

ENHANCING LOGISTICS RESILIENCE: STUDY OF CENTRAL ASIA

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Abstract

The research paper analyzes and investigates the importance and role of regional cooperation in advancing supply chain resilience in Central Asia. By examining logistics performance metrics, trade volumes, and infrastructure investments, the study finds opportunities and mechanisms for improving logistics performance and supply chain resilience through regional cooperation and mitigating the risks. Findings reveal that regional cooperation, supported by international institutions, can open the potential of the region and can reduce logistics costs by up to 15%. Harmonized trade policies, digital custom systems, and shared infrastructure investments are recommended.

Keywords: Logistics, Supply Chain, Inventory Optimization, AI, Operations, Fleet Management, Transportation, Efficiency, Risk Management, Compliance, Technology, Warehouse Management.

Introduction

Supply chain resilience is one of the critical aspects of modern logistics management, especially when it comes to talking about regions that are prone to various disruptions and risks due to a lack of infrastructure and cooperation. With its unique strategic geographical location and emerging economy, Central Asia is facing unique challenges related to logistics and supply chain resilience [4]. This has led to the mismanagement of resources in the area and challenges such as water scarcity, supply chain complexities, and transportation inefficiencies [6]. Even though the natural resources in each country of the region are similar, their economies are diverse, which fills each other's needs and needs to develop a diverse supply chain. Kazakhstan and Turkmenistan, for instance, are major oil and natural gas producers along with minerals in the region. Kazakhstan has an advanced and well-developed transportation and logistics infrastructure that supports export-oriented supply chains. Turkmenistan also has well-developed gas supply chains [4]. On the other hand, Uzbekistan is one of the unique countries in the world which is a double-land-locked country. To export or import goods through the oceans, the country must go through two countries from its north or south [3].

Countries compete for foreign direct investments to improve transportation and supply chain infrastructures. They should work together to build their integrated supply chains that leverage the unique strengths of each country of the region. There are some cross-border trade agreements to facilitate smoother customs processes but countries in the

region can take a lot of advantage of being strategically located along trade routes that connect Europe and Asia which offer great potential for supply chain logistics [4]. It mitigates risk and supply chain resilience through regional cooperation. The goal of this research is to show how enhancing regional cooperation and supply chain resilience brings better supply chain and logistics solutions to the region.

Methodology

This research adopts a mixed methodology, combining quantitative and qualitative analysis to analyze the logistics resilience and regional cooperation in the Central Asia region. World Bank [1], Asian Development Bank (ADB) [4], and the United Nations' [6] official trade and infrastructure reports are primary data sources. Secondary data sources include academic journals, articles, case studies, and other publications related to the industry that focus on supply chain resilience. To identify patterns and correlations between regional cooperation and supply chain improvements, logistics performance metrics, trade volumes, and investment trends were analyzed. Policy reviews and public information were analyzed for recurring themes, while quantitative data were visualized by using regression analysis to find patterns. The study focuses on five Central Asian nations, including Uzbekistan, Kyrgyzstan, Turkmenistan, Kazakhstan and Tajikistan. In addition to this, we examine their relationships with their key trade partners like China, Russia, and the European Union [4]. The research paper illustrates how successful cooperation influences supply chain resilience.

Current Situation of Supply Chain and Logistics in Central Asia

The countries of Central Asia are strategically located at the vital crossroads of Europe and Asia, serving as a pivotal connection between the two regions, much like they did during the Silk Road era [2]. Although these countries possess geographic advantages, Central Asia faces logistical and supply chain difficulties that prevent it from taking advantage of its economic potential.

Infrastructure Gaps: One of the biggest challenges that hinder efficient logistics is the lack of modern infrastructure and technological platforms in the region. [2] Despite countries like Kazakhstan and Uzbekistan boasting relatively modern rail and road infrastructure, other countries, such as Tajikistan and Kyrgyzstan struggle with undeveloped transport systems, especially, in mountainous areas. This difference limits Central Asia's ability to create an integrated supply chain system. For instance, the average cost of logistics across the region is significantly higher than other regions which makes them less competitive in global markets [4].

