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Impact of Dry Ports on Time and Cost of Logistics Management in Nepal

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Abstract

The objective of this study is to analyze the impact of dry ports on logistics time and costs in Nepal. This study used panel data from 1991 to 2024 to investigate the impact on logistics time and cost assessment using a fixed-effects model. The study findings show a positive and significant impact of dry ports on logistics time and cost reductions in Nepal. The Hausman test and VIF results both provide evidence supporting the validity of the fixed-effects estimates. Furthermore, the time and cost analysis as well as the performance analysis of selected dry ports, namely Tatopani ICP, Chobhar ICD, Nepalgunj ICP, Birgunj ICP, and Birgunj ICD, this study has also used vehicle tracking for the entry and exit data of a total of 167,940 vehicles from January 1 to July 20, 2025. The analysis of logistics and economic indicators shows that the selected ports are performing well, make a sustainable economic contribution, and have already been successfully operating under the public-private partnership model. Therefore, this study concludes that the construction of selected dry ports in Nepal is rational for reducing logistics time and costs, facilitating trade, and generating employment, thereby supporting overall regional and national economic productivity.

Keywords: Dry ports, Integrated check post, Inland container depots, International trade, Logistics costs, Economic development, Nepalese economy

JEL Classification: F15, R42, L91, H54

Introduction

Nepal, being a landlocked country, relies heavily on dry ports to facilitate international trade, enhance logistics systems, and boost economic connectivity with neighboring countries. The country has faced logistical challenges in international trade due to its landlocked geography. According to the Nepal Rastra

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Bank (2025), about 90.90 percent of international trade is facilitated by inland ports, including inland container depots (ICDs), dry ports, and integrated check posts (ICPs), while the remaining 9.1 percent is handled by air. Of Nepal's total international trade, about 45.82 percent is facilitated through *Birgunj* customs points, Nepal's largest customs point, which also handles about 70 percent of container-based cargo.

To handle cross-border cargo transshipment, provide warehouse and parking facilities, and provide integrated customs services within a premises, the government of Nepal initiated the dry ports and ICPs structure and, for this purpose, established a separate board called the Nepal Intermodal Transport Board (NITDB) on 19th January 1998 in accordance with the provision of the Development Board Act (1956) and the NITDB structure under the Nepal Intermodal Transport Development Order (2054). Subsequently, the Government of Nepal has been investing in the construction of ICDs and ICPs at different customs points to provide economical and efficient trade facilitation and logistics facilities. There are eight major structures in *Tatopani, Rasuwa*, *Kakarbhitta*, *Biratnagar, Birgunj, Bhairahawa, Nepalgunj, Dodhara Chandani,* and *Chobhar* Dry Ports, respectively. Dry ports do not provide logistics handling and integrated customs services but benefit from reduced transit times and costs, sufficient parking and warehousing facilities, security services, container-handling equipment, and the promotion of exports and overseas trade (Rekabi et al., 2025; Bergqvist, 2013).

The development of these dry ports at major customs points is strategic and significant, according to the NITDB, as the government of Nepal has been investing substantial financial resources, even taking loans from the World Bank and the Asian Development Bank. Indeed, these structures significantly contribute to economic development by facilitating international trade and reducing both logistics time and costs. However, there are still questions regarding the contributions of these assets from the general public and various stakeholders, including the media, public representatives at the local, provincial, and federal levels, and, occasionally, the private sector. As a result, assessing the impact of these dry ports on economic development, trade, customs clearance and forward time, and cost is crucial to understanding the potential benefits and challenges associated with the development of Inland Clearance Depots/Inland Clearance Check Posts (ICD/ICP). Understanding the sustainability and actual impact of ICPs on Nepal's economic development, and their contribution to business growth, employment generation, international trade facilitation, and the reduction of time and costs of customs clearance for both exports and imports, is pivotal. Therefore, this study aims to examine how dry ports affect the time and cost of logistics management in Nepal. This study provides comprehensive policy recommendations based on the given facts and the impact analysis outcomes to improve operational efficiency, sustainable operations and management, foreign trade facilitation, and economic growth.

In addition to this section, the paper is organized as follows: Section 2 provides a brief theoretical understanding of dry ports from different perspectives and the empirical foundation for impact assessment. Section 3 presents the study's approaches and methodologies, including research models, data sources, data analysis methods, and techniques. Similarly, Section 4 provides a detailed analysis covering cost-benefit analysis, economic profitability, and a discussion of the results, and the final Section 5 summarizes the overall study findings and lists potential actionable recommendations to improve the current status of the respective ICD and ICPs.

Theoretical Understanding

The consistent growth of containerization since the mid-1900s has required integrating intermodal terminals into the container seaport system to manage and develop the key components of seaport competitiveness. Inspired by the long-term stimulus of increasing global trade and globalization, the international freight transport industry thrives on continued evolution and development, as reflected in managerial practices, regulatory frameworks, and technological innovation across the sector (Cullinane, Bergqvist, and Wilmsmeier, 2012). The term dry port was originally defined as an inland terminal to and from which shipping lines could issue their bills of lading, with the concept being initially envisaged as applicable to all types of cargo (UNCTAD, 1982), but currently this term is widely applied in different contexts, having the common feature of transportation (Rose et al., 2009).

