

SUSTAINABILITY OF NEPAL'S DRY PORTS

Prepared By: Rajan Sharma

Final Report

ACKNOWLEDGEMENT

I sincerely thank the Executive Director of Nepal Intermodal Transport Development Board, Mr Ashish Gajurel, for his guidance and leadership throughout this endeavour. I also extend my appreciation to Director Yubak Dangol, Eng. Director Hari Krishna Mishra, Eng. Jeevan Raj Dhakal, and Accountant Ramesh Koirala for their invaluable support and coordination with the stakeholders involved. Their commitment and cooperation have been instrumental in facilitating this study.

I am also deeply grateful to the Terminal Management teams of Birgunj ICD and ICP, Kathmandu ICD, and Tatopani (Larcha) ICD for their valuable contributions. Their insights and practical inputs have played a crucial role in shaping this report's findings and recommendations.

Furthermore, I acknowledge the dedication and efforts of the Quality Freight staff, whose collaboration has been essential in this study. A special note of appreciation goes to Mr. Anjan Sharma for his leadership and active involvement in conducting the study, coordinating with key stakeholders, and providing critical inputs that have strengthened the overall outcome of this work.

This report would not have been possible without the collective efforts of all those mentioned above, and I am truly grateful for their support and collaboration.

EXECUTIVE SUMMARY

As a landlocked country, Nepal faces significant trade challenges due to the absence of direct access to seaports. Dry ports are crucial intermodal hubs connecting Nepal's road networks to international railway systems, ensuring smooth trade flows and economic integration with neighboring countries. Beyond logistics, sustainable dry ports are key in reducing trade costs, enhancing regional economic partnerships, and fostering economic diversification. Their development contributes to employment, infrastructure growth, and environmental sustainability through green technologies and efficient resource management. Aligning with multiple Sustainable Development Goals (SDGs), such as economic growth (SDG 8), infrastructure resilience (SDG 9), climate action (SDG 13), and responsible consumption (SDG 12), dry ports support Nepal's aspirations for inclusive and sustainable trade.

The study assesses and enhances key dry ports' financial viability, environmental sustainability, and social impact, including Birgunj ICD, ICP, Chobhar ICD, and Tatopani ICD. It adopts a mixed-method approach, including desk reviews, surveys, document collection, and descriptive analysis to evaluate operational efficiency, economic sustainability, and environmental performance. However, the study is limited by the availability of secondary data, reliance on qualitative methods, and the absence of econometric modelling. Despite these constraints, the research provides critical insights into sustainability challenges and opportunities within Nepal's dry port sector, offering strategic recommendations for long-term development.

Nepal has developed a network of eight dry ports along its borders to enhance trade accessibility and efficiency. Key facilities, including Birgunj, Bhairahawa, Biratnagar, and Kakarbhitta, are crucial trade corridors linking Nepal to India and beyond. Birgunj Dry Port is the largest, handling over 60% of Nepal's trade, supported by a rail link to Indian seaports. These ports facilitate significant import and export activities, including machinery, consumer goods, and agricultural products—however, congestion, inefficient customs clearance, and limited handling capacity impact overall trade flow.

Dry ports in Nepal are managed through public and private sector partnerships, with the Nepal Intermodal Transport Development Board (NITDB) playing a key regulatory role. While these partnerships have improved service delivery, governance gaps, outdated resource allocation, and slow adoption of modern technology hinder optimal efficiency. Nepal's logistics supply chain relies heavily on road transport, with limited rail connectivity. The study focuses on assessing the sustainability of Birgunj ICD and ICP, Chobhar ICD, and Tatopani ICD, highlighting their infrastructure, operational capacity, and challenges. Despite existing facilities such as container yards, warehouses, and customs buildings, outdated logistics systems and inadequate intermodal options increase costs and reduce Nepal's global trade competitiveness. Addressing these issues is essential for strengthening Nepal's trade capacity and regional integration.

Environmental Sustainability: Dry ports in Nepal, while essential for trade, contribute to significant environmental challenges, including air, water, noise, and light pollution. This stems from the extensive use of diesel-powered trucks, cranes, and cargo-handling machinery, particularly in high-traffic ports such as Birgunj. Water pollution from industrial runoff and wastewater, as well as noise from continuous operations, further exacerbate environmental concerns. Despite some basic energy-efficient measures like LED lighting, there is minimal use of renewable energy, and waste management practices remain

underdeveloped. Nepal's dry ports lack formal environmental monitoring, emission control mechanisms, and biodiversity conservation efforts. To address these issues, Nepal could implement best practices from global ports, such as transitioning to clean energy, investing in energy-efficient cargo handling equipment, and adopting stricter environmental regulations. Structured waste management systems, wastewater treatment, and biodiversity protection would also enhance environmental sustainability.

Financial Sustainability: Nepal's dry ports are financially important, generating significant revenue through terminal handling charges, equipment rentals, and storage fees. However, the economic sustainability of these ports is challenged by high lease costs, inadequate technological adoption, inefficient customs clearance, and limited connectivity. These inefficiencies lead to increased operational costs and reduced competitiveness. To improve financial sustainability, Nepal could draw from global best practices where automated systems and diversified services have been implemented. By modernising infrastructure, improving operational efficiency, diversifying revenue streams, and enhancing multimodal connectivity, Nepal's dry ports could boost their financial viability and remain competitive in the long term.

Social Sustainability: While Nepal's dry ports have the potential to generate significant economic opportunities, their social impact on surrounding communities remains minimal. Employment opportunities within the ports are limited, and community engagement is often restricted to occasional donations during festivals. The infrastructure improvements brought by dry ports, such as road upgrades, tend to benefit port operations more than local communities, with little impact on essential services like healthcare and education. Environmental and social concerns, including worker welfare and community health, are not adequately addressed. To enhance social sustainability, Nepal could adopt best practices from international ports that prioritise equitable employment, local business support, gender inclusion, and community engagement. By focusing on long-term investments in education, infrastructure that benefits surrounding communities, and fostering partnerships with local populations, Nepal's dry ports could better contribute to inclusive growth and national development goals.

It is crucial to integrate environmental, financial, and social sustainability to ensure the sustainable development of Nepal's dry ports. By adopting the action matrix provided, Nepal can foster dry ports that positively impact the environment, economy, and local communities. Immediate steps include policy alignment with favourable regulations, promoting public-private partnerships to attract investment and innovation, engaging local communities to ensure alignment with regional needs, and establishing monitoring mechanisms for ongoing performance evaluation. Key recommendations include enhancing government support through tax incentives, improving infrastructure via private-sector collaboration, prioritising local community engagement for lasting benefits, and implementing regular assessments to track progress. These actions will help transform Nepal's dry ports into efficient, sustainable, and competitive trade hubs, driving long-term growth and contributing to national development objectives.

Contents

ACKNOWLEDGEMENT	1
EXECUTIVE SUMMARY	2
1 INTRODUCTION	5
1.1 BACKGROUND	5
1.2 OBJECTIVES	6
1.3 METHODOLOGY	6
1.4 LIMITATIONS OF THE STUDY	7
1.5 STRUCTURE OF THE REPORT	8
2 ASSESSMENT OF EXISTING DRY PORTS	9
2.1 Number and location of dry ports	9
2.2 Management Structure	13
2.3 Logistics supply chain and infrastructure	13
2.4 Importance of Dry port in supply chain and risk mitigation in Nepal	15
3 ENVIRONMENTAL SUSTAINABILITY	18
3.1 Ecological impacts of Nepal's dry ports.....	18
3.2 Environmental considerations made while designing the dry ports.....	19
3.3 Challenges with achieving environmental sustainability of Nepal's dry ports.....	19
3.4 Best practices on the environmental sustainability of dry ports.....	20
3.5 Strategies for Environmentally Sustainable Dry Ports in Nepal	21
4 FINANCIAL SUSTAINABILITY.....	23
4.1 Economic vibrancy of Nepal's dry ports.....	23
4.2 Challenges with achieving financial sustainability of Nepal's dry ports.....	23
4.3 Best practices on the financial sustainability of dry ports.....	24
4.4 Strategies for financially sustainable dry ports in Nepal	26
5 SOCIAL SUSTAINABILITY.....	29
5.1 Social considerations in Nepal's dry ports	29
5.2 Challenges with achieving social sustainability of Nepal's dry ports	29
5.3 Best practices on social sustainability of Dry Ports	31
5.4 Strategies for Socially Sustainable Dry Ports in Nepal.....	33
6 NEPALI DRY PORT SUSTAINABILITY FRAMEWORK.....	35
7 CONCLUSION AND RECOMMENDATIONS	37

1 INTRODUCTION

1.1 BACKGROUND

As a landlocked nation, Nepal faces inherent challenges in accessing global trade networks due to the absence of seaports. This geographical constraint necessitates a heavy reliance on dry ports to bridge the gap between international markets and domestic trade activities. Dry ports, often referred to as inland intermodal terminals¹, play a pivotal role in facilitating the movement of goods by providing essential services such as customs clearance, cargo storage, and handling. They serve as critical nodes connecting Nepal's road networks to railway systems in neighbouring countries like India and, indirectly, to maritime routes. This logistical integration is fundamental for sustaining Nepal's trade flow, enhancing the competitiveness of its exports, and ensuring timely imports of essential goods.

The sustainability of dry ports in Nepal extends beyond mere operational efficiency; it is a cornerstone of the country's long-term economic resilience and regional economic connectivity. Economically, sustainable dry ports can lower logistics costs, reduce trade barriers, and promote economic diversification². For instance, efficient dry ports lessen the time and expense involved in customs processing and cargo handling, directly impacting the price of goods in Nepal's markets and fostering a favourable environment for businesses to compete internationally.

Additionally, dry ports strategically foster regional economic integration by strengthening Nepal's connectivity with neighbouring countries. Through partnerships with Indian and Chinese logistics networks, dry ports enhance Nepal's access to global markets while facilitating transit trade for goods bound for or coming from countries like Bhutan and Bangladesh. This regional integration is crucial for harnessing the economic potential of initiatives like the South Asian Free Trade Area (SAFTA) and the Belt and Road Initiative (BRI), thereby fostering regional cooperation in line with SDG 17: Partnerships for the Goals. Efficient logistics systems enhance Nepal's position in regional trade, promoting cross-border cooperation, economic integration, and trade partnerships essential for overall development.

Investments in dry ports often lead to the development of associated infrastructure, such as roads, utilities, and communication systems, which can improve access to essential services for nearby communities. Further, social sustainability can be enhanced by creating employment opportunities in construction, operations, and management; dry ports reduce unemployment and support livelihoods in surrounding regions.

From an environmental perspective, the sustainability of dry ports aligns with Nepal's broader goals of minimizing ecological degradation and addressing climate change. Modern, sustainable dry port operations incorporate green technologies, such as solar-powered facilities, energy-efficient equipment, and improved waste management practices. These measures reduce the carbon footprint associated with logistics and transportation³. Moreover, by optimizing routes and adopting intermodal transportation systems, dry ports can contribute to lowering emissions from freight vehicles.

Dry ports' operational efficiency and expansion directly support SDG 8: Decent Work and Economic Growth. Sustainable dry ports can enhance the logistics sector, creating employment opportunities and fostering private-sector investments. By reducing trade barriers and improving supply chain efficiency, they can significantly contribute to economic productivity. Furthermore, SDG 9: Industry, Innovation, and Infrastructure emphasizes building resilient infrastructure, and sustainable dry ports form the backbone of this goal by providing critical infrastructure that supports industrialization and economic diversification.

