INTERNATIONAL DEVELOPMENT IN FOCUS

Connecting to Thrive

Challenges and Opportunities of Transport Integration in Eastern South Asia

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4 Maximizing Rural Spillovers of Regional Corridors

A CASE STUDY OF BANGLADESH

CHARLES KUNAKA, NIKLAS SIEBER, AND ROMAN CONSTANTIN SKORZUS

Regional trade and transport integration initiatives in South Asia are based on the designation of corridors through which trade flows or is expected to flow. Many major corridors need better infrastructure, policies, and procedures to facilitate trade; other interventions are needed as well. The huge amount of resources typically invested in corridors makes it imperative to broaden the regional effects as much as possible. Extending the benefits of corridors at the local level cannot be achieved without integrating rural development into the design of regional transport corridors.

Empirical evidence shows that improving corridors increases intercountry connectivity and spurs development of the regions through which corridors pass (Alam and others 2018; Roberts and others 2019). However, the impacts have often been assessed only at an aggregate level, which does not capture the mechanisms or nature of interventions that may be needed to maximize them. This chapter argues that an important mechanism for reducing poverty is enhancement of the connectivity of local produce markets to corridors.

The extent and depth of the local impacts of corridors depends on the ability of local communities to access improved transport and logistics services to markets located across the border. Increased regional integration can yield meaningful local benefits—but only if economic agents located along corridors can take advantage of improved connectivity. As small and medium farmers and enterprises are the ones that typically suffer from inefficiencies (because of the high unit costs of their shipments), they are likely to benefit most from improved market access. The challenges faced by small and medium enterprises (SMEs) are greatest in rural areas, where economic activities are dominated by agriculture and small-scale production, most of which is led by women.

This chapter explores how the local impacts of corridor projects can be enhanced by improving markets along a corridor. It proposes an approach to determining a package of improvements for rural roads and local markets that would help maximize the impacts of improvements to core regional trade corridors. The chapter proposes a generic methodology that can be adapted to different situations to plan investments in ways that deepen the local impacts of regional corridors.

The chapter uses a case study—of Jessore district, in Western Bangladesh—to illustrate how the local impacts of a regional corridor could be maximized. A regional corridor connecting western Bangladesh to India passes through the district; the district also has an extensive network of rural roads and markets. The government of Bangladesh has designated the corridor a priority for improvement. The district therefore meets the prerequisites for identifying a combination of local roads and markets that would best leverage the proposed improvements to the corridor.

REGIONAL AND LOCAL DIMENSIONS OF CONNECTIVITY

Regional corridors, local transport networks, and associated services are components of the integrated transport networks in a country or region. However, the development impact of networks is often considered in a partial manner, as corridors are examined separately from the network of secondary and tertiary roads. This classical approach does not capture the manner in which goods flow, especially in economies where agriculture is the dominant sector. Goods and people pass through rural and urban nodes that are connected by transport and logistics services. Produce, for instance, may pass from the farm through a market town, where it is consolidated with the produce of other farmers; be loaded onto a vehicle with larger carrying capacity; and use a regional or national corridor to reach major consumption centers in the country or a gateway for export to another country. There is limited treatment in the literature of how transport and logistics networks can be integrated for more holistic planning and strategy development. This chapter develops and tests a conceptual approach that could be adopted to fill this gap.

The literature addresses the contribution of trade and transport corridors to development. It almost takes for granted that the development of corridors has positive outcomes. Corridors have increasing returns to scale in transport services, as they can handle large volumes of traffic at lower unit costs than surrounding networks. Roberts and others (2019) provide a comprehensive review of the literature on the development impact of corridors. Alam and others (2018) assess which design and implementation characteristics of transport corridors and country characteristics could help maximize the wider economic benefits from transport corridors. The two papers conclude that investing in corridors contributes to structural changes in districts on or near highways. They find that economic benefits as measured by household expenditure and poverty rates are maximized when investments are complemented with supporting policies and institutions. These conclusions are largely consistent with received knowledge that transport corridors increase market access and trade between connected locations. It is the local dimension that leads to the need to consider how rural communities connect to markets.

Different approaches can be used to model the interaction between local access and regional networks for trade and transport. One approach is to model accessibility at the local level, to optimize the placement of rural roads so as to maximize accessibility to key services. Such modeling takes into account population and the location of key services, such as health centers and schools; through simulation, it identifies the road improvements that would minimize travel time within a budget constraint for the improvements. The approach can also be used to determine optimal locations for economic infrastructure at the

local level (Heyns and van Vuuren 2018). These spatio-analytical approaches seek to optimize investments across geographical space in order to achieve intended outcomes. They are ideal for local development, especially in regions where agriculture is a dominant economic activity.

Alternative approaches focus more on access to markets, especially in large agglomerations. They focus more on the topology of rural supply chains and how producers can minimize costs to reach markets, especially in large urban centers. It is this second school of modeling that this chapter is based on, as its approaches can more explicitly integrate the impact of improvements at the local level and the development of regional corridors.