The assistance of intermodal systems, especially dry ports, is highly anticipated by container seaports and other key players to advance the shift from seaport-centric to consumer-centric logistics (Lee and Cullinane, 2016). Similarly, Dias et al. (2009) have also explained the strategic benchmark for designing a competitive and dynamic market by maximizing efficiency and reducing costs through the use of dry ports. A dry port, according to UNCTAD (1982) in theoretical terms, is an inland intermodal terminal that functions as an extension of a seaport. It is directly linked to a seaport primarily via rail and facilitates logistics operations such as customs clearance, cargo consolidation, and container handling at an inland location rather than the seaport itself. This setup helps reduce congestion at coastal ports, enhances hinterland connectivity, and improves the overall efficiency of the supply chain and product life cycle (Kotler and Armstrong, 2004). Essentially, a dry port extends the port's reach, making international trade more accessible to inland businesses (Bergqvist, 2013).

According to the theoretical arguments of Park and Kim (2003), Vis and Koster (2003), and Robinson (2002), dry ports basically promote intermodal connectivity, reduce port congestion, enhance logistics efficiency, promote environmental benefits, and support regional economic development through competitive supply chain systems and market demand-driven cargo handling services. The dry ports' infrastructure supports reducing transportation costs and improves production efficiency in multiple stages of the production process and supply chain networks (Cullinane and Wilmsmeier, 2011; and Kotler and Armstrong, 2004). The central point of this argument is to understand the process of large-scale container movements within the supply chain network to fulfill industrial intermediate and end-user demands in the markets via the transportation system. As business activities increase, the frequency of movement increases, which limits the space within the premises of the company, and this is supported by dry ports, which handle cargo at lower, and more affordable prices (Padilha and Ng, 2011).

Beresford and Dubey (1991) argued that reports and inland clearance or container depots (ICDs) were designed with a focus on cargo handling and customs clearance facilities at distant inland locations, particularly for landlocked countries with no seaports. According to Wilmsmeier and Monios (2021), this approach to cargo handling in the transportation system is currently useful for reducing both the cost and time required for cargo handling at ports and customs clearance. Likewise, Wilmsmeier et al. (2011) explained that dry port development is not limited to the absence of seaports; rather, it combines inland transport clearance with efficient cargo handling. Therefore, the construction of dry ports or Inland Clearance Depots will enhance cargo-handling efficiency and enable hassle-free customs clearance, leading to improvements in international trade growth, regional development, local economic activity, employment creation, customs revenue, and overall economic growth. In addition to this theoretical understanding, there is another perspective on dry ports based on distance and function. The distance-based establishments at the seaport for storage and consolidation hubs, moderate distance for additional logistics services, and quite far distance from the sea provide services to specific regional logistics needs. On the other hand, a functional perspective also provides services for container storage and distribution, a special category of cargo handling and efficient transportation and transshipment facilities as container transfer hubs.

As defined by Rose et al. (2009), dry ports and ICPs serve as extensions of seaports, improving hinterland connectivity and reducing congestion at coastal ports, thereby facilitating smoother trade flows and boosting regional economic activities. Likewise, these facilities support foreign direct investment (FDI) and improve logistics, as seen in India and China (Ng and Gujar, 2009). Like other structural supports, these facilities also support processing customs clearance, warehousing and distribution, and transshipment by contributing to local industrialization (Notteboom and Rodrigue, 2005). These facilities mainly help reduce transshipment and port clearance times and costs. By shifting cargo handling inland, dry ports reduce dwell times; for example, the Torkham ICP between Pakistan and Afghanistan reduced transit time by 70 percent (Woxenius et al., 2004) and faster customs clearance (World Bank, 2020). Similarly, according to Cheng and Yang (2018), long-haul trucking expenses are reduced at China's Xi'an Dry Port. Another significant contribution of these facilities is employment generation, technology, and knowledge transfer (Nguyen and Nottenoom, 2016).

In the Nepalese context, there are no seaports, and all international trade has been done through either land ports or airports. As Rodrigue (2020) explained, the term 'inland port' in the USA, Nepal is experiencing inland port facilities to facilitate international trade mainly to and from India and China. There are few studies on the multifaceted impact of ICPs and ICDs, such as those by Acharya (2012); Pradhan (2020); and Bajracharya (2021). The summary of the *Birgunj* ICD field visit, with support from UK Aid and the World Bank, outlines observations from the visit, including key infrastructure development, land acquisitions, operational and TEU-handling equipment, security systems, and other contingent issues for all stakeholders. Based on the above arguments and the global understanding of the use of dry ports and ICPs, this study investigates the effects of these properties on economic development, international trade facilitation, cost and time reduction, and the support of regional development and employment opportunities.