Sustainability also aligns with SDG 13: Climate Action, particularly in promoting environmentally friendly practices within the logistics sector. By adopting green technologies and reducing the carbon footprint of port operations, such as through energy-efficient equipment or renewable energy usage, dry ports can help Nepal mitigate climate change impacts. This also ties into broader global sustainability efforts, as transport and logistics significantly contribute to global emissions.

Sustainable practices in dry port management support SDG 12: Responsible Consumption and Production. For instance, improving waste management systems, optimizing resource use, and ensuring that ports operate with minimal environmental degradation are all aspects that can be achieved through sustainable port operations. These practices align with global sustainability efforts and improve the long-term viability of port infrastructure.

Sustainable dry port operations are integral to Nepal's inclusive growth and development aspirations. These facilities can reduce trade deficits, boost export-led growth, and ensure equitable access to global markets by balancing economic growth with environmental protection and operational efficiency. Strengthening the sustainability of dry ports thus represents a critical step toward Nepal achieving its broader developmental and trade-related objectives.

1.2 OBJECTIVES

The objectives of the study are:

- To assess and improve the financial viability of adopting sustainable practices, cost efficiency and operational effectiveness of Birgunj ICD and ICP, Chobhar ICD and Tatopani ICD among Nepal's dry ports.
- To promote environmental sustainability by integrating renewable energy, green building practices and other eco-friendly initiatives.
- To enhance social sustainability by improving community engagement and labour practices and supporting local economic development.
-

1.3 METHODOLOGY

The study has adopted a multipronged approach to understand the sustainability of Nepal's dry ports. The research is based on a qualitative assessment of data and its interpretation. For this, the following steps have been taken:

- a. **Desk review:** The first step involved conducting an extensive desk review to gather secondary data on the sustainability of dry ports in Nepal. Key documents reviewed included government publications, reports from Nepal's Ministry of Industry, Commerce and Supplies, Transports, and infrastructure development agencies, and academic articles on logistics and transportation in Nepal. Additionally, industry reports, news articles, and international studies on dry port sustainability were reviewed to provide context and benchmarks for the study. These sources offered insights into the current state of Nepal's dry ports, their operational models, and sustainability challenges regarding environmental impact, economic viability, and social integration.

- b. **Survey of dry ports:** An introductory survey was conducted at three major dry ports in Nepal to obtain primary data. The dry ports for this survey were based on the scope of the study. The survey was designed to collect quantitative and qualitative data on various aspects, such as:
- Operational Efficiency: Data on port throughput, infrastructure capacity, and logistics processes.
 - Environmental Impact: Measures taken by dry ports to reduce carbon footprints, waste management practices, and energy use.
 - Economic Sustainability: Financial sustainability, including revenues, funding sources, and investment in infrastructure.
 - Social Sustainability: Community engagement practices, employment opportunities, and contributions to local development.

The survey involved semi-structured interviews with key personnel at the dry ports, including port managers, staff members, and stakeholders from associated logistics and transport sectors.

- c. **Document collection:** Relevant documents were collected from the dry ports to support the desk review and survey. These included:
- Annual Reports and Strategic Plans: To understand long-term sustainability goals, resource allocation, and development strategies.
 - Environmental and Social Impact Assessments: To gauge how the ports address sustainability concerns related to their operations.
 - Financial Statements and Investment Records: To assess the ports' economic viability and ongoing sustainability.

These documents helped to triangulate data gathered from other sources, ensuring a comprehensive analysis of the sustainability dimensions.

- d. **Descriptive analysis:** The collected data was analyzed using descriptive techniques to identify patterns, trends, and challenges related to the sustainability of Nepal's dry ports. A comparative approach was applied to evaluate the three selected ports' sustainability initiatives, operational efficiency, and impact on local communities. Descriptive statistics were used for quantitative data, while thematic analysis was employed for qualitative data, particularly from the survey interviews.

This methodological approach allowed for a holistic understanding of the current sustainability status of Nepal's dry ports and provided recommendations for improvement based on the findings. By synthesizing insights from secondary data, primary survey results, and relevant documents, the study offers a detailed overview of the sustainability challenges and opportunities in Nepal's dry port sector.

1.4 LIMITATIONS OF THE STUDY

The study is based on primary and secondary data collection. The secondary literature, however, is limited to understanding the sustainability aspect of Nepal's dry port. Hence, strategies are based on best practices adopted worldwide. In addition, the information collected from the ports based on the survey/questionnaire may not be sufficient to fully understand the underlying challenges, inefficiencies, and external factors influencing port performance and sustainability. The study has not used mathematical or econometric modelling to project sustainability as it was not covered in the scope and, thus, is based on qualitative analysis and descriptive interpretation of the collected data.

1.5 STRUCTURE OF THE REPORT

The report is structured into five sections to provide detailed information on each aspect of the sustainability of Nepal's dry port. The first section outlines the study's rationale, objectives, methodology, and limitations. The second chapter briefly assesses the dry ports, while the third, fourth and fifth chapters explore Nepal's dry ports' environmental, financial and social sustainability, respectively. These three chapters provide information on best practices and strategies suited to Nepal. The final chapter, conclusion and recommendations, summarises the study and provides recommendations as an action matrix.

2 ASSESSMENT OF EXISTING DRY PORTS

2.1 Number and location of dry ports

Nepal has strategically developed a network of dry ports near its southern border with India to enhance accessibility and optimize trade operations. Eight dry ports are on Nepal's northern and southern borders. The principal dry ports include Birgunj, Bhairahawa, Biratnagar, and Kakarbhitta, each serving specific regional trade corridors.

- Birgunj Dry Port is the largest and most active. It is located near Raxaul, India, and is connected via rail to Indian seaports. It handles over 60 percent of Nepal's trade volume.
- Bhairahawa Dry Port, situated near Siddharthanagar, supports trade activities in western Nepal and facilitates movement to and from Uttar Pradesh, India.
- Biratnagar Dry Port focuses on eastern Nepal's trade needs, linking with India's Jogbani border.
- Kakarbhitta Dry Port caters to eastern Nepal and facilitates trade with Indian states such as West Bengal.

Figure 1 Biratnagar dry port



Figure 2 Nepalgunj dry port



Figure 3 Birgunj ICP



Figure 4 Birgunj ICD



Figure 5 Bhairahawa dry port



Figure 6 Kakarbhitta dry port



Figure 7 Tatopani dry port



Figure 8 Chobhar dry port



Additional facilities are under development or planned to strengthen regional logistics, improve trade capacity, and address geographic disparities in infrastructure availability. The movement of goods through Nepal's dry ports is substantial, with hundreds of trucks crossing these facilities daily. The trade flow includes:

- Imports: Heavy machinery, fuel, raw materials, consumer goods, and food products dominate the inbound cargo.
- Exports: Nepal's major exports include agricultural products, textiles, and handicrafts, which are critical to its economy.

The Birgunj-Raxaul rail link provides an alternative to road-based transport, reducing congestion and costs associated with truck movement. However, the overall flow is often hampered by congestion, inefficiencies in customs clearance, and limited handling capacity at many facilities.

2.2 Management Structure

Managing dry ports in Nepal involves collaboration between public and private entities. The Nepal Intermodal Transport Development Board (NITDB) is the primary public agency overseeing the operation and maintenance of key dry ports. It often works with private operators under public-private partnership (PPP) models to manage day-to-day operations, including container handling, warehousing, and logistics services. While this structure has improved service delivery, gaps remain in governance, resource allocation, and the adoption of modern technologies, which hinder optimal management and performance.

2.3 Logistics supply chain and infrastructure

Nepal's logistics supply chain relies primarily on road transport, supported by limited rail connectivity. Dry ports are essential hubs for consolidating cargo and facilitating its onward movement. Key infrastructure at

these ports includes container yards, warehouses, loading/unloading zones, and customs and cargo inspection facilities.

Out of the eight ports, this study shall focus on assessing three dry ports – Birgunj ICD and ICP, Chobhar ICD and Tatopani ICD. The salient features of these ports are presented in the Table below:

Table 1 Salient features of selected dry ports of Nepal

Birgunj ICD and ICP	Tatopani ICD	Chobhar ICD
<ul style="list-style-type: none"> - Rail based ICD; - Broad Gauge Railway yard with six full-length lines; - Boundary wall of 3.15 Km. Long & 3.6m. High; - Administrative block of 1130 Sq. m. floor area; - Container stacking yard of 685x64 m with 656 ground slots capable of holding 1586 TEUs; - Covered Container Freight Station of 203x 35m with 231 ground slots; - High-level goods platform of 38.5x 700m with full rail rake length; - Covered Goods Shed on a 1.2m high platform of 405x 26.5m with 160 ground slots; - Covered Customs litigation shed of 25x21m; - High mast lighting with boundary lights; - Electric substation of 630 KVA, 11/0.4 KVA with one 380 KVA D. G. SET; - Fire detection and alarm system 	<ul style="list-style-type: none"> - Border Inspection Building; - Warehouse; - Custom Inspection Shed; - Administrative Building; - Water Supply; - Electric substation; - Fire detection and alarm system. 	<p>Common Facilities:</p> <ul style="list-style-type: none"> - Boundary wall, Gate Systems - Perimeter Road - Administrative Buildings - Static Weigh Bridges - PCC Block pavement - Electrical Sub Station and LT Panel Room - Vehicle Repairing Shed - Vehicle Parking Area - Ground Level Reservoir & Pump House - Fire Fighting System - Water Supply and Drainage System - Sewage Treatment Plant - Canteen Block - Illumination System and Circulation Area - Greenery / Landscaping <p>Dedicated Facilities in Exim Area:</p> <ul style="list-style-type: none"> - Ware Houses – PEBs - Stuffing De-stuffing area - Container Stacking Yard - Litigation shed/ room - Cold Reefer Points Zone

		<ul style="list-style-type: none"> - Workers Rest Room, etc. <p>Dedicated Facilities in Domestic Area:</p> <ul style="list-style-type: none"> - Ware Houses – PEBs - Open cargo Storage Area - Container Stacking area - Cold Reefer Points Zone - Workers Rest Room, Etc.
--	--	---

Despite these provisions, challenges such as inadequate road infrastructure, outdated logistics systems, and insufficient intermodal transportation options persist. These factors increase trade costs and reduce the efficiency of the supply chain, limiting Nepal's ability to compete in global markets.

2.4 Importance of Dry port in supply chain and risk mitigation in Nepal

Nepal is a landlocked country with unique geographical and infrastructure restrictions; supply chain risks controlling and addressing mitigating techniques into action are essential. Effective trade is seriously hampered by Nepal's vulnerability to natural catastrophes, including earthquakes and floods, and by its dependency on neighbouring nations like India and China for transportation access. Treaties like the Nepal-India Transit Treaty, for example, determine Nepal's trade logistics but also render the country dependent on policies decided by its neighbours, particularly in bilateral and regional trade as well as third-country export-import transactions, where inefficiencies in logistics typically lead to erratic delivery schedules and higher costs, these difficulties are incredibly clear-cut.

