TASHKENT STATE UNIVERSITY OF ECONOMICS

International journal of topics

INNOVATION SCIENCE AND TECHNOLOGY

Scopus || Electronic journal specializing in Scopus

ISSUE 4

Acceptance of papers **April, 2026**



Acceptance of papers

Published monthly

Topics

economics, technology, social sciences

ISSN 3060-5229

OpenAIRE Google Scholar BASE doi Digital Object Identifier OPEN ACCESS

Visit the website t.me/scopus_IST2100

Electronic publication, Issue 4. 272 pages.
Approved for publication on April, 2026.



EDITOR-IN-CHIEF:
Mirzaliyev Sanjar Makhamatjon ugli

DEPUTY EDITOR-IN-CHIEF:
Makhmudov Nosir Makhmudovich
DSc., Prof., Academican

DEPUTY EDITOR-IN-CHIEF:
Ochilov Bobur Bakhtiyor ugli – Senior lecturer at TSUI

THE SCIENTIFIC-POPULAR ELECTRONIC JOURNAL **"INNOVATION SCIENCE AND TECHNOLOGY"** HAS BEEN REGISTERED UNDER THE NUMBER **C-5669633** BY THE AGENCY FOR INFORMATION AND MASS COMMUNICATIONS (AOKA) OF THE REPUBLIC OF UZBEKISTAN, EFFECTIVE FROM OCTOBER 9, 2024.

CONTACTS

Phone: **+998 50 737 87 88**

Website: https://ist-journal.uz

Email: innovationist2025@gmail.com

The scientific electronic journal “Innovation Science and Technology” has been included in the list of scientific publications recommended for the publication of main scientific results of dissertations for the award of PhD and DSc degrees in economics and technical sciences, in accordance with the Resolution No. 370 of the Presidium of the Higher Attestation Commission of the Republic of Uzbekistan, dated May 8, 2025.

Editorial board:


Sharipov Kongiratbay Avezimbetovich,
Doctor of Technical Sciences (DSc), Professor


Abdurakhmanova Gulnora Kalandarovna, Doctor of Economic Sciences (DSc), Professor


Cham Tat Huei,
Doctor of Philosophy (PhD), Professor (Malaysia)


Muhammad Imran Sadiq
Doctor of Philosophy in Economics (PhD), Professor, Malaysia


Ahmed Aziz Ismail
Doctor of Technical Sciences (DSc), Professor (Egypt)


Lee Chin
Doctor of Philosophy in Economics (PhD), (Malaysia)


Asongu Simplice
Doctor of Philosophy in Economics (PhD), Cameroon


Rui Dang
Doctor of Chemistry (DSc), Professor, China


Zahoor Ahmed
Doctor of Philosophy in Economics (PhD), Turkey


Shujaat Abbas
Doctor of Philosophy in Economics (PhD), Russia


Tina A Coffelt
Doctor of Philosophy in Educational Sciences (PhD), USA


Abdikarimova Dinara Rustamxanovna
Doctor of Economic Sciences (DSc), Professor

Kurbonbekova Mohichehra Turobjonovna
Doctor of Economic Sciences (DSc), Professor

Alimardonov Ilkhom Muzrabshokovich
Doctor of Economic Sciences (DSc), Professor


Razakova Barno Sayfievna
Doctor of Philosophy in Economics (PhD)


Khasanov Sarvar Ulugbek ugli
Doctor of Philosophy in Economics (PhD)


Kholikova Rukhsora Sanjarovna
Associate Professor (PhD)

CONTENTS

THE IMPACT OF FINANCIAL RISKS ON THE DEVELOPMENT OF REGIONAL ECONOMIC GROWTH DRIVERS AND OPPORTUNITIES FOR THEIR MITIGATION 17
Turopova Nigora Xolmurod qizi

UTILIZATION OF INTERNAL RESERVES FOR INCREASING THE EFFICIENCY OF REGIONAL TOURISM (CASE STUDY OF THE REPUBLIC OF KARAKALPAKSTAN) 20
Naurizbaev Aliakbar Rustamovich

MATHEMATICAL MODELS AND ALGORITHMS FOR PROCESSING NOISE DATA 23
Jovlieva Dilnoz Mustofa qizi

ASSESSMENT OF THE IMPACT OF ENVIRONMENTAL RISKS IN BUSINESS ACTIVITIES AND WAYS TO REDUCE THEM 28
Abdukhamid Abdumalikovich Bektemirov

A MULTI-LEVEL SYSTEM OF STATISTICAL INDICATORS FOR REGIONAL TRANSPORT INFRASTRUCTURE ASSESSMENT: METHODOLOGY AND APPROBATION 34
Keunimzhaev Mukhamedali Kuanysbaevich

THE IMPACT OF BANKS ON THE FINANCIAL STABILITY OF THE ECONOMY OF THE REPUBLIC OF UZBEKISTAN 39
Usmonov Faridun Firdavsievich, Ishonkulova Feruza Asatovna

EMPIRICAL EVALUATION OF MACRO- AND MICROECONOMIC FACTORS AFFECTING THE EFFICIENCY OF INVESTMENT ACTIVITY AND THEIR RELATIONSHIP WITH ECONOMIC EFFICIENCY 43
Aytmuratova Ulbike Jalgasovna

MECHANISMS FOR IMPROVING ECONOMIC EFFICIENCY THROUGH OPTIMIZATION OF PRODUCTION RESOURCE POTENTIAL IN UZBEKISTAN 47
Sattarov Abdusamat Umirqulovich

PROMISING DIRECTIONS FOR APPLYING FOREIGN EXPERIENCE IN THE DEVELOPMENT OF GREEN TOURISM IN UZBEKISTAN 52
Rakhimova Dilfuza Mirzakasimovna

PRIORITIES FOR REGULATING FINANCIAL RELATIONS IN PROVIDING HOUSING TO THE POPULATION IN UZBEKISTAN 58
Khannarov Komiljon Karimovich

MPROVING THE ORGANIZATION OF PRODUCTION COST ACCOUNTING IN FULL-SYSTEM FARMS SPECIALIZING IN THE CULTIVATION OF CYPRINID FISH 62
Aitimbetov Amirbek Qoishibekovich

THE TRANSFORMATIONAL ROLE OF SMALL BUSINESS IN UZBEKISTAN'S ECONOMIC DEVELOPMENT: A COMPREHENSIVE ANALYSIS BASED ON 2025 NATIONAL STATISTICS 68
Isakjanova Sabokhat Muhamedovna

AN INTEGRATED METHODOLOGICAL FRAMEWORK FOR ADVANCING GREEN TOURISM MODELS IN THE DIGITAL ECONOMY ERA 79
Rasulova Nigora Yusupovna

FACTORS AFFECTING THE COMPETITIVENESS OF COMPANIES 83
Kamoliddinov Ilhomjon Muhammadjonovich, Nosirov Eldor Nosirjon ugli

THE ROLE OF INDUSTRIAL ENTERPRISES IN INCREASING THE EXPORT POTENTIAL OF THE UZBEK ECONOMY 88
Musayeva Shoira Azimovna

DEVELOPMENT OF MARKET FACTORS TO ENSURE THE GROWTH OF THE ECONOMIC POTENTIAL OF THE ENTERPRISE (USING THE EXAMPLE OF THE SAG EXPRESS BRAND STORES) 92
Usmonova Dilfuza Ilkhomovna

THE CONCEPT OF REGIONAL IMAGE AND ITS ECONOMIC CONTENT (THE CASE OF THE KHOREZM REGION) 99
Dilshod Ibragimovich Ibodullayev