Nepal has several dry ports that facilitate the movement of goods between inland regions, seaports, and airports. These logistics hubs play a crucial role in streamlining trade, reducing costs, and improving supply chain efficiency. The ports of Nepal are *Chobhar* ICD, *Birgunj* Dry Port, *Birgunj* ICP, *Bhairahawa* ICP, Biratnagar ICP, *Kakarbhitta* ICP, *Tatopani* ICD, *Rasuwa* ICD, *Nepalgunj* ICP, and *Chandani-Dodhara* ICD (In Progress). As a landlocked country, Nepal is heavily dependent on dry ports to streamline cross-border trade with India and China. Nepal recognized the need for ports long ago, but the first dry port in Nepal was Birgunj Dry Port, established in 1994 with support from the Indian government (Shrestha, 2018). *Birgunj* is the primary gateway handling a major portion of container cargo coming from the Kolkata/Haldia seaport in India. After that, Biratnagar, *Bhairahawa,* and other ports were constructed. Despite their importance, Nepal's dry ports have faced challenges, including inadequate infrastructure, bureaucratic delays, and underutilization (ADB, 2019). The government, with support from international donors like the Asian Development Bank (ADB), has initiated modernization projects to enhance efficiency. The Nepal-India Transit Treaty has also been revised periodically to facilitate smoother cargo movement through these dry ports (Department of Customs, 2021). In recent years, Nepal has expanded dry port facilities near the northern border with China, such as the *Tatopani* and *Rasuwagadhi* dry ports, to diversify trade routes and reduce dependency on India (Khatiwada, 2022). However, geopolitical tensions and infrastructure gaps continue to pose challenges to the smooth and sustainable operation of ports. Amid these developments, Nepal has recently begun construction of the *Chandani-Dodhara* ICD. The governance structure of Nepal's ICP and ICDs is as given below:

Table 1: Governing composition of NITDB

Institutional Representative	Position
Secretary, Ministry of Industry, Commerce and Supplies	Chairman
Deputy Governor, Nepal Rastra Bank	Member
Director General, Customs Department	Member
Joint Secretary, Ministry of Physical Infrastructure and Transport	Member
President, Federation of Nepalese Chamber of Commerce and Industries	Member
President, Nepal Chamber of Commerce	Member
President, Nepal Freight Forwarders Association	Member
Executive Director, NITDB	Member Secretary

Source: Official website of NITDB, www.nitdb.gov.np

As per the NITDB formation order 2054, the above combination of governance structures is the best-fit model for the Public-Private Partnership (PPP) model of project development and operation in Nepal. Therefore, understanding the governance structure of Nepalese ICDs/ICPs is crucial to understanding their operational modalities.

Further, an assessment of impacts on economic development, employment generation, reducing customs time, and logistics costs has been carried out in many studies across the world, such as Ma et al. (2021); Cong et al. (2020); Coppens et al. (2007); and Heijman et al. (2017). There are several approaches to impact assessment of ports and port activities, including case study (Coppens et al., 2007), difference-in-difference (DID) analysis (Ma et al., 2021), logistics indicators analysis, and panel data fixed effect analysis (Ohakwe and Wu, 2025). Likewise, Cong et al. (2020) also used panel data to investigate the economic impacts of ports in China. In this way, several analytical methods are used across different contexts of port analysis in various studies. Therefore, there is no single analytical technique for examining the impact of dry port construction on economic development, trade times, and logistics costs. However, there is no evidence of similar analysis in the Nepalese context. Therefore, this study provides significant policy inputs to the concerned authority and serves as an academic reference for analyzing the economic benefits and roles of international trade promotion by improving the efficiency and safety of logistics systems in Nepal.

Methodology

The study has conducted an economic effect examination using a cost-benefit analysis, trade time and cost analysis using logistics performance indicators, and a pre- and post-analysis using a difference-in-differences method. This study has employed both primary and secondary data sources from the respective dry ports, the customs office, the terminal management company, and government sources, including the Nepal Rastra Bank and the Department of Customs. This study also used vehicle entry and exit times at the *Nepalgunj* and *Birgunj* ports, obtained from the management systems. We have analyzed 67,840 vehicles from *Birgunj* ICD, 55,100 vehicles from *Birgunj* ICP, and 45,000 vehicles from *Nepalgunj* ICP. In total, 167,940 vehicle entry and exit records have been examined to confirm average times for logistics holding, cargo transshipments, and customs clearance. Unfortunately, there is no system-generated data available for *Tatopani*; however, this study observed daily vehicle movements and conducted key informant interviews (KIIs) with officials and logistics companies. The secondary data were collected through desk reviews of existing literature, policies, and reports on dry ports, trade, and economic development. Similarly, the study uses primary data collected through KIIs from 53 respondents, including traders, logistics companies, government officials, and industry experts. To analyze the effect of establishing dry ports, four major ICP/ICDs have been selected from the eight, accounting for 50 percent of the sample.