Further aggravating these issues and making it difficult for Nepal to fulfil the trade facilitation criteria of the World Trade Organization is the limited acceptance of automation technology to enable commerce and shortcomings in trade facilitation policies. This gap emphasises the requirement of significant private-sector involvement in supporting and implementing technologically compatible solutions compliant with worldwide standards. For Nepal, sustainable trade policies, as described in the Paris Convention for Landlocked Developing Countries, still represent a long-term goal. Still, the complexity of multimodal transportation systems combined with inefficiencies and delays at transshipment locations makes reaching this target problematic.

Nepal's supply network is vulnerable in several ways that demand quick intervention. Common fraud and forgery are false invoicing to avoid taxes, document manipulation for illegal commerce, and fake certificates of origin claiming favourable tariffs. These behaviours create an unfair playing field, undermine confidence in the trade ecosystem, and discourage actual merchants. Further complicating the matter is the hiding of illegal items, such as firearms and drugs, within approved shipments. Not unusual are trade-based money laundering, over- or under-invoicing, and smuggling through hidden compartments in trucks and containers that cause major government income losses and damage Nepal's trading partner reputation.

Along with the importation of counterfeit goods, goods damage and pilfers complicate Nepal's supply chain vulnerabilities. For instance, counterfeit items compromise customer confidence and safety in addition to local businesses. These issues have far-reaching socio-economic effects that demand the acceptance of frameworks and technology in line with World Customs Organization criteria. For Nepal, regional

cooperation and learning from other landlocked developing nations—such as Rwanda's success in simplifying customs operations—can provide insightful analysis.

One cannot emphasise how much technology helps to reduce supply chain hazards. Blockchain technology, for example, might produce a tamper-proof ledger for trade transaction recording and validation, improving transparency and lowering fraud risk. Combining technology that confirms their authenticity with the digitisation of trade records provides a means toward simplified trade procedures. Advanced scanning instruments can indicate possible hazards and identify shipment anomalies using X-ray and gamma-ray scanners linked with artificial intelligence and machine learning. Predictive risk assessments enabled by artificial intelligence allow trade patterns that might indicate fraud so that action can be taken before it starts.

In tackling supply chain risks, real-time monitoring and tamper detection enabled by the Internet of Things are vital. IoT devices can guarantee compliance with sanitary and phytosanitary regulations by tracking variables like temperature and humidity during transit. For high-value or perishable items especially, this is crucial. Likewise, QR codes, NFC tags, and holograms offer improved product authenticity verification, making it more difficult for fake products to find their way to the market. Working with logistics companies like goods forwarders and customs brokers helps one create an open and dependable supply chain. This is so because most entities adopt and oversee new technology first.

Lack of efficient coordination among supply chain participants presents one of the main difficulties in Nepal's customs activities. Although the Nepal National Single Window system is only partially implemented, this is a positive start. Still, data exchange with transit nations is a significant challenge. Customs operations suffer inefficiencies that raise delays and expenses without smooth integration with systems of adjacent countries. Improving risk management mostly depends on better cooperation with terminal operators and tightening quarantine policies. Technologies like digital signatures and biometric verification help to guarantee that only authorised staff members handle customs clearance operations, lowering vulnerabilities.

Apart from these operational difficulties, Nepal has to handle significant health, safety, and cybersecurity concerns in its supplier chain. Serious dangers to public safety and biodiversity include counterfeit goods, non-compliance with quarantine rules, and illicit trafficking of drugs and threatened species. For example, the explosion of fake drugs compromises public health as well as confidence in regulatory systems. Likewise, cybersecurity risks aimed at customs databases and digital infrastructure are increasing and might have disastrous effects on trade activities. To protect against these threats, customs officials must invest in strong firewalls, encryption technologies, and cybersecurity training.

Beginning with pre-arrival procedures addressing problems including product value, weight disparities, and invoicing, risk management in Nepal's supply chain can be seen as a staged strategy. Ensuring the accuracy of documentation and reducing mistakes during this phase depends on cooperation among airlines, railroads, carriers, goods forwarders, and customs brokers. Focused on customs inspections, the phase of inspection and verification mostly depends on technology and stakeholder cooperation to find and reduce hazards. This step mostly depends on advanced scanning technologies and artificial intelligence, which help customs personnel to identify suspect goods with more accuracy. Equally crucial is the post-clearance audit phase, which watches and audits events following goods' clearance of customs. This stage helps discourage

dishonest behavior and builds confidence among stakeholders by using data analytics to spot trends of non-compliance.

Nepal must address documentation compliance, security, money laundering, illegal product entrance, and health and safety issues if it is to guarantee long-term success in regional and worldwide trade. The full application of the Nepal National Single Window system and addressing data sharing issues with transit nations are the top immediate concerns. Establishing alliances with foreign companies like the World Customs Organization will give Nepal the technical knowledge and financial support required to update its trade system.

Reducing transit delays and improving trade efficiency depend on higher medium-term investment in infrastructure, including dry ports and multimodal transportation systems. Inviting private-sector involvement in digitalisation projects can help Nepal's supply chain resilience even more muscular. Looking ahead, Nepal has to use its strategic location between India and China to establish itself as a centre of regional trade. Not only will aligning trade practices with global sustainability goals—including lowering carbon emissions in logistics—but also help to further more general environmental aims.

Nepal can strengthen its supply chain by using modern technologies, encouraging stakeholder cooperation, and implementing strong risk management systems. This would improve its competitiveness on the international scene, opening the path for sustainable economic development and supporting Nepal's transition to a developed nation.

3 ENVIRONMENTAL SUSTAINABILITY

3.1 Ecological impacts of Nepal's dry ports

As critical hubs in the logistics and transportation network, dry ports have significant environmental impacts, primarily through air, water, noise, and light pollution. The environmental consequences vary depending on the location, operations scale, and cargo volume handled at these ports.

a. Air pollution

Dry ports, especially those with high traffic volumes, contribute to air pollution primarily through vehicle emissions, including trucks, container handlers, and other machinery. Diesel-powered vehicles and equipment generate pollutants such as nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO), which can degrade air quality⁴. The magnitude of this pollution is influenced by the port's proximity to major road networks, the type of vehicles used, and operational intensity⁵. For example, at the Birgunj ICD, which handles a large volume of cargo, emissions from diesel trucks and cranes contribute to the deterioration of air quality in the surrounding areas.

b. Water pollution

Water pollution is another concern, especially where ports lack adequate wastewater management systems. Dry ports generate large quantities of sewage, runoff, and industrial effluents, which can contaminate nearby water sources. This is particularly critical in areas where ports are located near rivers or lakes, as in the case of Chobhar ICD near Kathmandu, which is close to the Bagmati River. Sewage discharge from port facilities and runoff from container yards can introduce hazardous substances such as oil, grease, and heavy metals into local water systems. Additionally, the industrial and logistical activities at the port increase the potential for hazardous spills, which, if not contained, can contribute to further water pollution.

c. Noise pollution

Noise is an inevitable consequence of dry port operations, given the constant movement of trucks, trains, and cargo-handling machinery. Noise pollution can adversely affect human health and wildlife, particularly in areas where ports are located near residential zones or sensitive ecosystems. High-traffic ports such as Birgunj, truck engines, container handling operations, and train movements generate elevated noise levels. Noise levels are usually measured in decibels (dB), with readings often exceeding the 85 dB threshold considered harmful over prolonged exposure.

d. Light pollution

Light pollution is another aspect that impacts dry ports, particularly those operating around the clock. Light pollution from port operations can disrupt local ecosystems and communities. Excessive artificial lighting can disturb wildlife patterns, such as migratory birds, and interfere with the sleep cycles of nearby residents. As ports grow, the demand for illumination increases, and without proper management, it can lead to increased light spill into surrounding areas.

3.2 Environmental considerations made while designing the dry ports

While some environmental considerations have been integrated into the design and operation of Nepal's dry ports, significant gaps remain in addressing pollution, resource efficiency, and ecosystem conservation. The lack of emissions control, wastewater treatment, environmental monitoring, and proactive biodiversity protection highlights the need for more comprehensive sustainability initiatives to mitigate the ecological footprint of dry port activities.

Energy efficiency measures at Nepal's dry ports primarily focus on lighting systems. LED lights are used to reduce energy consumption and lower carbon emissions. However, no initiatives have been taken to implement electric vehicles or renewable energy sources such as solar or wind power. The reliance on diesel-powered machinery and vehicles continues to contribute to greenhouse gas emissions and air pollution.

Waste management at dry ports includes basic segregation and disposal practices. Hazardous waste, such as used oils and chemicals, is separated and managed separately to prevent environmental contamination. Other general waste is handed over to municipal authorities for disposal. However, there are no structured recycling programs or waste reduction initiatives in place, limiting the effectiveness of these measures in minimizing environmental impacts.

No specific emissions control mechanisms have been implemented at Nepal's dry ports to address air pollution from trucks, container handlers, and other port-related activities. Similarly, water quality management remains inadequate, with water being sourced solely from government supplies without treatment. Wastewater generated at the ports is discharged directly into nearby rivers via the drainage system, increasing the risk of water pollution and environmental degradation.

No formal environmental monitoring system is in place at Nepal's dry ports. No environmental indicators have been developed to assess pollution levels, emissions, or overall ecological impact. The absence of monitoring mechanisms limits the ability to track environmental performance and implement necessary improvements.

Efforts to maintain biodiversity at dry ports are minimal. While designated gardeners maintain gardens and planted areas within port premises, no specific initiatives are in place to protect or restore local ecosystems. The hinterland areas around dry ports consist of natural vegetation, but no measures have been taken to conserve or enhance biodiversity. As a result, dry port development continues to exert pressure on surrounding ecosystems, potentially disrupting local flora and fauna.

3.3 Challenges with achieving environmental sustainability of Nepal's dry ports

- a. **Poor Technology Adoption:** Nepal's dry ports rely on outdated infrastructure and equipment, which hinders the implementation of environmentally sustainable practices. The absence of modern technology, such as automated cargo handling systems, real-time emissions monitoring, and energy-efficient machinery, leads to inefficiencies and increased environmental degradation. Relying on diesel-powered trucks, cranes, and container handlers contributes significantly to air pollution. Additionally,

the lack of digital tracking and monitoring systems makes it difficult to effectively assess and mitigate environmental impacts.

- b. **Very Low Volume of Cargo Movement:** The relatively low volume of cargo movement at Nepal's dry ports reduces the economic feasibility of investing in sustainability measures. Since these ports handle limited trade flow, stakeholders have little financial incentive to upgrade infrastructure, invest in renewable energy sources, or implement advanced waste management systems. The lower cargo volume also results in the underutilization of resources, making investments in eco-friendly solutions seem economically impractical. Consequently, sustainable development in dry ports remains a low priority.
- c. **Weak Contractual Agreements with Terminal Operators:** Many terminal operators function under weak contractual obligations that fail to enforce environmental sustainability measures. Without stringent regulatory requirements in their contracts, operators have little accountability for adopting green practices such as emissions reduction, proper waste disposal, or energy efficiency improvements. The lack of binding agreements leads to pollution control and ecosystem protection negligence. This weak governance structure creates a significant barrier to implementing sustainable operations at dry ports.
- d. **Lack of a Sustainable Policy Framework:** Nepal lacks a clear and comprehensive policy framework dedicated to the environmental sustainability of dry ports. No stringent regulations govern emissions reduction, wastewater treatment, or biodiversity conservation. The absence of legal mandates allows port operators and stakeholders to overlook environmental considerations, leading to unchecked pollution and resource mismanagement. Moreover, there are no incentives or subsidies to encourage sustainable practices, making it challenging to transition towards greener operations. The absence of a long-term sustainability strategy further exacerbates environmental challenges, preventing the adoption of globally recognized best practices.

