

Competing with Logistics Clusters

Vignettes from the International Experience

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Foreword

Logistics clusters boost logistics efficiency. The coronavirus disease 2019 (COVID-19) pandemic brought about a common global threat of historic proportions and yielded critical lessons as to the importance of supply chain resilience—from essential medical supplies to consumer goods—in responding to such a challenge. Today the world increasingly recognizes the value of adaptive infrastructure and service delivery platforms, often collaborative in nature, to face the “certainty of uncertain situations” at all levels of the value chain.

Logistics clusters are at the core of positioning transportation and logistics as a driver of productivity gains, environmental sustainability, resilience, and economic growth. At least this has been the experience of North America, Western Europe, and high-income Asian economies such as the Republic of Korea, where clusters facilitate cargo consolidation, increase capacity utilization, reduce inventory requirements, and promote multimodality, among other benefits.

Yet, outside of a select few upper middle-income, export-oriented countries well embedded in international value chains, such as China or Mexico, much of the developing world does not yet participate in these benefits, or does not do so at scale. This economic development gap, already critical before the pandemic and even more urgent now, can be addressed through better-informed policy making at the confluence of infrastructure provision, service delivery, and digitalization.

This report contributes to informing decision making, particularly in low- and middle-income countries, to deploy logistics clusters to underpin international and domestic commerce, employment growth, and investment. It provides a practical, action-oriented source of examples relying on the case study approach.

Particularly important is the report’s role as a tool to inform decision making to position logistics not as a source of environmental externalities to avoid, but as an indispensable contributor to the decarbonization and resilience plans increasingly adopted in the context of the Paris Agreement or as a matter of basic economic development.

This report discusses the impact as well as the limitations, lessons learned from, and pitfalls of the logistics cluster experience in North America, Western Europe, and the Republic of Korea. Policymakers—whether at the national or subnational level—looking for ways to facilitate modal shift to lower-carbon modes, make their trucking industries more efficient, help firms optimize inventory holdings, better connect importers and exporters with global markets, and/or expand investment opportunities in logistics will find examples here of possible ways to approach these challenges.

I am encouraged by the opportunity to “build back better” in the post-pandemic new normal. The global supply chain has been remarkably resilient during the COVID-19 crisis, but uneven outcomes call for strengthening the adaptability of logistics systems especially in low- and middle-income countries. I believe logistics clusters will facilitate this transition in the face of disruption, from climate change to global pandemics. This report thus comes at a highly opportune time.

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Executive Summary

The deployment and operation of high-volume, multimodally connected logistics clusters often enables logistics efficiency, driving productivity increases and economic growth. Logistics clusters are places where various kinds of logistics activities are co-located. Co-location unlocks several dimensions of logistics efficiency via service specialization, supply-demand matching, sharing of equipment and infrastructure assets across multiple users, multimodality, freight consolidation and deconsolidation, facilitation of backhauls, public-private partnerships, and collaboration between service providers and beneficial cargo owners. Most of the world's logistics top-performing countries, as measured by the World Bank's Logistics Performance Index (LPI) standard, have deployed logistics clusters as anchor nodes in their logistics systems.

The international experience with logistics cluster development is largely confined to high-income and a select few upper-middle income countries. In much of the rest of the world several questions regarding logistics cluster development remain underexplored, posing both challenges and opportunities for policymakers, industry practitioners, and investors. These questions include: What should be the role of government in the planning, investment, execution, and regulation cycle of logistics cluster development? How many logistics clusters should a country have or can justify, and how should one go about determining this in practice? How do logistics clusters promote desirable outcomes such as low-carbon logistics, lower logistics costs, and more resilient supply chains? More fundamentally, what does the term "logistics cluster" mean in different contexts; is there a consensus on these definitions, and does consensus matter? This report seeks to provide answers to these questions, with the objective of helping policymakers, particularly in middle-income countries, tailor their planning, decision making, and institutional practices to support the development of logistics clusters as a way to compete in the global economy. The report does this by presenting and drawing lessons from three vignettes of international experience through the case study approach: the case of North America, as represented by the United States; the case of the European Union, as represented by the Netherlands and Germany; and the case of East Asia, as represented by the Republic of Korea (referred to as "Korea" throughout the remainder of this report) .