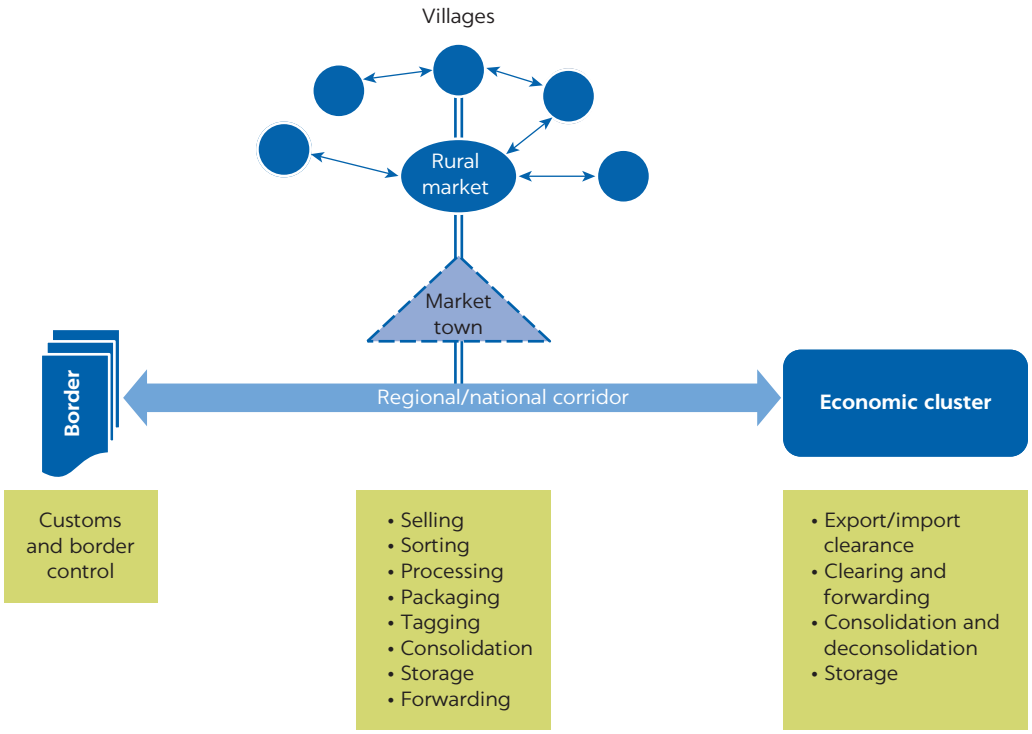
Rural communities connect to markets through a cascade of rural market centers, market towns, and secondary and tertiary networks of roads that link to larger markets, either directly or via regional and national corridors (figure 4.1). Rural roads and rural markets are the two main elements of rural trade and transport connectivity infrastructure.

Improved rural connectivity enhances access to economic opportunities and increases welfare (Jacoby 2000; Fafchamps and Shilpi 2009). Sieber and Allen (2016) identify two mechanisms of impact. First, rural roads induce market-led local development, via agricultural marketing and increased incomes from farming. Second, rural roads increase revenues from nonfarming activities, by spurring a shift from subsistence agricultural to commercial agriculture or nonfarm activities (Khandker, and Koolwal 2011; Gertler and others 2014; Gachassin, Najman, and Raballand 2015; Herrera Dappe, Andres, and Alam 2020).

Investing in infrastructure enhances efficiency in production, consumption, and distribution and increases productivity, which raises income levels.

FIGURE 4.1

Analytical framework for corridors and local connectivity



Source: World Bank.

Khandker and Samad (2016) examine the linkages between infrastructure endowments and household consumption and income growth in Bangladesh. They find that infrastructure development can be transformative in a rural economy, by helping villages and households increase and diversify incomes and consumption. Nonfarm income typically increases more than farm income.

Bradbury and others (2017) observe that good road access and transport services can enable people to diversify their income to nonagricultural and more profitable enterprise or employment. Mu and van de Walle (2008, 23) find "that rural roads had a positive impact on the presence and frequency of markets" in Vietnam. Better transport allowed farmers to export their produce and increased the inward flows of goods, knowledge, and ideas. Mu and van de Walle maintain that small road improvements have significant impacts on local development when they target areas that were poorly served with markets and are bundled with other social development policies (such as adult literacy). In theory, producer prices should rise after road rehabilitation, because of lower transport costs, which are transmitted to local producers in a competitive transport market.

Fan and Chan-Kang (2005) and Banjo, Gordon, and Riverson (2012) argue that rural roads should be improved where poverty is most severe and improved access to markets would provide opportunities for subsistence farmers to integrate into the market economy and thus increase farm production, marketing, and agricultural incomes. Based on a review of several studies, Starkey and Hine (2014, 4) maintain that "building roads (and/or trails and footbridges) to connect rural communities to the road network provides numerous benefits and reduces the numbers of people in extreme poverty. Trails and roads enable safer and faster access to markets and services."

Many studies of rural transport emphasize the importance of markets as a key component of rural connectivity. The development of markets is often an integral part of the development of rural road and transport networks. Tracey-White (1995) argues that enhancing access to markets can stimulate growth in agricultural production. The impacts are most pronounced for smallholders, who may rely on markets as their sole or main outlet for products. Exposure to more competitive conditions in large economic centers, especially cities, can force small-scale producers to upgrade their products through on-farm grading and packing and direct sales to consumers. Table 4.1 summarizes the benefits of markets for rural communities.

Raising standards in markets is likely to provide a means by which small-scale producers in rural areas can improve the efficiency of their marketing in order to compete in the sale of greater quantities of cheaper produce. In addition, a growing role for SMEs is helping transform rural supply chains. There are instances in which SMEs have become primary markets for rural producers, enabling the aggregation of volumes and the processing of produce to take place at the local level. Integration of producers and SMEs can be formalized through contract farming. The main impacts on logistics are through increases in per capita volumes and a reduction in unit costs of shipments to market, transformation of products to add value or prolong shelf life, and changes in the allocation of risks for any postharvest losses. All these factors can affect the topology of rural supply chains.