The study has used both qualitative and quantitative methods to assess the impact of dry ports on logistics time and costs in Nepal. Especially for the impact assessments of establishing dry ports, the study employed cost-benefit analysis (CBA), return on investment (ROI), and descriptive and inferential analyses. Primarily, the study uses the following fundamental equation to analyze the contribution of ICD/ICPs.

$$LC_{it} = \alpha_0 + \beta_1 ICD/ICPs_{it} + \delta_1 X_{it} + Y_t + \varepsilon_{it} \dots\dots\dots\dots\dots (1)$$

$$LT_{it} = \alpha_0 + \beta_1 ICD/ICPs_{it} + \delta_1 X_{it} + Y_t + \varepsilon_{it} \dots\dots\dots\dots\dots (2)$$

Where LC is logistics cost in real values, ICD stands for Inland Clearance Depots and ICP stands for Integrated Check Posts, and X stands for other macroeconomic factors influencing the logistics costs, Y stands for ports specific factors influencing to the costs and time (fixed error terms), α, β, δ, and Ɛ denote intercept value, coefficient of ICDs and macroeconomic control variables, and error terms respectively. Likewise, *i* and *t* denote the respective port and time, respectively. Based on the findings of fundamental analysis through equations (1 & 2) and to find the real impact of establishing ICDs on time and cost, the study will use the pre-and-post establishment analysis through the following equation:

$$\pi_{it} = \alpha_0 + \lambda_1 \sum_{t}^{i} \theta\_ik - \sum_{t}^{i} \vartheta\_ik + \delta_1 X_{it} + Y_t + \varepsilon_{it} \dots\dots\dots (3)$$

Where λ is the coefficient of the net impact before and after the establishment of ICDs in logistics time and costs from ICP/ICDs, and θ and ϑ denotes the coefficient for post- and pre-establishment of ICP/ICDs on the impact indicators mentioned above. Based on the analysis, the study will conclude on the actual impact of ICP/ICDs on logistics management at border points and on cost reduction. The major variables used to analyze the impact of ICP/ICDs are as follows:

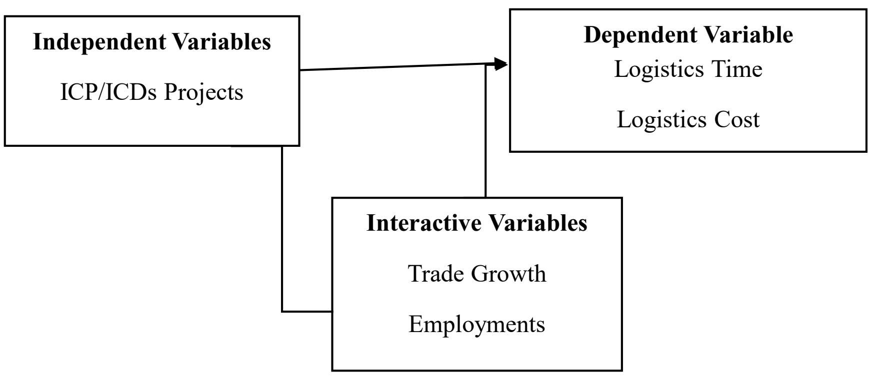
i. Logistics time is the proxy measure variable for total time within a premise from entry to exit of respective ports.
ii. Logistics costs are the proxy measure variable for total cost incurred within a premise from entry to exit of respective ports.
iii. Trade growth is the proxy of economic growth contribution to total international trade via respective ports
iv. The number of employments is the proxy of employment generation in the respective ports.
v. The independent variable or interactive variable is a dummy variable of ICD/ICPs having value of 1 for after establishment and 0 otherwise.

Similarly, for the project's impact analysis, this study has assumed the major impacts on cargo handling, transportation, and customs clearance time and costs. Generally, for estimating logistics costs, the Baumol and Vinod (1970) model is used. The same model has also been used by the World Bank to assess logistics project development. Therefore, this study also used the following model to calculate total logistics costs.

Logistic costs= Transportation costs+ moving inventory costs + Delay hedging costs………………. (4)

Where the total logistics costs are the sum of trucking firms' costs, inventory-moving associated costs on capital, and induced costs of uncertainty in warehousing and mode of transportation. Based on the literature reviews and methodological understanding, the conceptual framework presented in Figure 1 has been developed for this particular analysis.

Figure 1: Conceptual framework



Source: Author

Results and Discussion

Nepal's trade relies heavily on road transportation. As a landlocked nation, Nepal relies on road transport for approximately 92 percent of its foreign trade, and only 7 percent goes by air (Nepal Rastra Bank, 2025). As the ICD/ICPs are located more on the southern border, approximately 62.3 percent of total trade is with India, and the rest of the world, except China, also goes via India, which accounts for about 19 percent of Nepal's total foreign trade. This strategic infrastructure has been designed and is operating across the country's customs points. Therefore, this study has assessed the impact of ICD/ICP projects on logistics time and costs, and the results are presented in this section.

Brief information on selected ports

As per the NITDB formulation order and bylaws, the NITDB is responsible for Nepal's inland ports and transshipment management, so these ports are managed and operated under a public-private partnership model by the NITDB. Fortunately, this practice is being successful in Nepalese contexts. *Tatopani* and *Chobhar* ICDs are managed by Trans Silk Terminal Pvt. Ltd. Similarly, Nepalgunj and Birgunj ICPs are managed by TRS Atlas and TRS Himalayan Logipark (P) Ltd. However, *Birgunj* ICD is being managed and operated by Pristine Valley Dry Port Pvt. Ltd.

