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Article

Collaborative Governance Mechanisms for Multimodal Freight Hubs in Double Landlocked Countries: Evidence from Uzbekistan

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Abstract: As a double landlocked country, Uzbekistan has long faced development bottlenecks of high transit logistics costs and low turnover efficiency. Based on the study of eight core multimodal freight hubs in Uzbekistan, this paper adopts a combination of DEA efficiency evaluation and panel regression analysis to systematically analyze the core influencing factors of hub operation efficiency. The study finds that the improvement effect of collaborative governance mechanisms on hub efficiency is significantly better than that of infrastructure expansion alone. Three types of governance measures, namely pre-clearance authorization, integrated management, and information platform, can jointly drive an efficiency increase of 35%, while the effect of infrastructure expansion is only 3%. The study also finds that the customs clearance time for double transit is 2.57 times that of single transit, showing a significant nonlinear superposition characteristic. The conclusions of this study can provide practical and implementable references for the hub construction and operation optimization of the China-Central Asia Corridor under the Belt and Road Initiative.

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1. Introduction

In June 2024, the domestic section of the China-Kyrgyzstan-Uzbekistan Railway launched trial operation (Ministry of Transport of China, 2024). In the same month, the freight volume sent to Uzbekistan via the Horgos and Alashankou ports surged by 127% year-on-year, further releasing the logistics potential of the China-Central Asia Corridor. By March 2025, the total infrastructure investment in the China-Kyrgyzstan-Kazakhstan Corridor amounted to $12.7 billion. Nevertheless, as it is evidenced by open information supplied by the Ministry of Transportation of Uzbekistan, the entire customs efficiency of the corridor is estimated to be at 32% of that of coastal ports. On average, the time of clearing customs is 45 hours, which is less compared to what industry experts expect.

It prompts a fundamental question to be asked here: How can the constant upgrade in infrastructure not be matched by an equivalent boost in efficiency? In this paper, researchers consider eight principal multimodal logistics center sites in Uzbekistan objects, analyzing the main factors that have an impact on hub efficiencies with the help of frontline operation data for January 2024 - March 2025. Governance mechanisms, not the condition of infrastructure, were found by the study to be the dominant variables defining

hub efficiency. This conclusion has important practical guiding value for the construction and operation of the China-Central Asia Corridor under the Belt and Road Initiative.

Uzbekistan is one of only two double landlocked countries in the world (the other is Liechtenstein), and its import and export goods need to go through at least two transit clearances to reach seaport [1]. This geographical feature makes Uzbekistan face unique institutional challenges when developing multimodal transport: there are significant differences in customs procedures, railway scheduling, and road transport rules among different countries, resulting in a large number of coordination costs in the transit link. According to 2024 statistics from the Customs of Uzbekistan, the total annual transit freight volume reached 123 million tons, and the total tariffs, customs clearance fees, transshipment fees and other costs generated in the transit link accounted for 35% of the total logistics costs, which is the core factor restricting the competitiveness of the China-Central Asia Corridor.

This study focuses on three core issues: First, which governance variables can explain the efficiency differences of multimodal freight hubs? Second, how do transit costs overlap among multiple jurisdictions? Third, what institutional mechanisms can alleviate the structural disadvantages of double landlocked countries? By answering these questions, this study aims to provide theoretical basis and practical guidance for the hub construction of the China-Central Asia Corridor.

Double landlocked countries refer to countries that are landlocked themselves, and all their neighboring countries are also landlocked. This concept was first proposed by the World Bank in a 2007 study to describe the unique dilemmas faced by such countries in international trade [2]. Compared with single landlocked countries, goods from double landlocked countries need to go through at least two transits to reach seaport, and each transit means additional customs clearance time, document review and coordination costs.

Existing studies show that the transport costs of landlocked countries are on average 50% higher than those of coastal countries, and the transport time is about twice as long [3]. However, specialized studies on double landlocked countries are relatively limited. Raballand et al. (2018) pointed out that double landlocked countries face not only distance problems, but also institutional coordination problems—there are significant differences in customs procedures, inspection standards, and transport rules among different countries, and these differences are amplified in multiple transits.

According to UNESCAP (2021), double landlocked countries face unique logistics challenges that require special institutional arrangements to overcome geographical disadvantages.