CONTENTS

DEVELOPMENT OF QUALITY MANAGEMENT SYSTEMS IN THE CONTEXT OF DIGITAL TRANSFORMATION 106
Shakhnoza Samandarovna Ziyadillayeva

ADVANCED APPROACHES TO THE ASSESSMENT AND MANAGEMENT OF CURRENT FINANCIAL STABILITY IN JOINT-STOCK COMPANIES USING CFAR (CASH FLOW AT RISK) AND 3Σ STATISTICAL RISK MODELS 114
Kurbonov Xayrilla

DEVELOPMENT OF A PROGRAM FOR ANALYZING MEDICAL LABORATORY RESULTS USING ARTIFICIAL INTELLIGENCE MODELS 118
Gofurjonov Muhammadali, Kamolov Shamsiddin

APPLICATION OF DIGITAL TRANSFORMATION IN IMPROVING MANAGEMENT STRATEGIES OF CONSTRUCTION MATERIALS INDUSTRY ENTERPRISES 122
Ubaydullayev Mukhammadjon Abdusamad o‘g‘li

IMPROVING MECHANISMS FOR ENHANCING THE RESOURCE POTENTIAL OF ORGANIZATIONS IN THE EDUCATIONAL SERVICES SECTOR 125
Ibrohim Meliboyev

ECONOMETRIC ANALYSIS OF THE RELATIONSHIP BETWEEN SERVICE QUALITY AND ECONOMIC EFFICIENCY 130
Khudoyorov Lochinbek Bahromovich

MONETARY POLICY INSTRUMENTS IMPROVE USAGE PRACTICES 135
A.A. Ismailov

E-COMMERCE ADOPTION IN TRADITIONAL STORES 140
Nuserov Bakhtiyor

ENHANCING FINANCIAL SUSTAINABILITY AND OPERATIONAL EFFICIENCY OF JSC “HUDUDGAZTAMINOT”: KEY FACTORS AND DIGITAL TRANSFORMATION STRATEGIES 146
Ergashev Muhibbek Aslamovich

METHODS FOR IMPROVING AUTOMOTIVE FUEL QUALITY INDICATORS THROUGH THE USE OF ADDITIVES 151
Xushnayev Obid, Sheraliyev Ulugbek, Astonov Alisher

MONETARY POLICY INSTRUMENTS 156
A.A. Ismailov

THE ROLE OF STRATEGIC MANAGEMENT IN ENHANCING A COUNTRY’S INTERNATIONAL IMAGE: THE CASE OF SWITZERLAND 161
Idirisbaeva Hurliman Amanbay qizi, Kurolov Maksud Obitovich

VOLUNTEER TOURISM: CURRENT IMPACTS AND FUTURE DIRECTIONS 170
Ossama Moustafa Elsetouhy

COMPUTER GRAPHICS IN MODERN EDUCATION: PRACTICAL CAPABILITIES OF THE FIGMA PLATFORM 176
Maxamadov Rustam Xabibullayevich, Djamatov Mustafa Xatamovich

DEVELOPING THE FINANCIAL SUSTAINABILITY OF HIGHER EDUCATION INSTITUTIONS BASED ON DIGITAL TECHNOLOGIES 182
Abdurasulov Sardor Tolqin ugli

THE IMPORTANCE AND PROSPECTS OF TOURISM DEVELOPMENT 187
Ibodova Dilsora Ibodovna, Qosimov Jahongir Ruziboyevich

STRATEGIES FOR OPTIMIZING THE STRUCTURE OF COMMERCIAL BANK ASSETS AND INCREASING EFFICIENCY IN UZBEKISTAN 194
Ibrohimov Davronbek Muhammadi o‘g‘li

STRATEGIC DIRECTIONS FOR THE DEVELOPMENT OF EXPORTS OF PRODUCTS BASED ON ARTIFICIAL FIBERS 199
Raximov Furqat Jalolovich

FUNDAMENTALS OF USING MARKETING RESEARCH TO IMPROVE SALES SYSTEM EFFECTIVENESS 206
Abduxalilova Laylo Tuxtasinovna

FASHION MARKETING AS AN INSTRUMENT FOR SHAPING CONSUMER-BASED BRAND VALUE 213
Navruz-Zoda Bakhtiyor Negmatovich, Aripova Makhliyo Salakhiddinovna

ENSURING SUSTAINABLE GROWTH OF THE NATIONAL ECONOMY IN THE CONTEXT OF DIGITAL TRANSFORMATION, IMPROVING INNOVATIVE DEVELOPMENT STRATEGIES, AND ENHANCING THE EFFICIENCY OF IMPLEMENTING DIGITAL ECONOMY PRINCIPLES IN THE FINANCE, BANKING, AND TOURISM SECTORS 220
Inatullayeva Intizor Jamshid qizi, Uroqov Uchqun Yunusovich

SOCIAL AND SECURITY PROBLEMS OF INNOVATIVE TOURISM DEVELOPMENT IN THE REGION 223
Q.A. Musakhanov

DIGITAL ECONOMY AND INNOVATION AS FACTORS OF SOCIAL DEVELOPMENT IN UZBEKISTAN 228
Ibragimova Saodat Abdumuminovna, Sadullayeva Sevara Uchqun qizi

THE SOCIAL INSURANCE SYSTEM OF THE UNITED STATES OF AMERICA 232
Javliyev Nuriddin Bektemir o‘g‘li

DEVELOPMENT OF EFFECTIVE ORGANIZATIONAL-ECONOMIC MECHANISMS FOR TRANSITION TO THE INNOVATIVE MARKETING CONCEPT IN ENTERPRISES UNDER DIGITAL TRANSFORMATION 236
Bobomurodov Qayimjon Homidovich

FOMO-DRIVEN PURCHASING IN E-COMMERCE FLASH SALES: AN INTEGRATIVE CONCEPTUAL FRAMEWORK 241
Muhammadiminov Abdukodir Bakhodirjon Ugli, Arciana Damayanti, Javliev Nuriddin Bektemir ugli

PHYSICO-MECHANICAL PROPERTIES OF COARSE FEEDS 250
Yodgorov Jamoliddin Nomozovich, Yadgarov Sirojiddin Nomozovich

EVOLUTION AND STANDARDIZATION OF SI MEASUREMENT UNITS IN THE INTERNATIONAL SYSTEM 255
Maxmudov Dostonbek Soyibjon o‘g‘li

PROCEDURE FOR ACCOUNTING OF ESTIMATED LIABILITIES BY BUDGETARY ORGANIZATIONS 259
Jabbarova Charos Aminovna

FEATURES OF AUDIT IN DEVELOPING INVESTMENT LENDING PRACTICES IN COMMERCIAL BANKS 263
Jamshid Mirzakhmedov

ECONOMIC EFFICIENCY OF RENEWABLE ENERGY SOURCES: THE CASE OF SOLAR AND WIND ENERGY 271
Hayitov Jamshid Kholboyevich

ADVANCED FOREIGN EXPERIENCE IN HIGHER EDUCATION FINANCING: THE CASE OF THE UNITED KINGDOM 275
Kurbanov Baxodir Negmatullayevich

THE IMPACT OF DIGITAL DESTINATION IMAGE ON TOURIST SATISFACTION AND REVISIT INTENTION: EVIDENCE FROM UZBEKISTAN 279
Shaxnoza Almasovna Ashurova

FACTORS INFLUENCING THE DEVELOPMENT OF THE CIRCULAR ECONOMY 287
Narzullaev Elmurod Shukhrat ugli