Recent Developments: Several positive developments show a potential transformation in the region's logistics system. For instance, Uzbekistan's recent trade liberalization, investment in infrastructures, and its goal to join the World Trade Organization have made

the country more accessible for global trade and regional cooperation [3]. Many recent investments in railways and dry ports have reduced the barriers of being a double-landlocked country. Furthermore, the Central Asia Regional Economic Cooperation (CAREC) initiative has made more than 8,000 kilometers of roads and railways available by supporting the construction of these roads [11]. According to the Asian Development Bank (ADB), the quality and quantity of infrastructure in the region positively affect trade volumes which lead to more investments in transportation, energy networks, and increased trade activities. [4] For example, Kyrgyzstan experienced a significant increase in investments in the mining, energy, and transportation sectors from January to August 2024. As a result, it contributed to the GDP growth of the country by around 8.4% from January to September 2024. [16] In addition, The Biden-Harris administration also initiated the Economic Resilience Initiative in Central Asia (ERICEN) in September 2022 to advance the region's economic growth and provided \$25 million in 2022 and \$20 million in 2023 funding to improve and diversify trade routes [7]. Below (figure 1) is a comparison of the Logistics Performance Index (LPI) scores of Central Asian countries from to 2023 and the LPI shows a country's logistics system, infrastructure, customs efficiency, and shipment reliability and helps countries identify areas for improvement [14]. A higher score represents better performance, which ranges from 1 to 5. According to the World Bank's Logistics Performance Index (LPI), Central Asia ranks below the global average in customs efficiency and trade facilitation. In terms of customs efficiency and trade facilitation, the World Bank's LPI shows that the Central Asian region ranks below the global average rating.

Figure 1, A comparison of LPI Scores of Central Asian Countries

Country	LPI Score (2018)	LPI Score (2023)	Rank Change
Kazakhstan	3.00	3.15	+5
Uzbekistan	2.65	2.90	+10
Kyrgyzstan	2.20	2.35	+8
Turkmenistan	2.10	2.20	+4
Tajikistan	2.00	2.15	+3

(Source: World Bank Logistics Performance Index)

Kazakhstan leads Central Asia with its relatively advanced infrastructure and logistics capabilities. Tajikistan, however, has a lower score that indicates areas needing improvement.

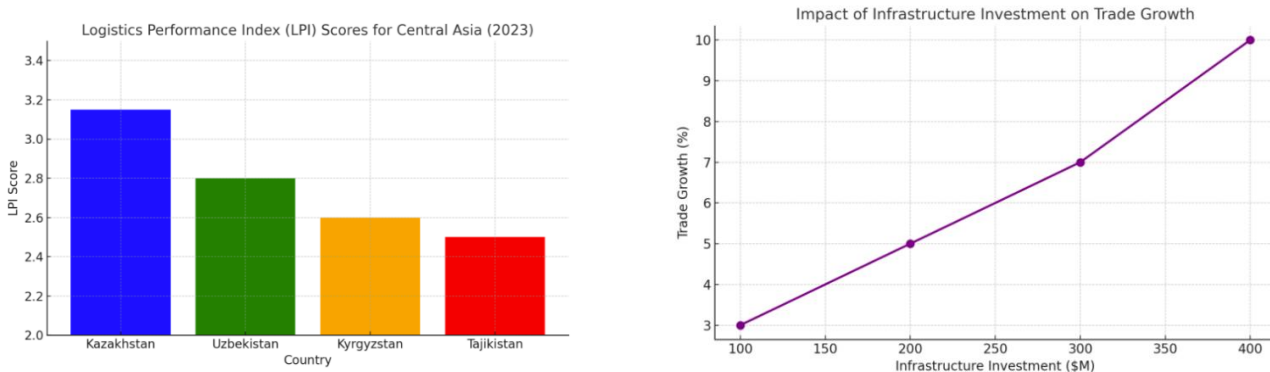


Figure 2, (bar chart) LPI Scores for Central Asia (2023) and Figure 3, Impact of Infrastructure Investment on Trade Growth

The bar chart (Figure 2) shows the variation in logistics performance among the four countries of the region, highlighting Kazakhstan’s higher and Tajikistan’s lower ranking. The line graph gives an overview of how increasing investments in infrastructure correlate with vital trade growth. In addition, external initiatives such as the Belt and Road Initiative (BRI) by China and the Asian Infrastructure Investment Bank (AIIB) have already started to address regional differences. [13].

Opportunities for Cooperation: Advanced cooperation of the region brings significant potential that enhances the logistics and supply chain landscape. Joint investment projects will improve the overall transport and logistics system of the region. This includes railways, roads, storage facilities, and more trade corridors such as the Trans-Caspian International Transport Route [4]. Moreover, standard and simplified customs procedures result in reduced transportation costs, fewer delays, improving connectivity, and encouraging more trade flows across Central Asia. Resource optimization is vital for the region as each country has resource constraints such as water, electricity, and so on [6]. This leads to a better supply chain environment and increases domestic and international demands. Investments in technology, digital platforms, blockchain systems, and AI-based logistics tools, are critical to achieve an optimal supply chain [9, 14].

