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Transport Corridors for Wider Socio–Economic Development

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Abstract: There can be two broad objectives of transport corridor development: to improve efficiency in the transport and logistics processes in the corridor, and to generate economic development in the corridor region, capitalizing on improved connectivity and transport networks. This paper focuses on the second objective of corridor development. A transport corridor can become a tool for spatially balanced and more sustainable economic development and human well-being in the corridor region. Considering the promise of this approach, this paper undertakes a critical review of transport infrastructure development studies undertaken in Sub-Saharan and South Asian countries to find evidence of infrastructure development impacts. Evidence gathered from the review suggests that transport infrastructure development can have significant positive impacts on economic growth, income, poverty, employment, equity, and inclusion. However, there can be important trade-offs between economy and welfare and environmental quality, and the distribution of impacts can be uneven. The paper also considers how some of the transport corridor development issues are addressed and complementary interventions that may be required, and, finally, discusses lessons learned from the review and their policy implications which can be useful for future corridor designs, and provides suggestions of research studies to fill the current knowledge gaps.

Keywords: transport corridor; transport infrastructure; transport development impacts; wider economic benefits; corridor management; South Asia; Sub-Saharan Africa

1. Introduction

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. For example, one transport corridor region in Bangladesh (Dhaka–Chittagong corridor) generates almost 50% of Gross Domestic Product (GDP) and handles about 85% of international maritime trade [1] (pp. 345–357).

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. In addition, an HVT corridor can bring together infrastructure facilities, policies, institutions, and investments to spur wider socio–economic development.

Transport development is linked to many Sustainable Development Goals (SDGs) and can be used as an intervention tool to achieve some of them (see United Nations (UN) [2] for SDGs). For example, HVT corridors and networks can be a tool to support achieving SDG 9 (sustainable infrastructure: Targets 9.1 and 9.a), and SDG 10 (reduced inequalities: Targets 10.2, 10.3, 10.7, and 10.8).

There are many theoretical works linking the contribution of transport infrastructure to growth and welfare. Aschauer [3] presented an econometric model of the relationship between production and public investments. Krugman [4] examined the forces that concentrate and disperse economic activity across economic space (geography). The new economic geography theories advanced by Krugman [4], Duranton and Puga [5], and other researchers have sought to explain the agglomeration of economic activity and its implications. Venables and Gasiorek [6], Department for Transport [7], Graham and Gibbons [8], Venables [9], and Vickerman [10] have considered the welfare implications of transport improvements in case of market failures and imperfect competition. They argue that conventional cost–benefit analysis (CBA) must be extended to include wider economic benefits (WEBs). WEBs are considered to be additional benefits, as they derive from sources of market failure and imperfect competition.

Discussions on some of the important theoretical works can be found in References [11,12] and elsewhere. It is generally agreed by academics, development practitioners, and policymakers that transport infrastructure is vital for economic development and human wellbeing. Transport development works through several mechanisms and various intermediate outcomes, such as decrease in trade costs, and increase in trade, investment, land value, and assets to induce WEBs in the long run.

An AECOM [13] study explains these effects of transport development in three stages. The first-order benefits (or direct benefits) are related to improvements in travel time, reductions in transport costs, increased reliability, and the introduction of new services, which result in cost reductions to transport users and transport service providers.

The second-order benefits arise as transport improvements enable access to larger markets and to wider facilities and services. The availability of better services and reduced cost of transport influence the location/relocation of firms, volume of trade, and higher agricultural production. An important characteristic of this stage is the visible signs of development: more traffic, shops, buildings, factories, etc.

The third-order effects arise in the long run from structural changes due to economy-wide dynamic processes activated by the second order effects. These changes ultimately lead to positive impacts on people's wellbeing, including poverty alleviation through an increase in employment, higher agricultural production and wages, and higher output prices. These changes, however, may also lead to externalities, such as negative impacts on the environment and some social aspects.

A recent study by Asian Development Bank (ADB) et al. [14] also describes a similar transformational process which leads to a set of final outcomes or wider economic benefits and costs. The chain of effects of transport development can be summarized in Figure 1.

It is important to mention here that the magnitude of such changes in different stages depends on responses of firms and households to effects in the first round, pre-existing conditions, institutional environment, and policy interventions of the government [15,16].

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:

- to review and analyze the literature on wider economic benefits and costs of major transport network/corridor development;
- to examine how some of the corridor development issues are addressed;
- to identify the current knowledge gaps related to transport corridor development and potential research studies that can be considered to fill these gaps.

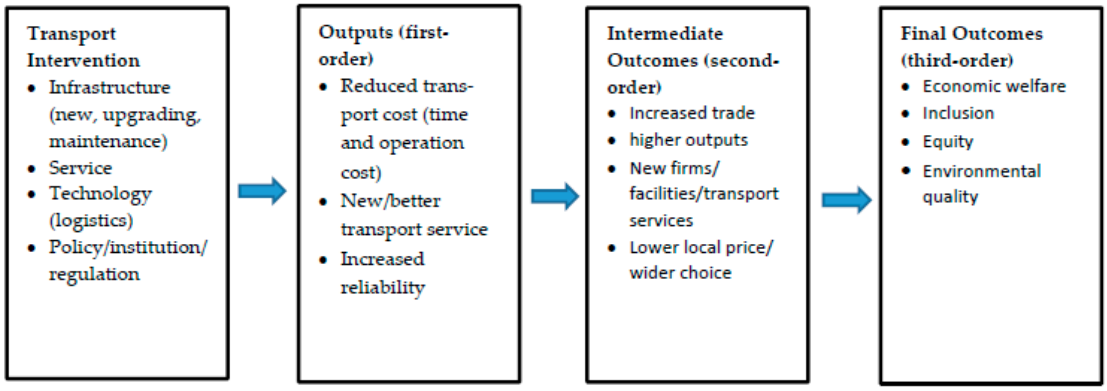

Figure 1. Effects of transport improvement/intervention. Source: Adapted from Asian Development Bank et al. [14] and based on preceding discussion.

To fulfil these objectives, the paper focusses on evidence from low- and middle-income countries from Sub-Saharan Africa (SSA) and South Asia, but relevant evidence from other developing countries are also considered.

Section 2 provides methodology and data sources. In Section 3, the paper provides a review of the development impacts of transport corridors and networks gathered from both peer-reviewed and grey literature.

The discussion in Section 4 is based on the main findings and lessons learned from the literature review. This section also considers issues related to corridor development and management and their policy implications, and future research to fill some current knowledge gaps.

2. Methodology

The findings and discussion in this paper are based on desktop literature review.

For this study, both peer-reviewed and grey literature have been used. Using search engines (Google Scholar, Google), an extensive search of online databases, namely, CrossRef, JStor, Research Gate, and Science Direct was undertaken, from which the cited papers were accessed.