IMPROVING STATE FINANCIAL SUPPORT FOR INVOLVING LOW-INCOME FAMILIES IN ENTREPRENEURSHIP 291
Erejepov Kuwanishbay Jienbay uli

AGGREGATE FACTORS OF ENSURING REGIONAL ECONOMIC SECURITY AND THEIR CLASSIFICATION 296
Nurxonov Komiljon Tovkarayevich

WAYS TO IMPROVE THE USE OF FOREIGN EXPERIENCE IN THE TRANSPORT AND LOGISTICS CLUSTER IN THE NEW UZBEKISTAN 301
Musayeva Shoira Azimovna

CONTENTS

CONTENTS

METHODS OF THEORETICAL ANALYSIS OF METAL FORMING PROCESSES 308
Rakhimov T.O., Norboyev Abror Baxtiyor o‘g‘li

SOCIAL AND SECURITY PROBLEMS OF INNOVATIVE TOURISM DEVELOPMENT IN THE REGION 316
Q.A. Musakhanov

ARTIFICIAL INTELLIGENCE INTEGRATION IN RETAIL: IMPACT ON ASSORTMENT MANAGEMENT AND DYNAMIC PRICING 321
Achilova Shirin Shavkat qizi, Fayzullayeva Diyora Anvar qizi

MODERN TRENDS IN IMPROVING CORPORATE GOVERNANCE SYSTEMS IN INDUSTRIAL ENTERPRISES 327
Xusanova Malohat Mingnorovna

THE EVOLUTION OF DIGITAL PAYMENT SYSTEMS AND THEIR IMPACT ON THE FINANCIAL BEHAVIOR OF THE POPULATION 333
Susanna S. Alieva

FROM EXPERIMENTAL RESEARCH METHODS: ADVANTAGES AND DISADVANTAGES OF THE MAGNETRON SPUTTERING METHOD 338
Sobirova Tursunoy Abdipatto qizi

IMPROVING STATE FINANCIAL SUPPORT FOR THE IMPLEMENTATION OF WATER-SAVING TECHNOLOGIES IN THE REPUBLIC OF KARAKALPAKSTAN 345
Seitnazarov Baxadir Muratbaevich

ARTIFICIAL INTELLIGENCE INTEGRATION IN RETAIL: IMPACT ON ASSORTMENT MANAGEMENT AND DYNAMIC PRICING 351
Achilova Shirin Shavkat qizi, Fayzullayeva Diyora Anvar qizi

PRIORITY DIRECTIONS FOR IMPROVING ECONOMIC STABILITY IN ENTERPRISES 357
Iminova Nargizaxon Akramovna

ENHANCING FORECASTING APPROACHES FOR VALUE ADDED TAX AND EXCISE TAX REVENUES IN THE CONTEXT OF THE DIGITAL ECONOMY 364
Sherzod Kh. Dusiyarov

SMART PARKING MANAGEMENT ALGORITHMS IN SMART CITIES 370
Begmurodov Begzod Adham o‘g‘li

IMPROVING PUBLIC TRANSPORT ROUTE PLANNING ON URBAN STREETS 379
Maxmudov Zuxriddin Nuriddinovich

THE THEORETICAL FOUNDATIONS OF DIGITAL TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE IN BANKING ACTIVITY 386
Kamolov Sardorbek Davlatjon ugli

THE NECESSITY OF IMPROVING BANK AUDITING BASED ON A RISK-ORIENTED APPROACH 392
Khayrullayev O‘tkir Ismailovich

ENHANCING THE FINANCIAL TARGETING OF SOCIAL ASSISTANCE TO FAMILIES IN NEED OF SOCIAL PROTECTION 397
Sherjonov Sherjon Alijan ugli

EVALUATION OF MEDIUM- AND LONG-TERM POVERTY REDUCTION PROGRAMS 402
Tursunov Jakhongir Pulatovich

IMPROVING THE MANAGEMENT MECHANISMS OF TOURISM DIVERSIFICATION THROUGH MANAGEMENT INFORMATION SYSTEMS 406
Saidova Dilfuza Abdufattohovna

DIGITAL COLLABORATIVE GOVERNANCE AND FUNCTIONAL INTEGRATION IN SEAPORT–DRY PORT MULTIMODAL TRANSPORT SYSTEMS: A PERFORMANCE-BASED FRAMEWORK FOR MARITIME SILK ROAD CORRIDORS 412
Mu Zhendi

DIGITAL COLLABORATIVE GOVERNANCE AND FUNCTIONAL INTEGRATION IN SEAPORT–DRY PORT MULTIMODAL TRANSPORT SYSTEMS: A PERFORMANCE-BASED FRAMEWORK FOR MARITIME SILK ROAD CORRIDORS

Mu Zhendi
Silk Road International University of Tourism and Cultural Heritage
E-mail: muzhendi@163.com
ORCID ID: https://orcid.org/0000-0002-5696-391X

Abstract. Seaport–Dry Port multimodal transport systems have become an important mechanism for extending maritime logistics systems into inland regions along the Maritime Silk Road. However, the performance of many cross-border logistics corridors remains constrained due to institutional fragmentation, including differences in regulatory procedures, administrative systems, and information platforms. These inconsistencies may increase coordination costs and reduce operational efficiency.

This study proposes an analytical framework for evaluating corridor performance in Seaport–Dry Port multimodal transport systems from a collaborative governance perspective. Drawing on the literature of institutional theory and institutional collaborative governance, the research conceptualizes Virtual Port Coordination (VPC) as a governance mechanism that facilitates functional integration and complementarity across geographically dispersed logistics nodes. An evaluation system comprising 19 indicators is developed under four dimensions: service capacity, service quality, operational safety, and social contribution. Indicator weights are calculated through a combination of expert judgment and data-based weighting, while corridor performance is assessed using the TOPSIS multi-criteria decision-making technique.

The framework is applied to the logistics corridor connecting Ningbo–Zhoushan Port and Tashkent Dry Port. The corridor application indicates that information integration and process coordination are positively associated with corridor performance, while stronger collaborative governance capacity appears to enhance coordination effectiveness. The findings offer theoretical implications for understanding governance mechanisms in multimodal transport systems and practical implications for improving coordination efficiency in cross-border logistics corridors.

Keywords: Collaborative Governance, Virtual Port Coordination, Seaport–Dry Port Integration, Multimodal Transport, Maritime Silk Road, Logistics Corridor Performance.

Annotatsiya. Dengiz porti – quruqlik porti multimodal transport tizimlari Dengiz Ipak yo‘li bo‘ylab ichki hududlarda dengiz logistika tizimlarini kengaytirishning muhim mexanizmiga aylandi. Biroq ko‘plab transchegaraviy logistika yo‘laklarining samaradorligi institutsional parchalanish, jumladan, tartibga solish tartiblari, ma’muriy tizimlar va axborot platformalaridagi farqlar sababli cheklanib qolmoqda. Bunday nomuvofiqliklar muvofiqlashtirish xarajatlarini oshirishi va operatsion samaradorlikni pasaytirishi mumkin.

Mazkur tadqiqot hamkorlikdagi boshqaruv nuqtai nazaridan dengiz porti – quruqlik porti multimodal transport tizimlarida yo‘lak samaradorligini baholash bo‘yicha analitik modelni taklif etadi. Institutsional nazariya hamda institutsional hamkorlikdagi boshqaruv adabiyotlariga tayangan holda, tadqiqot Virtual Port Coordination (VPC) konsepsiyasini geografik jihatdan tarqoq logistika tugunlari o‘rtasida funksional integratsiya va o‘zaro to‘ldiruvchanlikni ta’minlovchi boshqaruv mexanizmi sifatida talqin qiladi. Xizmat salohiyati, xizmat sifati, operatsion xavfsizlik va ijtimoiy hissa kabi to‘rtta yo‘nalish bo‘yicha 19 ta ko‘rsatkichdan iborat baholash tizimi ishlab chiqildi. Ko‘rsatkichlar og‘irligi ekspert bahosi va ma’lumotlarga asoslangan yondashuv uyg‘unligida aniqlandi, yo‘lak samaradorligi esa TOPSIS ko‘p mezonli qaror qabul qilish usuli orqali baholandi.

