

ECONOMIC GROWTH AND SPATIAL ANALYSIS IN TRANSPORT CORRIDORS: A PRELIMINARY REVIEW

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ABSTRACT:

The construction and development of international transport corridors have become a means of cross-border space governance, promoting the flexibility of international industrial chains and supply chains. Due to the uncertainty of cooperation, the development of international transport corridors entails a long-term and complex system of engineering. Transport corridors can generate wider economic benefits and costs through their effects on a potentially diverse set of development outcomes, such as economic growth, poverty, jobs, equity, environmental quality, and economic resilience. The focus on roads, rails, and waterways is justified, as transport corridors based on these modes have clearer potential for economic spillovers than, for example, airline routes. The current paper describes a multi-method approach involving spatial and non-spatial analysis to investigate spatial disparity along a proposed corridor and examine its integration within the existing settlement structure. The conceptual structure for the review is guided by a simple canonical model describing the policy maker's problem in maximizing the net wider economic benefits of corridors. The meta-analysis confirms that characteristics of individual studies, as well as the placement and design of transport infrastructures, systematically influence the findings of corridor studies. It also shows that, on average, estimated impacts of corridor interventions on economic welfare and equity tend to be beneficial, while they are often detrimental to environmental quality, and possibly also to social inclusion.

1. INTRODUCTION

Transport corridors are defined as integrated networks that facilitate the movement of goods and people. They typically involve various modes of transportation, such as road, rail, and Bus Rapid Transit systems that are strategically interconnected to create efficient routes for transit. These corridors can be domestic or international, connecting different cities, regions, or countries. The alignment and operation of transport corridors are designed to boost economic activity by facilitating trade, decreasing transportation costs and times, and improving access to markets.

In the context of road transport, these corridors often consist of major highways or motorways that serve as the primary thoroughfares for freight and passenger vehicles. Rail corridors, on the other hand, involve train networks that provide an alternative to road transportation by offering capacity for large volumes of goods and passengers. Rail can have the added benefit of being more energy-efficient and less disruptive to the environment compared to road transport when it comes to long distances.

Bus Rapid Transit is another significant component of transport corridors. BRT systems feature dedicated lanes for buses, enabling them to bypass traffic congestion and operate at faster speeds. This system typically includes elements reminiscent of metro or light rail, such as defined stations, off-board fare collection, and high-frequency service, thus combining the flexibility of buses with the efficiency of rail.

The goal of transport corridors is to create seamless connectivity, allowing for the smooth transfer of goods and passengers from one mode of transport to another. They are considered critical infrastructure for economic development, urban growth, and spatial integration.

The transportation system is essential to the country's economic construction, and the comprehensive transportation corridor is the backbone of the comprehensive transportation system. There are multiple transportation modes in the comprehensive transportation corridor; these transportation modes work together to complete the transportation tasks within or among city clusters. In a sense, the success or failure of the construction and operation of comprehensive transportation corridors directly affects the country's economic development.

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There are both competition and cooperation among different modes of transportation in the comprehensive transportation corridor. When various modes of transportation strive for more passengers for their own benefit, this shows their competition. When all modes of transportation share the passenger flow in the transportation corridor to complete the transportation task together, it shows cooperation among them. For the construction of transportation corridors, it is necessary to configure reasonable transportation modes within the transportation corridors by analysing the transport demand and the supply attributes of different transportation modes. For the operation of the transportation corridor, it is the goal to prevent unhealthy competition among different transportation modes and promote them to complete the transportation task in a coordinated manner. At present, a great deal of research has been done on the planning and construction of comprehensive transportation corridors; outstanding achievements have been made.

A method of transportation mode choice in a transportation corridor, combining prospect theory and gray correlation method to consider the different attitudes of travellers facing losses and gains in comparison of transportation mode.

High Volume Transport (HVT) corridors and networks comprise arterial and main roads and railways to form the national transport backbone, which connects the smaller feeder road and rail links. HVT corridors and networks carry the major share of passenger and freight traffic and play a key role in the economic and social development of a country. The impacts of investments in transport corridors and networks can be substantial. At the macro level, the transport network is linked to national output, employment, and income. At the micro level, well-connected transport networks link producers and consumers and affect people's wellbeing, including poverty alleviation through higher production and wages, new jobs, and lower input and higher output prices. Transport networks also facilitate access to education, employment, health, and other social and cultural facilities. A well-managed HVT corridor can help to improve the quality of transport and logistics services in the corridor, reduce the cost of transport, increase efficiency in the overall supply and distribution chain, and reduce the carbon footprint of freight transport.