3.4 Best practices on the environmental sustainability of dry ports

Environmental sustainability in dry ports is essential for reducing their negative impacts on air, water, noise, and energy consumption. Dry ports can adopt several best practices to improve environmental performance while meeting sustainability goals. Some of the strategies are:

- a. **Energy Efficiency and Renewable Energy Integration:** Dry ports can significantly reduce carbon footprint by implementing energy-efficient technologies and integrating renewable energy sources. This includes using energy-efficient lighting, equipment, and renewable energy solutions such as solar panels. For instance, the Port of Rotterdam has adopted solar energy, installing panels on rooftops and warehouses to generate clean energy. The record-breaking green energy system has been installed with some 3,100 solar panels fitted in an area of 7,500 square meters and can generate 750,000 kilowatts per hour of electricity a year⁶. This would be enough to meet the average annual energy needs of 250 family homes, significantly reducing the carbon footprint in Europe's largest port. Other ports, like the Port of Los Angeles, have incorporated energy-efficient systems such as automated lighting and temperature control systems⁷. These measures help reduce the reliance on fossil fuels and promote the use of cleaner energy.
- b. **Green Infrastructure and Low-Emission Vehicles:** Investing in green infrastructure can help mitigate the environmental impacts of dry ports. This includes creating green spaces, installing rain gardens, and using permeable pavement to manage stormwater. Ports like Hamburg Port have adopted strategies to

improve water quality and reduce runoff⁸. Another critical approach is using low-emission vehicles for cargo handling, such as electric or hybrid trucks and cranes. Rotterdam Port has incorporated hybrid vehicles into its operations, reducing emissions and improving air quality in the surrounding area⁹. Transitioning to electric or hybrid equipment can help significantly reduce the carbon footprint of dry ports.

- c. **Waste Management and Circular Economy Practices:** Sustainable waste management is a key element of port sustainability. Best practices include minimizing waste through recycling, reusing materials, and reducing unnecessary consumption. The Copenhagen-Malmö Port uses a circular economy approach, turning waste heat from port operations into energy for nearby buildings¹⁰. Ports can also implement advanced waste sorting systems to handle hazardous materials safely and reduce contamination. By reducing waste generation and promoting the reuse of materials, dry ports can minimize their environmental impact while improving operational efficiency.
- d. **Emission Monitoring and Pollution Control:** Regularly monitoring and managing emissions are crucial for controlling air and water pollution. Many ports have installed pollution monitoring systems to track air quality and ensure compliance with environmental standards. Valencia Port, for example, has a strict emission control program, monitoring air quality and reducing harmful emissions from port vehicles and machinery¹¹. Additionally, using technologies such as scrubbers on port cranes and trucks can help capture particulate matter and other pollutants before they are released into the air. Similarly, wastewater treatment systems and oil-water separators can prevent water pollution from port runoff.
- e. **Sustainable Water Management:** Water pollution is a significant concern in dry ports, especially where water resources are scarce. Sustainable water management practices, such as rainwater harvesting and wastewater treatment, can reduce a port's impact on local water systems. Ports like Singapore Port have integrated advanced water treatment systems to prevent contamination of nearby rivers. Singapore also uses rainwater harvesting techniques to reduce its reliance on local freshwater resources, making the port's operations more sustainable.¹²
- f. **Noise and Light Pollution Reduction:** Noise pollution is a common issue in busy dry ports due to the continuous movement of vehicles and cargo. Best practices include using quieter machinery and installing noise barriers to reduce disturbances to surrounding communities. Ports like Gothenburg Port have implemented noise-reducing surfaces and technologies to minimize sound levels¹³. Similarly, managing light pollution is critical, particularly for nighttime operations. Dry ports can minimize their light pollution impact by using energy-efficient, motion-sensing lighting and limiting lighting in residential areas. Rotterdam has implemented such measures, using smart lighting systems that automatically adjust based on operational needs.

3.5 Strategies for Environmentally Sustainable Dry Ports in Nepal

To enhance the environmental sustainability of Nepal's dry ports, the following strategies should be considered:

- a. **Adopting Clean Energy Solutions:** Nepal's dry ports should prioritize integrating renewable energy sources such as solar panels and wind energy to reduce dependence on fossil fuels. Installing energy-efficient systems, including LED lighting and automated energy management solutions, can also help reduce carbon emissions.
- b. **Modernizing Port Equipment and Infrastructure:** Investing in advanced, energy-efficient cargo handling equipment, electric or hybrid vehicles, and emissions control technologies can significantly

reduce environmental pollution. Digital monitoring systems should be implemented to track emissions, air quality, and environmental impact.

- c. **Implementing Strict Environmental Regulations:** The government should introduce stringent policies and guidelines mandating emissions reduction, waste management, and pollution control at dry ports. These policies should be backed by regular environmental audits and strict enforcement mechanisms to ensure compliance.
- d. **Enhancing Waste Management Practices:** Dry ports should establish comprehensive waste management strategies, including recycling programs, hazardous waste treatment, and segregation. Partnering with local municipalities for better disposal and promoting circular economy practices can minimize environmental impact.
- e. **Improving Water Management Systems:** Implementing wastewater treatment facilities, rainwater harvesting, and recycling systems can reduce water pollution and improve conservation efforts. Ports should ensure untreated wastewater is not directly discharged into nearby rivers or water bodies.
- f. **Strengthening Contractual Agreements with Terminal Operators:** Contracts with terminal operators should include binding clauses requiring adherence to sustainability practices. Operators should be incentivized to implement green initiatives, with penalties for non-compliance.
- g. **Establishing Environmental Monitoring and Reporting Mechanisms:** Developing key environmental indicators, conducting regular assessments, and implementing digital tracking systems will help measure environmental performance and identify areas for improvement.
- h. **Promoting Biodiversity Conservation:** Green spaces, tree plantations, and ecological buffer zones should be integrated into port infrastructure to support local biodiversity. Dry ports should collaborate with environmental organizations to restore and protect nearby ecosystems.

4 FINANCIAL SUSTAINABILITY

4.1 Economic vibrancy of Nepal's dry ports

Nepal's dry ports are pivotal in bolstering the nation's trade infrastructure, serving as essential nodes for importing and exporting goods. The primary revenue streams for these facilities encompass terminal handling charges, parking fees, equipment rental, and warehouse storage charges, all sanctioned by the Nepal Intermodal Transport Development Board (NITDB).

- a. **Terminal Handling Charges:** These fees are imposed for managing and processing cargo within the port. For instance, at the Birgunj Dry Port, terminal handling charges are structured based on the type of service and container size. As of August 2020, the charges for a 20-foot container range from NPR 7,054.30 to NPR 9,111.30, depending on the specific handling requirements.¹⁴
- b. **Parking Fees:** Dry ports levy parking charges on vehicles and containers to manage space and ensure orderly operations. At Birgunj Dry Port, parking fees for loaded or empty containers are free on the first unloading day. Subsequently, from the second to the seventh day, a 20-foot container incurs a daily charge of NPR 219.62, which increases to NPR 292.82 from the eighth day onwards¹⁵.
- c. **Equipment Rental:** Ports offer essential machinery and equipment for cargo handling, such as forklifts and cranes, available for hire. This service enables businesses to efficiently manage their logistics without requiring substantial capital investment in equipment.
- d. **Warehouse Storage Charges:** Dry ports provide warehousing facilities for temporarily storing goods. Storage charges are typically calculated based on the duration and volume of storage. For example, import warehouse charges at Birgunj Dry Port are free for the first three days. From the fourth to the tenth day, the charge is NPR 93.17 per metric ton per day, increasing to NPR 119.79 from the eleventh to the thirtieth day and NPR 186.34 beyond that period.¹⁶

The revenue generated from these streams is instrumental in maintaining and upgrading port infrastructure, enhancing operational efficiency. For instance, in the first quarter of the fiscal year, the Sirsiya Dry Port in Birgunj reported a revenue collection of NPR 12.7 billion¹⁷, underscoring its significant contribution to Nepal's trade and economy.

Further, the NITDB continues to focus on developing and managing these dry ports to facilitate Nepal's foreign trade. Efforts include building additional dry ports and enhancing existing facilities to meet growing trade demands.

4.2 Challenges with achieving financial sustainability of Nepal's dry ports

Nepal's dry ports are essential to its trade infrastructure but face significant challenges impacting operational efficiency and financial sustainability. These challenges are closely linked to the economic models governing dry port operations.

- a. **High Lease Costs and Financial Sustainability:** Their agreements stipulate that substantial lease payments to the NITDB burden terminal operators. These fixed financial obligations persist regardless of fluctuations in trade volume, placing operators in a precarious financial position. For instance, the initial lease terms for some dry ports involved a fixed lease rent for ten years. However, operators accumulated heavy financial losses under this model, leading to contract revisions introducing a revenue-sharing mechanism to alleviate the financial strain.¹⁸
- b. **Limited Technological Innovation:** The adoption of modern technology in Nepal's dry ports has been minimal, confined primarily to the terminal operators' internal management systems. This limited

integration of advanced technologies hampers operational efficiency and increases costs. Recognizing this gap, the NITDB has initiated plans to implement modern technologies such as gantry cranes, automated gates, and truck tracking systems in existing and upcoming dry ports. For instance, the Inland Clearance Depot in Birgunj is set to receive a gantry crane to enhance cargo handling efficiency.¹⁹

- c. **Absence of Policies for Supplier and Contractor Sustainability:** There is a notable absence of policies to ensure the sustainability of suppliers and contractors associated with dry port operations. This policy void creates uncertainty and instability within the supply chain, potentially disrupting services and increasing operational costs. A comprehensive policy framework is essential to support these stakeholders, ensuring a stable and efficient supply chain that underpins the financial viability of dry port operations.
- d. **Inadequate Connectivity and Infrastructure:** The efficiency of dry ports relies heavily on robust connectivity with seaports and hinterlands. In Nepal, challenges such as suboptimal road and rail links hinder seamless cargo movement. A study²⁰ comparing dry port operations in Malaysia and Nepal highlighted that Nepal's limited infrastructure connectivity adversely affects the efficiency of its dry ports.
- e. **Inefficient Border Processes:** Prolonged customs procedures and bureaucratic delays at border crossings contribute to increased transit times and costs. These inefficiencies discourage traders from utilizing dry ports, affecting their economic viability. The same comparative study²¹ noted that inefficient border transactions are a significant challenge for Nepal's dry ports.

