incentivized the development of economic activities and services along the corridor, including guesthouses, petrol stations and restaurants.³¹

On the contrary, other regional transport networks still lack a certain degree of connection in order to express their full potential. The Trans-African Highway (TAH) and the Trans-Asian Railway (TAR) provide two significant examples of absent linkages within regional transport infrastructure systems. As illustrated in **Figure 1**, the TAH currently consists of 56,683 km of road network distributed along nine corridors;³² however, the TAH does not have adequate linkages to regional road systems and is poorly maintained in sub-Saharan Africa.³³ Between 60,000 and 100,000 km of regional roads are needed to provide substantial connectivity on the continent.³⁴

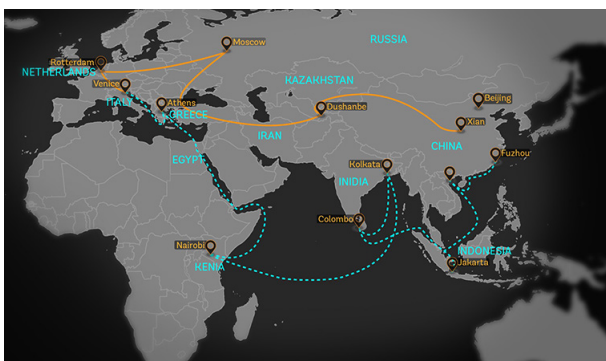
Figure 1: Trans-African Corridors³⁵



The TAR connects 28 countries with 117,000 km of rail network, providing beneficial connections for many Asian LLDCs.³⁶ Unfortunately, the TAR is also missing 10,500 km of required linkages.³⁷ Recent efforts have focused on establishing the necessary missing links; for example, the completion of the Afghanistan-Turkmenistan Lajaward railway network and the construction of the missing rail link between China, Kazakhstan, Turkmenistan and the Islamic Republic of Iran.³⁸

Another relevant example of efforts to improve international market integration and connectivity at the regional – and almost global level – is China's Belt and Road Initiative (BRI). The BRI is a trans-continental scale infrastructure programme that will involve 65 countries, which collectively account for over 30 per cent of the global GDP, 62 per cent of the population and 75 per cent of known energy reserves.³⁹ **Figure 2** shows the localization of the BRI. In terms of connectivity, through improved transport infrastructure in the Asian region, the BRI will halve the transport time for goods to reach Europe from China, also benefiting many Asian LLDCs through the creation of development opportunities along the way.

Figure 2: Belt and Road Initiative⁴⁰



An issue that falls within the lack of links, and contributes to it, is the quality and condition of existing roads. Road infrastructure is the primary means of transport for LLDCs, and roads are often unpaved and poorly maintained.⁴¹ In general, the percentage of LLDCs paved roads is still between 15 per cent and 25 per cent, with similar percentages for highways both in African and South American LLDCs.⁴² Maintenance is equally problematic as road infrastructure can deteriorate prematurely due to stresses caused by climate change or the failure to enforce regulations, such as overloading trucks.⁴³ This is compounded by the fact that governments often lack the resources and capacity to implement necessary maintenance works.⁴⁴

In addition to improving the quality and maintenance of road networks, increasing the efficiency of intermodal facilities can also improve regional integration and trade competitiveness of LLDCs. The term intermodal transfer refers to the connection between two or more methods of transport in the conveyance of goods. Increased efficiency of transit corridors may be accomplished by the establishment of intermodal facilities, such as the construction of dry ports infrastructure.

The establishment of dry ports is a significant tool for improving the efficiency of intermodal transfers and increasing regional integration and competitiveness of LLDCs. Dry ports are secure inland locations for handling, storing, inspecting and clearing customs of freight moving in international trade.⁴⁵ Relocating container

shipping from port loading/unloading areas to inland dry ports can help improve operational efficiency. Dry ports may also result in positive environmental sustainability impacts by alternating road transports with less polluting services such as rail and inland waterways.⁴⁶ Several LLDCs in Africa, Latin America and Asia are developing dry port infrastructure projects in an attempt to reduce transportation times with very positive results. Examples include the Khorgos-East Gate free economic area between Kazakhstan and China, and the Malaba dry port in Kenya, which reduced the period for clearance and transport of goods from the Mombasa sea port to Kampala, Uganda from 15 days to 4 days.⁴⁷