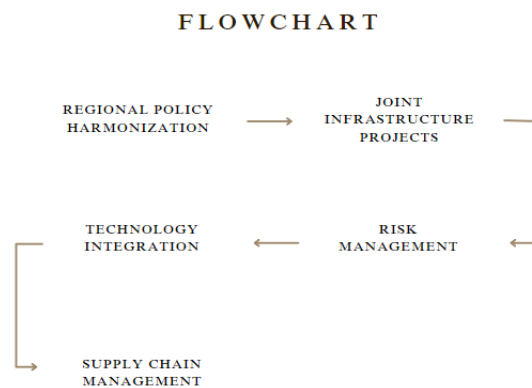
Figure 4, A SWOT analysis of regional cooperation for logistics in Central Asia.

Strengths	Weakness
Strategic Geo Location	Uneven Infrastructure Development
Abundant Natural Resources	Lack of Policy Harmonization Limited
Emerging Trade Routes	Access to Advanced Technologies
Opportunities	Threats
Potential Logistics Hub	Geopolitical Tensions
Foreign Investment Interest	Economic Disparities

Mechanisms For Advancing Supply Chain Resilience

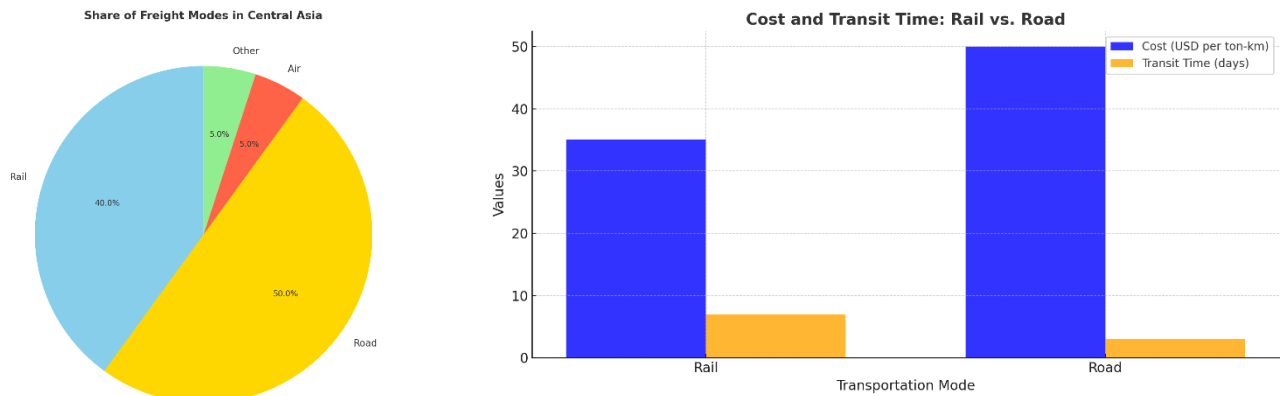
To get supply chain resilience, the region must adopt the mechanisms below. **Integrated Policies:** Unified customs and trade policies will decrease inefficiencies and foster trust among nations [8]. **Shared Infrastructure:** Investment in collaborative projects such as ports, railways, roads, energy pipelines, and technologies can strengthen the supply chain [4]. **Joint Risk Management:** Disaster risk management with all countries mitigates economic disruption and helps handle natural disasters more efficiently [9]. **Training Programs:** To build capacity, there should be regular regional training programs for supply chain and logistics professionals who can standardize skills and advance operational efficiency [10].

Figure 5, A Flowchart Shows Steps to Get to The Optimum Supply Chain Management



Reducing Logistics Costs: Generally, rail transportation is 35 % cheaper than road transportation. However, the freight movement in Central Asia makes up only 40% (Figure 6) due to bottlenecks such as outdated infrastructure and logistical inefficiencies. Hence, broadening railroad networks could reduce total logistics costs by 15%.