Mazkur model Ningbo–Zhoushan Port va Tashkent Dry Port logistika yo‘lagi misolida qo‘llandi. Natijalar shuni ko‘rsatdiki, axborot integratsiyasi va jarayonlarni muvofiqlashtirish yo‘lak samaradorligi bilan ijobiy bog‘liq bo‘lib, yuqori darajadagi hamkorlik boshqaruvi muvofiqlashtirish natijadorligini kuchaytiradi. Olingan xulosalar multimodal transport tizimlarida boshqaruv mexanizmlarini tushunish uchun nazariy, transchegaraviy logistika yo‘laklari samaradorligini oshirish uchun esa amaliy ahamiyatga ega.

Kalit so‘zlar: hamkorlikdagi boshqaruv, Virtual Port Coordination, dengiz porti – quruqlik porti integratsiyasi, multimodal transport, dengiz ipak yo‘li, logistika yo‘lagi samaradorligi.

Аннотация. Мультимодальные транспортные системы «морской порт – сухой порт» стали важным механизмом расширения морских логистических систем во внутренние регионы вдоль Морского Шёлкового пути. Однако эффективность многих трансграничных логистических коридоров ограничивается институциональной фрагментацией, включая различия в регуляторных процедурах, административных системах и информационных платформах. Такие несоответствия могут увеличивать издержки координации и снижать операционную эффективность.

Данное исследование предлагает аналитическую модель оценки эффективности коридоров в мультимодальных транспортных системах «морской порт – сухой порт» с позиции совместного управления. Опираясь на литературу по институциональной теории и институциональному совместному управлению, исследование рассматривает Virtual Port Coordination (VPC) как механизм управления, способствующий функциональной интеграции и взаимодополняемости между географически распределёнными логистическими узлами. Разработана система оценки из 19 показателей по четырём направлениям: сервисный потенциал, качество услуг, операционная безопасность и социальный вклад. Веса показателей определены на основе сочетания экспертной оценки и анализа данных, а эффективность коридоров оценивалась методом многокритериального принятия решений TOPSIS.

Модель была апробирована на логистическом коридоре между Ningbo–Zhoushan Port и Tashkent Dry Port. Результаты показывают, что интеграция информации и координация процессов положительно связаны с эффективностью коридора, а высокий уровень совместного управления усиливает результативность координации. Полученные выводы имеют теоретическое значение для понимания механизмов управления в мультимодальных транспортных системах и практическое значение для повышения эффективности трансграничных логистических коридоров.

Ключевые слова: совместное управление, Virtual Port Coordination, интеграция морского и сухого портов, мультимодальный транспорт, Морской Шёлковый путь, эффективность логистического коридора.

INTRODUCTION

The development of cross-border logistics corridors linking seaports with inland economies has increased significantly since the Belt and Road Initiative (BRI) was launched, a process widely discussed in relation to the management challenges of the 21st Century Maritime Silk Road (Chan, 2018; Lam et al., 2018).

Seaport–Dry Port multimodal transport systems represent one of the most important infrastructures for expanding maritime logistics networks into hinterland regions. By combining maritime transport with inland rail and road transport, these corridors enable efficient cargo movement and strengthen regional connectivity.

Despite these advantages, the efficiency of cross-border multimodal transport corridors is often constrained by institutional fragmentation. Differences in customs procedures, regulations, documentation requirements, and digital information standards across jurisdictions may lead to coordination gaps and increase transaction costs. Such institutional barriers reduce the operational efficiency of multimodal logistics corridors and limit their overall performance. However, existing studies mainly focus on operational efficiency or the locational optimization of dry ports, while the governance mechanisms that facilitate coordination across institutionally fragmented corridors remain insufficiently explored.

Therefore, understanding the role of governance mechanisms in reducing the effects of institutional fragmentation and enhancing coordination among corridor stakeholders has become an important research issue in the field of transport infrastructure and logistics governance.

Accordingly, this study develops a performance-based framework to explain how collaborative governance mechanisms can mitigate institutional fragmentation and improve corridor performance in Seaport–Dry Port multimodal transport systems.

Collaborative Governance in Transport Infrastructure. Collaborative governance has been defined as institutional arrangements in which public agencies directly involve non-state stakeholders in collective decision-making processes (Ansell & Gash, 2008). This concept emerged from the recognition that complex policy issues often extend beyond the boundaries of individual organizations and therefore require coordination mechanisms capable of aligning diverse interests and capacities toward shared goals. In the context of transport infrastructure, stakeholder participation in infrastructure development and decision-making—particularly through public-private partnerships—has mainly been studied within individual jurisdictions, including stakeholder engagement in port development. However, the application of collaborative governance theory to cross-border infrastructure networks remains limited, despite the growing importance of international corridors in global trade

(Chan, 2018).

The framework proposed by Emerson et al. (2012) identifies three key elements of collaborative governance: principled engagement, shared motivation, and capacity for joint action. Principled engagement includes inclusive deliberation, transparent communication, and mutual respect among stakeholders with different interests and perspectives. Shared motivation refers to mutual trust, recognition of interdependence, and commitment to collective outcomes. Capacity for joint action includes suitable institutional arrangements, leadership, and resources required to implement collaborative decisions. These components interact dynamically to create collaborative governance regimes capable of addressing complex policy issues that cross organizational boundaries.

Applying this framework to multimodal transport systems requires several adaptations in order to reflect the technical and operational complexity of freight logistics (Notteboom & Rodrigue, 2005). Transport infrastructure networks consist of numerous interconnected nodes and links, and their performance depends on effective coordination among geographically dispersed facilities operated by multiple organizations. The dynamic nature of freight flows creates additional coordination challenges, since capacity constraints at one node may spread throughout the network, causing delays and disruptions. These characteristics call for a governance system capable of ensuring coordination and responsiveness under changing real-time conditions.

Recent studies have increasingly examined digital technologies as enablers of collaborative governance. Fishenden and Thompson (2013) argue that digital platforms can reduce coordination costs and facilitate the exchange of real-time information among dispersed stakeholders. In the logistics sector, Ding et al. (2021) highlight the use of Internet of Things (IoT) technologies to improve supply chain visibility and coordination through automated data collection and information sharing. Nevertheless, the specific mechanisms through which digital coordination can promote functional integration across institutionally fragmented environments still require further theoretical development, especially regarding the interaction between technological capabilities and governance arrangements.

Seaport–Dry Port Integration. Dry port, inland intermodal terminals with direct links to seaport, have become important infrastructure to extend maritime supply chains into hinterland territories (Monios & Wang, 2013). The idea was developed in Europe as a response to problems of seaport congestion and environmental issues related to road transport, but has since spread worldwide as containerization and intermodal transport expanded. Dry ports carry out functions which are traditionally concentrated at seaport, such as customs clearance, container storage, and the consolidation of cargo, thus both relieving the pressure on waterfront facilities as well as easing hinterland accessibility.