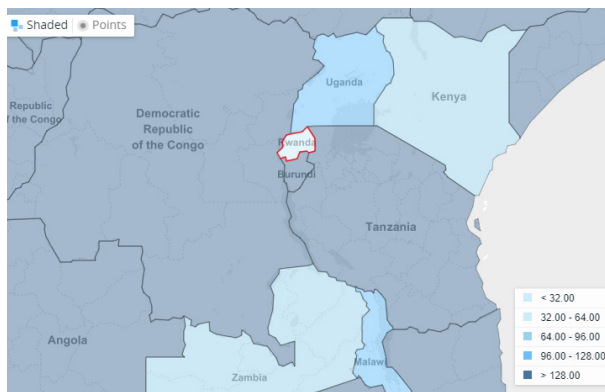
Digital communications

In order to enhance international integration, knowledge sharing, and promote LLDCs business environment, more efforts and investments are needed in the development of digital communications infrastructure. Although there has been a strong increase in the use of mobile communications – subscriptions have more than tripled between 2005 and 2016⁴⁸ – the number of internet users in LLDCs is still relatively low, with an average of 23 out of 100 people using the internet in 2016, compared to 39 out of 100 in transit countries.⁴⁹ The disparity in users among LLDCs is also very high, with Azerbaijan ranking first with 78.2 users out of 100 people, and Central African Republic ranking last, with only 4 users out of 100 people.

The high cost of internet access in many LLDCs is the main reason behind the low number of users. The monthly fixed broadband price is around 72 per cent of the average per capita income in LLDCs, a huge cost compared to the 5 per cent of developed countries and 20 per cent of transit countries.⁵⁰ High costs are due to the lack of proper infrastructure such as fiber-optics and transmission lines. In order to solve this constraint, LLDCs need to invest further in digital communication infrastructure at the national level.

Rwanda is a positive example of how investing in digital communications infrastructure has improved the business environment of the country and supported international integration. The government invested in the establishment of more than 4,500 km of fiber-optic broadband cabling, connecting all 30 districts of the country and creating nine regional links to neighbouring countries; the 4G LTE network was established, together with 10 Gbps broadband capacity. Moreover, Rwanda increased mobile penetration to 76.2 per cent.⁵¹ The outcome of these investments are visible in the ease of doing business in the country, which, in 2017, was more than three times higher than its neighbouring countries, and double Kenya's ranking, as shown in Figure 3.⁵² At the same time, the subscription to fixed broadband in the country increased from around 2,000 in 2014 to more than 21,000 in 2017,⁵³ and the Logistics Performance Index for the country increased from 2.04

Figure 3: Ease of doing business in 2017 in Rwanda and neighbouring countries (1 = most business-friendly)⁵⁵



in 2010 to 2.97 in 2018, a higher score than not only the average of LLDCs but also of transit countries and the global average score.⁵⁴

The provision of sustainable energy

High costs for both transport and digital communication access in LLDCs are also caused by poor energy infrastructure and the consequent unreliability of energy supplies. Sustainable and efficient energy infrastructure are fundamental for the improvement and growth of both transport and digital communication infrastructure.

Although there have been notable improvements in energy infrastructure over the last decade, LLDCs still lag behind the rest of the world in this area, with substantial disparities between LLDCs as well. As of 2014, 9 of the

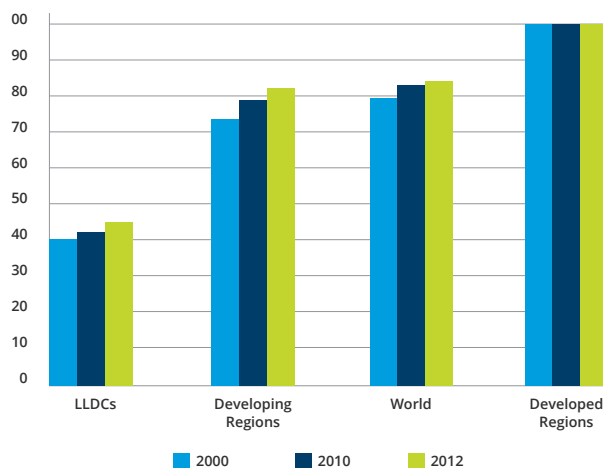
urban-rural gap. This issue can be addressed through cost-effective solutions, like replacing diesel-fired power generation with renewable energy sources. UN-OHRLLS reports that around 300 million people in LLDCs – approximately two-thirds of their population – still use biomass for indoor cooking, an unhealthy and polluting practice.⁵⁸ This highlights the need for a shift toward sustainable energy. The primary sources of renewable energy in LLDCs are hydropower, bio-energy, solar and wind-energy, with different countries excelling in different sources.