The grey literature came from development banks and their institutes (World Bank, Asian Development Bank, African Development Bank, Asian Development Bank Institute, etc.), UN organisations, and research organisations, such as the Economic Research Institute for ASEAN and East Asia (ERIA), and Asian Institute of Transport Development (AITD). The grey literature was accessed mostly from the respective organization's official websites or e-Library.

3. Findings from Literature Review

3.1. Transport Infrastructure Investment and Economy

This sub-section first reviews the literature for Sub-Saharan and South Asian countries, followed by a review of some important studies in developed countries. This has been done to find differences of the research in developed and developing countries.

Many studies have found positive effects of transport infrastructure investment on the economy. Although the measured growth effects vary among studies, the positive correlation between transport infrastructure investment and economic development is commonly accepted [17].

A number of studies have provided evidence of the substantial economic and social benefits of transport projects [14,18]. Estimates from multiple studies have suggested cumulative gains ranging from less than 1% to more than 10% of GDP [19–22]. The variation in estimates and other findings is thought to be due mainly to differences in characteristics of individual studies and the difference in context, and related to different phenomena (economic sectors, transport infrastructure, etc.) being measured [23].

A review of 78 studies, including 18 studies in Africa (from six countries, namely, Cameroon, Democratic Republic of Congo (DRC), Egypt, Ethiopia, Nigeria, Tanzania, and Uganda, and six regional studies) provides evidence of the substantial economic and social benefits of transport projects [16]. A meta-analysis of the results has revealed statistically significant benefits of transport networks for real and nominal income, consumption, gender, education, and job creation.

A major study, covering 16 countries in North Africa and 24 countries in SSA, found that infrastructure (transport and other infrastructure) accounts for more than half of Africa's recent economic growth and has the potential to contribute even more in the future [24].

Simulation-based estimates have demonstrated that transport infrastructure and services make substantial contributions to GDP in the long run [21,25–29]. Hahm and Raihan [25] used a Computable General Equilibrium (CGE) model to estimate the total economic gains from the six Belt and Road Initiative (BRI) economic corridors. The estimated gains in terms of percentage of GDP for three BRI countries in South Asia were 7% in Bangladesh, 4% in Pakistan, about 3% in India, and about 6% in Myanmar. For landlocked countries (Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Mongolia, Tajikistan, Turkmenistan, and Uzbekistan), estimates vary between 5 and 10% of GDP. However, some other low-income countries, such as Cambodia, may also experience growth in GDP of more than 10%.

Zhai [26] investigated the real income gains from investment in expanded regional transport infrastructure in developing countries in Asia. The analysis has suggested that developing countries in Asia as a whole would gain about USD967.7 billion in 2020, which is equivalent to 6.0% of their baseline income in 2008.

Gilbert and Banik [21] estimated the impacts of South Asia Sub-regional Economic Cooperation (SASEC) transport infrastructure to connect Bangladesh, Bhutan, northeastern India, and Nepal. The simulation study indicated that the cumulative impacts as a percentage of GDP would vary between 0.7% and 14.8% (India 0.7%, Pakistan 2.7%, Bangladesh 4.1%, Sri Lanka 4.6%, and Nepal 14.8%). In absolute value, the gain was the highest for India (USD4330.3 million) followed by Pakistan (USD2600.8 million), Bangladesh (USD2295.1 million), Sri Lanka (USD933.8 million), and Nepal (USD2057.1 million).

Similar potential gains from increased sub-regional infrastructure investments were found in other studies. Stone and Strutt [27] valued social impacts at USD8.1 billion, resulting from moderate improvements to road infrastructure and trade facilitation in the Greater Mekong Sub-region (GMS). A major transport infrastructure project can have similar impacts on regional GDP. Anas et al. [20] used an Input–Output (IO) model to examine the impacts of a major toll way in West Java, Indonesia. Freight costs were found to decrease by 17%, and GDP in Bandung District to increase by 1.2%.

Hlotywa and Ndaguba [30] assessed the impact of road infrastructure investment on economic development in South Africa. The results of the study demonstrate that road transport investment variables account for approximately 86.7% of the variation in economic development in South Africa. Another study in South Africa examined the macroeconomic impact of labor-based road construction in undeveloped rural areas. Input–output analysis of 11 projects found that the GDP multiplier ranges between 1.34 and 1.53 (average 1.45) [31].

Using a cross-country analysis of 60 countries for the period 1980–2010, Ng et al. [32] compared improvement in mobility (by investment in access-controlled highways, such as motorways and freeways), accessibility (investment in local roads providing more direct links to destination), and economic growth. Their study found that improvement in mobility facilitated export-led growth in countries of medium and high-level development. On the other hand, it was more important to facilitate local business and trade activities investment in local roads to improve accessibility in countries of low-level development.

Pradhan and Bagchi [33] examined the effect of road and rail infrastructure on economic growth in India over the period 1970–2010. Using a Vector Error Correction Model (VECM), they found bidirectional causality between road transport investment and economic growth, and unidirectional

causality between rail transport investment and economic growth. They also found bidirectional causality between road transport and gross capital formation and unidirectional causality from rail transport to gross capital formation. Considering the findings, they suggested that expansion of transport infrastructure, along with gross capital formation, can lead to substantial economic growth.

Hong et al. [34] examined the linkage between transport infrastructure and regional economic growth in China using a panel data model of 31 provinces from 1998 to 2007. Transport infrastructure was shown to play an important role in economic growth, and road infrastructure contributed more to economic growth in locations with poor roads. A retrospective analysis showed that the uneven distribution of transport infrastructure is an important reason for disparities between regions.

The major highway networks can significantly contribute to the manufacturing output growth of a country. Ghani et al. [18] found that the Golden Quadrilateral (GQ) highway network upgrades led to a substantial increase in Indian manufacturing activity. They found that the largest growth came from the non-nodal districts within 0–10 km of the network, which accounted for 34% of the initial levels. Their estimates credit about 43% of the observed increase to GQ upgrades and the rest to other factors. The N–5 highway in Vietnam had similar high output growth effects [14].

Evidence from the reviewed empirical studies suggests that transport infrastructure investment generally has strong positive growth effects. However, a common limitation of the reviewed studies is that they are restricted in scope, do not analyze 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 analyzed 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. The Standing Advisory Committee on Trunk Road Appraisal (SACTRA) in the United Kingdom (U.K.) examined the linkages between transport and economy [35]. 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" [35] (p. 8). A review of evidence on the transport sector's contribution to GDP in the developed countries can be found in Reference [36]. 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.