The experience of the United States, the Netherlands, Germany, and Korea confirms there can be multiple approaches to facilitating logistics through clusters. In the case of the United States, logistics cluster development unfolded organically based on market and demand-side considerations, with lead role participation of private sector entities, in particular real estate development companies, and almost always through some form of public-private partnership arrangement with local, state, and/or national government participation (often all three) to make the projects viable. The European experience is also market-led, but with a more gradual historical transition from greater incidence of central planning and with a strong tradition, preserved to this day, of collaboration between public sector, private sector, and

academia. The Korean experience, in contrast, shows a more prominent participation of the state through national and subnational planning, goal setting, performance management, supply-demand monitoring, and network design, among other key functions, while still placing emphasis on demand-driven development as a safeguard from unnecessary, unjustified, or wasteful investment.

The North American, Dutch, German, and Korean experiences with logistics clusters, while unique to each context, share certain fundamental principles across countries. First, all cases rely, albeit to varying degrees and in specific ways, on strong public sector institutions from the national down to the local level. These public institutions see connectivity and logistics from the wider lens of economic, social, and environmental management, and use clusters to achieve policy goals beyond the facilitation of freight activity alone, such as land use goals (for example, reducing land use conflicts), public safety and mobility goals (such as reducing heavy vehicle traffic in high-density areas and other forms of road congestion), job creation, and a more even spatial economic development. Second, logistics policy and decision making in these countries emphasizes agglomeration—the generation of economies of scale, scope, density, and frequency—by pursuing a necessarily limited number of high-volume nodes that can naturally develop as clusters. This is in contrast to approaches that have been less successful in the international experience, where terms like “logistics center” or “logistics park” or indeed “logistics cluster” are used loosely, leading to a proliferation of would-be logistics service co-location facilities without formal recognition as such, thereby often resulting in these facilities lacking multimodal connectivity or well-placed location, preventing agglomeration and value creation.

This report draws several lessons from the international experience on logistics cluster development relevant for developing countries embarking on this agenda:

- A limited number of “integrated” logistics centers (ILCs) should form the core of a national logistics clusters strategy. ILCs are defined as clusters of logistics activity well-connected to and integrated with (1) a high-capacity multimodal transport network; (2) one or more cargo terminals or gateways (such as a maritime port); and (3) a freight generation hinterland. Meeting these conditions facilitates multimodality and freight generation-attraction potential. Since these conditions can only be met in limited cases, the number of ILCs a country can justify and sustain is, by the nature of economies of agglomeration, limited, although no predefined way exists to determine this, nor necessarily does an “optimal” number of logistics clusters that a given economy might justify. This is in part because demand for logistics services is dynamic and therefore clustered logistics capacity should adjust to demand changes over time, not necessarily through the development of greenfield locations by, for example, deploying modular growth approaches. This also implies that logistics clusters are typically a fixture of leading rather than lagging regions in terms of freight generation, to enable economies of agglomeration. Specialized private sector participation, such as in the North American experience, may lead to early cluster development in

seemingly lagging regions, based on a deep understanding of future long-term land use and economic patterns.

- Standardization of equipment, information and communication technologies, and cost-effective operations are necessary to support infrastructure provision to allow logistics clusters to ultimately deliver on outcomes such as market uptake, multimodality and modal shift, environmental efficiency, and logistics costs savings.
- The value creation potential of a demand-driven logistics cluster tends to be, all else being equal, proportional to the extent and breadth of activity co-location at the cluster; that is, the availability of a wider set of logistics services, from customs clearance to asset- and non-asset-based multimodal transportation and logistics service provision, to equipment handling and repair, to value-added warehousing and free zone areas at a given location deepens the economic impact of the cluster and leads to stronger logistics outcomes.
- The role of government in the planning and development of logistics clusters tends to be larger and more mission-critical in denser regions, where land is scarcer and the general public may be more exposed to the negative externalities associated with the transportation and handling of freight, such as the emission of greenhouse gases and local pollutants, noise pollution, road accidents, and road congestion. This in part explains the relatively more prominent participation of the public sector in European logistics clusters, and the primary planning role the government of Korea has played in the development of Korean logistics clusters, compared to the North American experience.
- It is in principle possible to plan a network of logistics clusters at the national level—as the Korean experience shows. The centralized, more predictable nature of this approach, in contrast with the more fragmented, private sector-led approach of North America, with the European experience falling somewhere in-between, allowed the government of Korea to pursue complementary policy actions that resulted in a reinforcing set of outcomes: Identification of demand for logistics infrastructure led to the development of logistics facilities, which improved national logistics competitiveness, which led to trade growth, which ultimately led to economic development, thus generating greater demand for logistics infrastructure. This is the kind of “virtuous circle” logistics clusters can support, but this is also a process that plays out over time—in the case of Korea over a period of the past two-plus decades, since the early 1990s. Whether this planned approach is feasible in countries of different profile as Korea, such as large, continental countries, remains a question for further research. Nevertheless, international experience shows that irrespective of economic geography or other context-specific characteristics, some level of overarching (national, for instance) planning can help coordinate efforts at more geographically granular levels of decision making, to support goals such as standardization, national cohesion, international integration, corridor development, and interregional connectivity.