For example, Paraguay and Bhutan are very strong in the production of hydropower, and also manage to export it, while Ethiopia has recently constructed the largest wind farm in Sub-Saharan Africa, the Adama Wind Farm II.⁵⁹

Some of the challenges for the adoption of renewable energy infrastructure include a lack of expertise in project development and implementation, and a lack of institutional capacity and technical coordination at both the national and regional level. Knowledge transfer on renewable energies is usually very limited and there is a lack of information and inconsistency in the way energy sector data is collected, compiled and analyzed.⁶⁰ Additionally, local capacity is not always developed and many locally trained human resources may leave the country to seek better opportunities.⁶¹

Nepal is a relevant example of how inadequate design, delays in project implementation and significant underinvestment in base load generating capacity caused the significant under exploitation of sustainable energy. The country has an installed hydropower generation of 802.4 MW, which is less than 2 per cent of its commercially exploitable hydropower generation potential. The mismanagement of resources – together with unstable political relations with neighbours – contributed to the fuel crisis that affected Nepal in September 2015, due to the high reliance on fossil fuels imported from India.⁶² The shortage of fuel caused daily power cuts; the shutdown of schools, public and private transport; and an economic loss of more than \$7 billion, lowering the growth forecast from 6 per cent to 2 per cent.⁶³

Figure 4: Proportion of population with access to electricity (%)⁵⁷



32 LLDCs had achieved universal access to energy, while another 9 LLDCs maintained access rates at 20 per cent or below.⁵⁶ Figure 4 shows the proportion of the population with access to electricity in LLDCs, developing regions, the rest of the world, and Europe and North America.

One of the leading issues in increasing access rates in LLDCs, as much as in all developing countries, is the



UNOPS APPROACH TO INFRASTRUCTURE

UNOPS supports an approach that recognizes the interdependence of infrastructure as a system-of-systems.

It is crucial to consider the entire lifespan of infrastructure in order to recognize opportunities and avoid risks. Due to the typically long lifespan of infrastructure assets, they should be designed and developed with a focus on their sustainability and resilience.

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Applying this notion to infrastructure systems requires that these systems and assets are planned, designed, implemented, operated, maintained and decommissioned with consideration for limiting the negative – and increasing the positive – social, environmental and economic impacts on the communities that they serve, now and in the future.

The resilience of an infrastructure system is related to the degree that an infrastructure system can withstand external shocks and stresses from the environment, economy and society over its lifetime.

It is important to understand that sustainability or resilience cannot be achieved unless these concepts are understood and embedded in the infrastructure system through an evidence-based and integrative approach. Sustainable and resilient infrastructure is about ensuring that people, communities, cities and countries are able to continuously develop and grow, regardless of the shocks and stresses that they face over the long-term.

Therefore, sustainability and resilience are essential elements to consider when rethinking infrastructure as a system-of-systems. The idea of infrastructure as a system-of-systems resulted from the recognition that



A combined solar and wind energy plant produces 3,000 mega-watt hours of electricity each year for Herat, Afghanistan. ©UNOPS/Muhamad Salehudin

a purely “physical assets” approach to infrastructure is simplistic and may end up in the failure of the assets and the services they should provide. This “silo-based approach” does not acknowledge the multiple dimensions of infrastructure that are critical to understanding how infrastructure fulfils essential functions within a society and the context within which it operates.

Infrastructure systems are made up of three dimensions: assets, institutions and knowledge. Knowledge is defined as the human resource that is engaged within the system and has the knowledge to carry out the actions required in the planning, creation, operation and maintenance of the system; while institutions are defined as key bodies (governmental and non-governmental) that provide the regulations, policies, financing and legal frameworks for the planning, creation, operation, maintenance and disposal of the assets. These two components are collectively known as the capacity of the system.

In general, no infrastructure system exists in isolation. Interdependencies between the assets, institutions and knowledge that make up an infrastructure system and link different infrastructure systems means that infrastructure must be considered as a complex system of interacting systems: a system-of-systems.⁶⁴

Moreover, there is a general recognition that there are five core infrastructure sectors – also defined as networked infrastructure – that form the backbone of modern society: power, water, transport, solid waste and digital communications. Non-networked infrastructure comprises mainly of a single asset type – a building or a facility – that supports the delivery of a service, such as:

hospitals, schools, industrial facilities, community centers and government buildings.