More recently, government agencies and researchers in the developed countries have undertaken studies focusing on estimation of WEBs for inclusion in CBA of transport projects. The Department for Transport (DfT) in the U.K. has been a pioneer in including WEBs in the CBA of transport projects [37,38]. The Department recommends three categories of WEBs, namely, agglomeration, increased or decreased output in imperfectly competitive markets, and labor market impacts, and provides detailed guidelines to estimate them.

Following the DfT, other countries such as Australia and New Zealand have considered the inclusion of WEBs in CBA of transport projects. However, the number and category of WEBs and their treatment in evaluation vary. In New Zealand, five categories of WEBs (agglomeration, imperfect competition, increased competition, labor supply and job relocation) are considered in the evaluation framework, whereas, Australia's framework requires the exclusion of WEBs in CBA. WEBs are reported separately and considered for sensitivity tests, but not as an element of evaluation [39].

An inter-agency Workstream report [40] provides a comparison of WEB estimates for nine urban rail projects in Australia, New Zealand, and the U.K. The estimates for each category of WEB, in proportion to direct benefits in CBAs, varied considerably by project. The highest estimate of WEBs was for the Crossrail project in the U.K. (56%) and the lowest for the Brisbane cross-river project in Australia (19%). A similar comparison of seven rail and road projects can be found in Douglas and O'Keeffe [41]. These estimates show that for many projects, estimated WEBs can be substantial.

A study by Wangsness et. al. [42] investigated how 22 developed countries (Nordic countries, 15 countries in the EU, the USA, Canada, Switzerland, Australia, New Zealand, and Japan) treat WEBs in transport project appraisals. They found that 15 countries recognized at least one category of WEB, and only 10 of them recommended methods for their assessment. The recommended methods generally differed across the countries. Agglomeration benefits, which were most widely recognized, and by far the largest component of WEBs in many studies, were recognized by 14 out of 22 countries. However, only five of them recommended their monetization for CBAs, while the others were in favor of their inclusion in other types of analysis.

The criticisms of WEBs are largely due to questionable assumptions used in estimation methods and application in specific evaluations. Researchers [41,43,44] observed that there were several factors which might lead to biased estimates. These valid criticisms suggest that although the theoretical links are strong, empirical evidence is weak, and estimated values for WEBs are disputed.

The above discussion shows that WEBs are not universally accepted, and researchers and government agencies have divergent views on them. It also suggests that the quantification of WEBs is a new field of research in which more work is required.

Generally, the estimated contribution of transport infrastructure to GDP in developing countries is much higher than in developed countries. This is plausible, as transport networks in developing countries are not well-connected and generally not in good condition. Further infrastructure investment to improve network connectivity or infrastructure quality can produce substantial economic growth. Some of the reviewed studies identified different types of impacts, but did not explicitly consider their underlying causes or separately estimate different categories of WEBs. The review also did not find any study in developing countries that considered estimation methods for WEBs or their consideration in an evaluation framework.

3.2. Trade and Investments

An empirical study by Buys et al. [12] found that isolation from regional and international markets contributed significantly to poverty in Sub-Saharan Africa. Poor transport infrastructure and border restrictions were identified as significant deterrents to trade expansion. In another study, Hummels [45] found that the volume of trade between countries that share a land border varied widely by regions. It was only between 1 and 5% of trade for Africa, the Middle East, and Asia, compared to 10–20% for Latin America, and 25–35% for Europe and North America.

The land-locked developing countries (LLDCs) in Asia and SSA suffer more than coastal countries because of their higher transport costs. In a study of transport costs and trade, Limao and Venables [46] found that poor infrastructure accounts for 60% of transport costs for landlocked countries, compared to 40% for coastal countries. The estimated elasticity of trade flows with respect to trade cost was around −3. The analysis of trade flows showed that the relatively low level of trade in African countries was due mainly to poor infrastructure.

The decrease in transport cost has been the major driver of the increase in international trade [45]. Freund and Rocha [47] investigated the effects of different components of trade time on export in SSA. They found that a one-day increase in overland travel time implies a nearly 7% decline in exports. Buys et al. [12] investigated the economics of upgrading a primary road network that connects the major urban areas in Sub-Saharan Africa. Simulation results of the study indicated that upgrading has the potential to increase overland trade between countries in Sub-Saharan Africa by about USD250 billion over 15 years. The upgrading programme would require an estimated USD20 billion for initial upgrading and USD1 billion annually for maintenance.

Another empirical study by Bosker and Garretsen [48] also suggested that market access matters for economic development. The study showed that improvement of market access for Sub-Saharan Africa by investing in intra-continent infrastructure or through increased continental integration can have substantial positive effects on future economic development.

Simulation results of a study by Hahm and Raihan [25] showed that all countries under the BRI initiative would experience a rise in exports of goods and services. For example, the increase for Bangladesh, India, and Myanmar would be 3–7%, and 14% for Pakistan. Several other countries would also experience a high increase in exports. Exports of agricultural commodities would increase more than manufactured products. The export increase of agricultural commodities from Bangladesh, Cambodia, Lao People's Democratic Republic, and Myanmar could contribute to poverty reduction in those countries.

Hahm and Raihan [25] also suggested that the increase in imports would be higher than exports. For example, the import increase in Bangladesh, India, and Myanmar would be about 8–14% (compared to 3–7% export increase) and for Pakistan 14% (same as imports), and, for some countries, well above 15%. The researchers noted that this would lead to deterioration in the trade balance in most countries and would pose a risk for the overall balance of payments, which in turn could adversely affect economic growth.

Papriev and Sodikov [49] used a gravity model to evaluate overland trade expansion in 28 countries, resulting from improvements to the Asian highway network. The study has indicated that the highway network offers major potential for overland trade expansion through upgrading and improvement of the surface condition of selected roads, costing an estimated USD6.5 billion. One scenario of improving road quality indices up to 50 suggests that total intra–regional trade would increase by about 20%, or USD48.7 billion annually. In the second scenario of improving road quality indices up to 75, the predicted increase would be about 35%, or USD89.5 billion annually.

A gravity model-based study for the GMS by Fujimura and Edmonds [50] suggested that the development of cross-border road infrastructure has had a positive effect on intraregional trade in major commodities, with its elasticity in the range of 0.6–1.4. Similar effects on growth in trade were also observed in a study in Eastern Europe [51]. The gravity model simulations suggested that road upgrade could increase trade in the region by 50% above baseline, which exceeded the expected gains from tariff reductions or trade facilitation programmes of comparable scope. In nominal terms, this was about USD45 billion of trade benefits, and the estimated cost for road upgrade was USD8 billion.