This paper provides a rigorous review of the empirical literature estimating the impacts of large transport investments. In doing so, it aims to improve policy makers' understanding of the multiple, and potentially varied, impacts of transport corridor investments. This includes enhancing understanding of the potential trade-offs that the investments can generate both between different development outcomes and between different groups of economic actors.

In reviewing the literature and thinking about the wider economic impacts of transport corridors, our interest is not so much in the immediate outcomes such as savings of travel time and vehicle operating costs (VOC) that remain the focus of most cost-benefit analyses (CBA) for transport projects. Although their importance should not be dismissed and their accurate measurement remains an issue for CBA, these savings are unable to capture the full economic benefits of a transport project in anything other than a hypothetical world of perfectly competitive and complete markets.

Considering the promise of transport corridors to be an important policy intervention tool, this paper aims to review the

current knowledge on wider economic benefits and costs of transport corridor development.

The specific objectives include focus on the study of traffic corridors and their impact on various aspects of transportation and economic growth. The primary objective of the research is multi-faceted:

1. To investigate spatial disparity along a proposed corridor and examine its integration within the existing settlement structure.
2. To analyse competition and cooperation among different modes of transportation in the comprehensive transportation corridor and their impact on economic development.
3. To review empirical literature estimating the impacts of large transport investments to enhance policymakers' understanding of the various impacts of transport corridor investments.

2. LITERATURE SURVEY

The discourse on transport corridor methodologies spans over a quarter of a century, beginning with Aura Reggiani et al.'s 1995 investigation into advanced transport telematics aimed at addressing traffic flow inefficiencies. In 1997, Randolph W. Hall analyzed the implications of mixed traffic on corridor performance through a survey. The focus shifted to boosting performance and capacity in 1998 with Moazzem Hossain et al.'s promotion of Bus Rapid Transit systems. The turn of the millennium saw integration of policy domains through Wil Priemus, et al.'s 2003 'Corri design'.

By 2013, modal choice analysis became vital in assessing corridor efficiency, as explored by Hui Zhao et al. Fast tracking to 2018, the economic sustainability of High-Speed Rail corridors was at the forefront of studies conducted by both Jeffrey C. Peters et al. and Anthony D. Perl et al. The seminal Growth Pole theory by Dzumbira et al. in 2017 provided insights into the strategic influence of corridors, alongside Saleh et al.'s assessment of traffic load volumes.

GIS took the stage in 2018 with Yu, M et al.'s assessment of anticipated impact on corridor accessibility post-HSR implementation. The ensuing year, 2019, witnessed Tsyganov delving into traditional control systems within railway transportation, while Manisha Jain et al. adopted a multi-method approach to tackle corridor-based inequalities. Concurrently, Zhijian Wu et al. investigated the effects of highway spacing through Automated Highway Systems.

By 2020, the analysis of corridor dynamics extended to the frequency of trains within rail corridors, explored through queuing theory techniques by Norman Weik et al., and area-wide traffic control via Q-learning highlighted by Juan Carlos Muñoz et al. In the following year, 2021, Xueli Liu et al. presented primary findings on High-Speed Rail network accessibility, focusing on various accessibility indicators.

Finally, in 2022, Abhilasha Saroj et al. introduced clustering analysis to detect brief intermittent gaps in discrete data, suggesting the increasing complexity and data-driven nature of transport corridor analysis. Altogether, these studies trace a multifaceted narrative, evidencing the evolution of tailored methodologies and their varying contributions to the realm.

From the perspective of growth pole theory, W. Dzumbira et al. (2017) explore the dynamism of the Maputo Development Corridor (MDC) and its developmental influence. It's a development tool that focuses on the potential benefits of multilateral developing countries and investigates ways for them to improve their long-term development outcomes. Corridors also faced challenges because to Maputo's weak terminating nodes, strong auxiliary nodes, lengthy distances compared to node size, and structural constraints connected to unequal development resource allocation. The growth pole model develops corridors based on end node dominance. Local connectivity at marginalised secondary nodes throughout the corridor should be extended, and global connectivity should be strengthened through a process of stacking Maputo end nodes.