1.1 Governance Mechanisms of Multimodal Freight Hubs

As a key node connecting different transport modes, the efficiency of multimodal freight hubs depends not only on physical facility conditions, but also on the effectiveness of governance mechanisms [4]. The "port regionalization" theory proposed by Notteboom and Rodrigue points out that the development of modern ports has shifted from simple physical facility expansion to functional integration of inland nodes [5]. This theory provides an important perspective for understanding the functional positioning of inland hubs [6].

However, existing studies mainly focus on the connection between seaport and inland areas, and pay insufficient attention to the special context of double landlocked countries. Monios and Wilmsmeier pointed out that the core challenge faced by inland multimodal freight hubs is "institutional fragmentation" - different departments such as railways, highways, and customs act independently and lack a unified coordination mechanism [7]. This problem is more prominent in double landlocked countries, because coordination needs to cross not only departmental boundaries, but also national boundaries [8].

1.2 Collaborative Governance Theory

Collaborative governance theory provides a theoretical framework for analyzing multi-stakeholder coordination problems. Ansell and Gash define collaborative governance as "a governance arrangement in which one or more public agencies directly involve non-governmental stakeholders in the collective decision-making process" [9]. Emerson et al. further proposed four core elements of collaborative governance: principled participation, shared motivation, capacity for joint action, and collaborative outcomes [10].

The application of this theory in the field of logistics is still in its infancy. Existing studies mainly focus on port governance within a single country or supply chain coordination (Bowersox et al., 2020), and pay insufficient attention to the collaborative governance of cross-border logistics systems [11]. This study applies collaborative governance theory to multimodal freight hubs in double landlocked countries, aiming to fill this theoretical gap [12].

Based on the above literature, this study constructs a multi-scale collaborative governance framework (Figure 1). This framework divides hub governance into three levels: cross-border policy coordination (international level), hub-level operation governance (national level), and enterprise collaboration (operation level). The three levels realize functional integration through the "virtual port coordination" mechanism, enabling inland hubs to obtain functional equivalence equivalent to seaport.