The reviewed studies show that improvement of cross-border transport infrastructure can substantially increase transnational trade. However, they do not provide insight into how the growth of trade may affect other aspects of the economy. Only one study refers to the risk for the overall balance of payments due to the deterioration of trade balance. Neither do some studies provide any indication of the transport investment that would be needed. Further studies with a more comprehensive scope would be required to understand the trade-offs among increase in trade, fiscal risks, economic welfare, and other aspects of the economy, including negative effects.

3.3. Rural Economy, Poverty Reduction, and Social Impacts

People living in rural areas may also gain from major transport networks, especially roads and strategic transport infrastructure, such as a major bridge. Several studies provide evidence of transport networks having positive social impacts on rural people through poverty reduction and increased employment in non-farm activities [14,52–54]. Two studies [14,54] found a structural shift in the rural economy in terms of increase in non-farm activities and more employment.

The NH–5 Highway corridor in Vietnam made substantial positive impacts in the corridor region. The number of households living in poverty dropped by 35% between 1995 and 2000. Cities closer to and further away from NH–5 both experienced higher income growth per capita, as well as faster reduction in poverty than the rest of the country. The poverty rate in Vietnam as a whole reduced by 27% during this period as a result of broader spill overs from NH–5 to other regions [14].

An empirical study by Blankespoor et al. [52] investigated the impact of the Jamuna bridge on Bangladesh. They found that cropping intensity increased by 3% and the area using chemical fertilizer by 7%. The large reduction in transport costs (about 50%) due to the bridge led to agricultural development in the newly connected hinterland as a result of technology adoption and a better match

of land to crops. The long-term estimate (2005–2013) was positive and statistically significant, with an increase in rice yield of 5.2%.

Neupane and Calkins [53] examined the status of poverty and income inequality in Southern Thailand along the Asian Highway network route (AH18) in Songkhla province. They used descriptive statistics and Analysis of Variance (ANOVA) method that included poverty and income inequality indices to analyze the household survey data. They found that the average household income varied with location, and poverty was lower along the Asian Highway route.

The impacts of a major National Highway (NH2) in three states in India were analyzed in a study by AITD [54]. Compared with a baseline survey, literacy increased by 6%, female literacy by 12%, school enrolment by 7%, female school children by 12%, and population gaining access to medical facilities by 7%. The study observed improvements in women's participation in the labor force (9% increase), employment in non-agricultural activities (7% increase), and an increase in annual (deflated) per capita income by Rs 243.

Another study found that the welfare impacts on rural people along the GQ highway in India was not similar in all areas [14] (p. 247). The highway reduced poverty significantly in districts with a large agro-processing base, but poverty did not drop in the average district near the highway.

In their study, Fan and Chan-Kang [55] found a trade-off between growth and poverty reduction from road investments in different parts of China. Road investments gave the highest economic returns in the eastern and central regions of China, while contributions to poverty reduction were greatest in western China.

An empirical study in Ethiopia by Minten et al. [56] found that an increase in transaction and transport costs over a 35 km distance led to a 50% increase of the prices of fertilizer and a 75% reduction in its use. The cost to bring fertilizer over a distance of 10 km from the distribution centre was as high as the costs to bring fertilizer to the distribution centre from the port about 1000 km away. The study concluded that tackling the "last mile(s)" costs should thus be a priority.

A study by Omamo [57] in Kenya showed that improved rural road networks that reduce transport costs could reduce the motivation of small farmers to meet food needs through domestic production and promote specialization that raises farm incomes.

Dorosh et al. [58] examined the effects of increases in road investments on travel times and agricultural production. They found that improvements in road infrastructure can facilitate a substantial increase in agricultural production in Sub-Saharan Africa.

The findings of some of the above studies show that transport development leading to improvements in access in rural areas can have direct welfare impacts for the rural people. However, the impacts may vary in different situations and for different groups. On the other hand, transport developments involving HVT corridors and networks are of strategic significance to a national economy, but their direct benefits to the rural people may remain limited unless they are linked with a system of feeder roads providing access to remote areas.

3.4. Equity/Inclusive Development, Employment

Roberts et al. [16] found that transport networks had a beneficial effect on social inclusion in terms of education and gender in most of the studies reviewed. About 75% of studies showed benefits of equality in terms of spatial distribution, though all studies showed substantial negative effects in terms of overall income distribution.

A major study by Donaldson [59] investigated the impact of India's vast colonial railway network using archival data. Donaldson [41] (p. 931) found that "Railroads reduced the cost of trading and interregional price gaps, and increased trade volumes". He (p. 931) also found that when the network was extended to a typical district, real agricultural income in that district rose by approximately 16%.

The findings of Zhenhua and Haynes [60] confirmed that the high-speed railway network in China contributed to decreasing regional economic disparity and promoted regional economic convergence.

The review by Roberts et al. [16] found that roads have a beneficial effect on social inclusion in terms of job creation. More jobs, especially in non-farm activities, and greater participation of women in the labor force were also observed in the AITD study [54].

The rehabilitation and improvement of the Maputo corridor successfully boosted transit trade flows and bilateral trade between South Africa and Mozambique. The Maputo corridor led to more than USD5 billion worth of investments, and 15,000 direct jobs in the construction and operation of transport, logistics, energy, and industrial ventures along the corridor [14].

The NH–5 highway corridor in Vietnam has attracted investment and created jobs. In 2006, 83,453 and 134,846 jobs were generated along the corridor in Hung Yen and Hai Duong provinces, respectively [14].

An International Labor Organization (ILO) study in two states of India (Gujarat and West Bengal) found that investment in infrastructure created a substantial number of jobs [61]. The study found that a 10% increase in the investment in highways and urban road construction sectors (INR2345 million in Gujarat and INR1831 million in West Bengal) led to 83,401 more workers being hired in Gujarat and 178,181 more workers hired in West Bengal. This also led to INR13.52 billion growth in Gujarat and INR14.05 billion growth in West Bengal.

Two studies on the Jamuna bridge in Bangladesh have provided evidence of its impacts on rural employment and job transition patterns, even though they followed different methodologies [44,45]. Blankespoor et al. [62] found that besides increasing employment, the bridge construction facilitated a farm to non-farm shift in employment. About 40% of the employment increase in services came from the reduction of employment in the manufacturing sector, and the rest from agriculture. The results suggest a long-term structural change in the employment pattern.

Mahmud and Sawada [63] also found that the bridge led to an increase in local employment and facilitated a shift from farm to non-farm in both districts. The share of non-farm employment increased from 6.7 to 14% in one district and from 8.6 to 16% in the other district.

A shift in production and labor from agriculture was also found in a study done in Cameroon [64]. The study found that better road access led to a diversification of the economic activities within those households that were most isolated.