Table 2: Basic Information of *Tatopani*, *Chobhar*, *Nepalgunj*, *Birgunj* ICD, and *Birgunj* ICP

Projects/Features	*Tatopani* ICD	*Chobhar* ICD	*Nepalgunj* ICD	*Birgunj* ICD	*Birgunj* ICP
Property size (Hectare)	4.2	13.23	22.07	38.04	52.61
Parking capacity (TEUs)	160	500	200	1568	
Investment (Rs. Billions)	2.93	1.89	3.2	4.8	3.5
Development Agency (Financing)	PRC	World Bank	Gov. India	Gov. India	Gov. India
Average TEUs (Annual)	16500	2000	35414	65600	182500
Average Clearing times (Hrs)	4	4	6	7	12.9
Minimum Lease Rent for five years (Rs. Millions)	117	28.8	208.8	4710	1809
Trade direction	China	India & China	India	India	India

Source: Author's computation based on collected data and contract documents of port management and operations of respective ports.

Table 2 provides brief information on each selected project considered for the study. Of the four selected ports, the *Birgunj* ICP is the largest, and *Tatopani* is the smallest in terms of land area and parking capacity. The *Tatopani* ICP is absolutely targeted for China-oriented trading. On the other hand, *Nepalgunj* and *Birgunj* ICP/ICD are designed to facilitate logistics and cargo handling with India. However, the objective of the *Chobhar* ICD construction was different from that of border-point ICDs/ICPs. *Chobhar* ICD is designed for city transshipment, reducing cargo truck congestion and improving warehousing and the safety of goods carrying and forwarding. *Chobhar* ICD has two sections: the first is the international terminal area for Exim service, and the second is the domestic terminal, which is mainly used for warehousing and parking/holding yards with full-fledged utility services, including banking services. As per the objective of integrated services, all integrated check posts and dry ports offer fully flexible utility services, banking, customs, warehousing, transshipment, quarantine, and security services on-site.

Service Delivery Time Analysis

As per the port management and operation agreement contract between the lessor and the terminal management company (TMC), an operation and service delivery standard time taken by the cargo and port service handling within a port's premises has been specified under global practices and mutual understanding of the two parties in order to provide professional and quality services. The status of the agreed service time is summarized below.

Table 3: Standard Service Time Vs Actual Time at ICD/ICPs

S.N.	Activities	Standard Time	Actual time
1	Stuffing of a 20-foot container for mixed cargo	1 hour	>
2	Destuffing of a 20-foot container for mixed cargo	1 hour	>
3	Stuffing of a 40-foot container for mixed cargo	2 hours	>
4	Destuffing of a 40-foot container for mixed cargo	2 hours	>
5	Lift on/off a container to truck/trailer	15 minutes	>
6	Loading/unloading of break bulk cargo in to/from truck	45 minutes	>
7	Weighting a truck/trailer	10 minutes	<
8	Identification of cargo location	15 minutes	>
9	Issuing of entry/exit pass for vehicle	15 minutes	<
10	Processing of terminal charges and its acceptance	45 minutes	>

Source: Author's computation based on field visit and secondary data sources obtained from the respective ports.

There is an automatic billing system installed at all ports, which helps reduce processing time and seems to provide efficient entry and exit processes. As a result, weight measurement, cargo location tracking, entry and exit ticketing, and payment for services have been completed within standard time. However, stuffing and destuffing of containers are slow due to inefficient labor, especially for *Tatopani*, *Nepalgunj*, and *Chobhar* cases, where as *Birgunj* is managing its services slightly on time. The field observations and KII survey data show that the actual time for the customs and port handling process is less than 5 hours, including stuffing, destuffing, billing, customs payment, security checks, and other necessary procedures. But most vehicles spend time inside the port as a resting and parking area. Due to parking congestion and cargo holding on the roadside, carriers feel comfortable using it as a resting spot, which is also one of the objectives of these ports, where all kinds of facilities can be enjoyed, including resting, parking, warehousing, and transshipment of cargoes.

Table 3 above shows the standard port service providing time as per the operational and management contract and the actual time taken by the service provider. However, the precise quantitative time savings resulting from the operation of these dry ports are presented in Table 4.

Table 4: Transshipment and Port Service Time (Mean Hours)

Particular	Before ICP/ICDs/Trip		After ICP/ICDs/Trip			Time Saving/Trip		
	Holding Hours	Customs Process	ICD Premises Holding	Customs Process	ICP	From ICD	From ICP	Diff (ICD-ICP)
Mode of Vehicle								
Truck	36.40	9.15	7.1	3.57	20	29.30	16.40	12.90
Container (F-20)	26.20	7.30	6.3	3.41	10.14	19.90	16.06	3.84
Container (F-40)	40.00	4.50	7.05	4.02	23.5	32.95	16.50	16.45
Trailer-20	-	-	6.3	3.53	-	-	-	-
Trailer-40	-	-	6.32	3.09	-	-	-	-
Types of goods								
Non-degradable	36.30	10.41	-	-	-	36.30	36.30	-
Degradable goods	38.00	3.58	-	-	-	38.00	38.00	-
Banks time	10.00	10.00	5.00	-	5.00	5.00	10.00	-

Source: Author's computation based on entry-exit database of respective ports and field observation

As shown in Table 4, average holding hours for trucks, containers (F-20), and containers (F-40) are 36.40, 26.20, and 40 hours, respectively. However, after the operation of ICP/ICDs, the cargo holding and customs clearance processes have been significantly reduced, as shown in the table. The average saving hours for trucks, containers F-20 and F-40 are 29.30, 16.06, and 16.5 hours, and ICP saves 16.40, 16.06, and 16.5 hours, respectively. Although different modes of transportation are benefiting from the new structure, the nature of goods means there is no significant contribution from ICP/ICD to operations; TMC is definitely giving high priority to degradable goods compared to non-degradable goods.