Other influences on the structure of rural supply chains occur through the adoption of digital applications and platforms. By accessing almost real-time information on market conditions, producers and traders are able to

TABLE 4.1 Benefits of markets for rural communities

BENEFIT	EFFECT
Reductions in crop losses	• Quicker and better handling reduces crop losses. • Provision of covered stalls, better storage, and end to flooding of markets in rainy season reduce postharvest losses. • Improved security reduces theft.
Improved efficiency of market operations	• Market operators enjoy substantial savings. • Potential for greater throughput increases. • Rents and charges increase.
Public health benefits	• Better sanitary conditions for the slaughter of poultry and the sale of meat and fish, provision of public toilets and hand-washing facilities, adoption of better market-cleaning and solid-waste disposal practices, and adequate paving and drainage reduce food contamination.
Amenity and aesthetic benefits	• Better stalls provide greater protection from sun and rain. • Produce is cleaner and more attractively displayed.
Time savings	• Waiting times for delivering and collecting produce are shorter. • Relocation of markets away from main road reduces travel time for nonmarket visitors.
Impact on agricultural production	• Greater access to market opportunities arising from demographic and income changes increases growth of agricultural production. • Efficiency of marketing for small and medium enterprises increases agricultural production. • More sophisticated techniques, such as on-farm grading and packing and direct sales to supermarkets, are used.
Other effects	• Income from additional services increases. • Public funds are generated.

Source: Tracey-White 1995.

continuously modify their behavior and patterns of shipments to access the markets that offer them the highest returns. The evidence of the impact of digital apps on costs of rural logistics is mixed, however. In some cases, the apps encourage fragmentation of volumes.

The decision of which markets producers choose to access has implications for the quality of the connecting road infrastructure and the range of services offered at different marketplaces. The theoretical background for the location of markets and how they are connected to each other is the concept of central locations, developed by Christaller in 1933. According to Christaller's model, marketplaces form a three-level hierarchy of central locations, distributed on a hexagonal grid. Each level of the hierarchy provides specific goods and services to its catchment area. The quality and capacity of connecting transport infrastructure are influenced by the position in the hierarchy of the centers being connected. Low-level centers are usually connected with tertiary links, for example; higher-level centers usually have higher-quality and–capacity links.

The hierarchy of markets typically reflects the function a market serves in an area. Tracey-White (2005) identifies four main types of markets (leaving out supermarkets):

- *Rural primary markets*. Trade at rural primary markets is characterized by direct sales of small quantities of produce by producers to village traders and by retail sales to rural consumers. Rural markets normally form part of a local

trade network and are usually arranged on a periodic basis, on specific weekdays. They are usually organized at a central place in a village or district center or beside a village's access road. In some instances, provincial and district-level markets serve this function, as well as providing an assembly function (by combining produce in larger quantities for onward sale to outside buyers).

- *Assembly markets*. Assembly markets are rural markets at which larger quantities of produce are traded, by producers or traders. They are often combined with local rural or town markets and are normally situated on main highways near local transport interchange points. Traders, product consolidators, and commission agents acting on behalf of urban wholesalers are the main buyers of produce at these markets.
- *Wholesale markets*. Terminal wholesale and semi-wholesale markets are located in or near major cities. They may be supplied by purchasing/assembly centers in rural areas or directly from farms, particularly farms in peri-urban areas. Agents, traders, and farmers themselves supply these markets.
- *Retail markets*. Retail markets serve consumers directly. In many countries, small retail shops (often called "comer" shops) and roadside stands sell produce close to consumers' homes. These retailers usually purchase their produce from wholesale markets. In some cities, hawkers operating from bicycles or small carts provide retailers with small quantities of produce or sell directly to consumers. Although primarily retail, these markets may have a semi-wholesale function, particularly if they allow farmers to trade in them. In this case, they are often called *farmers markets*.

For connectivity to corridors, assembly markets are most relevant, as they are where locally produced goods are marketed in larger quantities for onward sale to outside buyers. The main market functions are exchange of goods and consolidation of large quantities for transport. Instead of farmers carrying small quantities of produce to the wholesale market, traders use large vehicles, which reduces transport costs. With a growing volume of local production, the quantities marketed and transported soar and truck loads increase. For this reason, good access to assembly markets is essential.

Although physical markets remain the dominant facilities for market exchanges in rural areas, other mechanisms can also help facilitate trade. They include producer cooperatives, in which groups of farmers coordinate to supply products to consumers or traders, and information technology–based solutions, especially mobile phone–based applications, which link producers and consumers and even facilitate payment. Ultimately, however, regardless of the mechanism used to organize rural supply chains—physical, organizational, or virtual mechanisms—the challenges of optimizing logistics and minimizing unit costs are the same.

Accessibility

Access to markets is a *sine qua non* condition for rural development. A World Bank (2016) study finds that agricultural production is highly correlated with travel time to urban markets. The highest productivity, at 45 percent of production potential, is within four hours of an urban market; the lowest, at 5 percent, is eight hours away. However, when population distribution is included in the analysis, 45 percent of the population in low-income countries is within one hour of the nearest market (World Bank 2016). Secondary and tertiary road

networks and the placement of market infrastructure are critical in terms of the time it takes to get to market. In fact, larger markets, especially assembly markets, are often important junctions or located at major junctions in transport networks.

Based on their work in Bangladesh, Gautam and Faruqee (2016) argue that continued investments in infrastructure will remain a high priority given the role roads play in raising productivity, promoting diversification, and creating employment opportunities for rural communities. Traders identify poor road conditions and roadblocks, limited access to and the high cost of financing, and the lack of shop or storage space as constraints (figure 4.2). More than half of the traders they surveyed viewed poor road conditions and roadblocks as major or severe problems; another fourth rated them as minor or moderate problems.

Market access needs to be considered from the perspectives of both farmers and traders. Farmers need to transport their products on the "first mile" (from the field or homestead to the market). They use market access roads—the roads, paths, and tracks within the catchment area needed to reach the market. Traders need to transport goods to and from the market. They use market feeder roads—roads that connect markets to the main road network.

Rural goods are transported on paths, trails, tracks, footbridges, pontoons, and earth and sealed roads. On-farm transport is mainly along paths belonging to the farm estate. The remaining part of the first mile is conducted on infrastructure owned by the community. Local and regional transport is mainly on tracks and roads managed by district or provincial authorities. Rural roads usually account for the largest proportion of road network length in many countries, although they may carry only a small proportion of motorized traffic.