The findings of the above studies suggest that transport investment can be an important policy instrument to create jobs and may contribute to decreasing regional economic disparity. However, substantial negative effects on overall income distribution can be expected. The studies do not provide any analysis of how the negative effects on overall income distribution may affect different groups, either in relative or absolute terms. The results of some studies suggest that transport development in conjunction with appropriate complementary interventions, such as in Vietnam, can make substantial positive changes in the economy.

3.5. Location and Spatial Effects

While the estimated overall impacts of transport networks are generally beneficial, there are often negative impacts in some country regions and for some groups in society. Dzumbira et al. [65] found differences in the development impacts of the Maputo Development Corridor. Economic impacts, access to services, employment opportunities, income levels, and access to formal housing in nodes along and near the N4 spine were better than those away from the corridor.

In an empirical study on the impacts of railways in colonial India, Donaldson [66] found that the network extended to a typical district increased its real agricultural income, but reduced the real income of its neighboring district without rail access.

A study by the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) [22] used a CGE model to assess the development impacts of three Asian Highway routes from Kunming, China through Southeast Asia to South Asia. The results showed that, although most country regions would remain unaffected, some regions would have substantial gains in GDP of about 2.2–2.8%. For other regions, the average losses would be small, about 0.3–0.4% in GDP.

Other simulation-based studies have also found an uneven distribution of economic benefits along transport corridors, such as the Dhaka–Kolkata corridor in Bangladesh [14], and the Delhi Mumbai Industrial Corridor (DMIC) in India [67].

In China, the National Express Network (NEN) has increased real incomes in nearby prefectures by nearly 4% on average, but decreased real wages in many prefectures in the urban and rural sector [68]. Other studies also provide evidence of uneven distribution of the impacts of transport networks [14,18,60,69]. This finding from many studies has implications for the planning and design of transport projects.

The major transport networks can motivate businesses to relocate in areas better served by the network. An empirical study in Uganda found that businesses gain more from being located in areas that offer agglomeration economies, availability of skilled workforce, and better infrastructure conditions [70]. Public infrastructure investments in other locations are likely to attract fewer private investors.

To ensure more inclusive development, it is important to understand the distribution of impacts across population groups as well as across geographical areas. The studies discussed above clearly show that the distribution of impacts can be uneven across geographical areas. However, this review did not find any major study that explored the distribution of impacts across different segments of the population. More research would be required to examine the distribution of impacts across different segments of the population for each development outcome and in different situations.

3.6. Cross-Border Facilitation

De [71] analyzed the effects of inefficient facilitation of trade flow and concluded that transaction costs and delays at borders affect trade flows in the same way as tariffs do. The higher the transaction costs, the less is trade between partners in neighboring countries. A 10% drop in transaction costs at borders increases exports by about 2%.

Intercountry trade in goods and services can be greatly improved with efficient facilitation at border points and improved transit procedures [47,71]. These improvements would boost trade between landlocked countries [72]. However, the gains to countries may not be equal in either relative or absolute terms [21,22].

Stone and Strutt [27] have suggested that welfare gains of USD8.1 billion could be attained from moderate improvements in road infrastructure and trade facilitation in the Greater Mekong Subregion (GMS).

UN ESCAP has developed a corridor performance method that provides information on the relative importance and variability of time and cost at each interface point in a corridor [73]. This method was used to analyze the performance of trade corridors in East and Central Asia, and showed cost details for transport modes and transit time at each border post in the corridors.

Arvis et al. [72] did case studies on cost, time, and reliability of exports on some corridors in LLDCs, focusing on transit traffic for landlocked countries. The researchers concluded that the transit procedures regulating goods were poorly designed and implemented, which discouraged competition and high-quality logistics services.

In recent years, some countries have taken initiatives to streamline their border control and clearance procedures. These include Integrated Check Posts (ICP) by India and a single window system for southeast Asian countries which allows synchronized submission and processing of data, as well as faster clearance and release of shipments. The clearance process at border posts in the Maputo Corridor in southern Africa has also been streamlined. However, the literature does not provide any major studies on these initiatives or their impacts on trade flows and other aspects. Studies on these initiatives can provide important insights into how cross-border facilitation arrangements can be improved and adapted for other situations.

3.7. Corridor Governance

Transnational corridor development and operation is complex because of their wide reach and scope, and involvement of a large variety of stakeholders. Corridor management can be unique for various reasons, including the historical development of the corridor, initial conditions, and political objectives and institutions in countries along the corridor [72]. As a result, several management structures have emerged, see for example, References [72,74–76]. These structures include:

- Public–private partnership management structures, such as Maputo Corridor Logistics Initiative (MCLI) for Maputo Development Corridor (MDC) [75,77,78];
- Consensus-building structure, such as the Dar-es-Salaam Corridor Committee for Dar-es-salaam corridor [75,77];
- Project coordination structure, such as the Central Asia Regional Economic Corridor (CAREC) corridors in Central Asia [74];
- Legislative management structure based on treaties between countries, such as the Northern Corridor Transit and Transport Coordination Authority (NCTTCA) [75,77].

Many national corridors also have a formal management structure for coordination between government authorities, especially if they are large, multi-sectoral, or multi-modal. Several management structures for national corridors have emerged in India, Malaysia, and other countries [79,80]. These management structures were established under respective national laws; however, their legal status and governance structures are different.

This review finds that most transnational corridor managements have a multi-layer structure, including an apex/umbrella body, an executive/coordination committee, and a secretariat. However, the details of their structures and institutional arrangements vary. National corridors in India, and Malaysia also have multi-layer management structures [79,80].

Legal instruments such as treaties, conventions, agreements, protocols, covenants, compacts, exchange of notes, memoranda of understanding, etc., govern corridor management and operations [77]. Legal instruments can be bilateral, covering two countries, or multilateral, covering many countries along a particular corridor, a subregion, region, or global.

As mentioned above, corridor management ranges from a private sector-led entity operating as a lobby group (such as MCLI) to an intergovernmental body or state-run authority (such as NCTTCA). Each management structure has its strengths and weaknesses, but this review did not find any study that assessed the current management structures. Neither did the review find any study on designing of corridor governance structure, which is important for efficient corridor operation.

Inefficient facilitation arrangements at border crossings is a major deterrent to trade expansion. Corridors in Africa and Asia operate mainly under bi-lateral or sub-regional agreements [77,81]. Some 42 sub-reginal agreements have been signed in Asia alone. However, only some of these are in force. Non-uniformity of these agreements is a major challenge for region-wide trade and movement of traffic. In Africa, for example, multiple corridors cross Tanzania and DRC; these corridors operate under different management structures and their governance instruments are also different, which can lead to inconsistent corridor outcomes and administrative complications. However, studies on these issues are yet to appear in the academic literature.