This interdependence is both an enabler of the total system, or parts thereof, and also a risk. A failure of one system, or part thereof, can lead to a cascading failure that can have catastrophic effects. An example is the impact of Hurricane Sandy on the infrastructure systems and services of New York City in 2012. The hurricane caused storm surges and flooding, which damaged electricity sub-stations, causing power cuts for two million people and interrupted key infrastructure services. In particular, the power cuts considerably impacted the health sector with five hospitals closing and around 2,000 patients evacuated. The transport system was also damaged with six vehicular tunnels, all six subway tunnels, and several other tunnels out of service for days.⁶⁵

With infrastructure systems becoming more complex and interdependent, new opportunities and risks for development arise. These need to be better understood by governments, particularly in LLDCs, in order to exploit opportunities and better mitigate risks.

With an estimated \$97 trillion in infrastructure investment required globally by 2040,⁶⁶ there is no better time to start thinking about how to understand this complexity and embed sustainability and resilience into infrastructure development. This represents a massive opportunity to achieve meaningful long-term evidence-based results, but will require a shift in thinking.

UNOPS can support governments make this shift.

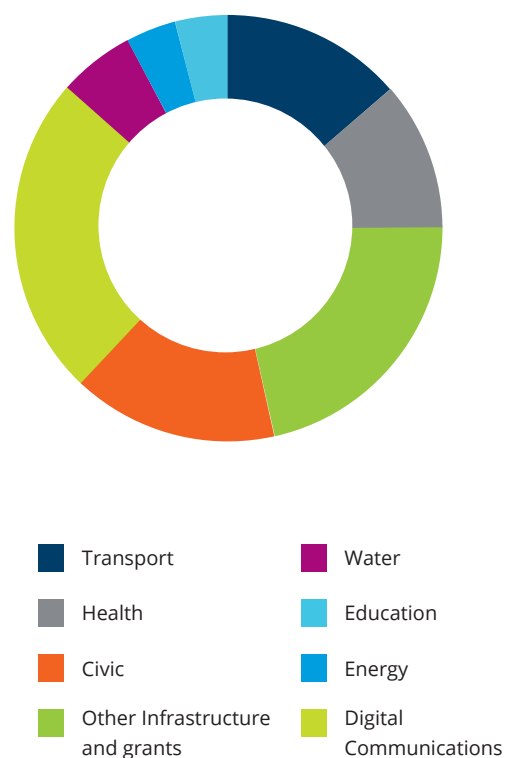
HOW CAN UNOPS HELP?

UNOPS has more than 20 years of experience in the development of infrastructure and infrastructure-related services. This includes the design and construction of infrastructure, as well as technical assistance in the planning, delivery and management of infrastructure (e.g. feasibility studies and environmental and social impact assessments). UNOPS experience centres around most infrastructure types: civic (e.g. rule of law), health, education, transport, energy, digital communications, potable water, wastewater and solid waste management facilities. **Figure 5** represents the percentage of infrastructure expenditure in 2017 for these different sectors.

UNOPS is using this experience and its UN mandate for infrastructure implementation to support the achievement of the 2030 Agenda. According to a recent publication by UNOPS and the University of Oxford-led ITRC titled “Infrastructure: Underpinning Sustainable Development”, infrastructure plays a central role in all the SDGs. The research found that 155 out of the 169 targets (92 per cent) across all of the 17 SDGs are influenced by infrastructure development.

Infrastructure therefore holds a critical role in the functioning of every modern human activity and the ability of these systems to function effectively and efficiently is extremely important. With this in mind, it is essential to consider aspects such as sustainability, resilience and national capacity when planning, delivering, managing or rehabilitating infrastructure.

Figure 5: UNOPS infrastructure expenditure in 2017, highlighting the breakdown of infrastructure project types by sector.



Infrastructure projects delivery

UNOPS has successfully contributed to the development and integration of LLDCs.

A relevant example of an infrastructure project carried out in LLDCs is the World Bank-funded Agricultural Sector Recovery Program, in which UNOPS built and rehabilitated 2,500 km of roads, 12 bridges, 20 markets, 20 warehouses, and improved irrigation systems in 3 remote provinces in northwest Democratic Republic of the Congo between 2011 and 2015. The aims of the project were to boost agricultural recovery and provide access to markets for 340,000 people living on isolated farms.

Another key project is the construction of a combined solar and wind energy plant that produces 3,000 megawatt hours of electricity each year for the city of Herat, Afghanistan. With funding from the government of Japan, the project is benefiting around 1,500 households and 100 businesses, reaching around 15,000 Afghani citizens.