Similarly, the time analysis shows an interesting finding: the time saved for logistics and cargo handling at ICD is greater than at ICP. This is because of the nature of cargo handling via ICDs and railways, especially in the *Birgunj* ICP case; in other ports, this doesn't exist. The analysis results show that the saving difference between ICP and ICD is 12.9, 3.84, and 16.45 hours for trucks and containers F-20 and F-40, respectively. Additionally, the average time for vehicle entry and exit is 28.30 hours, with durations ranging from a few minutes to several days. Empty vehicles clear within just 2-3 minutes, while holding vehicles can be up to 1000 days in some cases. However, an average cargo vehicle clears within a working day. While analyzing the data, it was found that the green line sometimes takes 11 minutes to complete and commonly takes up to 28.30 hours.

Economic Analysis

One of the objectives of this study is to see the economic sustainability of constructed dry ports in Nepal. The government of Nepal is investing a large amount of money in inland ports and is also receiving technical and financial assistance from the governments of India and China at their respective border-sharing points. Additionally, the government has been engaging the private sector to operate and manage the ports under leasing laws and the public-private partnership model. As shown in Table 2, the selected ports are managed by various joint-venture companies, both foreign and domestic. However, our concern is whether the projects are economically sustainable. Therefore, Table 5 presents the financial and economic indicators for the ports considered in this study.

Table 5: Economic Indicator Analysis

Indicators	*Tatopani* ICD	*Chobhar* ICD	*Nepalgunj* ICP	*Birgunj* ICD	*Birgunj* ICP
Net Present Value (Rs.)	3.92	1.77	1.23	15.66	1.64
Return on Investment (%)	30.56	16.16	13	52.81	15.68
Cost-Benefits Ratio (Times)	1.46	1.03	2.62	2.34	1.14
Payback Period (Year)	-	-	9.1	4.9	9.93

Note: For *Tatopani* and *Chobhar*, the economic indicators are the analysis of economic indicators and the rest of the three financial indicators, and we have not calculated the payback period of these two projects because *Tatopani* and *Chobhar* are economically feasible, but financially they are not, as the government of Nepal has invested.

Source: Author's computation based on collected data for the Respective Ports.

The economic indicator analysis results show that all four projects benefited economically and financially, with positive net present values for each. The most benefited project is *Birgunj* ICD, followed by *Tatopani* ICP, *Chobhar* ICD, *Birgunj* ICP, and *Nepalgunj*. Likewise, the return on investment for selected projects follows the same pattern as the NPVs. The return on investment indicates the return over the capital investment, addressing the cost of capital. However, the cost-benefit analysis is comparatively better with *Nepalgunj*, followed by *Birgunj*, *Tatopani*, and *Chobhar*. The cost of operations in *Birgunj* and *Nepalgunj* is high due to weather, traffic, and power supply issues. In sum, from an economic perspective, all four selected projects strategically benefit Nepal's economic growth, international trade facilitation, logistics management, employment generation, and the reduction of logistics time and costs.

Empirical Results

Logistics infrastructure is crucial and strategic for facilitating trade, supply chain networks, labor engagement, productivity improvements, and overall regional and national economic growth. This infrastructure is more critical for countries like Nepal, which has no direct seaport access and faces geographic constraints in expanding its road transportation system. Recognizing this fact, the government of Nepal has been operating inland and dry ports to address the critical importance of overall economic development by reducing logistics time and costs. Therefore, a regression analysis has also been conducted to assess the impact of selected ports on economic development through logistics time and cost reductions.

First, this study analyzes the impact of dry ports on logistics time reduction following their establishment in Nepal. For that purpose, this study has employed OLS regression analysis of panel data from 1991 to 2024, covering the customs points of *Tatopani*, *Chobhar*, *Nepalgunj,* and *Birgunj*. The regression analysis of the reduction in logistics management time after the establishment of dry ports is presented in Table 6.

Table 6: Regression Analysis for Logistics Time

Variables	OLS	Fixed Effect	Random Effect	Pooled OLS
Dry Ports	-3.954 (-1.560)	-45.094*** (-3.530)	-3.954 (-1.560)	-3.953 (-1.170)
Trade Growth	0.224** (2.680)	0.237*** (3.160)	0.224*** (2.86)	0.223*** (3.950)
Investment inflows	-0.001*** (-8.250)	-0.001*** (-4.640)	-0.001*** (-8.250)	-0.001*** (-5.800)
Employment	-0.009*** (-9.680)	-0.011*** (-9.04)	-0.009*** (-9.860)	-0.009*** (-15.50)
Constant	117.092*** (3.801)	119.561*** (3.352)	117.290*** (5.380)	117.10*** (10.381)
Time Effect	No	Yes	Yes	No
Place Effect	No	Yes	Yes	No
Adj. R-Square	0.974	0.974	0.977	0.917
F-Value	37.90	60.07	231.61	582.51

Note: The dependent variable is logistics time; the independent variable is a dummy variable for dry ports (ICP/ICD), with 1 for dry ports and 0 otherwise; and the control variables are international trade growth, investment, and employment generation. ***, **, and * denote the level of significance at the 0.10, 0.05, and 0.01 levels, and the value in the parentheses is the t-statistic.