3.8. Financing and the Private Sector's Involvement

The public sector has been the main source of financing new transport infrastructure, followed by official development assistance (ODA). For example, in Africa, more than half of transport infrastructure investments were from the public sector; the remaining were through ODA (from the Organization for Economic Co-operation and Development (OECD) and non-OECD countries) and the private sector [24]. Low-income countries (LICs) have not been very successful in attracting private investment in infrastructure development. Only 4% of private-financed projects took place in LICs,

while the majority of projects have taken place in developing countries with relatively higher incomes countries [82].

Large gaps between required and available funds are a major challenge for developing transport infrastructure in LICs. Some recent studies have identified substantial investment gaps in infrastructure development. For example, the estimated investment need in South Asia is about 8.8% of GDP, but the current level of investment of about 3.2% of GDP [83,84]. The estimated financing gap for Africa's infrastructure is in the range of USD67.6–USD107.5 billion [85].

More recent data on private investment in infrastructure shows that globally private investment has declined [86]. The same trend has been observed in Asian countries [83]. It is necessary to understand the reasons for the decline in private investment and what can be done to reverse this trend. Given the limited success in implementing private-financed projects, LICs may explore alternative financing options, such as commercial borrowing by the government, issuing of bonds, and other financing modalities that may be available.

3.9. Environment

There are direct costs of transport development to the environment, such as deforestation, loss of biodiversity, and general degradation of ecosystems [87]. Roberts et al. [16] found that transport networks and corridors have a harmful impact on the environment in terms of deforestation and carbon dioxide (CO_2) emission. A study by Laurance et al. [88] provided evidence of road clearings on tropical forests in Central Africa and other regions. A highway across the northwestern Congo Basin has promoted massive logging, poaching, and forest loss.

The transport sector is a major consumer of energy resources and also one of the major emitters of carbon dioxide. Globally, the road sector accounts for most of the energy consumption in the transport sector. In 2010, the transport sector in the UN ESCAP region consumed 27.4% (648 million tons of oil equivalent, or Mtoe) of the sector's total global energy consumption (2362 Mtoe). In the UN ESCAP region, the road sector accounted for more than 80% of the total energy consumption in the transport sector [89]. Compared with the global increase, energy consumption by the road sector in the region is rising more steeply.

In a report by the United States (U.S.) Energy Information Administration [90], it is projected that during the period 2012–2040, the annual growth of the transport sector's energy consumption in Africa (3.1%) and Asia (2.9%) (excluding China and India) will be higher than in other regions.

Globally, transport accounted for one-quarter of total emissions in 2016 (about 8 $GtCO_2$) which was 71% higher than in 1990 [91]. Of this, the share of road transport emissions was 74%. In line with the global increase, CO_2 emissions from the transport sector in Asia and Africa also show an upward trend. CO_2 emissions in the transport sector in Asia increased from 0.78 $GtCO_2$ in 1990 to 2.44 $GtCO_2$ in 2016, and in the same period, Africa's emission increased from 0.11 $GtCO_2$ to 0.46 $GtCO_2$ [91]. Compared with the global share (24.21%), the share of emission from the transport sector in Asia was much lower (about 14%) but its share in African countries was much higher (39.65%).

The steep rise in CO_2 emissions from the sector is expected to continue with further economic development in African and Asian countries. As CO_2 emissions is a major source of negative impacts on welfare, greater efforts will be required to reduce the current trend of emission increase from the transport sector.

It may be generally assumed that transport projects will have negative effects on environmental quality outcomes. However, there is a knowledge gap in that the current studies do not provide insight into the trade-offs between economic and social impact outcomes and environmental quality. It may also be pragmatic to consider the environmental impacts of some transport projects from a different perspective, for example, the Delhi–Mumbai dedicated rail freight corridor (DFC). The alternative to DFC would have far more detrimental impacts in terms of CO_2 emissions [92]. The authors of Reference [58] estimate that annual CO_2 emissions under the low-carbon scenario with DFC (0.28 million tons) are less than one-fortieth under the business-as-usual scenario without DFC (12.32 million tons).

3.10. Congestion and Road Safety

Traffic congestion is an important source of welfare loss in almost all major developing countries. An Asian Development Bank report suggests that road congestion costs countries in the region about 2–5% of GDP every year, due to lost time and higher transport costs [93]. Congestion also has other negative impacts on the welfare of people. The major cities in Asia suffer from the highest air pollution levels in the world, about 80% of which is from transport. Kuala Lumpur, the capital city of Malaysia, has serious traffic congestion. According to a World Bank report [94], the city wastes 1.2 billion L of fuel on traffic congestion, which is about 2% of GDP. The results of a study show that the traffic congestion cost in Beijing was about RMB 58 billion (4.22% of GDP) in 2010 [95]. The estimated annual congestion cost in Dhaka in Bangladesh was USD3868 million, which included an environmental externality cost of USD375 million [96]. Similar congestion cost estimates for some African cities are also available.

The TomTom traffic index, a measure of traffic congestion, shows that in 2018, some of the most congested cities in the world were in Asia (Mumbai, Delhi, Jakarta, and Kuala Lumpur, for example). In Africa, except Cairo and Lagos, the other most congested cities were in South Africa [97]. Measures to reduce the congestion level can greatly help to reduce its adverse impacts on the environment and people's welfare.

The road traffic death rate is highest in Africa (26.6/million people) followed by south and southeast Asian countries (20.7/million people). In both regions, the death rate has increased compared with 2013. The burden of road traffic injuries and deaths is disproportionately borne by vulnerable road users and those living in low- and middle-income countries [98]. In addition to a public health problem, road traffic injuries are a development issue. Low- and middle-income countries lose approximately 3% of GDP as a result of road traffic crashes [99].

The LICs have about 9% of the world population and their vehicle population accounts for only 1% of the total vehicles but they share 13% of total road deaths in the world. The LICs in Africa has the highest rate of road traffic deaths in the world of 29.3 per 100,000 population [98]. The low standard and poor condition of most roads and inadequate/lack of road infrastructure facilities in most low- and middle-income countries in Africa and Asia are among the causes of high road traffic fatalities.

An analysis of the 2010 road safety data covering 34,370 km of highways in 23 countries, available in the Asian Highway database, clearly shows that the higher class of roads are generally much safer than the lower class of roads [89]. A number of safe road demonstration corridor projects are being implemented in many states of India and other countries. A preliminary analysis of some of these safety improvement projects finds similar results. For example, the Kadapa to Renigunta safety demonstration corridor project implemented under the Andhra Pradesh & Telangana Road Sector Project (APTRSP) in India shows impressive results. The locations where curves and junctions were improved saw a 53% reduction in road crashes and 42% reduction in fatalities [100]. These results show that significant improvement in road safety can be achieved through the upgrading of highways and safer road infrastructure design.