Advisory services

As well as directly delivering a range of infrastructure asset types to support governments, UNOPS can also support LLDCs by providing advisory services on the planning, delivery and management of their infrastructure systems to improve their sustainability and resilience.

UNOPS has adopted an EBI approach to support governments with the planning, delivery and management of national infrastructure systems. It is based on first understanding the needs of our partners by identifying key challenges and opportunities for action. These actions are then crafted into specific tailored solutions for our partners.

To support this process, UNOPS has developed a series of tools and methodologies that are applicable to LLDCs and other developing economies while they are on their journey to sustainable and resilient development.

Capacity Assessment Tool for Infrastructure

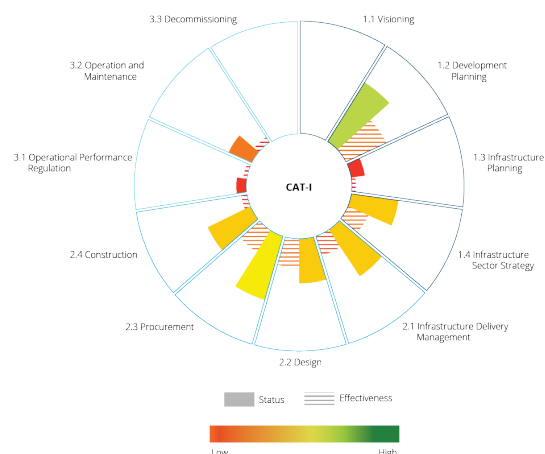
The Capacity Assessment Tool for Infrastructure (CAT-I) is a tool to assess and identify the gaps in government capacity (at national, regional and municipal levels) to effectively plan, deliver and manage sustainable, resilient and inclusive infrastructure systems. CAT-I looks at all aspects of the institutions and knowledge components of an infrastructure system, namely: the policies, standards, financial mechanisms, procurement procedures, regulation, enforcement mechanisms, and codes and standards which govern an infrastructure asset's life cycle.

The specific objectives of CAT-I are to:

1. Create a common language and framework for infrastructure capacity development;
2. Identify capacity gaps in the planning, delivery and management of infrastructure systems;

3. Support the identification of potential solutions to build capacity;
4. Create a pipeline of programmes and projects to build capacity; and
5. Show progress against a measured baseline.

Figure 6: CAT-I Diagram



One recent application has been with Mato Grosso State in Brazil where the results from CAT-I helped support the government to update and improve legislation which supports upstream planning to ensure the right assets are being selected and implemented to promote sustainable, resilient and inclusive development.

CAT-I was developed by the UNOPS Infrastructure and Project Management Group in close collaboration with partners in Mato Grosso (Brazil), Nepal, Serbia and with UNOPS infrastructure experts and practitioners from around the world.

Understanding your assets

Understanding what infrastructure assets a government owns, and what condition it is in, is fundamental to a government's ability to plan and prioritize infrastructure investments. To support governments with the asset component of an infrastructure system and the challenge of asset assessment and management, UNOPS is developing additional tools which include DEBI and FieldSight. DEBI is being developed as a software platform to assist those responsible for the management, operation and maintenance of national infrastructure systems or key infrastructure services with the ability to visualize, oversee and access high level information related to performance and function of national assets.

FieldSight is a data collection tool that supports field monitoring and quality assurance for infrastructure projects. Developed and tested after the earthquake in Nepal, FieldSight has been used to monitor more than 50,000 sites in country for housing, WASH, roads and school projects, and is being scaled up throughout the UNOPS network.

NISMOD-International

NISMOD-Int enables decision-makers to explore and understand the performance of existing and future infrastructure systems. NISMOD-Int supports the strategic planning of national infrastructure, in accordance with a pre-defined development vision, while accounting for the complex interdependencies between infrastructure sectors.

The NISMOD-Int methodological process consists of six steps (Figure 7):

Step 1: Evaluate the performance of current infrastructure systems;

Step 2: Review the long-term needs for infrastructure services;

Step 3: Establish a vision for future infrastructure performance;

Step 4: Identify strategic alternatives for delivering the vision;

Step 5: Analyze of the scale and timing of the strategic alternatives; and

Step 6: Recommend adaptive pathways of policies and investments.