The traffic load increases by 34 percent and 37 percent, respectively, on Teuku Muhammad Hasan Road and Prof. on Ali Hasimi Road at the Surabaya crossroads, according to sales etc. al (2017). Tgk medium. Traffic will reduce by around 0.7 percent in Imum Lueng Bata. The level of service research revealed that during the construction of Teuku Muhammad

Hasan Road and Ali Hasyimi Road, the level of service (LOS) deteriorated. Tsyganov (2019) presents a new theoretical configuration for rail transport that includes a profit trade-off. Break-even is especially significant in lines like the NERC (Northern-Asian Railway Corridor), according to statistics. Rail collisions have typically been rare in the EU, Russia, China, and Kazakhstan. Tracks are broken down into "chunks." The standard control method for the block allows for a 4–12-minute average spacing between trains. It is critical in this circumstance to avoid train accidents. This effect could happen considerably more quickly than the long-term building of additional freight cars on the China-Eurasian railway link.

Manicia Jain et al. (2019) contributed to the Southern Hemisphere planning conversation by emphasising the necessity of corridor solutions for improving access corridors and closing gaps. This study shows that to analyse spatial mismatch, an analytical framework must be developed as part of a multi-method approach that includes both spatial and non-spatial analysis (see Figure 1).

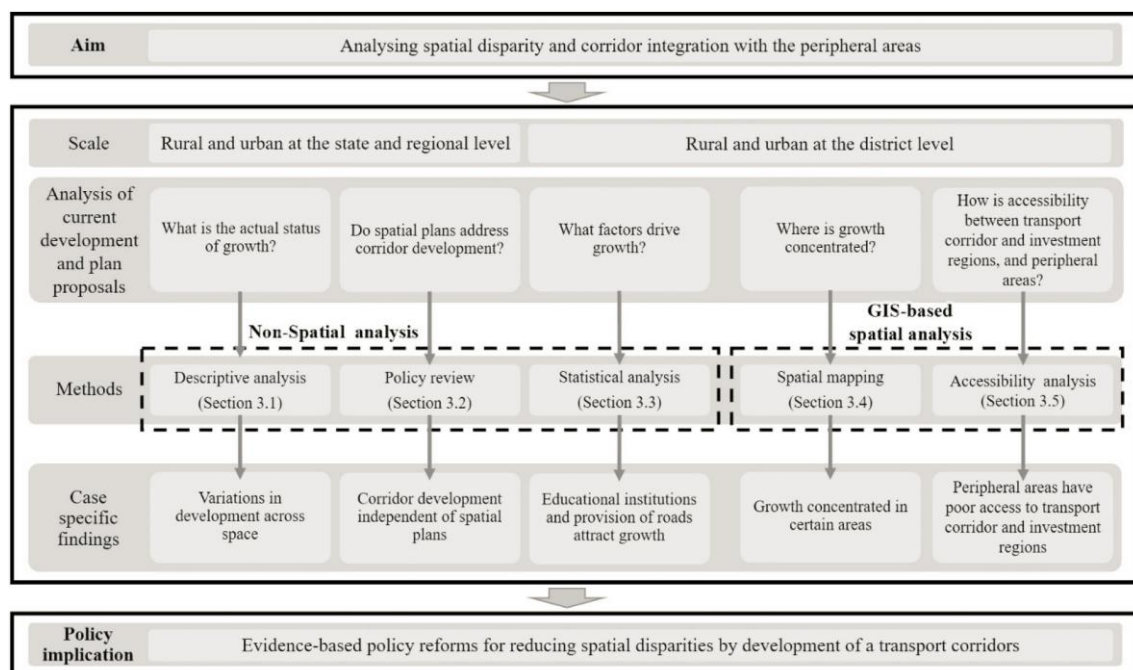


Figure 1. Analytical framework for analysing corridor

Much of the region through which the corridor runs has experienced job growth that is negative. Population growth is drawn to locations that are physically well linked and provide educational and training opportunities. Between the countryside and the city, the corridor runs through a relatively accessible location.