The impact analysis has been done using panel data of *Tatopani* ICP, *Chobhar* ICD, *Nepalgunj* ICP, *Birgunj* ICD, and *Birgunj* ICP. The analysis estimates simple OLS, fixed-effects, random-effects, and pooled OLS models for robustness checks. However, the Hausman test result suggests that the fixed-effect model is the best fit with the available data. Therefore, fixed-effects analysis estimates are considered for the impact assessment. Table 4.5 shows that the beta coefficient for dry ports with logistics time is negative and significant at the 0.01 level. This indicates that the operation of dry ports has reduced logistics management time compared to traditional customs points, where a wide range of services were offered, and there were no dedicated integrated customs clearance services. The pattern of results is also similar across simple panel OLS, random-effects, and pooled OLS estimation. However, these estimates are not significant in a fixed-effects model. After the operation of dry ports or integrated checkpoints, the logistics forwarder provides all necessary services for cargo handling, customs clearance, warehousing, goods transshipment, banking, security, and other associated services, thereby reducing holding and trade-off service times.

The analysis also considered trade growth, investment inflows, and employment as control variables. These variables are used to assess the contribution of ports to trade growth, investment inflows, and job creation in their respective communities. The coefficient on trade growth is positive and significant at the 0.01 level, indicating that rising international trade growth leads to congestion and traffic over limited resources. As a result, the procedural time increases. Therefore, there is a positive relationship between international trade growth and reductions in logistics time. However, increasing trade helps improve the efficiency of logistics management and the digitalization of all procedures. However, there is an inverse relationship between investment inflows in regional development and logistics time, indicating that rising logistics costs demotivate investment by increasing the cost of production inputs. Similarly, the coefficient on logistics time is negative and significant at the 0.01 level, indicating a negative relationship between logistics time and employment. This result indicates that a decrease in employment increases logistics time due to professional inefficiency and a shortage of service providers. When there is a labor shortage, cargo handling will be delayed and logistics time will increase. The patterns across all model estimates are consistent.

Table 7 presents the analysis results of the impact assessment on the logistics costs. The dependent variable is logistics costs; the independent variable is dry ports (a dummy variable indicating post-operation of dry ports, with 1 indicating post-operation and 0 otherwise); and the control variables are trade growth, investment as a proxy for regional development, and employment opportunities after dry port operations.

Table 7: Regression Analysis for Logistics Costs

Variables	OLS	Fixed Effect	Random Effect	Pooled OLS
Dry Ports	-1737.42*	-14387.22*	14387.22	-1737.42
	(-1.85)	(-1.910)	(1.610)	(-1.110)
Trade Growth	-186.225***	-155.67**	-186.225*	-186.225*
	(2.78)	(-2.690)	(-1.780)	(-1.78)
Investment	0.426***	0.184*	0.425***	0.426***
	(6.91)	(1.901)	(2.970)	(2.970)
Employment	2.012**	2.059**	2.012	2.013
	(2.63)	(2.180)	(1.501)	(1.500)
Constant	5404.01***	7935.04**	4204.001**	5404.001***
	(3.09)	(2.780)	(2.310)	(2.310)
Time Effect	No	Yes	Yes	No
Place Effect	No	Yes	Yes	No
Adj. R-Square	0.883	0.865	0.977	0.897
F-Value	63.34	6.75	231.61	45.38

Note: The dependent variable is logistics costs; the independent variable is a dummy variable for dry ports (ICP/ICD), with 1 for dry ports and 0 otherwise; and the control variables are international trade growth, investment, and employment generation. ***, **, and * denote the level of significance at the 0.10, 0.05, and 0.01 levels, and the value in the parentheses is the t-statistic.

The beta coefficient for dry ports is negative and significant at the 0.10 level for logistics costs, indicating that the founding of dry ports has reduced logistics costs in Nepal. As in the first model, this model also suggests using the Hausman statistic to assess the results of the fixed-effects estimation. These results explained that after the development and operation of dry port services in *Tatopani, Chobhar, Nepalgunj*, and *Birgunj*, they supported logistics management costs. However, the OLS, FE, RE, and POLS patterns do not support it; the conclusion will be drawn from the fixed-effects analysis model. Similarly, the coefficient on trade growth with logistics costs is negative, indicating that increasing foreign trade improves logistics efficiency and helps reduce logistics costs.

Likewise, there are positive and significant relationship's between investment and logistics costs, as well as between employment and logistics costs. The coefficient on investment, a proxy for regional development, is positive, indicating that reduced logistics costs will increase investment inflows and employment opportunities, as well as lower production costs. These results also show that an increase in employment will raise income levels, thereby increasing the family's or individual's spending capacity. As a result, both investment and employment will be in demand. In sum, with increased investment and employment, logistics costs will decrease, and production efficiency will increase. According to both study models, Nepal's international trade and logistics management procedures save time and money by using dry ports located throughout the country.