FIGURE 4.2

Traders' perceptions of obstacles to business operation in Bangladesh

Source: Gautam and Faruqee 2016.

On the first mile, goods are transported by "intermediate means of transport" (IMT)—nonmotorized transport, animal traction, motorcycles, and other means of transport that fall between walking and four-wheel vehicles—which is more cost-efficient than motorized transport and has far lower infrastructure requirements. Innovations in IMT technology, especially the introduction of electric, solar powered vehicles, is rapidly transforming the rural transport landscape, especially in South and East Asia. From fields and plantations, produce is transported to buying points, village storage facilities, and local markets or directly to rural hubs, using infrastructure that is inexpensive to build and can be maintained by local manpower. From buying points or rural hubs, goods are transshipped onto light or heavy goods vehicles, which operate on market feeder roads, allowing higher speeds at lower costs.

All-weather accessibility is essential for the marketing of agricultural produce year round. Therefore, a low-cost approach for road improvements is recommended. Instead of upgrading main roads to higher standards, priority is given to upgrading a larger network to an all-weather standard. Only if the capacities of roads are largely exceeded can upgrading to wider standards be justified.

Market infrastructure

Different types of markets have different endowments of infrastructure, facilities, and associated services. A major concern is usually the susceptibility of products to losses during handling and storage. Bradbury and others (2017) show that several factors contribute to postharvest crop, "including the age of the produce, handling during harvesting, loading and unloading, and quality of transport and storage." They find that in Tanzania, initial transport costs and crop losses reduce the net income from the sale of potatoes and pineapples by 30–40 percent. In Bangladesh nearly 30 percent of aubergine traders and 26 percent of chicken traders experienced product damage or loss over a three-month period (Gautam and Faruqee 2016). Transport caused 21 percent of aubergine losses and 44 percent of chicken losses.

Because of their perishability, most high-value agricultural products require careful handling; special facilities (packhouses, cold storage, and refrigerated transport); and rapid delivery to consumers to maintain quality and reduce physical and nutritional losses. In order to satisfy demand from customers and adhere to quality standards, products have to undergo a number of processes, including precooling, pack line operations, ripening, degreening, and labeling. A well-equipped and hygienically maintained infrastructural asset base is a pivotal element of the chain. Assets include storage and handling capacity, transportation equipment and related facilities, processing machinery, and financial capital (Reardon and others 2009). Recent studies of agricultural food value chains and market infrastructure in several countries reveal significant investment in all of these areas in rapidly transforming food systems (Reardon 2007; Tschirley, Reardon, and others 2015).

The goal of the exercise was to maximize the benefits generated by the corridor by improving the endowment of markets with logistic and market facilities, market feeder roads connecting the market with the corridor, and the market access road within the catchment area of the market. The approach seeks to optimize investments under a given budget in order to maximize impact. Because of data limitations, which are common in rural areas, the approach was made as simple as possible.

ENHANCING LOCAL CONNECTIVITY: A CASE STUDY

Jessore district is located in the southwestern region of Bangladesh. It borders India to the west and other districts in Bangladesh to the north, east, and south. It is predominantly an agricultural district, producing primarily cereals and vegetables.

The district produces various agricultural products all year round, making all-weather connectivity imperative. Trade with India is mainly through the Benapole land customs station, Bangladesh's largest land border crossing point with India. The border post sits at one end of a major corridor that leads to Dhaka and other important economic centers in Bangladesh as well as the northeast states of India. Jessore is also a major junction on Bangladesh's railway network, with links to the Indian network in the west and the rest of the broad gauge-based network of Bangladesh to the east. Jessore district was selected for the case study because it is an agricultural economy with a major corridor that is about to be developed, a network of rural markets, and a dense network of rural feeder roads.

The analysis identified the improvements needed to enhance the performance of and grow specific value chains. The requirements for modern supply chains differ for each product. Significant potential may exist to increase the marketing of traditional products, for example. As estimates of the increase cannot be made without local knowledge, stakeholder participation is crucial. Investments in logistic facilities can be identified only through discussions with local and regional stakeholders, such as market committees, local and regional councils, government officials, and possible private investors.

The methodology for the analysis included three stages: identifying the set of interconnected markets in the district; classifying the road network, especially the rural road network; and identifying a package of interconnected roads and markets that determine the spatial extent of the corridor hinterland. Each stage is described below; annex 4.A outlines the data needed for the analysis.

Identifying a market cluster

The first step in designing the package is to select the markets that should be part of the assessment procedure. Only assembly markets are relevant for this analysis; other markets are excluded, because they either serve only local demand (rural primary markets, retail markets) or supply large towns with agricultural goods (wholesale markets, supermarkets).

The catchment area of a market is needed to identify market access roads and the number of inhabitants potentially affected by the market. The markets of interest in the district are identified using the principles of the Christaller model. The flat plane assumption of Christaller is relaxed and markets are identified by their spatial distribution patterns and later the existence of connecting road links. The catchment area and population of a market may be defined as follows:

$$cam = \frac{3}{2} * dm^2 * \tan(30°)$$

$$in = \sum_{1}^{n} cam_n * pd_n$$

where

cam_n = catchment area of market n
dm = average distance between neighboring markets
in_n = number of inhabitants in market n
pd_n = population density of ward where market n is located.

The distance between neighboring markets, dm, can be derived empirically from GIS data by calculating the average distance to the neighboring assembly market.

Two official data sets provided information on the locations and sizes of rural markets in Jessore district. Between them, they provide information on the name and class, location, and lease values of the markets. The lease values are the rental fees charged by the local authorities to users of the markets. The values evolve to reflect the intensity of use of each market. They are used as a proxy for the size of each market. Based on the data sets, the markets within the corridor were extracted, given unique market identifiers, and used for the analysis.