According to Jeffrey C. Peters et al. (2014), the value of high-speed rail (HSR) is primarily determined by the number of passengers and the ability to produce sufficient income to cover maintenance and operating costs. Based on experimental assumptions used in prior HSR passenger counts forecasts and annual savings in travel time, safety, and vehicle operating costs under the HSR model increased from \$200 million in 2012 to more than \$400 million by 2050. These effects should be considered in a consistent comparative analysis with highway

and airport expansion projects. When money is combined with the social benefits, HSR may become a viable transportation option in the Midwest region.

Xueli Liu et al. (2021) used a variety of measures of HSR network accessibility, including point degree, proximity centrality, and average trip time, to come up with the following primary findings: To begin with, HSR network accessibility has a strong favourable economic influence on metropolitan home values. House prices will climb by around 17% if the average travel time is cut by 100 minutes. Second, in the slow centre areas and regions near the developed eastern regions, the influence of high-speed rail network accessibility on urban housing prices is particularly pronounced. Finally, the effect of HSR network connectivity on property values varies according on the type of residence.

Congestion, fatalities, and pollution are among the most important concerns in European transportation systems and road corridors, according to Aura Reggiani et al (1995). These externalities don't just affect road users; they also have a significant impact on society. ATT (Advanced Transportation Telematics) is the standard in this architecture. In many corridors, providing up-to-date real-time ATT information can assist reduce traffic inefficiencies, but the ultimate benefit is this new technology (or another set of new technologies).

The real consequence of the worldwide experience was assessed from favourable to bad by Anthony D. Perl et al (2015). High-speed rail, according to economic study, is typically economical in congested traffic corridors of 300-800 kilometres (180-500 miles) between big population centres, whereas long-distance high-speed rail, which includes tiny population centres, is costly to operate and difficult to cover. The Japan Corridor model includes the original Tokyo-Osaka route, which runs 515 kilometres between the two major cities and is the world's most successful high-speed rail operation (320 miles). Because of the exorbitant expense of constructing massive infrastructure, the national high-speed rail network's operating outcomes stay hidden.

3. ANALYTICAL INVESTIGATIONS

Yu, M (2018) used geographic information system (GIS) techniques to assess the impact of future high-speed rail route accessibility on the Piedmont Atlantic Region (PAM) in the United States. The accessibility of very large areas is assessed using three accessibility indicators. This contains WATT (Weighted Average Travel Time), DA (Daily Accessibility), and PA (Potential Accessibility) (see Figure 2). (PA). The findings show that future HSR corridors will improve accessibility across wide areas, particularly during peak seasons. HSR, according to coefficient of variation (CV) statistics, increases accessibility inequality in the Piedmont Atlantic Region (PAM) (see Figure 3). Using the predicted travel time, three metrics are calculated.

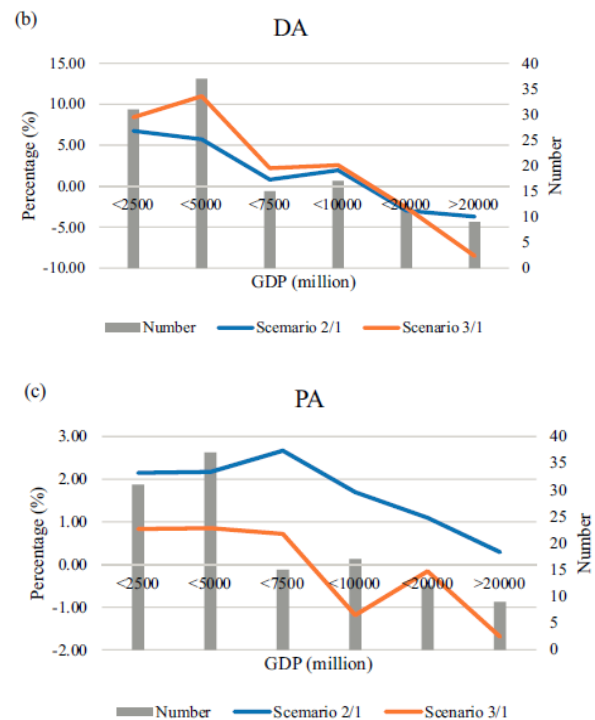
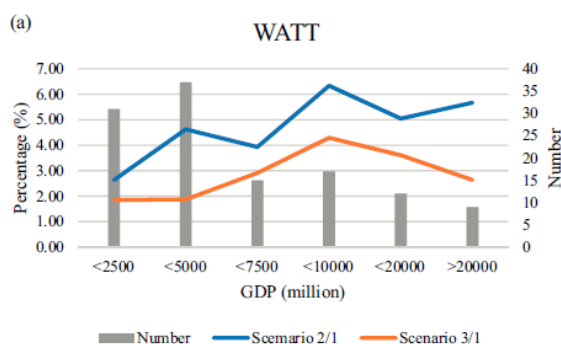
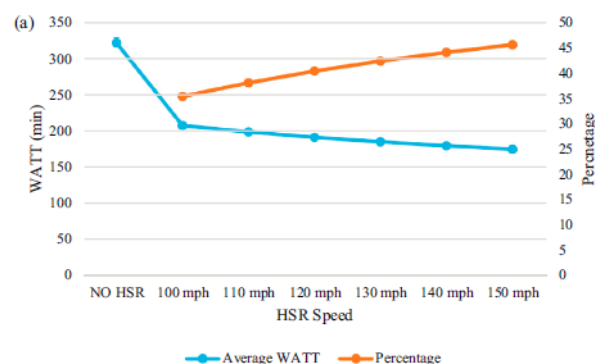