4.3 Best practices on the financial sustainability of dry ports

Dry ports are crucial in facilitating international trade and supporting economic growth by serving as inland hubs for cargo handling, storage, and distribution. However, ensuring their financial sustainability requires a combination of efficient operations, diversified revenue streams, and strong stakeholder engagement. Across the globe, dry ports have implemented innovative strategies tailored to their unique contexts, addressing challenges such as high operational costs, limited connectivity, and evolving market demands. Some of the strategies are:

- a. **Efficient operations:** Efficient operations are the backbone of financially sustainable dry ports. Isaka Dry Port in Tanzania improved customs clearance by implementing ICT systems that streamline documentation and tracking, resulting in shorter dwell times. Similarly, Khorgos Gateway in Kazakhstan, a critical point along the Belt and Road Initiative, employs automated container handling systems, significantly reducing labour costs and increasing throughput. In India, the Concor-operated Tughlakabad Inland Container Depot optimized its layout to minimize cargo transfer times, boosting operational efficiency. These cases demonstrate the importance of leveraging technology and process improvements to handle higher cargo volumes at lower costs.
- b. **Revenue diversification:** Revenue diversification strategies have been crucial for many dry ports to ensure consistent income streams. Modjo Dry Port in Ethiopia, the largest dry port in the country, partnered with private firms to offer refrigerated storage for agricultural exports, tapping into the growing demand for perishable goods logistics. Tughlakabad Inland Container Depot in India introduced value-added services like packaging, labelling, and training centres for logistics professionals, attracting additional customers and increasing revenue. Meanwhile, Nairobi Inland Container Depot in Kenya rents space to logistics and trucking companies, further enhancing its income

portfolio. These measures help reduce dependency on core cargo handling revenue, buffering the ports against market fluctuations.

- c. **Connectivity enhancements:** Connectivity improvements have also played a pivotal role. In East Africa, Mombasa Dry Port in Kenya enhanced its integration with the Standard Gauge Railway (SGR), which connects the coastal port of Mombasa to inland regions, ensuring faster and more cost-effective cargo movement. Zambia Dry Port in Namibia, strategically located to serve the Southern African Development Community (SADC), invested in dedicated road and rail networks to connect with regional economic centres. In China, the Zhengzhou International Hub Development and Construction Co. developed a high-speed rail link to facilitate e-commerce trade, reducing transit times for goods destined for Europe. These examples highlight how improved connectivity can boost trade volumes and attract more users.
- d. **Customer-centric initiatives:** Several ports have implemented Tailored initiatives to retain clients and attract new business. For instance, Inland Port Greer in South Carolina, USA, operates 24/7, offering unmatched flexibility to meet client schedules. The port also provides end-to-end logistics solutions, integrating rail and truck services for seamless cargo movement. Sousse Dry Port in Tunisia incentivizes long-term use by logistics firms through discounted tariffs, fostering loyalty and increasing recurring revenue. Dubai's Jebel Ali Free Zone (JAFZA), while not a dry port in the traditional sense, sets an example with its customer-oriented services, including dedicated account managers and customizable storage solutions, which inland dry ports can replicate.
- e. **Sustainability focus:** Sustainability and environmental initiatives are increasingly becoming a priority for dry ports. The Rotterdam Dry Port in the Netherlands has integrated renewable energy sources, including solar panels, to power operations and uses electric vehicles for internal cargo movement, reducing its carbon footprint. Aman Dry Port in Jordan implemented rainwater harvesting systems to lower water usage costs. In India, the Concor dry ports have adopted green building practices, such as energy-efficient lighting and waste recycling, aligning with global sustainability standards while achieving cost savings. These initiatives also enhance the ports' reputations, attracting environmentally conscious customers.
- f. **Public-private partnerships (PPPs):** PPPs have been a significant driver of success for many dry ports. Thilawa Dry Port in Myanmar was developed through a PPP model with Japanese investment, ensuring state-of-the-art infrastructure and operational expertise. Similarly, South Korea's Uiwang Inland Container Depot partnered with private logistics companies to optimize its container handling processes, benefiting from private sector efficiency while sharing financial risks. PPPs also provide knowledge transfer and innovation opportunities, as seen in the Khorgos Gateway, where Chinese and Kazakh investors collaborated to build a world-class logistics hub.
- g. **Conducive investment environment:** Policy and regulatory support have been essential for some dry ports to thrive. The Durban Inland Terminal in South Africa worked with government agencies to streamline customs regulations, reducing bottlenecks and improving cargo flow. In Laos, the Vientiane Dry Port was designated a Special Economic Zone (SEZ), offering tax incentives and simplified regulations to attract businesses. These policy measures create an enabling environment for dry ports to operate efficiently and attract investment.
- h. **Performance monitoring and data usage:** Data-driven decision-making and performance monitoring have become critical tools for dry port management. The Dry Port of Zaragoza (Plaza) in Spain employs real-time data analytics to optimize train schedules and track key performance indicators (KPIs) such as turnaround times and customer satisfaction. Similarly, the Port of Virginia Inland Port in the USA

uses centralized monitoring systems to predict peak usage times and allocate resources accordingly. These practices help ports maximize their capacity and improve service quality.

- i. **Capacity enhancement and modernization:** Investments in infrastructure modernization have ensured that dry ports remain competitive and capable of handling future demands. Kuala Lumpur Dry Port in Malaysia upgraded its facilities with advanced container cranes and expanded its rail links to accommodate rising cargo volumes. It also partnered with e-commerce platforms to position itself as a regional hub for online trade. Ludhiana Dry Port phased its expansions in India to align with projected trade growth, ensuring efficient use of resources without overextending finances.
- j. **Community engagement:** Community and stakeholder engagement has proven invaluable for some ports. Bangalore Dry Port in India tailored its services to meet the needs of local businesses, offering subsidized logistics for small enterprises. Nairobi Inland Container Depot in Kenya conducted awareness campaigns to educate local communities on the economic benefits of dry ports, fostering goodwill and mitigating potential conflicts. These efforts underline the importance of building strong relationships with surrounding communities and stakeholders.

4.4 Strategies for financially sustainable dry ports in Nepal

Drawing from global best practices, Nepal can adopt the following targeted strategies to improve the long-term viability of its dry ports.

- a. **Enhancing Operational Efficiency:** Operational efficiency is key to reducing costs and increasing the competitiveness of Nepal's dry ports. Outdated processes and limited technological adoption result in high overhead expenses and delays. Implementing automated customs clearance, cargo tracking systems, and paperless transactions can significantly improve service delivery. Isaka Dry Port in Tanzania successfully streamlined customs procedures using ICT-based systems, reducing clearance times and enhancing trade facilitation. Optimizing terminal layouts, as seen at Tughlakabad Inland Container Depot in India, can minimize unnecessary cargo movements, leading to faster turnaround times. Investments in modern cargo-handling equipment, such as gantry cranes and automated stacking systems similar to those used at Khorgos Gateway in Kazakhstan, can improve efficiency and reduce labour costs.
- b. **Revenue Diversification:** Currently, Nepal's dry ports rely heavily on terminal charges, parking fees, and warehouse rentals, making them vulnerable to trade fluctuations. Introducing diversified revenue streams can ensure financial stability. Value-added services such as cold storage for perishable goods, packaging and labelling facilities, and training centres for logistics professionals can attract additional business. Modjo Dry Port in Ethiopia expanded its revenue base by offering refrigerated storage for agricultural exports. At the same time, Nairobi Inland Container Depot in Kenya increased its income by leasing space to logistics and trucking companies. Nepal's dry ports can follow these examples to create alternative income streams and reduce reliance on cargo handling fees.
- c. **Strengthening Multimodal Connectivity:** Improving connectivity between dry ports and major trade routes is essential for increasing cargo volumes and ensuring cost-effective logistics. Nepal's dry ports need better integration with rail and road networks to enhance competitiveness. For instance, Mombasa Dry Port in Kenya improved efficiency by linking directly to the Standard Gauge Railway, enabling faster and more affordable cargo movement. Similarly, Zambia Dry Port in Namibia invested in dedicated freight corridors to connect with regional economic hubs. Nepal should prioritize

infrastructure development, including dedicated road links and potential rail connections to border points, to facilitate smoother cargo movement and attract more traders.

- d. **Customer-Centric Initiatives:** A customer-focused approach is crucial to retaining existing clients and attracting new business. Many successful dry ports worldwide have implemented tailored solutions to enhance user experience. Inland Port Greer in South Carolina, USA, operates 24/7, providing flexibility that appeals to logistics companies. Sousse Dry Port in Tunisia incentivizes long-term users with discounted tariffs, fostering customer loyalty. Nepal's dry ports can adopt similar measures by extending operating hours, offering end-to-end logistics solutions, and providing customized services such as bulk cargo discounts to encourage repeat business.
- e. **Sustainability and Green Practices:** Integrating sustainability initiatives can help dry ports reduce operational costs while meeting global environmental standards. Many ports are shifting towards renewable energy and eco-friendly logistics practices to improve long-term viability. Rotterdam Dry Port in the Netherlands has installed solar panels and electric cargo-handling vehicles, reducing its carbon footprint and energy costs. Aman Dry Port in Jordan implemented rainwater harvesting systems to lower water usage expenses. Nepal's dry ports can adopt similar green initiatives by investing in energy-efficient infrastructure, encouraging eco-friendly transport options, and exploring government incentives for sustainable logistics.
- f. **Policy and Regulatory Reforms:** A conducive policy environment is essential for ensuring the financial sustainability of dry ports. High lease costs and rigid financial agreements put terminal operators at financial risk. Revisiting lease agreements to introduce flexible financial models, such as revenue-sharing arrangements, can ease the burden on operators. Countries like Laos have successfully designated dry ports as Special Economic Zones (SEZs), offering tax incentives and simplified regulations to attract investment. Nepal's policymakers should explore similar initiatives to create a business-friendly environment that supports dry port growth. Additionally, establishing rules to ensure the financial stability of suppliers and contractors can help create a more resilient logistics ecosystem.
- g. **Performance Monitoring and Data-Driven Decision-Making:** Leveraging technology for data-driven decision-making can enhance efficiency and optimize resource allocation. Many advanced dry ports use performance monitoring tools to track cargo movement, predict peak usage times, and improve service quality. The Dry Port of Zaragoza in Spain employs real-time analytics to optimize train schedules and improve turnaround times. Similarly, the Port of Virginia Inland Port in the USA uses centralized monitoring systems to predict cargo demand and allocate resources accordingly. Nepal's dry ports can benefit from implementing similar technologies to track performance metrics, streamline operations, and enhance customer satisfaction.
- h. **Infrastructure Modernization and Capacity Building:** Upgrading infrastructure and expanding capacity is crucial for ensuring that Nepal's dry ports can handle increasing trade volumes efficiently. Many global dry ports have invested in modernization to remain competitive. Kuala Lumpur Dry Port in Malaysia upgraded its facilities with advanced container cranes and expanded rail links to accommodate growing cargo demands. Ludhiana Dry Port in India strategically phased infrastructure expansions to align with trade growth, avoiding financial strain and enhancing capacity. Nepal should prioritize targeted investments in port infrastructure, ensuring that expansion efforts align with projected trade volumes to maximize efficiency.
- i. **Public-Private Partnerships:** Collaborating with the private sector can bring much-needed investment and expertise to Nepal's dry ports. Many successful dry ports worldwide have leveraged PPP models to enhance operations. Thilawa Dry Port in Myanmar was developed through a PPP framework with

Japanese investment, ensuring state-of-the-art infrastructure and operational efficiency. Similarly, South Korea's Uiwang Inland Container Depot partnered with private logistics firms to optimize container handling processes. Nepal can attract private sector participation by offering incentives, streamlining investment procedures, and encouraging joint ventures in dry port management.