Based on annual lease values (a proxy for turnover), 38 markets were identified as having large enough turnover for inclusion in the analysis (table 4.2 presents the top 10 markets). The markets included in the analysis account for more than 95 percent of total lease values of all markets in Jessore. One market (Market 51) accounts for almost two-thirds of the turnover of all markets within the corridor buffer. It is an important hub for the district's trade with Dhaka; as it is located near the border with India, it also has potential for trade with India. Markets 64, 70, and 67 have lease values of about Tk 3 million each. Because of their high turnover, these four markets were categorized as Tier 1 markets and the rural hubs for trade in Jessore. The next-largest markets have annual turnover of about Tk 1 million each. They are categorized as Tier 2 markets.

Tier 3+ markets are the starting point for this analysis. However, the starting level in each case depends on the peculiarities of the supply chains that are most dominant. On the first mile, which provides access to these markets, goods are typically transported by IMT or head loading. Although the first mile is an essential part of the network, accounting for a large share of

TABLE 4.2 Lease values of large markets within 10 kilometers of corridor

MARKET ID NUMBER	LEASE VALUE (THOUSAND TK)	SHARE OF LEASE VALUE OF THE 38 MARKETS IDENTIFIED (PERCENT)	CUMULATIVE SHARE (PERCENT)	TIER
51	36,893	65.8	65.8	1
64	3,178	5.7	71.5	1
70	2,925	5.2	76.7	1
67	3,333	5.9	82.6	1
69	1,442	2.6	85.2	2
82	1,689	3.0	88.2	2
48	994	1.8	90.0	2
71	1,170	2.1	92.1	2
50	974	1.7	93.8	2
81	957	1.7	95.5	2

Source: World Bank estimates based on data from the Local Government Engineering Department, Bangladesh.

transport costs, it was not taken into account, because analyzing the first mile would require the location of each household and a large number of village roads and tracks to connect to the road network.

Hub-and-spokes systems optimize the flow of goods and the use of transport infrastructure. Not every market need be connected to the main corridor; some markets can be linked to the closest larger market near the corridor, which then distributes goods to smaller markets. Consumers and vendors need not interact with larger markets; instead, they can access smaller markets, based on their needs. Some markets share access ways; investment in some routes could make more than one market accessible.

Classifying the road network

The classification of road networks is an important step in the design, financing, construction, maintenance, and management of networks. Traditional approaches emphasize the volume of traffic carried or likely to be carried by a road when determining its class. Modern approaches focus on the function of the road.

A functional approach allows the class of a road to be revised depending on patterns of spatial development in an area or region. In the case of local connectivity to regional corridors, the class of roads is as much a function of its place in the wider network of roads as it is of the market centers it connects. Recent research on economic corridors suggests that the depth of their impacts is in part defined by the density of surrounding lower-order roads. Ghani, Goswami, and Kerr (2016) find that in India the economic impact and benefits of corridor investments are concentrated within 10 kilometers of the transport corridor. For the analysis in Bangladesh, a 10-kilometer zone around the transport corridor was used to identify the roads that provide access to the corridor while at the same time connecting high-order market centers (map 4.1). The roads and markets were classified based on the criteria used by the road agencies in Bangladesh. As the function of each road is deemed most important, the local roads included both secondary and tertiary roads, as classified by the agency responsible for rural roads.

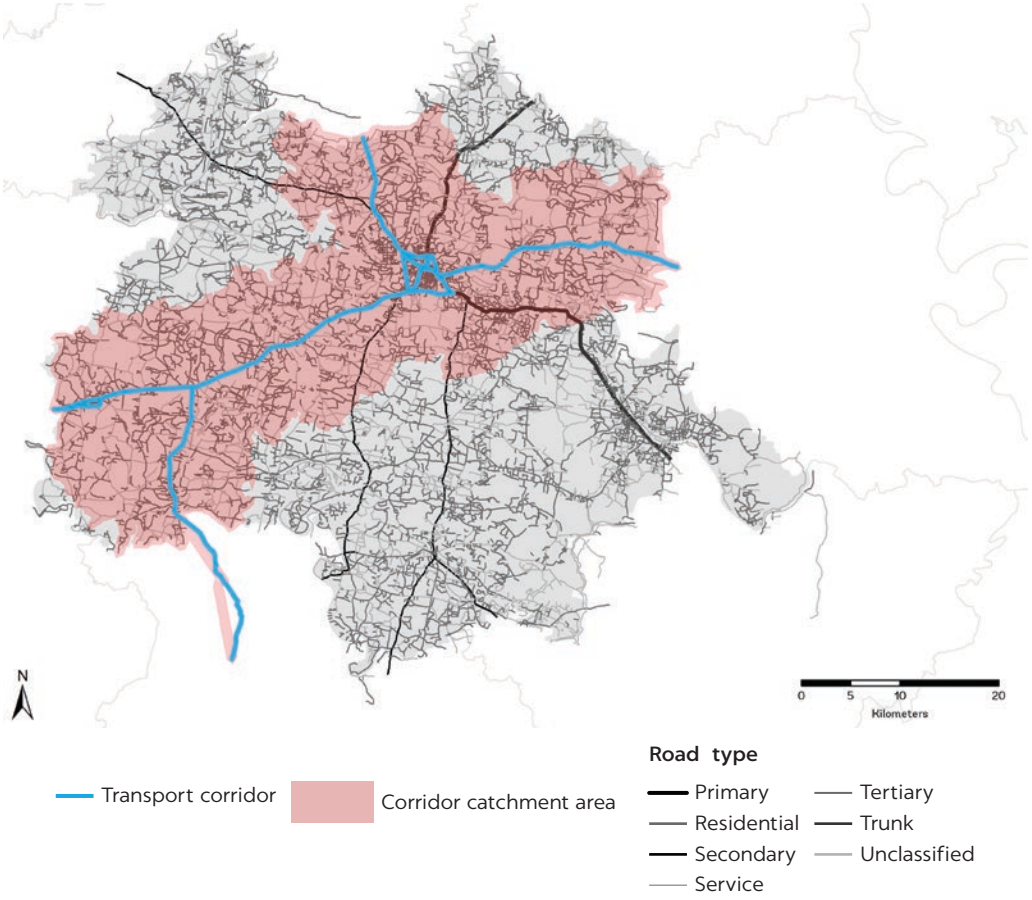
Identifying a package of interconnected markets and roads