Figure 2. CV of the WATT, DA, and PA vs. GDP

Priemus, H et al. (2003) describe seven mega corridors that were chosen as beginning locations for the investigation. CORRIDESIGN originated with the realisation that regional economies across Europe are intertwined.

They discovered the creation of corridors connecting various policy domains, such as (1) better coordination between other policy and social sectors, (2) better collaboration between public and commercial organisations, and (3) better coordination. There was an evident need for more coordination, in his opinion. Because corridors are cross-border, coordination occurs at the interstate level and (4) promotes coordination between central and local administrations.



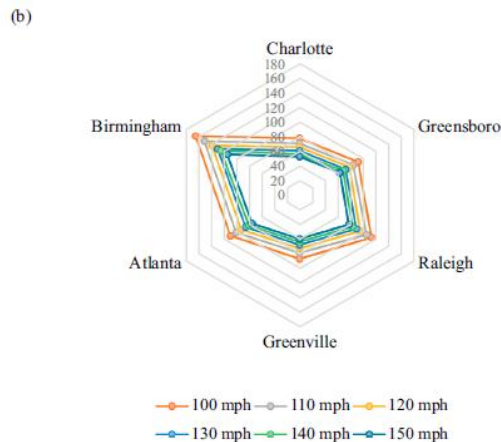


Figure 3. (a) Average WATT (minutes) values in the PAM vs. HSR speed; and (b) WATT values for the six cities with HSR speeding up

The results of the cluster analysis were presented by Abhilasha Saroj et al. (2022), who discovered that the incidence of discontinuous short-term intermittent data gaps was higher than the incidence of many consecutive data gaps. Short-term data gaps should be adequate for data transmission, and the randomization of data gaps should mitigate the overall damage. Digital twins developed by "ground truth" representatives with 100 percent data availability are used to design simulation trials. Ten replicate runs for five alternative sample-missing volume patterns were done for each of the three conflict error scenarios (20%, 50%, and 80%). The effect on the resulting journey time is determined by a combination of crossover approaches that suffer from partial data loss.

The impact of traffic fluctuations on railway corridor capacity, such as the likelihood of trains operating and stopping times, is described by Norman Weik et al. (2020). The analysis discovered that network backflow irregularities have a significant impact on train frequency and the railway corridor's ability to operate reliably (Figure 4). You can obtain throughput and effective train times for rail corridors without reliable timetable data by applying hint-theoretic techniques formerly used to describe production lines in industrial systems.

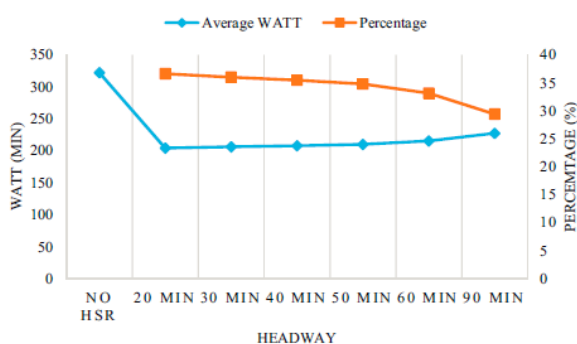


Figure 4. Average WATT (minutes) values in the PAM vs. headway

Zhijian Wu et al. (2019) investigated the effects of highway spacing on highway and arterial traffic levels for a highway corridor. The motivation for the research was to investigate some of the impacts of concentrating highway capacity on a small number of routes (as in an Automated Highway Systems), relative to distributing capacity across a larger number of routes

with lower capacity. The paper assumed that the rate at which trips are generated, and trip lengths, are unaffected by highway spacing, and that trip generation rates are invariant to location.