- Perhaps the most formidable challenge facing the global logistics clusters industry at present, across the income spectrum, is adapting to the digital technology revolution under way. On the one hand, the co-location of logistics activity in clusters facilitates learning and technology transfer across firms, which should support the technology transition. On the other hand, the proliferation of digital supply chains with lower levels of inventory, through optimization, could redefine the role of logistics clusters by making physical co-location less critical to the economic and financial sustainability of supply chains. The balance of these trends may have implications as to what “agglomeration” means in logistics and what drives value. Government agencies will need to adapt policies to this changing context.

1. Logistics Clusters: Motivation and Context

The geographic- and place-specific clustering of logistics activities with multimodal connectivity to and from one or more freight-generating hinterlands yields multiple economic benefits and is therefore a desirable policy outcome. Logistics clusters rest on the principle of activity co-location: the agglomeration of multiple shippers, transport and logistics service providers (whether on an own-account or for-hire basis, and when for-hire, whether on a common-user or dedicated basis), terminal operators, and ancillary service providers, at a place that has ready and generally uncongested access to the network of multiple (typically at least two) transport modes. Activity co-location generates value¹ through economies of scale, scope, density, and frequency, and it both incentivizes and enables the sharing of resources among cluster members.

The economic impact of logistics clusters has long been observed in the (mostly) high-income countries generally recognized as the world's most logistics-efficient nations. As a result, logistics clusters, as a resource, have long been championed by countries with performance in logistics. For example, by the standard of the World Bank's Logistics Performance Index (LPI), 29 of the 30 most logistics-efficient countries in the world are high-income economies, and substantially all are known to have deployed logistics clusters, either as nodes or as part of broader networks. Most of these countries are European Union (EU) member states. As illustrated in figure 1.1, the European experience has led to the operation of logistics clusters either linked to metropolitan areas, or deployed along well-defined transport corridors—or both—a sign of market maturity that seeks to balance cost leadership (with storage centralization) with service leadership and rapid customer response (with storage decentralization). China, as the only country in the LPI's top-30 not a high-income nation, is already a global leader in maritime clusters and inland waterway logistics. Currently, China is conducting rail freight modernization initiatives as the development of its vast high-speed rail (passenger) network has release conventional rail lines for more efficient transportation of cargo. In addition, China has adopted national and subnational plans to develop large-scale, modern, multimodally connected inland logistics clusters. To date, most of China's operationally proven logistics clusters are located along its eastern seaboard. The development of logistics clusters in the western provinces is seen as a policy lever to promote a more balanced economic geography across the country.

The LPI top-30 countries outside of the EU are home to some of the most important production and consumption markets in intercontinental supply chains. This includes, above all, the United States, where long lengths of haul, along with a highly efficient rail intermodal and asset- and non-asset-based trucking network underpin the development of some of the world's largest and most diversified, best-connected logistics clusters, including CenterPoint Intermodal Centers Elwood-Joliet, in the Chicago area (largest inland logistics hub of North America), and AllianceTexas, in the vicinity of Dallas. The list also includes Singapore (largest maritime transshipment hub

port in the world), the United Arab Emirates (UAE), operator of a major regional transshipment hub port, and Korea, which has operated a centrally planned network of logistics clusters connected to ports and multimodal transport as a key component of its national development strategy.

Figure 1.1. Main European Logistics Clusters



Source: Lu and Savy 2012.