The concept of basic accessibility (Lebo and Schelling 2001) argues for providing reliable access to as many rural residents as possible. Instead of providing high-capacity roads for a few farmers, the principle provides for low-cost access to a larger production area. All-year access is provided on low-cost roads for motor vehicles and paths and tracks that serve as IMT. Investment in nonmotorized infrastructures may reap returns on investment that are comparable to returns on traditional roads (Sieber 1996). Priority should be placed on market access roads, which connect lower-hierarchy markets to major markets. The first mile, which connects the farmstead with the local market, should also be taken into account. Costs can be particularly high over the first mile, as there are limited opportunities to scale up volumes.

A network analysis was performed to evaluate the spatial relationship between Tier 1 and Tier 2 markets. Each Tier 2 market was assigned to a Tier 1 market based on the shortest travel time within the network. Map 4.2 shows the

MAP 4.1

Main transport corridors passing through Jessore district and 10-kilometer impact area



Source: World Bank.

Tier 1 and Tier 2 markets in Jessore district, the shortest routes between them, and the first two layers of the hub-and-spoke system. The location of the Tier 1 and 2 markets along the existing corridor may explain their high turnover values.

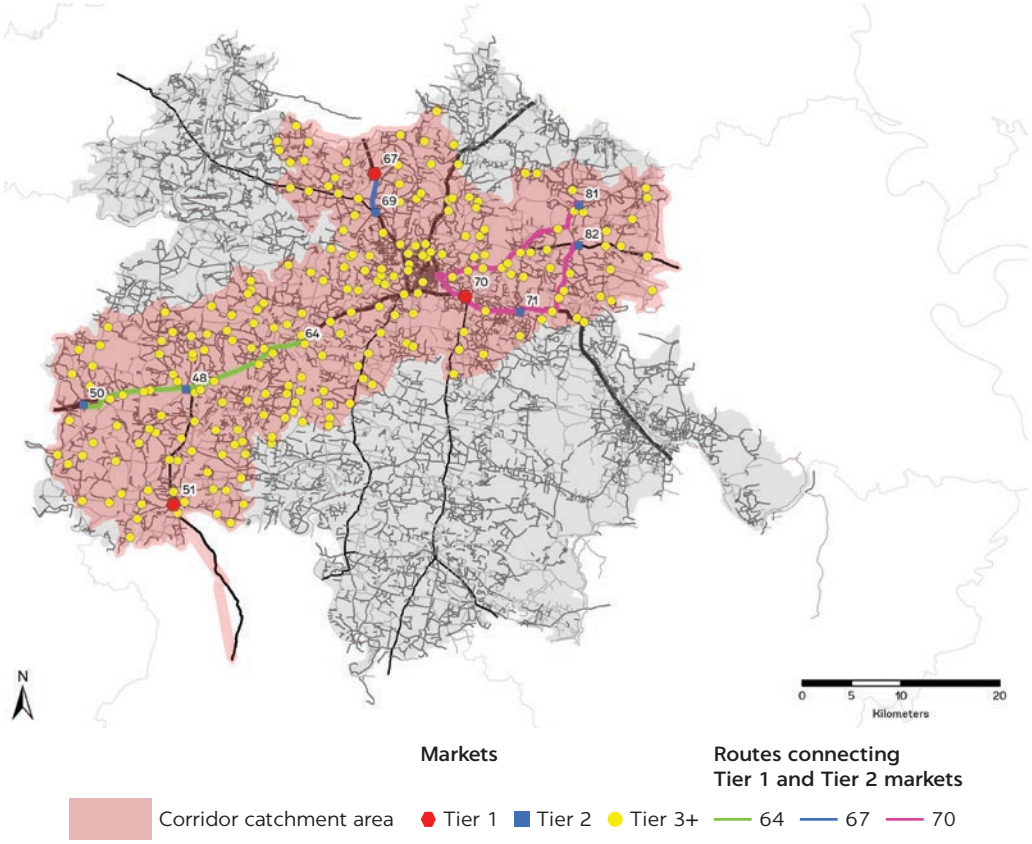
For road improvements, the following principles should be considered:

1. Improve only roads within the catchment area of small markets.
2. Minimize distance. As all-year accessibility is critical for marketing agricultural products, elasticity to travel time tends to be low, which means that some farmers may take large detours when roads are not passable.
3. Adopt a low-cost approach. Instead of improving a few roads to a high standard, perform spot improvement on a larger number of paths, tracks, trails, and roads that allow for year-round passability.
4. Consider widening or upgrading of roads only when warranted by traffic and the need to deploy larger vehicles.

Estimates of the impact of rural roads are subject to much uncertainty. It is particularly difficult to predict how agricultural output will change or traffic levels develop. Where benefits can be monetized, planners can adopt a producer

MAP 4.2

Location of Tier 1, Tier 2, and Tier 3+ markets in Jessore district



Source: World Bank.

surplus approach (Carnemark, Biderman, and Bovet 1976), which assumes an increase in agricultural production.