Randolph W. Hall is a well-known author (1997) the speed of cars is dramatically slowed when the fraction of unpowered vehicles is raised by more than 30%, and the influence on mixed traffic performance is minimal. The prohibition of unpowered vehicles could cut the time it takes for powered vehicles to move through corridors by 30%. Similarly, passenger mobility in corridors can be boosted by more than 300 percent without increasing travel times or changing present vehicle usage patterns. Separating lanes from linkages that ordinarily use intersections isn't a good idea because intersections cause a lot of delays.

Moazzem Hossain et al. (1998) constructed a mathematical model that compared the performance of closed and open BRT (Bus Rapid Transit) systems centred on a single corridor. For the tiny and medium-sized city of Valdivia, Chile, an optimal rectangular model was needed to give great performance between the two modes of public transportation. The city not only runs through the city's central commercial sector, but it's also the city's main transportation artery. As a result, this street will be a natural location for the bus high-speed rail corridor to be installed in order to boost the corridor's capacity and performance. Furthermore, the performance of the open BRT is somewhat improved as driving distance and time values grow, according to the investigation.

Munoz, J. C et al. (2020) address the use of variable message signs (VMS) and ramp metering for integrated control of highway/freeway traffic corridors using reinforcement learning. Q-learning was one of the topics I researched. The research region was the Gardiner/Lakeshore segment of the waterfront network along the Humber, which represents a generally active corridor of major roads and feasible parallel arterials. Use Paramics Modeller to integrate ITS technologies like VMS and ramp metering into the network. The most important aspect of this assignment is a set of application programming interface (API) functions connected to the development of Q-learning agents. The findings of the test suggest that the Q-learning method may provide traffic control for an entire region, particularly in the event of an accident.

According to Liao Yong (2022), the transportation corridor has a variety of passenger transit modes, and there may be strong competition among them. Healthy competition encourages carriers to invest in new technologies, lower transportation costs, and improve service quality. The concept of developing a passenger mode adjustment model for general transportation corridors. The collaborative model's goal is to evenly share the passenger flow of various modes of transportation in the transportation corridor so that each carrier may continue to operate and reap unique benefits without going bankrupt.

4. DISCUSSIONS

From the previous research works, the given article seems to draw upon several aspects to reach its objectives:

Economic Impact of High-Speed Rail: Previous studies emphasized the economic benefits of HSR, such as reduced travel time and associated increases in property value. This research can be utilized to analyse how HSR within transport

corridors can potentially stimulate economic growth and regional development.

Spatial Disparity: Analysis from previous works on how transport corridors can affect spatial disparities, for instance by increasing property values in connected areas or influencing social equity through improved accessibility, would be relevant to understand both positive and negative implications of transport corridor development.

Mode Network Accessibility: Research that examines the accessibility of transport networks, including HSR, can contribute to the current paper's examination of how transport corridors affect the overall accessibility of regions and the consequential economic impacts.

Environmental Impact: The environmental considerations highlighted in prior studies on European transport systems can inform the current research on the ecological footprint of transport corridors and guide the discussion on how to mitigate any negative environmental impacts.

Each of these elements from the previous research is relevant for a comprehensive understanding of transport corridors in the context of economic, social, and environmental impacts. By synthesizing this previous work, it aims to contribute to the literature on transport corridors by providing a broad and multifaceted analysis, including considerations of both the benefits and potential drawbacks of such infrastructure projects.

A common limitation of the reviewed studies is that they are restricted in scope, do not analyse how the growth effects of transport investment may have affected other aspects of economy, and, except for one study, do not show how growth effects may vary in different situations and for different groups. Some of the above studies indicate that other policies may have also contributed to the impacts of transport infrastructure. However, the review did not find any study that analysed how the other policies may have influenced the impacts of transport infrastructure.