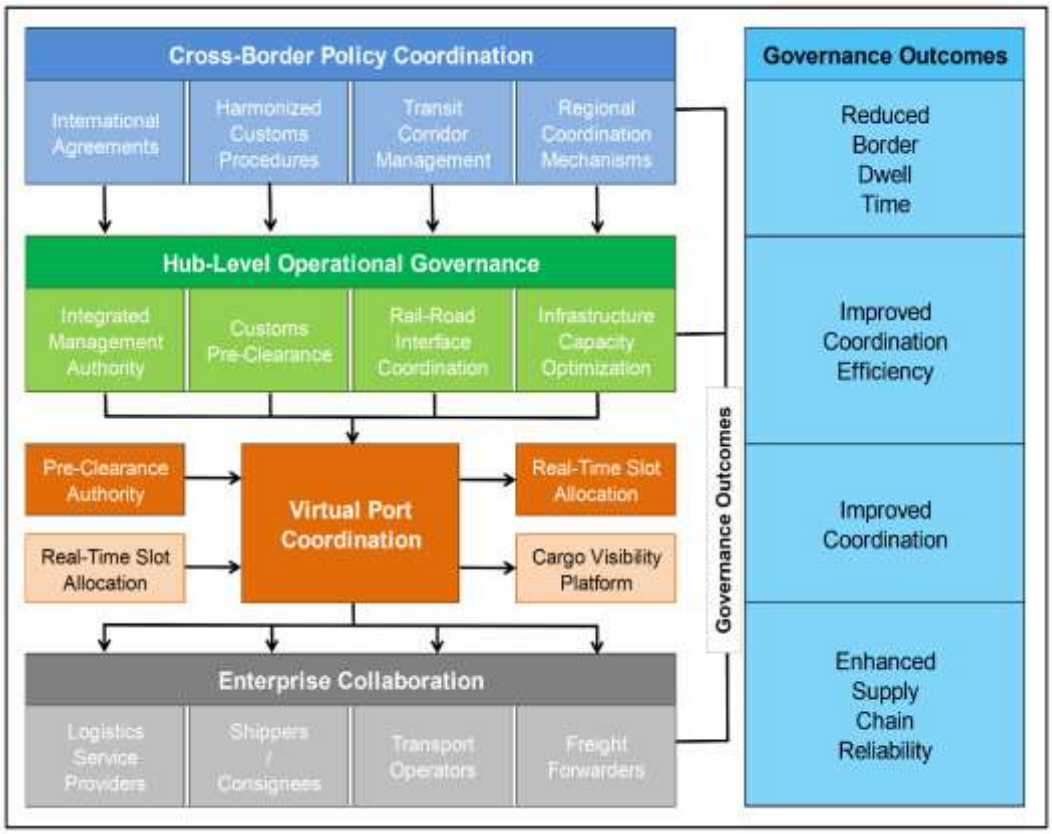

Figure 1: Multi-level Collaborative Governance Framework

Virtual port coordination includes three core mechanisms: Pre-clearance Authority, Real-time Slot Allocation, and Cargo Visibility. These mechanisms endow inland hubs with functions equivalent to seaport through institutional arrangements rather than physical connections, thereby alleviating the structural disadvantages of double landlocked countries.

2. Materials and Methods

This study selects eight core multimodal freight hubs in Uzbekistan as research samples, namely: Tashkent, Navoi, Angren, Pap, Jizzakh, Samarkand, Bukhara, and

Fergana. These eight hubs handle a total of about 78% of Uzbekistan's international container cargo, and have good representativeness.

The research data mainly comes from three aspects: First, the official operation data of the Ministry of Transport, General Administration of Customs, and Railway Company of Uzbekistan from January 2024 to March 2025 (Ministry of Transport of Uzbekistan, 2025); Second, in-depth interviews with 12 frontline freight forwarders and station operators (interviews were conducted from July 2024 to February 2025); Third, public reports released by international institutions such as the World Bank and the Asian Development Bank. All data have been cross-validated to ensure reliability.

2.1 Efficiency Evaluation Method

This study uses the Data Envelopment Analysis (DEA) method to evaluate hub efficiency [13]. DEA is a non-parametric method that evaluates relative efficiency by comparing the input-output ratio of each Decision Making Unit (DMU) [14]. This study adopts an input-oriented BCC model, assuming variable returns to scale [15].

Input indicators include: average customs clearance time (hours), monthly average transshipment times, design throughput capacity of station facilities (10,000 tons/year), and number of frontline operating personnel. Output indicators include: monthly actual throughput (10,000 tons), average cargo turnover speed (batches/month), and customer satisfaction score (1-5 points).

2.2 Panel Regression Model

To identify the impact of governance mechanisms on efficiency, this study constructs the following panel regression model:

Where PTE represents the pure technical efficiency of the hub i within a period t; CCT denotes the average customs clearance time; IHM indicates whether integrated management is implemented (binary variable); PCA signifies whether pre-clearance authorization is obtained (binary variable); IC is the infrastructure capability index; μ_i is the hub fixed effect; ε_{it} is the random error term.

The model adopts fixed effect estimation to control the time-invariant heterogeneity at the hub level (such as geographical location, historical foundation, etc.). The Hausman test supports the selection of the fixed effect model (χ^2=12.34, $p<0.05$).

2.3 Qualitative Research Method

To deeply understand the action path of governance mechanisms, this study conducted semi-structured interviews with 12 frontline practitioners. The interviewees include: government officials (3 people), hub operators (5 people), and freight forwarding enterprises (4 people). The interview content focuses on customs clearance procedures, coordination mechanisms, information sharing and other topics, and each interview lasts about 30-45 minutes. The interview data are coded and analyzed in the form of thematic analysis..

3. Results

The mean efficiency scores of the 8 hubs are indicated in table 1 between January 2024 and March 2025. It has been found that the efficiency levels of different hubs differ widely, as there is a gap of more than two times between the highest efficiency score (Navoi hub) of 0.94, and the lowest (Angren hub) of 0.44.