Hausman test

Further analysis was conducted using the Hausman test to confirm the best-fit model, and the results showed a chi-square probability value of 0.038, which is lower than 0.05. This indicates that the fixed-effects model has been applied to draw a conclusion about the impact of dry ports on logistics time reduction. Similarly, the second model's Hausman test shows a Chi-square probability value of 0.0154, indicating that the fixed-effects model is suitable for further analysis. Therefore, this study employed a fixed-effect panel data analysis model to draw the final conclusion on the impact of dry ports on logistics time and cost reductions.

VIF test

Before proceeding with further analysis, this study also conducted a variance inflation factor (VIF) analysis to detect multicollinearity. As per the rule, if VIF < 5, there is no major concern about multicollinearity. The mean VIF is 2.81, i.e., 2.81 < 5. The analysis results indicate no multicollinearity, as shown in Table 8.

Table 8: VIF Analysis

Variables	VIF
Dry Ports	2.51
Trade Growth	1.10
Investment	3.17
Employment	4.45
Mean VIF	2.81

Source: Author's own computation based on given data estimation

The VIF analysis is used to assess multicollinearity among independent variables. According to standard guidelines, VIF values greater than 5 indicate a serious issue with the variables. However, the mean VIF and the mean of all individual variables also meet the fundamental property of multicollinearity. Therefore, this data variable has no serious issue of multicollinearity.

Conclusion

This study has investigated the impact of dry ports on logistics time and cost reduction in Nepal by using panel data from 1991 to 2024 for *Tatopani, Nepalgunj, Chobhar*, and *Birgunj* Customs and dry ports. To analyze the impact of dry ports on time and costs, this study has employed fixed-effects OLS using panel data from the selected dry ports. The study's analysis shows that dry ports have a significant impact on both time and cost reduction in Nepal's overall logistics management. However, time reduction has a greater impact than direct logistics cost reduction, as the results are significant at the 0.01 level of significance, whereas the impact on costs is significant only at the 0.10 level. Therefore, this finding indicates that reducing logistics handling time after the operation and management of dry ports is more significant than the costs. However, this study also indicates that the costs associated with delays in logistics handling are more critical, causing multiple shocks to logistics management efficiency and overall productivity, which directly affect employment, foreign trade, and the regional and national development of Nepal.

Further, this study has employed multiple analytical approaches, including logistics indicator analysis, standard service delivery analysis, and economic indicator analysis, to provide a robust assessment of the time and costs associated with the logistics management of the respective ports. This study also highlights the effectiveness of investment in dry port development and the rational utilization of resources for Nepal's ICDs/ICPs at various customs and trade points on both the northern and southern sides of Nepal.

The study concludes that dry ports have significantly and positively contributed to logistics management time and costs. Based on these findings, this study proposes five major executive and policy recommendations to improve the efficiency and productivity of Nepal's logistics management.

Integrated Service of ICD and ICP in Birgunj

Currently, *Birgunj* ICP and ICD operate and are managed independently, with separate customs points. This is quite a hassle, increases operational costs for the customs office, and could also cause security and other operational issues. If these two properties merge and operate as a single entity, it will help provide more robust and efficient services from a single customs point in *Birgunj*. As the Government of Nepal has already acquired the land between the two properties, the NITDB should now further expedite the development of the integrated infrastructure, and the Department of Customs should facilitate the provision of integrated customs services at dry ports.

Immigration Service

The concept of ICP is to provide integrated customs and immigration services, and the infrastructure is also being developed accordingly. However, Nepal's side ports are not offering immigration services, whereas our counterparts are. This is a hassle for travelers because they have to come for immigration clearance at one point and return to another existing point of entry, as is practiced at the *Nepalgunj* and *Birgunj* ICPs. Thus, we suggest providing integrated immigration services from ICP as well, which supports the full use of ICP/ICD infrastructures.

Infrastructure improvement

The ports of *Tatopani* (China), Nepalgunj, and *Birgunj* (India) are handed over to Nepal after construction by their respective neighbors. However, due to some technical and fundamental issues, the quality of infrastructure is questionable. Water supply and drainage, electricity cables, lighting, building roofs, furniture, and other utility infrastructure are not properly managed and maintained at a standard quality. Keeping in mind the quality of service and user safety, the office should improve and maintain the quality of the infrastructure. Some infrastructure is out of service or underutilized. The TMC or NITDB, whoever is responsible for this job, must take this seriously and act accordingly.

Capacity development

Nepal's dry ports are designed to facilitate foreign trade and provide efficient and effective logistics services. However, most of the ports are still unable to provide professional services to domestic companies and individuals. Therefore, for domestic employment creation, trade promotion, and regional participation in these activities, the ports should focus on institutional and individual capacity development in handling logistics in Nepal.

Data sharing

This study also suggests that the TMC and the customs office should be actively integrated and share necessary data regularly; it would be preferable to enable real-time data sharing through a secure data management system. Currently, the customs office uses the ASYCUDA system, which is also provided to the TMC for digital linkage, but due to the system's capacity or technical limitations, it is disrupted regularly, directly affecting cargo clearance and logistics handling.

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