Numerous studies were undertaken in developed countries to find empirical evidence that transport infrastructure investment boosts overall economic growth. They observed that empirical evidence of the scale and significance of such linkages was weak and disputed and concluded "that the theoretical effects can exist in reality, but that none of them is guaranteed". The earlier studies indicate that for a 10% increase in capital stock, GDP increases by about 2%. However, later studies based on more complex modelling indicate a much lower value.

First, much more research is required to clarify the nature and extent of trade-offs. In particular, the impact of large transport projects on measures of economic welfare has been studied extensively. However, the evidence of impacts on other types of outcomes is more limited and less rigorous. A prime example is the impact on economic resilience—defined as the resilience of economic agents to various types of shock, rather than the resilience of the transport infrastructure itself. For this impact, we were unable to find a single paper that met the criteria for inclusion in our sample.

Second, the importance of trade-offs points to the importance of complementary policies. The literature has done little to analyze the role of other policies in shaping the impacts of transport infrastructure. Hence, we find virtually no evidence on the

appropriate design of complementary policies in different circumstances. An important technical reason for this neglect of complementary policies may be that the literature has been striving to cleanly identify the impacts of the transport infrastructure itself.

An important limitation of the current studies is that they are not comprehensive in scope, generally focused on some specific outcome, for example, economic growth, trade, etc. Comprehensive studies which consider the impacts of specific transport projects on all aspects of outcomes, including negative externalities, simultaneously would be useful to gain insight into the nature of trade-offs between different outcomes.

Further research is also required to understand the uneven impacts across geographical locations and population groups for different types of infrastructure, and complementary policies, interventions, and institutions that can be considered to alleviate the adverse effects of uneven impacts. Findings of these studies can help when considering the choice of appropriate interventions and institutions which may then become part of the planning and design of HVT corridors and networks.

Several corridor management structures have emerged. The review did not find any study on the assessment of the current management structures. An assessment study can provide valuable insights into the current structures and contribute to designing new and improving the current management structures.

The contribution of this paper to research development includes:

1. Providing a comprehensive review of existing empirical studies on the subject.
2. Systematically analysing the findings to understand how the placement and design of transport infrastructure affect economic and social variables.
3. Offering a canonical model for assessing the net wider economic benefits of corridor development.
4. Highlighting the necessity for further research to better understand the trade-offs associated with large transport projects.

5. CONCLUSIONS

The primary objective of this paper was to perform a multi-faceted analysis of international transport corridors and understand their spatial and economic impacts. Through a mixed-method approach involving spatial analysis and policy evaluation, we have addressed the connectivity gaps between economies and examined the infrastructure improvements proposed under such initiatives.

Our findings have demonstrated that transport corridors have a complex array of effects on development outcomes, influencing economic growth, poverty, job creation, equity, environmental quality, and economic resilience. We have highlighted the competition and cooperation among various modes of transportation within corridors and established that a careful balance of these elements is essential for the corridors' success and contribution to the country's economic development.

In successfully applying the multi-method analysis, we have also provided insights into how the corridors can be integrated within the existing settlement structures, thus providing policymakers with the necessary data to ensure both maximization of welfare and mitigation of risks for participating economies. Through our rigorous review, we have enhanced understanding of the potential trade-offs in transport investments between different development outcomes and between different groups of economic actors.

By analysing the impacts of transport corridors on welfare and equity, and recognizing the potential adverse effects on environmental quality, the research has achieved its objective. It has offered a clearer picture for policymakers regarding the costs and economic effects of infrastructure improvements, thus suggesting that investments in transport corridors, when complemented with proper policy reforms and institutions, can indeed deliver substantial economic benefits.

As our review has indicated, the estimated impacts of corridor interventions on economic welfare tend to be positive. However, these interventions require a well-managed approach to improve the efficiency, reduce costs, and minimize environmental footprint in the transport and logistics services within the corridor.

Our study has contributed to the broader understanding of the economic and spatial considerations essential for designing transport corridors. It underscores the need for policy reforms that harmonize transport modes within corridors, fostering an environment where both competition and cooperation lead to sustainable economic development. This analysis serves as a significant resource for policymakers aiming to maximize the benefits of transport corridor investments while managing their inherent risks and trade-offs.

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