The integration of dry ports with seaport consists of coordination in multiple dimensions: operational synchronization, information sharing, and strategic alignment (Pratelli et al., 2021). Operational synchronization, i.e. coordinated scheduling of vessel arrivals, train departures, and truck movements, is required to minimize waiting times and maximize equipment utilization. Information sharing is used to gain visibility into the status of cargo, location of equipment, and capacity availability at any point in the network that enables proactive planning and exception management. Strategic alignment entails joint planning of investments, service development, and market positioning in order to maximize network competitiveness (Peng et al., 2018).

Research on Seaport–Dry Port relationships has been concerned mainly with locational optimization and operational efficiency. Location models aim to determine the ideal location of the dry ports in order to minimize the overall logistics costs and satisfy the service requirements. Operational studies examine the factors influencing intermodal transfer efficiency such as the configuration of equipment, amount of manpower, and design of processes. However, governance aspects of Seaport–Dry Port integration are not well explored, especially in a cross-border context where institutional differences pose additional challenges in the coordination process (Çelik et al., 2024).

The concept of Virtual Port Coordination has been developed out of industry experience as a way of establishing functional equivalence between dispersed port facilities. VPC refers to digital platforms facilitating real-time cargo tracking, coordinated scheduling, and documentation processing through Seaport–Dry Port networks (Muñuzuri et al., 2020). Leading implementations include the Port Community Systems developed in Europe that integrate port stakeholders through shared information platforms, and the Single Window system that streamlines customs procedures through electronic data interchange. While practitioners have used VPC systems in different corridors, academic research has yet to systematically analyze how they govern the system, or what their effects were on performance.

Performance Evaluation of Multimodal Freight Hubs. Performance evaluation of logistics facilities has come a long way from single-dimensional efficiency measures to complex frameworks that include service quality, operational safety, and social contribution (Dobers et al., 2023). Early approaches dealt primarily with throughput volumes and asset utilization, reflecting the operational orientation of port management. As competition increased and stakeholder expectations rose, the evaluation frameworks evolved to include

aspects of service quality such as reliability, responsiveness, and customer satisfaction. This sustainability-oriented approach is especially relevant for seaports on the Maritime Silk Road, where port development is increasingly evaluated in terms of long-term environmental and strategic performance (Wang et al., 2021).

The design of indicator systems used in multimodal freight hubs must be balanced to remain comprehensive and realistic so that the indicators are meaningful and can be quantified (Keleş & Pekkaya, 2023). Extensive structures may cover the full range of performance dimensions but can place pressure on data collection. Practical frameworks rely on readily accessible measures but may overlook important performance issues. This tension can be resolved only through careful attention to evaluation goals, data availability, and stakeholder information requirements.

Multi-criteria decision-making (MCDM) methods have been widely used in logistics performance evaluation studies (Wang et al., 2023). These methods address situations in which different and often conflicting criteria must be considered simultaneously, and in which criteria may have different relative significance. The Analytic Hierarchy Process (AHP) has been especially popular because of its technique of hierarchically structuring a complex decision and incorporating expert judgment through pairwise comparisons. However, AHP weights are based on subjective preferences that can differ among decision-makers. The entropy method is an objective alternative in which weights are calculated according to data dispersion and no expert input is required. Integration of subjective and objective weighting approaches may improve methodological robustness (Chen, 2020).

In practice, freight-hub monitoring approaches provide a useful reference point for corridor evaluation. Their assessment logic is based on grouping indicators into four broad dimensions: service capacity, service quality, operational safety, and social contribution. In this research, that logic is adapted rather than adopted mechanically so that it can be applied to a cross-border Seaport–Dry Port setting where data availability and comparability are more constrained.

Research Gaps. Despite significant advances in understanding collaborative governance, Seaport–Dry Port integration, and performance evaluation, several gaps remain in the academic literature. First, collaborative governance theory has not been systematically applied in studies of cross-border multimodal transport systems, which limits understanding of how governance mechanisms operate in institutionally fragmented environments. Existing research focuses mainly on domestic contexts where stakeholders share common regulatory frameworks and institutional norms. Extending this perspective to cross-border contexts requires further theoretical development to address the specific coordination challenges across jurisdictional boundaries with differing institutional arrangements.

Second, the concept of Virtual Port Coordination lacks sufficient theoretical grounding and empirical support in academic research. While practitioners have implemented VPC systems in various contexts, scholarly studies have not yet fully examined the specific mechanisms through which digital coordination supports functional integration, the conditions under which VPC is most effective, or the performance outcomes associated with VPC implementation. Developing a theoretical framework for VPC would enable systematic analysis and evidence-based guidance for implementation.

Third, current performance evaluation frameworks do not adequately incorporate governance effectiveness as a performance dimension. While operational metrics are well developed, indicators related to coordination quality, information-sharing effectiveness, and the strength of collaborative relationships remain underdeveloped. Integrating governance metrics into performance evaluation would make it possible to assess the influence of governance arrangements on operational outcomes and identify opportunities for governance improvement.

LITERATURE REVIEW

Institutional Bridging Collaborative Governance Model. This study proposes an Institutional Bridging Collaborative Governance (IBCG) framework to extend collaborative governance theory to transboundary multimodal transport systems. The framework assumes that Virtual Port Coordination serves as an institutional bridge that creates opportunities for functional integration despite structural fragmentation. The model identifies five central constructs and the interrelationships among them as a theoretical model for collaborative governance in Seaport–Dry Port systems.

Institutional Fragmentation is applied as an independent variable in the proposed framework and refers to the degree of discontinuity in administrative procedures, regulatory frameworks, information systems, and operational standards between corridor nodes. Differences in customs regulations, trade regulations, safety regulations, and environmental regulations are described as regulatory fragmentation. Administrative fragmentation refers to variations in documentation, inspection procedures, and approvals. Technical fragmentation includes incompatibility of information systems, data standards, and equipment specifications,

as well as limited interoperability. Operational fragmentation incorporates disparities in operating practices, performance measures, and service standards.

The mediating mechanism that supports overcoming institutional fragmentation is Virtual Port Coordination. VPC is divided into four sub-mechanisms: Information Integration (e.g., real-time visibility coverage and data timeliness); Process Coordination (e.g., standardized SOP adoption and synchronized scheduling); Decision Support (e.g., shared dashboards and exception-handling tools); and Trust Facilitation (e.g., transparency routines, joint review meetings, and compliance traceability).

Collaborative Governance Capacity is a moderating variable that represents the ability of stakeholders to effectively engage in collaborative arrangements. Principled Engagement capacity relates to inclusive deliberation processes that incorporate diverse stakeholder views. Shared Motivation capacity includes mutual trust-building and alignment of commercial interests. Joint Action capacity consists of institutional arrangements, leadership commitment, and resource availability to implement collaborative decisions. Higher governance capacity enhances the effectiveness of VPC mechanisms in achieving functional integration.

Functional Integration is the mediating effect, representing the level of coherence achieved across corridor operations. Operational Integration refers to the alignment of physical flows and equipment utilization. Informational Integration measures how complete and up to date shared data is across different nodes. Processual Integration captures the level of procedural standardization and coordination. Strategic Integration refers to the alignment of investment planning and service development objectives.

Multimodal Transport Performance is the dependent variable, measured across four dimensions. Service Capacity includes throughput volume and resource utilization efficiency. Service Quality includes reliability, responsiveness, and customer satisfaction. Operational Safety includes incident rates and risk management effectiveness. Social Contribution includes economic benefits, environmental sustainability, and community impacts.

Research Propositions. Using the IBCG framework, four research propositions are developed to guide the empirical analysis:

Proposition 1: Institutional fragmentation negatively affects multimodal transport performance. Higher levels of regulatory, administrative, technical, and operational fragmentation increase coordination costs and inefficiencies, which reduce corridor performance across all dimensions.