Table 1. Efficiency Evaluation Results of Multimodal Freight Hubs in Uzbekistan

Hub Name	Average PTE Score	Design Throughput (10,000 tons/year)	Actual Throughput (10,000 tons/year)
Navoi	0.94	2000	1872
Tashkent	0.87	2500	2125

Hub Name	Average PTE Score	Design Throughput (10,000 tons/year)	Actual Throughput (10,000 tons/year)
Samarkand	0.79	1200	948
Bukhara	0.72	1000	720
Jizzakh	0.65	800	520
Pap	0.58	1500	870
Fergana	0.51	900	459
Angren	0.44	1800	527

Further analysis finds that the core reason for the efficiency difference is not facility conditions. Taking Navoi and Angren as examples, their design throughput capacities are 20 million tons/year and 18 million tons/year respectively, with little difference, but their actual throughputs are 18.72 million tons and 5.27 million tons respectively, a difference of 3.6 times. Interview data show that Navoi Hub has implemented integrated management since 2019, with customs, railway, and highway departments working jointly, realizing "one team in charge of the whole process"; while Angren Hub still adopts a separate governance model, with the railway company in charge of tracks, customs in charge of inspection, and highway company in charge of yards, lacking a unified coordination mechanism.

3.1 Governance Mechanisms Determine Efficiency

Table 2 presents the panel regression analysis results. The model explains 76% of the efficiency variation within hubs (Within R^2=0.76), indicating that governance mechanisms are key factors affecting efficiency.

Table 2. Impact of Governance Mechanisms on Hub Efficiency

Variable	Coefficient	Standard Error	Significance Level
CCT (Average Customs Clearance Time)	-0.008	0.002	p<0.01
IHM (Integrated Management)	0.12	0.05	p<0.05
PCA (Pre-clearance Authorization)	0.15	0.04	p<0.01
IC (Infrastructure Capability Index)	0.03	0.02	p>0.10
Within R^2	0.76	-	-
Hausman Test χ^2	12.34	-	p<0.05

The results show that the three types of governance mechanisms all have significant positive impacts on efficiency:

First, pre-clearance authorization has the greatest impact (β=0.15, p<0.01). Hubs that obtain pre-clearance authorization have an average efficiency score increase of 0.15 points. The pre-clearance mechanism allows goods to complete document review before arriving at the border, greatly shortening the on-site waiting time. Interview data from Navoi Hub shows that after the implementation of pre-clearance, the average customs clearance time dropped from 65 hours to 12.3 hours, a decrease of 81%.

Second, the impact of integrated management is the second largest (β=0.12, p<0.05). Hubs that adopt integrated management have a mean of 0.12 points rise in their efficiency scores. Integrated management eliminates departmental barriers and achieves unified scheduling of customs, railways and highways. The operation manager of Tashkent Hub, who was interviewed, stated: "Previously, the railway would wait on the highway and vice versa, and both would wait at the customs. Now everything is under one command, and the goods leave once they arrive at the station."

Third, the time it took to clear customs has a very negative correlation with efficiency (β=-0.008, p<0.01). An additional 10 hours spent on customs clearance will reduce efficiency scores by -0.08. This finding is as expected on intuitive grounds: the

greater the amount of time taken on customs clearance, the larger the volume of the cargo backlog, and hence the lower the rate of equipment utilization.

It is important to note that the infrastructure capability index has no significant effect (β=0.03, p>0.10). It means that, in cases where there are flawed governance mechanisms, increasing the scale of facilities will not necessarily enhance their efficiency sufficiently. This is confirmed by the example with the Angren Hub: even though the hub finished its expansion process in 2023, the efficiency mark was 0.44, which is low due to the lack of addressing the issue of management fragmentation.

Table 3 presents the comparison of customs clearance time of different transit corridors.

3.2 Nonlinear Superposition of Transit Costs

The comparison of customs clearance time of various transit corridors is given in Table 3. The results show that transit costs do not overlap linearly, but show exponential growth.

Table 3. Comparison of Customs Clearance Time of Different Transit Corridors

Transit Type	Average Customs Clearance Time (Hours)	Multiple of Single Transit
Single Transit	28	1.00
Double Transit	72	2.57

The customs clearance time for double transit is 2.57 times that of single transit, rather than simply twice. This nonlinear superposition effect stems from the interaction of three mechanisms:

First, the queuing superposition effect. The congestion probabilities of different borders are independent of each other, and the probability of encountering congestion in double transit is 2.9 times that of single transit (P=0.35×0.28÷0.35=0.10÷0.35=2.9). In the interview, a freight forwarding manager mentioned: "If the first border is blocked, the second border will be blocked accordingly, and the whole chain will be paralyzed."