- j. **Community and Stakeholder Engagement:** Engaging with local communities and stakeholders is essential for ensuring long-term success and reducing resistance to development projects. Dry ports can play a role in regional economic development by supporting small businesses and creating employment opportunities. Bangalore Dry Port in India provides subsidized logistics services for small enterprises, fostering economic growth in surrounding areas. Nairobi Inland Container Depot in Kenya conducts community awareness campaigns to educate the public on the benefits of dry ports, promoting goodwill and reducing potential conflicts. Nepal's dry ports can adopt similar strategies to strengthen relationships with local businesses, ensuring that dry port development aligns with community interests.

5 SOCIAL SUSTAINABILITY

5.1 Social considerations in Nepal's dry ports

The establishment of dry ports in Nepal and the selection of their locations has been influenced by several social factors. However, significant gaps exist in their integration with local communities and national development objectives. The impact of dry ports on social welfare and economic opportunities remains limited, with minimal engagement and support for the surrounding populations.

- a. **Employment generation and economic opportunities:** Although dry ports are often seen as a potential driver for local economic development, mainly through employment creation, reality shows limited engagement with local communities. While dry ports like those near Birgunj are positioned to capitalize on cross-border trade, the number of locals employed in these facilities remains low. Additionally, while some employment exists, the financial contributions to local communities are nominal, with only sporadic donations made during festivals rather than sustained investment in community development or employment training.
- b. **Proximity to border communities:** The strategic placement of dry ports near international borders, particularly with India, is intended to foster trade and regional integration. However, the actual benefits for local communities are less pronounced. The dry port in Birgunj, despite its proximity to a high-traffic trade route, has not led to meaningful engagement with local populations in terms of providing sustained economic opportunities or fostering long-term partnerships between the terminal operators and surrounding communities.
- c. **Infrastructure and social services:** Although dry ports contribute to infrastructure development in their vicinity, such as roads and utilities, these improvements do not necessarily directly benefit the local population. While transport networks may be enhanced for port operations, broader social services like healthcare, education, and housing have not seen notable improvements directly linked to the port's establishment. The local population's access to these essential services remains largely unaffected by the presence of the dry port.
- d. **Environmental and social impact considerations:** There is limited engagement with local communities regarding environmental and social safeguarding. While operational safety is maintained within the dry port, such as the use of helmets for workers and the availability of first aid boxes, no substantial programs address local populations' environmental or social concerns. No meaningful outreach or community development programs are in place, and the terminal operator's adherence to national labour laws does not extend to fostering broader social and environmental accountability in the region.
- e. **Alignment with national and regional development goals:** While the Nepalese government aims to reduce regional economic disparities through projects like dry ports, the actual outcomes in terms of local development have been minimal. The dry port operators' focus on operational matters, without a significant commitment to social responsibility or local community engagement, has limited the alignment with national and regional development objectives. The absence of substantial outreach or developmental programs means that these infrastructure projects have not yet contributed significantly to inclusive growth or poverty alleviation in the regions surrounding the ports.

5.2 Challenges with achieving social sustainability of Nepal's dry ports

Nepal's dry ports are intended to stimulate economic growth and regional integration. However, several challenges hinder their effectiveness in delivering social, environmental, and financial benefits to local

communities and the nation. These challenges stem from operational limitations, inadequate local engagement, and infrastructure and policy alignment gaps.

- a. **Limited Local Employment and Economic Benefits:** Despite the strategic location of dry ports, the local workforce has minimal involvement in their operations. The lack of significant local hiring opportunities in port operations, logistics, and ancillary services limits the broader economic impact on surrounding areas, particularly those economically disadvantaged. A study²² on employment challenges in Nepal highlights the need for inclusive growth and development, emphasizing the importance of creating employment opportunities for local populations.
- b. **Insufficient Community Engagement and Support:** Another significant challenge is the lack of meaningful engagement with local communities. Dry port operators have made minimal contributions to the social welfare of surrounding populations, primarily limited to occasional festival donations. No comprehensive community development programs or consistent investments in local social services like healthcare, education, or housing exist. This lack of engagement has resulted in missed opportunities to build stronger relationships with local communities and promote shared benefits from port operations. The United Nations Development Programme (UNDP) emphasizes the importance of community engagement and ownership in making local development plans sustainable²³.
- c. **Weak Environmental and Social Safeguarding Measures:** Environmental and social safeguarding remains a significant gap in the operations of Nepal's dry ports. Although safety measures for workers, such as the use of helmets and the presence of first aid facilities, are in place, there is little focus on broader environmental and social concerns. Issues like land use, environmental pollution, and the potential displacement of local populations are not adequately addressed. The absence of structured outreach programs or consultation processes further limits the ability to mitigate the negative impacts of port operations on local communities. The World Bank's Environmental and Social Framework Overview Assessment highlights the need to strengthen Nepal's environmental and social risk management frameworks²⁴.
- d. **Inadequate Infrastructure Development for Broader Community Benefits:** While dry ports contribute to infrastructural improvements, such as upgraded roads and transport networks, the benefits of these developments are primarily confined to port operations. There is little evidence that infrastructure improvements have significantly enhanced access to essential social services like education, healthcare, and housing for local populations. The lack of a comprehensive approach to infrastructure development that prioritizes the needs of surrounding communities exacerbates social disparities in these regions. The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) notes that infrastructure development in Nepal should consider the importance of its impact on local communities²⁵.
- e. **Coordination and Communication Gaps Among Stakeholders:** Effective coordination between dry port operators, local authorities, and other stakeholders is crucial for addressing the social, environmental, and economic challenges associated with dry port operations. However, these groups' lack of effective communication and cooperation has hindered the development of integrated strategies that balance port operations with local community needs. Poor coordination results in inefficiencies and missed opportunities for collaborative efforts that could lead to more sustainable and inclusive outcomes. ESCAP emphasizes the need for international agencies to focus on bringing out guidelines related to transshipment, port leasing, and other aspects to improve coordination²⁶.
- f. **Limited Alignment with National Development Policies:** While Nepal's national development goals aim to reduce regional disparities and promote inclusive growth, the operations of dry ports have not

sufficiently aligned with these objectives. The lack of robust social responsibility initiatives and community engagement programs means these infrastructure projects have not contributed significantly to poverty alleviation or regional development. The dry port operators' focus on logistical and operational aspects, without a corresponding commitment to social development, limits the broader impact of these projects on national development goals. ESCAP notes that dry ports in Nepal are often located in areas that align with national policies aimed at regional development and social inclusion²⁷.

5.3 Best practices on social sustainability of Dry Ports

Dry ports are not just logistical hubs but key regional development, employment, and community well-being drivers. Social sustainability ensures that dry ports contribute positively to their communities by promoting equitable access to resources, minimizing social disruption, and fostering long-term benefits for local populations. Dry ports worldwide have implemented innovative practices to achieve social sustainability, addressing equitable employment opportunities, community engagement, and social inclusion challenges.

- a. **Promoting equitable employment opportunities:** One of the core aspects of social sustainability is the creation of job opportunities that benefit local populations. Modjo Dry Port in Ethiopia employs a significant percentage of its workforce from surrounding communities, offering skills training programs to enhance employability²⁸. Similarly, Ludhiana Dry Port in India works with local training institutions to prepare residents for logistics and supply chain management roles. Khorgos Gateway in Kazakhstan, located in a remote area, has created jobs for local communities, provided stable income, and reduced migration to urban centres²⁹.
- b. **Supporting local economic development:** Dry ports often catalyze regional economic growth by enabling local businesses to access global markets. Durban Inland Terminal in South Africa works closely with small and medium-sized enterprises (SMEs), providing logistical support and facilitating export opportunities³⁰. Thilawa Dry Port in Myanmar has integrated local suppliers into its operational supply chain, ensuring its economic benefits extend to surrounding communities³¹. Zambia Dry Port in Namibia has created dedicated facilities for local traders to streamline their access to regional trade networks.³²
- c. **Gender inclusion and social equity:** Ensuring gender equity is vital to social sustainability. Concor Dry Ports in India have taken proactive steps to hire women in logistics roles traditionally dominated by men, setting an example for gender inclusion³³. Rotterdam Dry Port in the Netherlands has launched initiatives to train and employ women in technical and managerial positions, ensuring equitable participation³⁴.
- d. **Environmental justice and community well-being:** Many dry ports have integrated environmental justice measures to protect and benefit nearby communities. Aman Dry Port in Jordan installed soundproof barriers and green buffers to minimize noise and air pollution for neighbouring residents³⁵. Rotterdam Dry Port has adopted renewable energy sources to reduce emissions, ensuring a healthier environment for local populations³⁶. In China, the Zhengzhou Inland Port collaborates with local authorities to monitor environmental impact and ensure compliance with air and water quality standards³⁷.
- e. **Cultural preservation and integration:** In regions with rich cultural heritage, dry ports have taken steps to respect and integrate local traditions. Khorgos Gateway in Kazakhstan organizes cultural exchange programs and supports local festivals, fostering goodwill with nearby communities³⁸.

- f. **Education and capacity building:** Capacity building through education initiatives has been a key focus for many dry ports. Nairobi Inland Container Depot in Kenya runs logistics and supply chain training programs for local youth, enhancing employment prospects³⁹. Tughlakabad Inland Container Depot in India collaborates with universities to offer internships and apprenticeships, bridging the gap between academic learning and practical experience⁴⁰. These efforts address skill gaps and create a steady pipeline of trained professionals to support port operations.
- g. **Infrastructure for community benefit:** Investments in infrastructure that benefit surrounding communities are another hallmark of socially sustainable dry ports. The Vientiane Dry Port in Laos and the associated Vientiane Logistics Park (VLP) are being developed to foster significant economic growth in the region. A key component of this development is the creation of shared-use facilities, including roads and utilities, which support the port's operations and benefit the local community.⁴¹ Modjo Dry Port in Ethiopia has installed community water access points and health facilities as part of its corporate social responsibility initiatives⁴². Further, the Moorebank project's Port Rail Shuttle reduces road traffic congestion around the port and connects roads by moving container transfer from trucks to rail.

5.4 Strategies for Socially Sustainable Dry Ports in Nepal

Drawing inspiration from global best practices, Nepal can implement strategies that promote equitable employment opportunities, community engagement, environmental stewardship, and long-term social benefits. These strategies can transform dry ports into regional development and social well-being drivers.