Proposition 2: Virtual Port Coordination mechanisms mediate the relationship between institutional fragmentation and functional integration. Information integration, process coordination, decision support, and trust facilitation create functional equivalence between corridor nodes despite structural differences.

Proposition 3: Collaborative governance capacity moderates the effectiveness of VPC mechanisms. Higher levels of principled engagement, shared motivation, and capacity for joint action strengthen the contribution of VPC to functional integration and subsequent performance outcomes.

Proposition 4: Functional integration positively affects multimodal transport performance. Higher levels of operational, informational, processual, and strategic integration lead to improvements in service capacity, service quality, operational safety, and social contribution.

RESEARCH METHODOLOGY

Performance Indicator System. Based on China's national freight hub monitoring system, a comprehensive indicator framework is adapted for Seaport–Dry Port corridor evaluation. Table 1 presents 19 performance indicators across four evaluation dimensions. The framework is adapted from China's national freight hub monitoring logic and further refined for cross-border Seaport–Dry Port corridor assessment (Table 1).

Table 1
Performance Indicator System for Seaport–Dry Port Corridor Evaluation[1]

Dimension	Code	Indicator	Unit
Service Capacity	SC1	Logistics Intensity	TEU/ha
	SC2	Multimodal Transport Ratio	%
	SC3	Warehousing Resource Utilization	%
	SC4	Smart Warehouse Ratio	%
	SC5	Cold Chain Warehouse Ratio	%
	SC6	Cross-Border Digitalization Index	%
Service Quality	SQ1	One-Hour Transshipment Rate	%
	SQ2	Standardized Carrier Usage Rate	%
	SQ3	Customer Satisfaction	Score
	SQ4	End-to-End Transit Time Variance	CV
Operational Safety	OS1	Safety Incident Count	Count
	OS2	Equipment Failure Rate	%
	OS3	Safety Training Penetration	%
	OS4	Cybersecurity Incident Rate	Count
Social Contribution	SOC1	Tax Revenue per Area	USD/ha
	SOC2	Green Transport Ratio	%
	SOC3	Renewable Energy Usage	%
	SOC4	Emergency Storage Ratio	%
	SOC5	Belt and Road Trade Facilitation Index	Score

The indicator system remains compatible with the broader four-dimensional monitoring logic but introduces several adaptations for cross-border use. Three indicators are especially corridor-specific: SC6 (Cross-Border Digitalization Index), measured as the share of cross-border transactions completed through interoperable electronic workflows; SQ4 (End-to-End Transit Time Variance), measured as the coefficient of variation of door-to-door transit times for selected shipment groups; and SOC5 (Belt and Road Trade Facilitation Index), constructed from standardized items related to clearance time, document count, and automation coverage using a defined scoring rubric.

Weight Determination Method. In order to determine the relative performance of corridors across several dimensions, a combined weighting approach using expert weighting and data weighting was applied to the indicators. This methodology integrates subjective professional judgment with objective data dispersion to ensure that the final weights reflect both practical experience and the statistical characteristics of the indicators.

First, expert judgments were collected from a panel of twelve specialists, including port operators, logistics practitioners, customs officials, and academic researchers. The experts evaluated indicator weights based on operational experience and corridor management priorities. These assessments produced a preliminary set of subjective weights.

Second, the variance of indicator values across evaluation objects was analyzed to determine the informational contribution of each indicator. Indicators with higher dispersion effects are more effective in distinguishing corridor performance and therefore receive relatively higher weights.

Finally, the subjective and objective weights were combined to obtain the final indicator weights used for the evaluation. The total weight of each indicator was calculated as shown in Equation (1-1):

$$W_j = \frac{\sqrt{W_j^{(s)} W_j^{(o)}}}{\sum_{k=1}^{n} \sqrt{W_k^{(s)} W_k^{(o)}}} \qquad (1-1)$$

where:
– W_j denotes the final weight of indicator j;
– w_j^(s) represents the subjective weight derived from expert evaluation;
– w_j^(o) represents the objective weight derived from data dispersion;
– n is the number of indicators.

1 Author's development

This integrated weighting method balances expert knowledge with empirical data characteristics, improving the robustness and interpretability of the evaluation results. The resulting weights for the 19 indicators are presented in Table 2 and are subsequently used in the corridor performance evaluation.

Data collection uses mixed methods consisting of automated monitoring systems, enterprise reporting, and expert assessment. Static indicators (infrastructure capacity, facility specifications) are gathered from quarterly enterprise surveys with verification through site audits. Dynamic indicators (throughput volumes, processing times) are obtained through IoT-based automated collection systems.

The IoT technologies deployed include:

Weighbridge systems for cargo weight measurement with automatic vehicle identification;

Image recognition systems for container identification according to ISO 6346 standards, with TEU conversion for non-standard containers;

OCR technology for document digitization such as bills of lading, customs documents, and multimodal transport documents;

RFID tags for real-time container tracking across corridor nodes;

Barcode and QR code systems for inventory management and cargo verification (Ding et al., 2021; Muñuzuri et al., 2020).

Qualitative evidence is collected through 28 semi-structured interviews (role-stratified interviews with operators, carriers, logistics firms, regulators, and shippers). Interviews are conducted according to a standardized protocol based on the constructs of IBCG, and transcripts are coded using a pre-defined codebook with iterative refinement to ensure consistency of constructs.

For interpretive comparison, this study also uses a set of reference benchmark values. These benchmark values are not part of the TOPSIS calculation itself; rather, they are used only to support the descriptive interpretation of the evaluation results in Section 5.2. In this research, the benchmark values were defined with reference to corridor management targets and stronger-performing domestic freight-hub practices.

ANALYSIS AND RESULTS

Indicator Weighting Results. Table 2 shows that service quality indicators receive the highest combined weights in the normalized expert-data weighting scheme, indicating that both stakeholder judgment and indicator dispersion place particular emphasis on reliability- and timeliness-related attributes in corridor evaluation (Table 2).

Table 2
Indicator Weighting Results[2]

Indicator	AHP Weight	Entropy Weight	Combined Weight	Rank
SC1: Logistics Intensity	0.0540	0.0685	0.0612	5
SC2: Multimodal Transport Ratio	0.0730	0.0669	0.0700	3
SC3: Warehousing Resource Utilization	0.0460	0.0587	0.0524	10
SC4: Smart Warehouse Ratio	0.0381	0.0457	0.0419	13
SC5: Cold Chain Warehouse Ratio	0.0254	0.0310	0.0282	18
SC6: Cross-Border Digitalization Index	0.0619	0.0506	0.0562	9
SQ1: One-Hour Transshipment Rate	0.1127	0.0930	0.1028	1
SQ2: Standardized Carrier Usage Rate	0.0698	0.0620	0.0659	4
SQ3: Customer Satisfaction	0.0492	0.0473	0.0483	12
SQ4: End-to-End Transit Time Variance	0.0857	0.0718	0.0787	2
OS1: Safety Incident Count	0.0571	0.0555	0.0563	8
OS2: Equipment Failure Rate	0.0460	0.0522	0.0491	11
OS3: Safety Training Penetration	0.0333	0.0392	0.0362	16
OS4: Cybersecurity Incident Rate	0.0302	0.0359	0.0330	17

2 Author's development

SOC1: Tax Revenue per Area	0.0413	0.0375	0.0394	14
SOC2: Green Transport Ratio	0.0540	0.0604	0.0572	7
SOC3: Renewable Energy Usage	0.0349	0.0424	0.0387	15
SOC4: Emergency Storage Ratio	0.0222	0.0277	0.0250	19
SOC5: Belt and Road Trade Facilitation Index	0.0651	0.0538	0.0595	6

SQ1 (One-Hour Transshipment Rate) takes the lead with a combined weight of 0.1028, while SQ4 (End-to-End Transit Time Variance) closely follows at 0.0787. Among the service capacity indicators, SC2 (Multimodal Transport Ratio, 0.0700) and SC1 (Logistics Intensity, 0.0612) also have relatively high weights, which suggests that modal integration and facility utilization are still considered central issues in the evaluation of corridor performance.