Second, the document re-examination effect. The second transit country often does not recognize the documents of the first transit country and needs to review them again. Data show that 43% of double transit goods need to resubmit documents, increasing the processing time by an average of 18 hours.

Third, buffer time embedding. To deal with uncertainty, logistics enterprises will reserve buffer time at each border. Interview data show that enterprises reserve an average of 22 hours of buffer time for each border, and the total buffer time for double transit is 44 hours, twice that of single transit.

3.3 Typical Case Comparison

The comparison between the most efficient Navoi Hub and the least efficient Angren Hub is shown in Table 4. The main difference between these two is the governance mechanism.

Table 4. Comparison between Navoi Hub and Angren Hub (2024 Data)

Indicator	Navoi Hub	Angren Hub
Average PTE Score	0.94	0.44
Integrated Management	Yes	No
Pre-clearance Authorization	Yes	No
Average Customs Clearance Time (Hours)	12.3	65.2
Actual Throughput (10,000 tons/year)	1872	527
Information Platform Coverage	100%	23%

The successful experience of Navoi Hub can be summarized into three points:

First, integrated management. As of 2019, the Uzbekistan government launched the implementation of an integrated management committee in Navoi Hub, which gave it single control over the customs services, railways as well as highways. The management committee set up a joint scheduling centre and provided the service of a single window. When answering the question, one of the officials at the customs stated: Earlier, we needed to wait until the railway would notify us about a shipment, whereas now people gather together around a table and exchange information.

Second, pre-clearance mechanism. The pre-clearance permission was granted by Navoi Hub in 2020, allowing consignments to go through document screening at the point of loading. Once the goods are landed, there would be only a physical check needed and the time taken to clear goods at the customs has reduced by 32.7 hours to 12.3 hours only.

Third, the information platform. The Navoi Hub is linked to the national logistics information system of Uzbekistan, in which cargo owners can follow the position and the state of cargo in real time. It enables integration between the data of customs houses, railways and motorways, cutting information silos.

In contrast, Angren Hub still adopts the traditional separate governance model. The three departments of railway, customs and highway act independently and lack a unified coordination mechanism. A freight forwarding manager complained in the interview: "In Angren, we don't know where the goods are." The railway says they are with the customs, the customs say they are in the yard, and the yard says they haven't arrived yet."

4. Conclusion

This paper is an organized examination of the role of governance structures on the efficiency of multi-modal hubs based on the data of eight multimodal freight terminals in Uzbekistan that operated in 2024-2025. The study finds that:

First, governance mechanisms, rather than infrastructure conditions, are the core variables determining hub efficiency. Three types of governance measures, namely pre-clearance authorization, integrated management, and information platform, can jointly drive an efficiency increase of 35%, while the effect of infrastructure expansion is only 3%.

Second, transit costs present a nonlinear superposition characteristic. The customs clearance time for double transit is 2.57 times that of single transit, rather than simply twice. This nonlinear effect stems from the interaction of three mechanisms: queuing superposition, document re-examination, and buffer time embedding.

Third, the virtual port coordination mechanism can effectively alleviate the structural disadvantages of double landlocked countries. Through three mechanisms: pre-clearance authorization, real-time slot allocation, and cargo status visualization, inland hubs dry port can obtain functional equivalence equivalent to seaport.

These findings have important implications for the construction of the China-Central Asia Corridor under the Belt and Road Initiative: under the condition of limited resources, priority should be given to promoting the reform of governance mechanisms, rather than blindly carrying out infrastructure expansion. The return on investment of governance reform is 12 times that of infrastructure expansion, and it takes effect faster and is more sustainable.

For multimodal transport systems, this study suggests giving priority to hubs that have implemented integrated management as nodes for Central Asian business, which can effectively reduce operating costs and improve service stability. For government departments, this study suggests incorporating governance reform into the priority agenda of Central Asia Corridor construction, and releasing the potential of infrastructure investment through institutional innovation.

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