3.11. Trafficking, Spread of Disease, and Socio–Political Issues

Cross-border transport infrastructure is accompanied by a wide range of negative externalities, such as the spread of HIV/AIDS, trafficking of vulnerable groups, particularly women and girls, illegal trading of narcotics and other items, effects on local farmers and businesses, and erosion of social values and cultural identities. As a result, the perceptions of local people in border areas may not always be favorable to cross-border infrastructure [101–103].

Trafficking of women and girls is a serious problem in border areas of countries in South and South-East Asia. Deane [104] examined cross-border trafficking of women and girls from Nepal to India. This study cited different sources to estimate that 7000 to 10,000 girls between the ages of 9 to 16 years are trafficked each month from Nepal to India. The trafficking problem between other countries has been examined in other studies [105,106].

Cross-border transport infrastructure can also have other adverse social impacts on the local people. Günther Slesak et al. [107] reported alarming vulnerability rates in ethnic minorities to sexually transmitted diseases (STDs) and HIV/AIDS along a new major intercountry road in south-east Asia. A review by Regondi et al. [108] found evidence of the spread of HIV/AIDS along the road network in Southern Africa. The number of HIV-positive persons and AIDS patients increased sharply in Savannakhet in Lao People's Democratic Republic during the construction of the Second Mekong Bridge [103].

Some of the above externalities are deeply rooted in the problem of widespread poverty, especially in remote border areas. Along with direct intervention measures, other measures to reduce poverty in the border regions would also be necessary. However, apart from trafficking and the spread of diseases, the literature does not provide insights into other social issues. Displacement and marginalization of local communities, including indigenous people, are possible due to land appropriation and grabbing, and changing social structure along the corridors, especially in border areas. However, the review did not find any study on these social issues. The review also did not find any study on mitigation practices to counter the negative impacts of cross-border transport.

4. Discussion

For the convenience of discussion, a summary of the main impacts of transport infrastructure investment, discussed in Section 3, is presented in Table 1.

The outcomes or impacts of transport infrastructure development are generally positive on economy, income, poverty, employment, equity, and inclusion. However, there can be important trade-offs between economy and welfare and impacts on environmental quality. In some situations, there can even be trade-offs between economic growth and poverty [55]. In addition, the distribution of impacts can be uneven. To ensure more sustainable and inclusive development, the potential gains to economy and welfare must be balanced against the potential adverse impacts, and the gains should be more equitably distributed.

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.

Transport development is necessary but may not be sufficient to generate wider economic benefits. Additional complementary interventions may also be required. For example, in the case of GQ Highways in India, non-availability of land for non-farm uses and low education and skills of the local labor force were found to be the main constraints for wider sharing of socio–economic benefits of the highways in some districts [16]. It also shows that transport investments and complementary policies should be based on a better understanding of the underlying mechanisms and the initial conditions that may affect the development outcomes. Otherwise, there is a risk that transport investments may not always produce the expected outcomes.

Table 1. Summary of main impacts from the reviewed literature.

Area/Aspect of Impact (Section)	Summary of Main Impacts from the Reviewed Literature
Transport Infrastructure Investment and Economy (Sub-Saharan Africa and South Asia) (Section 3.1)	• substantial positive impacts on economy; gains from investment from less than 1% to more than 10% of Gross Domestic Product (GDP) • Asia: estimated gains from regional transport infrastructure USD967.7 billion in 2020, equivalent to 6.0% of baseline income in 2008 • estimated gains for most Belt and Road Initiative (BRI) countries 3 to 10% of GDP • infrastructure led to more than half of Africa's recent economic growth • Africa: significant benefits to real and nominal income, consumption, gender, education, and job creation • generation of wider economic benefits (WEBs) may need complementary investment, policy, and other measures; depends on initial condition and other factors
Transport Infrastructure Investment and Economy (developed countries) [1] (Section 3.1)	• economic impacts lower than developing countries (generally contribution to GDP 1% or less) • WEBs generally recognized; induce higher productivity for firms and workers but applications in evaluation not universal • WEBs can be substantial (20–50% of conventional benefits in cost–benefit analysis (CBA)); considered in evaluation framework of some countries but treatments vary; U.K. considers three, New Zealand five, Australia reports separately • agglomeration benefits most widely recognized, and the largest component of WEBs in many studies
Trade and Investments (Section 3.2)	• improved cross-border transport infrastructure can substantially increase transnational trade • poor infrastructure accounts for 60% of transport costs for landlocked countries compared to 40% for coastal countries • estimated elasticity of trade flows with respect to trade cost about −3 • one day increase in transit time implies nearly 7% decline in exports in Sub-Saharan Africa (SSA) • upgrading of roads can increase overland trade in SSA by about USD250 billion over 15 years • BRI corridors in South Asia can increase imports between 8–14% compared to export by 3–4% • increased trade can deteriorate trade balance in many countries; risk for the overall balance of payments
Rural Economy, Poverty Reduction and Social Impacts (Section 3.3)	• access improvements have direct welfare impacts for rural people • positive impacts on rural people through poverty reduction and more jobs in non-farm sector • NH–5 Highway corridor in Vietnam: poverty dropped by 35% between 1995 and 2000 • NH–2 corridor in India: increase of literacy by 6%, female literacy by 12%, school enrolment by 7%, female school children by 12%, access to medical facilities by 7%, women's participation in labor force 9%, employment in non-agricultural activities 7% • increase in agricultural production and technology adoption
Equity/Inclusive Development, Employment (Section 3.4)	• beneficial effect in terms of substantial number of new jobs • more jobs especially in non-farm activities • greater participation of women in labor force • benefits of more equality in terms of spatial distribution • substantial negative effects in terms of overall income distribution
Location and Spatial Effects (Section 3.5)	• uneven impacts on population groups and geographical areas • increase of real income in an area can decrease in other areas • businesses can relocate to gain from agglomeration economies; some areas may lose businesses
Cross-Border Facilitation (Section 3.6)	• inefficient facilitation arrangements deter trade expansion • cost reduction at borders increases exports and welfare; 10% drop in costs increases exports by about 2% in South Asia • moderate improvements in infrastructure and trade facilitation can increase welfare gains of USD8.1 billion in Greater Mekong Sub-region (GMS) • gains to countries are not equal in either relative or absolute terms