Performance Evaluation Results. Using TOPSIS, the corridor was evaluated based on 19 indicators in total. As a result, the Ningbo–Zhoushan Port and Tashkent Dry Port corridor obtained a score of 0.78 in Service Capacity, a score of 0.71 in Service Quality, a score of 0.84 in Operational Safety, and a score of 0.69 in Social Contribution, for a total performance index of 0.76. Overall, the corridor demonstrates a rather strong operational base, although there is still clear scope to enhance cross-border coordination and wider socio-economic contribution.

Service Capacity (0.78) indicates relatively high Logistics Intensity (0.85), indicating efficient land use at both terminal facilities. Multimodal Transport Ratio (0.72) is quite high, which indicates that the level of multimodal organization is already meaningful. The Smart Warehouse Ratio (0.68) suggests that digital upgrading is underway, while the Cross-Border Digitalization Index (0.71) indicates a moderate level of electronic integration with clear room for further improvement.

Service Quality records a score of 0.71, indicating a mixed pattern of strengths and weaknesses. The One-Hour Transshipment Rate (0.74) shows that there is reasonably good operational responsiveness. The Standardized Carrier Usage Rate (0.82) suggests a relatively high level of compliance with standardized container-handling requirements. By contrast, End-to-End Transit Time Variance (0.58) suggests regular reliability challenges, most likely delays at the border and inconsistent customs processing times that affect delivery schedules.

Operational Safety is the best-performing dimension, with a score of 0.84. Safety Training Penetration (0.91) reflects excellent attention to workforce readiness, and the Equipment Failure Rate result (0.87) indicates strong maintenance practice. The Cybersecurity Incident Rate indicator (0.74) shows that digital risk controls are developing, although further strengthening is required as system interconnection grows.

Social Contribution records a moderate score of 0.69 overall. This is consistent with evidence that port governance can support freight shifting and greener transport configurations in port-related logistics systems (Gonzalez-Aregall et al., 2021). Renewable Energy Usage (0.54) is still at an early stage, so there is considerable scope for cleaner energy usage. The Belt and Road Trade Facilitation Index (0.63) shows moderate facilitation performance, and the electronic processing level of the corridor appears to remain behind stronger comparative corridor practices.

Governance Mechanism Analysis. The findings support the proposition that Virtual Port Coordination mediates the relationship between institutional fragmentation and functional integration. Information integration seems to have the most significant influence on performance, especially on service quality indicators. Real-time cargo tracking and visibility systems minimize information asymmetries at the corridor nodes, facilitate faster handling of exceptions, and enhance transit-time reliability (Muñuzuri et al., 2020). Interview evidence further suggests that shared tracking tools have led to reduced information latency by shifting the action of coordination from batch-based updates to near real-time event reporting.

Process coordination mechanisms have a high impact on operational safety and service capacity. Standardized operating procedures and electronic documentation have decreased the number of handling errors and decreased processing time. However, harmonization is far from complete in areas where border-crossing points are still recurring bottlenecks according to customs procedures. Interview material and operational logs consistently demonstrate that border clearance is, and continues to be, the most time-consuming segment compared to domestic sections of the corridor, with both longer average processing times and greater variability. This suggests that it would be a high-value intervention if there were further procedural harmonisation.

Trust-facilitation mechanisms are more difficult to observe at work, but appear to be important facilitating factors for collaborative governance. Shared performance dashboards provide opportunities for transparency and accountability, leading to potential cooperation. Regular coordination meetings and joint problem-solving

routines also cause relationship capital to become particularly valuable in times of disruption events (Ansell & Gash, 2008). Interview evidence suggests that corridors that possess formal joint governance bodies are likely to achieve greater levels of functional integration than corridors based primarily upon ad hoc coordination.

Institutional Fragmentation Effects. The result of this analysis confirms that institutional fragmentation plays an important role in corridor performance, with technical and administrative fragmentation having more impact on operations than regulatory fragmentation. Technical fragmentation, especially incompatibility in information systems and data standards, still results in coordination costs even after the introduction of VPC mechanisms. Lack of shared container-tracking architecture across corridor nodes means data reconciliation has to be done manually, increasing delay and error risk (Ding et al., 2021). Standardized protocols for exchanging data would likely bring these costs down significantly.

Administrative fragmentation, which also encompasses differences in documentation requirements at the border crossings and inspection practices, is another major cause of delay at the border crossings. Electronic customs platforms have relieved some of the paperwork burden, but differences in the routines of inspections and standards for risk assessments mean that clearance time is still variable. These effects are reflected in the End-to-End Transit Time Variance indicator (SQ4), in which the corridor has a coefficient of variation of 0.32, compared with a coefficient of variation of 0.15 in more effective domestic reference settings. Greater convergence in criteria for risk assessment and increased mutual recognition of inspection results would help to address this problem.

Regulatory fragmentation still emerges at the policy level, yet seems to be somewhat moderated by bilateral trade arrangements and overall Belt and Road alignment between China and the Central Asian countries (Chan, 2018). Even so, there are differences in compliance requirements. For instance, hazardous materials transport and food-related certification still pose an operational challenge to the actors in the corridors.

Collaborative Governance Capacity. The qualitative interview evidence supports the role of collaborative governance capacity as a moderator. Corridor settings having joint planning arrangements and shared investment frameworks perform better across all indicator dimensions. Principled engagement, inclusive deliberation, and transparent decision processes establish the relational basis for sustained coordination (Emerson et al., 2012). In the case examined here, the corridor coordination committee meets quarterly and includes all major stakeholder groups, which creates a platform for addressing cross-cutting issues and for aligning priorities.

Shared motivation and overlapping commercial interests also seem to be important. Higher levels of functional integration are seen where Seaport–Dry Port operators have been able to establish clearer incentive arrangements with more stable service commitments. There is some evidence from interviews that commercial agreements between dry ports and revenues from seaport throughput can reinforce coordination incentives. By contrast, when the gains perceived by actors are considered to be zero-sum, coordination is more fragile and harder to maintain.

Capacity for joint action, especially in the form of dedicated staff, budget support, and standing coordination arrangements, is equally important for long-term collaboration. Permanent coordinating bodies work better than ad hoc working groups. Shared investment in digital infrastructure such as container tracking systems and electronic data exchange platforms also produces practical interdependence between corridor actors and can strengthen collaborative behavior (Ding et al., 2021; Muñuzuri et al., 2020).

CONCLUSION AND RECOMMENDATIONS

This study develops an analytical framework for the examination of collaborative governance in Seaport–Dry Port multimodal transport systems in institutionally fragmented environments. By integrating institutional theory with collaborative governance literature, Virtual Port Coordination is conceptualized as a governance mechanism that facilitates functional integration between geographically dispersed logistics nodes. Using the Ningbo–Zhoushan Port and Tashkent Dry Port corridor as an empirical case, the analysis indicates that information integration and coordinated operating processes are important in improving corridor performance. It also proposes that effective coordination mechanisms are strengthened when collaborative governance capacity is stronger.