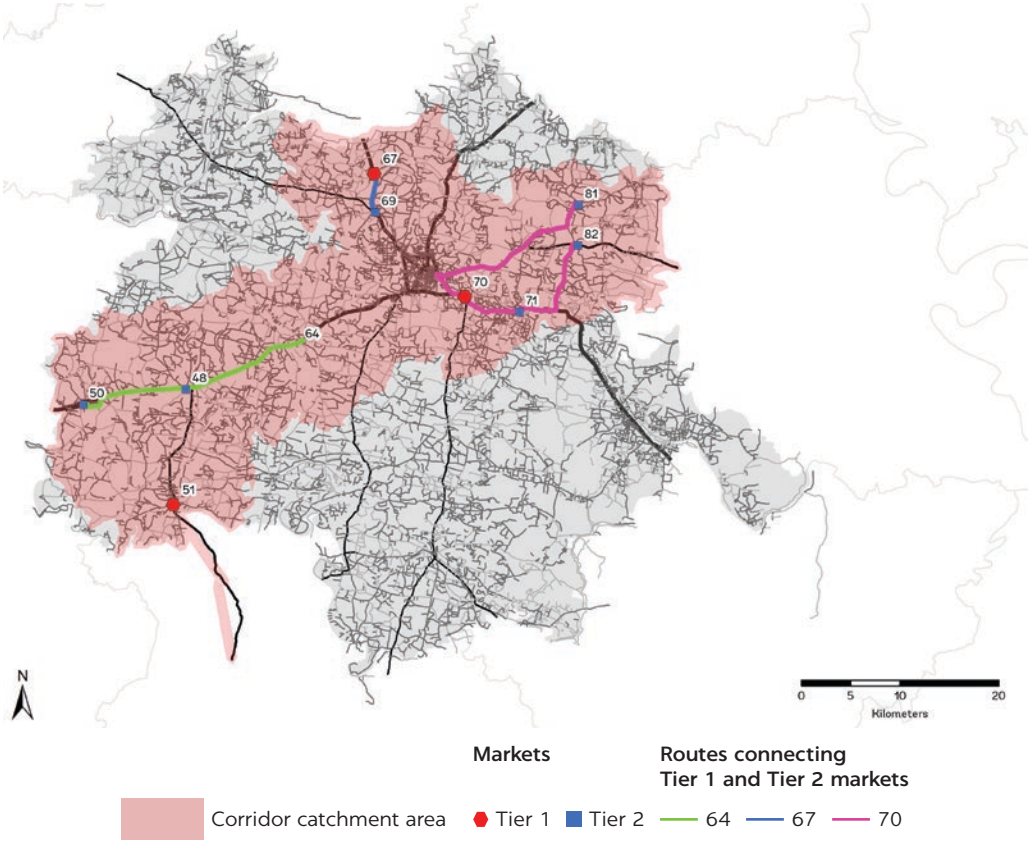
When benefits cannot easily be quantified in monetary terms, as in the case of roads with very low volumes, cost-effectiveness should be used (see Liu 2000; Lebo and Schelling 2001). The easiest approach is to compare the cost per inhabitant within the catchment area of the market, where the costs of improving a package of markets and roads is the sum of the costs of investing in and maintaining markets and feeder and access roads. Consequently, and consistent with the functional approach described above, the selection of roads to be included in a package has to be based on a participatory and iterative process involving local stakeholders, especially farmers and traders.

The selection of the investment packages is determined by the project's budget for market and rural road improvements. The costs of the ranked investment packages are cumulated until the budget is reached. The clusters that would have the most impact included Tier 1 and Tier 2 markets (map 4.3). All other markets (Tier 3 and beyond) either had very low turnover values or no data were available on them. These markets benefit from the network effects of connecting to a higher-order center.

All routes in the Jessore district were identified in terms of their relationship with the four Tier 1 hubs, resulting in four hub-and-spokes subsystems (map 4.4). The potential catchment area of each cluster of markets was then obtained, with each point assigned to the nearest market.

MAP 4.3

Shortest routes between Tier 1 and Tier 2 markets in Jessore district



Source: World Bank.

The length of the roads that connect small markets with the hubs was calculated within the newly generated catchment areas of the clusters (table 4.3).

SUMMARY AND CONCLUDING REMARKS

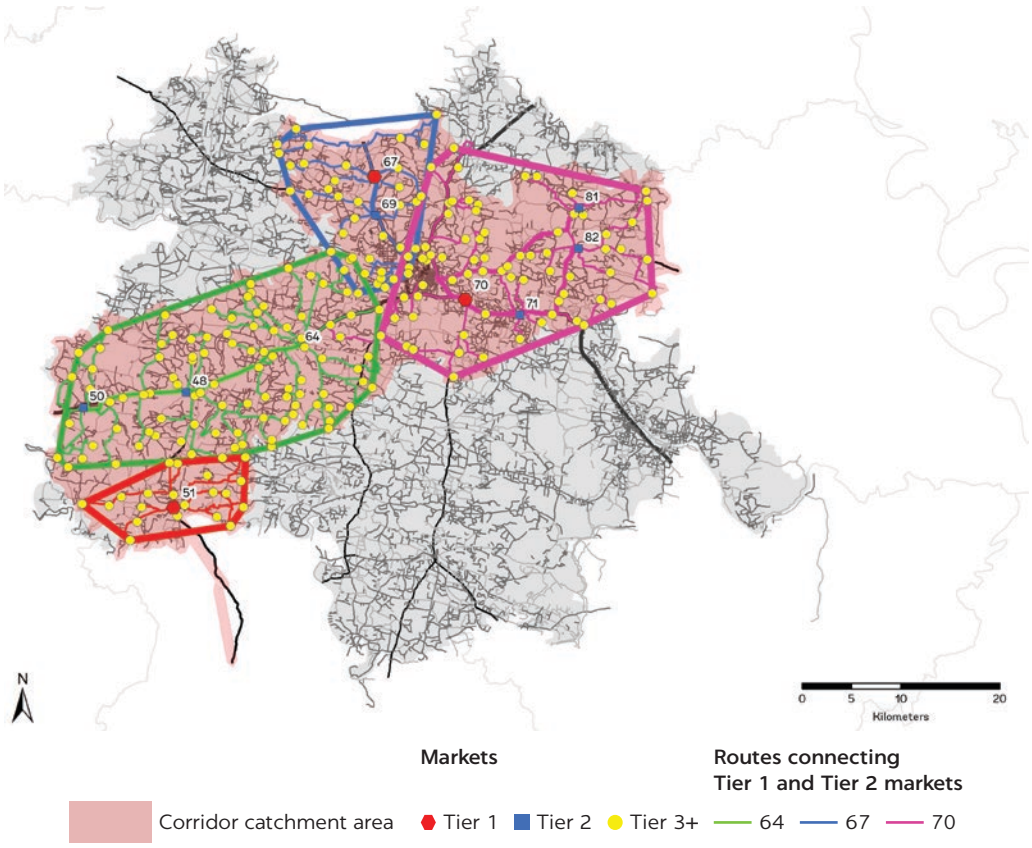
Corridors are high-capacity systems that are most efficient when they facilitate the unimpeded movement of large volumes of traffic. Large-scale investments in trade corridors are especially important for long-distance access to major markets. A development challenge is that most rural producers, including in territories through which corridors pass, generate small and irregular volumes of marketable produce. There is a need to consolidate these traffic volumes, so that producers can benefit from the economies of scale that corridors offer.