- a. **Promoting Equitable Employment Opportunities:** One of the most pressing needs in Nepal's dry ports is to create more employment opportunities for local populations. This can be achieved through targeted workforce development and skills training programs. Drawing from successful examples like Modjo Dry Port in Ethiopia, Nepal could establish training partnerships with local educational institutions to prepare residents for logistics, transportation, and supply chain management roles. By prioritizing local hiring and offering professional development programs, dry ports can increase their contribution to reducing unemployment and boosting regional economies. Additionally, creating opportunities for women in non-traditional roles, as seen in Concor Dry Ports in India, could further promote social equity and inclusivity in the workforce.
- b. **Supporting Local Economic Development:** Dry ports should serve as logistics hubs and catalysts for local economic growth. Nepal's dry ports can integrate local businesses into their supply chains, much like Thilawa Dry Port in Myanmar, which ensures that surrounding communities benefit from the port's economic activities. Providing logistical support to small and medium-sized enterprises (SMEs) and facilitating access to regional and global markets would enable local businesses to expand their reach and create jobs. Furthermore, establishing dedicated facilities for local traders, as demonstrated by Zambia Dry Port, would streamline access to trade networks and enhance economic opportunities for local entrepreneurs.
- c. **Gender Inclusion and Social Equity:** Gender equality is a key social sustainability pillar. Nepal's dry ports can draw from the successes of Rotterdam Dry Port in the Netherlands, where gender-inclusive initiatives have enabled women to take on managerial and technical roles. Nepal can implement policies that encourage the hiring and training women in logistics and other traditionally male-dominated fields. This would not only promote gender equity but also create diverse and resilient workforces in dry ports. Additionally, supporting women entrepreneurs by providing access to trade networks and business support could help foster a more inclusive economic environment in the regions surrounding Nepal's dry ports.
- d. **Environmental Justice and Community Well-being:** Environmental concerns around dry ports, including noise, air pollution, and congestion, must be addressed to ensure the long-term well-being of local communities. Nepal's dry ports could adopt green initiatives similar to those at Aman Dry Port in Jordan, which installed soundproof barriers and green buffers to minimize environmental disruptions. Embracing renewable energy sources, as Rotterdam Dry Port has done, would also help reduce emissions and promote a healthier environment. In addition, partnering with local authorities to monitor environmental impacts, as seen in Zhengzhou Inland Port in China, would help ensure compliance with air and water quality standards, benefiting both port operations and nearby communities.
- e. **Cultural Preservation and Integration:** In regions with rich cultural heritage, it is vital that dry ports respect and integrate local traditions. Nepal's dry ports could follow the example of Khorgos Gateway in Kazakhstan, which organizes cultural exchange programs and supports local festivals. By promoting cultural awareness and supporting community-driven cultural initiatives, dry ports can build stronger relationships with local populations and foster goodwill. This approach would help mitigate social tensions and ensure that the development of dry ports is seen as a positive force in local communities.

- f. **Education and capacity Building:** Investing in education and capacity building is crucial for ensuring that local populations benefit from the long-term opportunities created by dry ports. Nepal's dry ports can establish training programs similar to those at Nairobi Inland Container Depot in Kenya, where local youth are trained in logistics and supply chain management, enhancing their employability. Collaborating with universities and technical institutions to offer internships and apprenticeships, as demonstrated by Tughlakabad Inland Container Depot in India, would create a steady pipeline of skilled professionals. This would fill critical roles at the ports and build human capital to support broader economic development in the region.
- g. **Infrastructure for Community Benefit:** To maximize the positive impact of dry ports on local communities, infrastructure development must go beyond the port's immediate operational needs. By investing in shared-use facilities such as roads, utilities, and public services, dry ports can contribute to the overall development of the surrounding areas. The Vientiane Dry Port in Laos offers a successful model where infrastructure investments benefit the port and the local community. Similarly, Nepal's dry ports could incorporate community benefits into their infrastructure plans, such as providing access to clean water, healthcare facilities, and education services. These investments would enhance the quality of life for local populations and ensure that the social benefits of the port extend beyond its immediate operational scope.

6 NEPALI DRY PORT SUSTAINABILITY FRAMEWORK

Developing a sustainable dry port in Nepal requires a comprehensive approach integrating green objectives, social responsibility, and strong governance. A well-structured framework that aligns environmental, social, and governance (ESG) principles with Nepal's logistics and trade facilitation needs can ensure long-term sustainability while strengthening the country's regional and global trade role.

A key objective of this framework is to establish Nepal as a regional transshipment hub by leveraging its strategic location between India and China. To achieve this, efficient cross-border logistics must be prioritised through digitalised customs clearance and multimodal connectivity. Public-private partnerships (PPP) will play a crucial role in infrastructure development, ensuring that investments in technology and operational efficiency enhance Nepal's position in regional trade. At the same time, sustainability must remain at the core of this transformation, focusing on becoming a carbon-neutral port. Implementing carbon accounting, offset mechanisms, and promoting energy-efficient transportation such as electric trucks and rail connectivity are essential steps toward this goal. The dry port must also drive decarbonisation in the supply chain by encouraging low-emission vehicles, enhancing carbon reporting standards, and integrating digital solutions to minimise inefficiencies and unnecessary transportation emissions.

Building a green port culture is fundamental to this transition, requiring a shift toward electrification and renewable energy. Adopting electric cargo-handling equipment such as cranes and forklifts, along with establishing charging infrastructure for electric freight vehicles, will significantly reduce the port's carbon footprint. Renewable and alternative energy sources like solar and wind should be prioritised, supplemented by battery storage solutions to ensure a stable power supply. Additionally, integrating clean and smart grids powered by IoT and AI-based energy management systems will enhance efficiency. Maintaining air quality around the port is another key priority, requiring real-time monitoring, strict anti-idling policies, and afforestation initiatives to mitigate haze and pollution.

Sustainable port development must also include environmental protection and circular economy principles. Carbon reduction initiatives will be crucial, including setting emission targets, developing carbon credit systems, and integrating electrified rail transport for long-haul freight movement. Wastewater treatment, rainwater harvesting, and biodiversity conservation should be embedded within the port's infrastructure planning. Promoting sustainable supply chains by encouraging eco-friendly packaging, enhancing transparency, and facilitating paperless trade will ensure a more environmentally responsible logistics network. Circular waste management models, such as reusing construction materials and implementing zero-landfill policies, will further contribute to sustainability. These efforts should extend to industry-wide emission reduction initiatives, requiring suppliers and transporters to align with green standards. The adoption of low-carbon cement, LEED-certified buildings, smart lighting, and passive cooling techniques will ensure that infrastructure development adheres to sustainability principles.

Sustainability must also extend to procurement and collaboration with government agencies. Green procurement policies should prioritize eco-certified suppliers and sustainable materials. By working closely with ministries, customs authorities, and environmental agencies, Nepal can align its dry port policies with national and international sustainability commitments, including its Nationally Determined Contributions (NDCs) under the Paris Agreement. International funding and technical assistance should be leveraged to accelerate these green initiatives.

A truly sustainable dry port must not only focus on infrastructure but also foster a circular economy and workforce development. Establishing a resource-sharing ecosystem, promoting the reuse of port infrastructure materials, and supporting eco-friendly packaging solutions will enhance resource efficiency. Workforce training programs on green logistics and sustainability will equip port workers with the necessary skills to operate energy-efficient equipment and manage sustainable supply chains. Partnering with universities for research and innovation will further strengthen Nepal's expertise in sustainable logistics. Additionally, engaging local communities in port development, providing livelihood support for those affected by infrastructure expansion, and improving public transport connectivity around port areas will ensure that sustainability efforts have a positive social impact.

Governance and compliance are critical in maintaining ethical and sustainable dry port operations. The port must adhere to corporate social responsibility (CSR) policies, maintain transparency in operations, and align with the United Nations Sustainable Development Goals (SDGs). A robust code of conduct will ensure fair labour practices, ethical procurement, and anti-corruption measures. Community relations and outreach efforts should involve public consultations, engagement in local development programs, and incentives for small and medium enterprises (SMEs) that use the port sustainably. Health and safety measures must be prioritised, including occupational safety programs, emergency response systems for hazardous cargo, and mental health and wellness initiatives for workers.

Regulatory and legal compliance will ensure the port operates within environmental and labour laws while adhering to international trade and logistics regulations. Strengthening customs digitalisation will improve operational efficiency and transparency. Security risks must also be addressed, requiring a strong risk assessment framework and robust cybersecurity measures. AI-driven monitoring can enhance cargo security, while strict data protection protocols will safeguard sensitive trade and logistics information. Implementing cyber resilience programs and leveraging blockchain for secure trade documentation will strengthen the port's governance framework.

This Nepalese Dry Port Sustainability Framework is a roadmap for developing a green, efficient, and future-ready logistics infrastructure. Nepal can position its dry ports as key trade hubs that align with global sustainability trends by decarbonising operations, promoting social responsibility, and ensuring strong governance. Investing in green technologies, fostering partnerships, and prioritising ethical practices will enhance operational efficiency and contribute to Nepal's long-term economic and environmental resilience.

7 CONCLUSION AND RECOMMENDATIONS

Integrating sustainability across all environmental, financial, and social dimensions is critical to ensuring that Nepal's dry ports contribute positively to the environment, economy, and local communities. Based on the strategies discussed in this document, an action matrix can guide the development socially, environmentally, and financially sustainable dry ports in Nepal. The following recommendations outline specific actions and timelines to achieve these objectives.

Objectives	Action	Description	Timeline	Responsible Entities
Environmental sustainability	Adopt Clean Energy Solutions	Integrate solar panels, wind energy, and energy-efficient systems to reduce reliance on fossil fuels.	Short-term (1–2 years)	Port Authorities, Renewable Energy Providers
	Modernize Equipment and Infrastructure	Invest in energy-efficient cargo handling equipment, hybrid/electric vehicles, and emissions control technologies.	Medium-term (2–3 years)	Port Authorities, Terminal Operators
	Implement Environmental Regulations	Enforce stricter emission control, waste management, and pollution control policies with regular audits.	Immediate (1 year)	Government, Port Authorities
	Enhance Waste Management	Establish recycling programs, hazardous waste management, and circular economy practices.	Medium-term (2 years)	Port Authorities, Local Municipalities
	Improve Water Management	Implement wastewater treatment, rainwater harvesting, and water recycling systems.	Medium-term (2–3 years)	Port Authorities, Environmental NGOs
	Promote Biodiversity Conservation	Create green spaces and ecological buffer zones, and collaborate with environmental organizations.	Long-term (3–5 years)	Port Authorities, Environmental NGOs
Economic sustainability	Enhance Operational Efficiency	Implement automated systems for customs clearance and cargo tracking and optimize terminal layouts.	Short-term (1–2 years)	Port Authorities, IT Providers

	Diversify Revenue Streams	Introduce value-added services such as cold storage, packaging, and logistics training to increase income sources.	Medium-term (2–3 years)	Port Authorities, Private Sector Partners
	Strengthen Multimodal Connectivity	Improve infrastructure links to rail and road networks, facilitating smoother cargo movement.	Medium-term (2–3 years)	Port Authorities, Ministry of Transport
	Introduce Customer-Centric Initiatives	Extend operating hours, offer end-to-end logistics solutions, and provide tailored services to attract clients.	Short-term (1 year)	Port Authorities, Logistics Companies
	Adopt Green Practices for Long-Term Viability	Invest in renewable energy, sustainable transport options, and eco-friendly infrastructure.	Medium-term (2–3 years)	Port Authorities, Private Sector Partners
	Policy and Regulatory Reforms	Introduce flexible financial models, revenue-sharing agreements, and tax incentives for dry ports.	Immediate (1 year)	Government, Port Authorities
Social Sustainability	Promote Equitable Employment Opportunities	Prioritise local hiring, offer workforce development, and create professional training programs.	Short-term (1–2 years)	Port Authorities, Educational Institutions
	Support Local Economic Development	Integrate local SMEs into the supply chain, offer logistical support, and establish dedicated facilities for traders.	Medium-term (2–3 years)	Port Authorities, Local Businesses
	Ensure Gender Inclusion	Implement policies to hire and train women in logistics and support women entrepreneurs.	Short-term (1 year)	Port Authorities, Women's Organizations
	Environmental Justice and Community Well-being	Address noise, air pollution, and traffic congestion through green buffers, renewable energy, and	Medium-term (2–3 years)	Port Authorities, Local Communities, Environmental NGOs

		environmental monitoring.		
	Cultural Preservation and Integration	Respect local traditions by organizing cultural programs and supporting community-driven initiatives.	Long-term (3–5 years)	Port Authorities, Local Communities
	Invest in Education and Capacity Building	Establish training programs and internships for local youth to develop the skills needed for logistics and port operations.	Medium-term (2–3 years)	Port Authorities, Universities, Technical Institutions
	Infrastructure for Community Benefit	Develop shared-use infrastructure like roads, utilities, and public services that benefit the port and local communities.	Long-term (3–5 years)	Port Authorities, Local Government

Recommendations for Immediate Action:

- Policy Alignment:** The government must play a pivotal role in supporting all these strategies through enabling policies, tax incentives, and infrastructure investments. Immediate actions should include revisiting lease agreements and introducing favourable regulations for sustainability.
- Public-Private Partnerships:** Nepal's dry ports should engage with private sector players to attract investment, expertise, and innovative solutions, especially for financial sustainability and infrastructure development.
- Community Engagement:** Active engagement with local communities and stakeholders should be prioritized, ensuring that the development of dry ports aligns with regional needs and generates long-term goodwill.
- Monitoring and Evaluation:** Establishing performance monitoring mechanisms for both environmental and financial sustainability is crucial. Regular assessments will allow for adjustments and ensure that goals are being met.