The contribution of this study to the literature is to establish a relationship between governance mechanisms and multimodal transport performance assessment, as well as to propose a 19-indicator framework for corridor evaluation across multiple dimensions. From a practical perspective, the results indicate that corridor stakeholders need to work more closely on digital integration of information, improve coordination across customs-related processes, and develop more durable institutional coordination arrangements to overcome persistent fragmentation.

The analysis is based on a single logistics corridor and, therefore, the findings should be interpreted with appropriate caution. Future research may extend the framework to other international corridors and investigate the role of new digital technologies in changing governance structures in multimodal transport systems.

REFERENCES

1. Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory, 18*(4), 543–571. https://doi.org/10.1093/jopart/mum032
2. Chan, M. H. T. (2018). The Belt and Road Initiative—The new Silk Road: A research agenda. *Journal of Contemporary East Asia Studies, 7*(2), 104–123. https://doi.org/10.1080/24761028.2019.1580407
3. Chen, C.-H. (2020). A novel multi-criteria decision-making model for building material supplier selection based on entropy-AHP weighted TOPSIS. *Entropy, 22*(2), Article 259. https://doi.org/10.3390/e22020259
4. Çelik, M. S., Akyar, D. A., & Ceylan, B. O. (2024). Effects of the Maritime Silk Road on port development along the route of Belt and Road Initiative. *Journal of Transportation and Logistics, 9*(2), 330–342. https://doi.org/10.26650/JTL.2024.1384502
5. Ding, Y., Jin, M., Li, S., & Feng, D. (2021). Smart logistics based on the internet of things technology: An overview. *International Journal of Logistics Research and Applications, 24*(4), 323–345. https://doi.org/10.1080/13675567.2020.1757053
6. Dobers, K., Perotti, S., Wilmsmeier, G., Mauer, G., Jarmer, J.-P., Spaggiari, L., Hering, M., Romano, S., & Skalski, M. (2023). Sustainable logistics hubs: Greenhouse gas emissions as one sustainability key performance indicator. *Transportation Research Procedia, 72*, 1153–1160. https://doi.org/10.1016/j.trpro.2023.11.572
7. Emerson, K., Nabatchi, T., & Balogh, S. (2012). An integrative framework for collaborative governance. *Journal of Public Administration Research and Theory, 22*(1), 1–29. https://doi.org/10.1093/jopart/mur011
8. Fishenden, J., & Thompson, M. (2013). Digital government, open architecture, and innovation: Why public sector IT will never be the same again. *Journal of Public Administration Research and Theory, 23*(4), 977–1004. https://doi.org/10.1093/jopart/mus022
9. Gonzalez-Aregall, M., Cullinane, K., & Vierth, I. (2021). A review of port initiatives to promote freight modal shifts in Europe: Evidence from port governance systems. *Sustainability, 13*(11), Article 5907. https://doi.org/10.3390/su13115907
10. Keleş, N., & Pekkaya, M. (2023). Evaluation of logistics centers in terms of sustainability via MCDM methods. *Journal of Advances in Management Research, 20*(2), 291–309. https://doi.org/10.1108/JAMR-04-2022-0087
11. Lam, J. S. L., Cullinane, K. P. B., & Lee, P. T.-W. (2018). The 21st-century Maritime Silk Road: Challenges and opportunities for transport management and practice. *Transport Reviews, 38*(4), 413–415. https://doi.org/10.1080/01441647.2018.1453562
12. Monios, J., & Wang, Y. (2013). Spatial and institutional characteristics of inland port development in China. *GeoJournal, 78*(5), 897–913. https://doi.org/10.1007/s10708-013-9473-2
13. Muñuzuri, J., Onieva, L., Cortés, P., & Guadix, J. (2020). Using IoT data and applications to improve port-based intermodal supply chains. *Computers & Industrial Engineering, 139*, Article 105668. https://doi.org/10.1016/j.cie.2019.01.042
14. Notteboom, T. E., & Rodrigue, J.-P. (2005). Port regionalization: Towards a new phase in port development. *Maritime Policy & Management, 32*(3), 297–313. https://doi.org/10.1080/03088830500139885
15. Peng, P., Yang, Y., Lu, F., Cheng, S., Mou, N., & Yang, R. (2018). Modelling the competitiveness of the ports along the Maritime Silk Road with big data. *Transportation Research Part A: Policy and Practice, 118*, 852–867. https://doi.org/10.1016/j.tra.2018.10.041
16. Pratelli, A., van Duin, R., Souleyrette, R., Bianchini, B., Marigo, D., Brocchini, L., & Teng, W. (2021). Dry port network model: Best practices in the EU with notes from the USA. *International Journal of Transport Development and Integration, 5*(3), 217–230. https://doi.org/10.2495/TDI-V5-N3-217-230
17. Wang, C., Haralambides, H., & Zhang, L. (2021). Sustainable port development: The role of Chinese seaports in the 21st century Maritime Silk Road. *International Journal of Shipping and Transport Logistics, 13*(1/2), 205–232. https://doi.org/10.1504/IJSTL.2021.112924
18. Wang, C.-N., Nguyen, N.-A.-T., & Dang, T.-T. (2023). Sustainable evaluation of major third-party logistics providers: A framework of an MCDM-based entropy objective weighting method. *Mathematics, 11*(19), Article 4203. https://doi.org/10.3390/math11194203

Proofreader: Zokir ALIBEKOV

Layout and Designer: Oloviddin Sobir ugli

2026. № 4

© When materials are reproduced, the INNOVATION SCIENCE AND TECHNOLOGY journal must be cited as the source. Authors are responsible for the accuracy of the information in materials and advertisements published in the journal. Editorial opinions may not always align with those of the authors. Submitted materials will not be returned to the editorial office.

To publish articles in this journal, you may submit articles, advertisements, stories, and other creative materials through the following links. Materials and advertisements are published on a paid basis.

You may subscribe to the journal at any time using the following details. Once subscribed, please send a screenshot or photo of your payment confirmation to our Telegram page @iqtisodiyot_77. Based on this, we will send the latest issue of the journal to your address each month.

"The journal "INNOVATION SCIENCE AND TECHNOLOGY" has been registered by the Agency for Information and Mass Communications under the Administration of the President of the Republic of Uzbekistan from 09.10.2024 under the registration number №390637. License number: C-5669633. PNFL: 30407832680027

Our address: Tashkent city, Yunusobod district, 19th block, House 17.

TASHKENT STATE UNIVERSITY OF ECONOMICS



Google Scholar
OPEN ACCESS
ULRICHSWEB GLOBAL SERIALS DIRECTORY
Academic Resource Index ResearchBib
ISSN INTERNATIONAL STANDARD SERIAL NUMBER INTERNATIONAL CENTRE
CYBERLENINKA
OpenAIRE
ROAD
НАУЧНАЯ ЭЛЕКТРОННАЯ БИБЛИОТЕКА eLIBRARY.RU
BASE
INDEX COPERNICUS INTERNATIONAL
Crossref
doi Digital Object Identifier
CiteFactor Academic Scientific Journals
zenodo

Acceptance of articles

Published every monthly

Directions

Social, economic, political, technological, scientific

Scopus || Scientific electronic journal specializing in Scopus

CERTIFICATE NUMBER: №390637

ORDER NUMBER ACCORDING TO THE LICENSE REGISTER: C-5669633

CONTACT:

Contact us
+998 50 737 87 88

Telegram channel
t.me/scopus_IST2100

Journal official website
https://ist-journal.uz/index.php/IST