Table 1. *Cont.*

Area/Aspect of Impact (Section)	Summary of Main Impacts from the Reviewed Literature
Corridor Governance (Section 3.7)	• transnational corridor management can be unique • several management structures have emerged • most corridor managements have a multi-layer structure • a wide array of legal instruments governs corridor management and operations; most agreements are bi-lateral and sub-regional • non-uniformity of agreements is a challenge for region-wide trade expansion in Africa and Asia • some domestic corridors have formal management structures
Financing and Private Sector's Involvement (Section 3.8)	• public sector is the main source of infrastructure financing • only 4% private-financed projects took place in low-income countries (LICs) • large funding gaps in LICs for infrastructure development • globally private investment has declined in recent years
Environment (Section 3.9)	• harmful impact on the environment in terms of deforestation and loss of biodiversity • transport sector is a major consumer of energy resources and emitter of CO_2 • globally transport sector emitted one-quarter of total emissions in 2016; share of road transport was 74% • road sector accounts for 83.3% of CO_2 emissions in ESCAP region • CO_2 emissions in Asia increased from 0.78 $GtCO_2$ in 1990 to 2.44 $GtCO_2$ in 2016 (312% increase) and in Africa's from 0.11 $GtCO_2$ to 0.35 $GtCO_2$ (318% increase)
Road congestion and road safety (Section 3.10)	• congestion costs Asian countries 2 to 5% of GDP every year; Kuala Lumpur wastes 1.2 billion L of fuel, about 2% of GDP • about 80% of air pollution in Asian major cities is from transport • road congestion is an important source of welfare loss in African and Asian developing countries • road traffic death rates are among the highest in Africa (26.6/million people) and south and southeast Asia (20.7/million people) • low- and middle-income countries lose about 3% of GDP from road traffic crashes • evidence shows that safety improvement measures and better infrastructure can reduce road traffic deaths and injuries
Trafficking, Spread of Disease and Socio–Political Issues (Section 3.11)	• trafficking of women is a serious problem in many border areas • adverse impacts on local people, including displacement and marginalization, effects on local firms and businesses • transport development can help spread of HIV/AIDS and other diseases • illegal trading of narcotics and other items in border areas

Source: Based on discussion presented in Section 3. [1] Comparison with developed countries has been made for this aspect only.

The NH–5 highway corridor in Vietnam is a good example of complementary interventions. The highway development was implemented in conjunction with complementary policies, including human resource development. The availability of an educated labor force allowed quick transfer of labor from agriculture to manufacturing and helped a major transformational shift in the economy [14]. The Maputo Corridor in Southern Africa is another good example where infrastructure rehabilitation and upgrading of transport infrastructure, along with improved facilitation measures at border posts, made the corridor successful in boosting transnational trade.

The review showed that HVT corridors and networks can create agglomeration effects in some locations. Businesses gain more from being in areas that offer agglomeration economies. Public infrastructure investments in other locations are likely to attract fewer private investors. Because of agglomeration benefits in established main centres, investment only in transport infrastructure has limitations to attract businesses to secondary centres outside the established main centres. Other intervention measures, such as public investment and policies, may be needed to induce growth in less attractive secondary centres or regions.

The burden of environmental and social costs of transport can be substantially reduced through various measures. For example, road safety is an important development issue in both SSA and South Asian countries, and should not be left as an "afterthought" in road infrastructure development projects. Although road safety is a cross-sectoral issue, evidence from the review suggests that the incidence of road crashes can be substantially reduced through road development with proper road safety audits at the road design stage.

Even though Environmental Impact Assessment (EIA) is now customary, further research may be necessary to guide the planning of transport infrastructure projects in environmentally sensitive areas. Other measures, such as the development of multi-modal transport systems, where possible, can substantially reduce the negative effects (see, for example, References [92,109]). Price instruments (congestion and pollution charges, for example) and regulations (such as emission and fuel standards) are useful tools to change the behavior of individuals and firms and address environmental externalities. However, the use of these tools is not common in LICs. They should be considered to reduce the burden of negative externalities, where feasible.

To improve transport project evaluation in developing countries, it would be worthwhile finding out if the same categories of WEBs, as in developed countries, are also important for developing countries. Further studies with such a focus, as well as developing suitable estimation methods for WEBs, would be needed.

Researchers have used a variety of models and methodologies to study the impacts of transport development, including CGE-based simulation studies, multi-regional input–output (IO) model, and difference-in-difference and other statistical and econometric models. Models based on CGE and IO methodologies are promising for estimating transport infrastructure investments and their distributional effects. Theoretically, the CGE and structural models are superior to other models. However, the structure and application of such models are still in the developmental stage. They are more complex, data-intensive, and require considerable expertise. Further efforts would be required to develop operational models for practical applications.

Research studies may also be considered to assess the effectiveness and suitability of the currently available analytical tools/models to understand the distributional impacts of regional and national transport projects/networks at the subnational level. Research is also needed to examine how such tools/models may be adapted for policy analysis and policy formulation, including designing of complementary intervention measures. A related issue in developing practical models for impact assessment is the availability of required data. The suggested research may also examine how this problem can be overcome.

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. Therefore, a study on this matter is recommended.

There is another issue linked to management structures: the governance of transport corridors. Currently, there is no general framework for designing governance structures for transport corridors. Research may be considered on how a transport corridor governance structure can be organized, structurally and procedurally, so that multiple stakeholders in corridor development, management, and operation can play their roles and interact effectively. Allied to this, the research may also consider how governments can promote institutions to build partnerships, collaboration with such actors, and facilitate their action.

The establishment of functional linkages between local and rural communities and the urban/national economy by using major highways and railways is a major challenge. In addition to rural feeder road networks, some countries have considered rural logistics and market centres along the major transport networks and other intervention measures to improve efficiency in rural supply and distribution chains, serve as a direct market outlet for local produce, and generate non-farm local employment [110]. However, these initiatives are not widespread and do not follow a coordinated approach to establish effective rural–urban linkages. A study can be considered to develop case studies on such measures, and assessment for their adaptation in other countries.

The negative externalities of cross-border transport need closer attention. Human trafficking, illegal trade in narcotics and other items, and the spread of diseases are some of the major challenges that need to be tackled through appropriate interventions. Other social issues related to corridor development, such as displacement and marginalization of local communities, changing social structure, etc. need the attention of researchers. Research may be undertaken to study these problems in operational corridors. The study may also consider the effectiveness of the current mitigation measures, develop a general framework to formulate action plans for remedial measures, and examine how these measures may be incorporated in corridor project design, as well as in legal and regulatory instruments for border-crossing procedures.

Railways are expected to have a greater role in the future to meet the growing demand for transport infrastructure services. In recent years, many countries in South Asia and SSA have been building new railway lines. In addition, freight movement by railway is expected to be a key design feature of multimodal transport corridor projects in the future. However, evidence of the impacts of rail transport in the literature is not rich. A better understanding would be needed for designing economically and environmentally efficient and socially inclusive railway projects. Studies are suggested on impact evaluation of recent railway projects, including both passenger and railway freight corridors, which some countries are currently constructing.

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