In general, although a corridor may enhance access, doing so often does not imply that economic impacts spread automatically and equally across a region. Additional investments in rural roads and markets are needed to maximize the local benefits of corridor improvements.

Investments in rural transport have been proven to be critical to accessibility to markets. Many studies confirm that rural roads spur market-led local development, via agricultural marketing and increased income from farming. The effect of improved access can be enhanced by investing in facilities such as markets. By enhancing opportunities to sell produce, the development of markets

MAP 4.4

Clusters of markets and shortest routes between Tier 3+ and Tier 1 and 2 markets in the catchment area of the corridor in Jessore district



Source: World Bank.

TABLE 4.3 Lengths of target roads to improve market access in Jessore district

TARGET ROAD	CLUSTER NUMBER			
Road type	70	51	67	64
Primary	27.3	4.5	0	5.3
Residential	29.4	13.5	26.6	52.2
Secondary	13.4	0	8.6	2.0
Service	0	0	0	0.7
Tertiary	29.9	13.8	2.4	18.9
Trunk	53.9	0	15.2	60.6
Unclassified	81.4	23.8	51.6	152.9
Total	235.2	55.6	104.2	292.7

Source: World Bank.

stimulates agricultural production, especially for smallholder farmers, who are highly dependent on local markets to sell their produce. In order to participate in marketable chains, farmers need to transport their products over the "first mile" (from the field or homestead to the next small market) and from there to a major hub. They do so over market access roads—the roads, paths, and tracks within the catchment area needed to reach the market.

Many developing countries pursue investments in regional corridors, feeder roads, and markets separately. While often this may be effective if not convenient from a project design and implementation perspective, it can result in suboptimal outcomes.

Using an empirical approach, the chapter lays out a methodology that can be adopted to identify a package of roads and markets that could leverage investments in regional corridors in order to extend the scale effects of a corridor into surrounding rural regions. The approach, based on a case study of a district in Bangladesh, shows that it is possible to identify clusters of rural markets and their connecting transport infrastructure that would expand the zone of influence of a corridor into predominantly rural areas. The approach solves two simultaneous equations, one that describes a corridor as a limited access system with only a few points of entry and another that describes numerous small-scale producers whose traffic has to be consolidated in order to reach faraway markets with minimal product losses.

The approach has three steps. The first is to identify a cluster of rural markets that are co-dependent, either as origins of shipments or as assembly markets where shipments from small facilities are consolidated. The second step involves classifying the links that make up the connecting transports system depending on the volume of traffic that they carry. The third step integrates the results of the first two steps, in order to identify a package of markets and roads that maximizes returns for rural producers within a budget constraint for infrastructure. The solution provides the minimum set of markets, in hierarchy and length of roads, needed to integrate the cluster.

Improving local connectivity to corridors is important to strengthen the economies of lagging regions and reduce economic inequalities. As South Asian countries invest in large-scale corridors for regional integration, it is important that they pay special attention to local connectivity, which is particularly important in a region that is still predominantly rural and based on agriculture.

ANNEX 4.A: DATA REQUIREMENTS FOR IMPLEMENTING THE ANALYTICAL MODEL

TABLE 4A.1 Data requirements for implementing the analytical model

DATA	DESCRIPTION
Administration	
Administrative units	Shape files of administrative units
	Area of units
Population	
Inhabitants	Number of people within administrative units
Markets	
Location	Coordinates or shapefiles
Function	Rural primary market, assembly market, wholesale market
Turnover	Annual turnover or lease value

table continues on next page

TABLE 4A.1, *continued*

Facilities	Availability and condition of following facilities:
	Cooling house
	Deep freezer
	Warehouse
	Packaging facilities
	Processing facilities
	Sanitary facilities: Water supply, tanks, toilets
	Social facilities: Training room, women's corner
	Transport facilities: Parking, bus, loading and unloading facilities
	Technical facilities: Electricity, Internet, telecommunication, mill
	Multistory building
Roads	
Location	Shape files
Road type	National, regional, etc.
Design	Road design of section according to design standard
Length	Length of road section
Surface	Surface of road section
Road condition	Very good, good, average, bad, very bad or International Roughness Index
Speed	Average speed on road section
Traffic volume	Past and present annual average daily traffic
Design standards	National standards for width, maximum speed, traffic volumes
Investment costs	
Market facilities	Investment costs for market facilities (as given above)
	Annual maintenance costs
Road works	Regular maintenance costs per kilometer
	Periodic maintenance costs per kilometer
	Rehabilitation costs per kilometer
Road improvement	Costs per kilometer of upgrading to next design standard
	Standard costs per kilometer of upgrading from earth to sealed
	Costs per kilometer of widening of road

Source: World Bank.

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