Figure 6, (pie chart) Share of Freight Modes in Central Asia - Highlights the dominance of road transport and the potential for rail expansion and Figure 7, Cost and Transit Time: Rail vs. Road

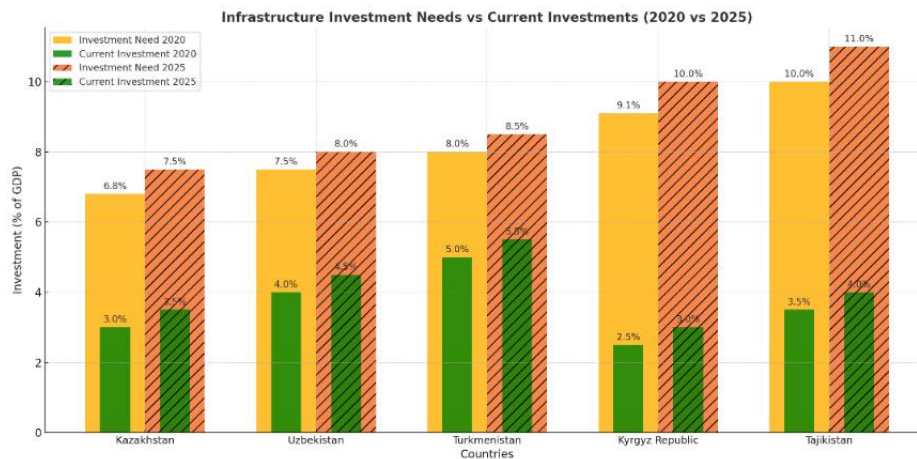


As shown above (Figure 7), rail transportation costs less but it has more transit time compared to road transport. In the report of the International Transport Forum, it is mentioned that between 2020 and 2021 to facilitate international transportation specific measures were applied in several

Central Asian countries. [18] Also, China's BRI initiative and other railroad projects are taking place which shows that there is a good chance to see more freight transported by railways. The role of international organizations such as the Asian Development Bank, World Trade Organization, and United Nations Development Programs is important to support the mechanisms above. Asian Development Bank (ADB) has helped bring infrastructure development funding and promote regional connectivity across the region. One of its initiatives, the Central Asian Regional Economic Cooperation (CAREC) program, has positive influences such as advancing transport corridors, trade facilitation, and energy network cooperation. Central Asia needs to take advantage of ADB's support in infrastructure development, capacity building, and technology support. ADB provides technical, financial, and development plans for supply chain and logistics infrastructure projects. The World Trade Organization (WTO), as a global trade governing organization, plays a pivotal role in standardized trade policies, reducing barriers to trade with its agreements like the Trade Facilitation Agreement (TFA). Central Asian nations can benefit from WTO's efforts by simplifying customs processes and adopting new digital customs systems reducing delays and improving cross-border trade. Also, policy harmonization with consistent trade policies and dispute resolutions helps to foster better regional cooperation, resolve disputes, and bring smoother supply chain operations. The United Nations Development Program supports sustainable development goals (SDGs) that help logistics and supply chain resilience in CA with its inclusive trade policies, risk management projects that mitigate climate-related disruptions, and data-driven insights that help organizations and governments find risks and opportunities to optimize supply chains. To have deeper regional ties, unified regulations, and collaborations surely foster cooperation and promote dialogues on supply chain security, economic growth, and geopolitical risks. The region also needs diversification of trade routes, which opens opportunities to new potential markets and enhances logistics. One of the options can be joining the Trans-Caspian International Transport Route or Middle Corridor in other words. It is a multimodal transport route connecting Central Asia with the Caspian and Black Seas, southern Europe, Caucasus, and the Middle East. [4] This helps to respond effectively to external shocks. Reducing nontariff trade barriers and improving regulatory quality could increase trade by around 17 % on average between Caucasus and Central Asia according to an article on the IMF website. [5] However, this requires significant investment to build the whole transportation infrastructure. [8] There is a 3.9 % growth in 2024 in gross domestic product of the Caucasus and CA region, and it is projected to be 4.8 % in 2025. [9]

Challenges to Regional Cooperation

Uneven Development: Unfortunately, even though there is great potential for CA countries' development, regional cooperation faces several issues. Since 2017, CA countries have resolved too many challenges such as borders, and natural resources distribution. But there are still unequal levels of development amongst them, and it makes imbalances when it comes to **resource allocation**. For instance, Tajikistan needs the highest infrastructure investments (10% of GDP) [4]. Moreover, it seems, there is **a lack of unified long-term vision and strategies** that undermine the solid efforts of the countries. These differences make it hard to do regional cooperation [15]. **Reliance on External Investments:** Another challenge can be reliance on **external funding and investments**. External investments might bring uneven developments between them and political complications. Figure 8, Infrastructure Investment Needs vs. Current Investments (2020 vs 2025)