Supporting the implementation of the process is the NISMOD-Int platform - an open source, interactive analysis and decision support tool. Recent applications of NISMOD-Int have been carried out in Palestine and Curacao, with further studies being explored in a diverse range of countries and contexts around the world.

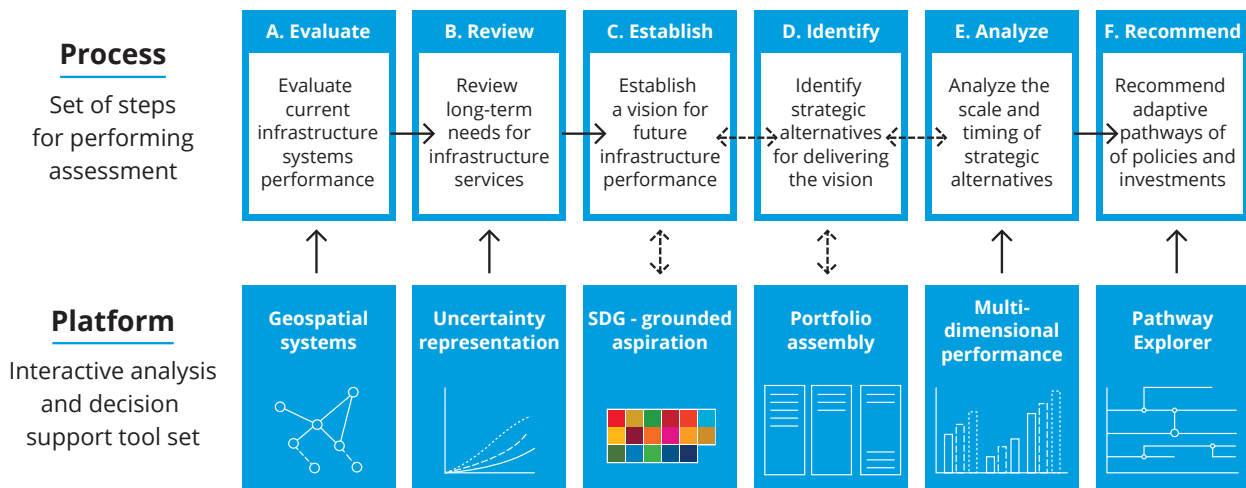


Figure 7: Overview of the NISMOD-Int assessment process and platform⁶⁷

CONCLUSION



Despite the achievement of moderate economic growth and improved social and environmental development, LLDCs are still falling behind other developing countries in achieving sustainable development due to the challenges of their geographical locations. The implementation of sustainable and resilient infrastructure projects – in particular in the transport, digital communications and energy sectors – can provide the key trigger for economic, social and environmental development at national, regional and local levels. Infrastructure projects – such as transit corridors, dry ports and other intermodal facilities – can help LLDCs and transit developing countries improve transit efficiency and regional integration, resulting in a more hospitable business environment and market competitiveness.

Given UNOPS experience in sustainable and resilient infrastructure development, it is well positioned to provide technical assistance and support in the planning, delivery and management of infrastructure projects in LLDCs. The application and continuous development of the EBI initiative – along with its associated tools and methodologies – has proved UNOPS ability to adapt its approach to infrastructure development to one that supports governments and communities on their path toward sustainable development.

UNOPS stands ready to carry out discussions with LLDCs to find viable and concrete infrastructure solutions at the local, regional and national levels.

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GLOSSARY

Corridor - A geographic area between two points, linking multiple centers, and moving people and freight. This definition includes both the transportation infrastructure (e.g., the roadbed, rails and stations) and the new and existing development that surrounds that infrastructure.⁶⁸

Dry port - A secure inland location for handling, temporary storage, inspection and customs clearance of freight moving in international trade.⁶⁹

Intermodal - Involving two or more different modes of transport in conveying goods.⁷⁰

ABBREVIATIONS

APoA - Almaty Program of Action

AAT-I - UNOPS Asset Assessment Tool for Infrastructure

CAT-I - UNOPS Capacity Assessment Tool for Infrastructure

EBI - Evidence-Based Infrastructure

LLDC - Landlocked Developing Countries

NISMOD-Int - National Infrastructure Systems Model - International

UN-OHRLLS - United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States

VPoA - Vienna Programme of Action

ITRC - Infrastructure Transitions Research Consortium

SDGs - Sustainable Development Goals

GDP - Gross Domestic Product

EWEC - East-West Economic Corridor

TAH - Trans-African Highway

TAR - Trans-Asian Railway

BRI - Belt and Road Initiative

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