By following this action matrix, Nepal can move towards building dry ports that are efficient and competitive and contribute positively to the environment, economy, and society, ensuring a more sustainable and inclusive future for the country.

Section 1: General Information

1. Name of the Dry Port: _____
2. Location: _____
3. Name of the Respondent: _____
4. Position: _____
5. Years of Experience: _____

Section 2: Environmental Sustainability

1. **Energy Efficiency:**
 - What percentage of your port's energy comes from renewable sources?

 - Have energy efficiency measures been implemented? (e.g., LED lighting, electric vehicles)
☒ Yes ☒ No
If yes, please specify the measures:

2. **Waste Management:**
 - What measures are in place for handling hazardous waste?

 - How do you manage non-hazardous waste (e.g., recycling, composting)?

3. **Water and Air Quality:**
 - How is wastewater managed at your port?

 - Are there policies to control air emissions from trucks/trains and port operations?
☒ Yes ☒ No
If yes, please elaborate on these policies:

4. **Environmental Monitoring:**
 - Is there regular monitoring of environmental indicators (e.g., water quality, air quality)?
☒ Yes ☒ No
If yes, how often are these indicators measured?

5. **Biodiversity Protection:**
 - What actions are taken to protect hinterland and local ecosystems?

Section 3: Economic Sustainability

1. **Economic Contribution:**
 - What is the port's contribution to the local economy (e.g., jobs created, revenue generated)?

2. **Cost Efficiency:**

- What strategies have been implemented to reduce operational costs while maintaining sustainability?

- 3. **Innovation and Technology:**
 - Has the port adopted new technologies to enhance sustainability (e.g., automated systems, smart logistics)?
☒ Yes ☒ No
If yes, please describe:

 - Are there policies to ensure suppliers and contractors follow sustainable practices?

Section 4: Social Sustainability

1. **Employee Welfare:**
 - What measures are in place to ensure the health and safety of employees?

 - Are there training programs for employees on sustainability-related practices?
☒ Yes ☒ No
If yes, please specify:

2. **Community Engagement:**
 - How does the port engage with the local community regarding environmental and social initiatives?

 - Are there outreach programs for local stakeholders (e.g., fishermen, residents)?

3. **Human Rights and Labor Standards:**
 - Does the port have policies to ensure compliance with international labor standards?
☒ Yes ☒ No
If yes, please elaborate:

4. **Cultural Heritage:**
 - Are there programs to protect or promote local cultural heritage?

Section 5: Governance and Policy

1. **Sustainability Policy:**
 - Does the port have a formal sustainability policy?
☒ Yes ☒ No
If yes, please provide a brief overview of the policy:

2. **Sustainability Reporting:**
 - Does the port publish a sustainability report?
☒ Yes ☒ No
If yes, how frequently is the report published?

3. **Regulatory Compliance:**

- How does the port ensure compliance with local, national, and international environmental regulations?
-

Section 6: Challenges and Opportunities

1. Challenges:

- What are the port's main challenges in implementing sustainability initiatives (e.g., financial, technological, regulatory)?
-

2. Opportunities:

- What opportunities do you see for further improving sustainability at the port?
-

3. Collaboration:

- Does the port collaborate with external stakeholders (e.g., governments, NGOs) to enhance sustainability efforts?

☒ Yes ☒ No

If yes, please describe these collaborations:

Section 7: Additional Comments

- Please provide any additional comments or suggestions for improving port sustainability.
-

- Average vehicles movement in the dry ports and carbon emissions: _____

- Water flow management and wind, solar systems: _____
-

End of Questionnaire

¹ Varese, Erica & Marigo, Danilo & Lombardi, Mariarosaria. (2020). Dry Port: A Review on Concept, Classification, Functionalities and Technological Processes. *Logistics*. 4. 29. 10.3390/logistics4040029.

² Khaslavskaya, A., Roso, V. Dry ports: research outcomes, trends, and future implications. *Marit Econ Logist* 22, 265–292 (2020). <https://doi.org/10.1057/s41278-020-00152-9>

³ Theo Notteboom, Athanasios Pallis and Jean-Paul Rodrigue (2022) *Port Economics, Management and Policy*, New York: Routledge, 690 pages / 218 illustrations. ISBN 9780367331559.

⁴ Teodora Milošević ; University of Rijeka, Faculty of Medicine Lado Kranjčević ; University of Rijeka, Faculty of Engineering Stjepan Piličić ; University of Rijeka, Faculty of Medicine Marko Čavrak ; Teh-Projekt Oprema doo Igor Kegalj orcid.org/0000-0002-1469-0642

⁵ Chengcheng Yu, Zhengtao Qin, Yougeng Lu, Haocheng Lin, Chao Yang, Quan Yuan, Qingyang Wu, Integrated strategies for road transportation-related multi-pollutant control: A cross-departmental policy mix, *Transportation Research Part D: Transport and Environment*, Volume 132, 2024, 104257, ISSN 1361-9209, <https://doi.org/10.1016/j.trd.2024.104257>.

⁶ <https://www.seatrade-maritime.com/ports-logistics/rotterdam-port-gets-energy-boost-from-new-solar-panel-system>

⁷ [https://www.portoflosangeles.org/environment/air-quality/alternative-maritime-power-\(amp\)#:~:text=About%20AMP%C2%AE&text=Instead%20of%20running%20on%20diesel,power%20source%20for%20oceangoing%20vessels](https://www.portoflosangeles.org/environment/air-quality/alternative-maritime-power-(amp)#:~:text=About%20AMP%C2%AE&text=Instead%20of%20running%20on%20diesel,power%20source%20for%20oceangoing%20vessels).

⁸

https://www.tideelbe.info/fileadmin/user_upload/Downloads/Broschueren/Strategy_watersde_access_Port_of_Hamburg_2022.pdf

⁹ https://www.polisnetwork.eu/wp-content/uploads/2020/12/ZEZ-F_How-to-Guide_low.pdf

¹⁰ Karimpour, Reza & Ballini, Fabio & Ölçer, A.I.. (2019). Circular economy approach to facilitate the transition of the port cities into self-sustainable energy ports—a case study in Copenhagen-Malmö Port (CMP). *WMU Journal of Maritime Affairs*. 18. 10.1007/s13437-019-00170-2.

¹¹ <https://sustainableworldports.org/wp-content/uploads/Supporting-info-PAV-Strategy-towards-zero-emissions-by-2030-.pdf>

¹² https://www.pub.gov.sg/-/media/Images/Feature/Home/Resources/Publications/PUBInnovationMagazineIssue12_11042022.pdf

¹³ Mikael Ögren, Peter Molnár, Lars Barregard, Road traffic noise abatement scenarios in Gothenburg 2015 – 2035, *Environmental Research*, Volume 164, 2018, Pages 516-521, ISSN 0013-9351, <https://doi.org/10.1016/j.envres.2018.03.011>.

¹⁴ <https://lca.logcluster.org/nepal-212-birgunj-dry-port>

¹⁵ ibid

¹⁶ ibid

¹⁷ <https://nepalmonitor.com/2024/10/21/birgunj-dry-port-revenue-soars-to-12-7-billion-in-first-quarter/>

¹⁸ https://www.unescap.org/sites/default/files/6.7.Nepal_.pdf

¹⁹ ibid

²⁰ <https://www.toms.com.hr/index.php/toms/article/view/504>

²¹ ibid

²² <https://repository.unescap.org/handle/20.500.12870/5529>

²³ <https://www.undp.org/nepal/news/community-engagement-and-ownership-making-local-development-plans-sustainable>

²⁴ <https://thedocs.worldbank.org/en/doc/5694d80f7ca36f93d16ea89c211e2b77-0310012024/nepal-environmental-and-social-framework-overview-assessment-framework>

²⁵ https://www.unescap.org/sites/default/files/6.7.Nepal_.pdf

²⁶ https://www.unescap.org/sites/default/files/Nepal_Presentation%20WGD%282%29_14-15%20November%202017_0.pdf

²⁷ <https://www.unescap.org/sites/default/files/6.%20Nepal.pdf>

²⁸ https://ewsdata.rightsindevelopment.org/files/documents/90/WB-P156590_AixbjxE.pdf

²⁹ https://ewsdata.rightsindevelopment.org/files/documents/97/WB-P153497_pnn3Pbn.pdf

³⁰ https://www.timeslive.co.za/news/south-africa/2022-06-29-transnet-invites-smes-to-help-it-spend-billions-to-expand-sas-major-ports/#google_vignette

³¹ <https://oxfordbusinessgroup.com/reports/myanmar/2019-report/economy/incentives-for-growth-development-of-three-special-economic-zones-continues>

³² <https://www.sundaynews.co.zw/zimbabwe-dry-port-in-namibia-breaks-into-profitability/>

³³ <https://www.concorindia.co.in/work-culture.asp>

³⁴ <https://portusonline.org/navigating-equality-empowering-women-in-the-maritime-industry-of-northern-europe/>

³⁵ <https://www.araburbanism.com/tafseela/en/the-green-buffer-pavement-of-amman>

³⁶

https://cdn.locomotive.works/sites/5ab410c8a2f42204838f797e/content_entry5ab410faa2f42204838f7990/5be174d6337f770010c1b69f/files/1.2.2_Rotterdam_Climate_Agreement_ENG.pdf

-
- ³⁷ <https://www.adb.org/sites/default/files/project-documents//zhengzhou-xian-railway-project.pdf>
- ³⁸ <https://www.eurasian-research.org/publication/the-geo-economic-importance-of-the-khorgos-gateway-current-developments/>
- ³⁹ <https://documents1.worldbank.org/curated/ar/253121510894144054/pdf/121435-16-11-2017-16-6-4-TransportLogisticsapprovalcopy.pdf>
- ⁴⁰ <https://thebetterindia.com/47944/shipping-container-street-art-start-india-tughlakabad-delhi/>
- ⁴¹ https://thanalengdryport.com/tdp_007/
- ⁴² https://ewsdata.rightsindevelopment.org/files/documents/90/WB-P156590_AixbjxE.pdf