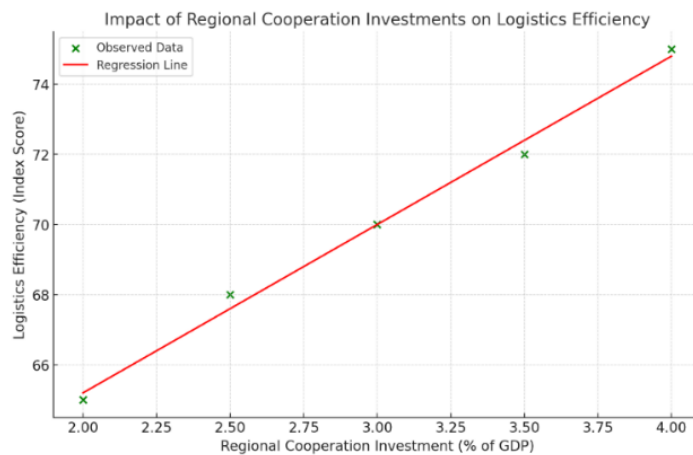
The bar chart illustrates the infrastructure investment needs and current investments among five Central Asian countries from 2020 to 2025 as a percentage of GDP. This shows investment gaps and highlights insights into changes over time. All countries show a big gap between infrastructure investment needs and current investments. Tajikistan needed the highest investment of 10% in 2020, but its current investment was 3.5% of GDP in the same year, showing a 6.5% difference. Two key players of the region Kazakhstan and Uzbekistan who have the largest economies in the region, are still in need of more investments. However, Uzbekistan will show a significant increase in current investments by 2025 narrowing its gap slightly. According to the Asian Development Bank, Central Asia needs 7.8% of GDP for infrastructure investment to meet its needs till 2030 [17]. To close these gaps, the countries need regional cooperation and international support from ADB, WTO etcetera. In addition, governments should encourage public-private partnerships for infrastructure financing [17].

Discussions and Analysis

The findings of this research indicate that enhancing supply chain resilience and the cooperation of the Central Asian countries are both vital economically and politically. Well-developed countries of the region like Kazakhstan and Uzbekistan can serve as heads for regional trade, whilst other countries, such as Tajikistan and Kyrgyzstan can benefit from shared funding and investments. On the other hand, these countries must harmonize their national interests with regional goals and eradicate historical mistrust.

Impact of Regional Cooperation Investments on Logistics Efficiency: An analysis has been conducted to examine the potential relationship between regional cooperation investments and logistics efficiency in Central Asia. This analysis uses a linear regression model, and hypothetical data for illustrative purposes. Regional cooperation investments are the independent variable (calculated as a percentage of GDP), whilst logistics efficiency is the dependent variable (measured on a logistics performance index). The regression analysis (Figure 9) illustrates a clear and positive relationship between independent and dependent variables. This simulation forecasts an increase (10%) in regional cooperation investments (from the mean value) that can improve logistics efficiency by approximately 3.5 points on the LPI [4]. The line shows the importance of regional cooperation investments in driving advancements in trade and logistics performance across the region. The results show that collaborative investments of just 1% of GDP could result in a dramatic increase in logistics efficiency and demonstrate the importance of shared infrastructure development.

Figure 9: Hypothetical Linear Regression Analysis—Illustrates the positive relationship between regional cooperation investments and logistics efficiency.



The regression analysis shows a positive relationship that highlights the critical role of collaborative investments in driving trade and infrastructure advancements.

Conclusion

This study is focused on advancing supply chain resilience with regional cooperation in dealing with logistics and supply chain challenges in the Central Asian region. They can enhance resilience and alleviate risks by integrating infrastructure developments, policies, and adopting new technologies. Despite some issues remaining in the region, the huge potential and opportunities for growth and global integration can help overcome these barriers. Policymakers and enterprises should prioritize regional infrastructure projects, digital custom systems, cooperation, and long-term planning to open the full potential of the region by public-private partnerships and regional trade agreements [13, 15, 17]. Also, cooperating with international organizations will be important when it comes to closing the infrastructure investment gaps and enhancing sustainability in the region. As a result of Central Asia's strategic location and abundant resources, it can become a key player in the global supply chain and economy if the region focuses on regional cooperation as a driver for development and transformation.

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