A direct relationship connects the efficient operation of node- and network-based logistics clusters with logistics performance. This relationship has not gone unnoticed in the developing world, and has led to heightened interest, particularly on the part of middle-income countries, in pursuing interventions that can facilitate logistics clusters as a matter of economic strategy. Meanwhile, low-income countries have the opportunity to learn from the experience of high- and middle-income countries and pursue “early interventions” in logistics clusters, to facilitate a

transition to integrated logistics service delivery as the value density of the commodities moved in these countries increases.

Yet, the practice of planning for and implementing a logistics clusters strategy in middle-income countries remains incipient, insufficiently understood, and with a mixed track record of execution in most cases. Outside of select cases in some of the largest middle- and high-income countries across Latin America, limited development of modern logistics clusters takes place in middle-income countries (figure 1.2). The same is true even in some high-income environments. This signals a need for a base of evidence to help countries create and execute reform and planning pathways that lead to successful facilitation of logistics clusters where operationally warranted.

Figure 1.2. Major Global Logistics Clusters with Modern Logistics Stock, 2015



Source: <https://www.prologis.com/news-research/global-insights/evolution-logistics-real-estate-clusters>

Logistics clusters lack a unified definition; providing clarity on this issue should be a major, if basic, focus of any effort to contribute to the sectoral policy dialogue. From a policymaking point of view, a logistics cluster ultimately refers to the physical organization of logistics activities where co-location of—and collaboration among—complementary activities creates value. But not all clusters are “created equal.” A key distinction between manifestations of logistics clusters is the extent of this activity co-location (“agglomeration”) along the dimensions of multimodal transport infrastructure access, logistics service delivery, ancillary service delivery, and the availability of human and technical (for example, information technology) resources. It can be argued that the agglomeration of (typically containerized) logistics activities where the extent of activity co-location is *substantial and comprehensive* rather than limited is desirable. Then again, not all economies, nor all contexts within a given economy, can necessarily sustain large-scale, integrated logistics clusters that provide substantial activity co-location, and in those instances less comprehensive

agglomeration is warranted. A practical, illustrated discussion of this nuance can elevate the policy-making dialogue associated with logistics clusters.

At their most granular level, logistics clusters manifest the concept of *location logistics*. While this issue has been explored in highly technical (such as supply chain optimization) literature, it is seldom addressed in policy documents. Location logistics is as much about logistics and supply chain management practice as it is about real estate practice, land use planning, land use-transport planning integration, and land use administration: the performance of logistics clusters hinges upon location, land use, long-term land valuation, urban and regional planning, land development, and landlord-tenant relationship management (such as, critically, the ability of a landlord to attract *anchor tenants* to the cluster).

This report intends to shed light on the international experience with the development of logistics clusters in support of increased competitions in global and regional markets. It will do so through the case study approach, by exploring the experience of Western Europe, North America, and Korea—three successful examples—indeed, powerhouses—in the logistics clusters space. The development experience of Korea, complemented by selected vignettes from the international experience in high-income countries, will be used to illustrate points and derive policy implications. The report will also offer answers to a set of guiding questions that could inform policy making in a practical, applied manner, yet are nuanced enough to illustrate both the pitfalls and value-creating power of logistics cluster development.

The report draws on several research methods. The work has been informed by structured face-to-face and remote interviews with practitioners, such as operators of logistics clusters and end-users of these clusters; extensive review of the literature on logistics clusters; historical analysis of the evolution of logistics clusters over time in the report's chosen case studies; the deep, first-hand familiarity of the Korea Transport Institute (KOTI) with Korea's experience; and the World Bank's international experience capturing common challenges and policy issues facing countries looking to develop a network of logistics clusters as part of their logistics strategies.

Policymakers in developing countries, particularly middle-income countries constitute the report's main audience, who can benefit from lessons from what other countries have done to improve logistics performance through logistics clusters. The Korean experience may be particularly illustrative, given Korea's relatively recent transition from middle-income to high-income nation.

The structure of the report is as follows: An opening chapter presents definitional and conceptual issues related to logistics clusters. The report will then present, in turn, the case studies of the Netherlands, Germany, the United States, and Korea. Lessons will be drawn from these cases in separate chapters. Lastly, the report will propose a list of policy questions, derived from the World Bank's cross-country

experience, and attempt to answer them based on the evidence presented in the preceding chapters.

Note

1. For the purposes of this report, the term “value” denotes both *enterprise value* at the firm level—typically measured by such metrics as return on capital employed, and *economic value* at the local, regional, national, and even global level—typically measured by such metrics as economic internal rate of return.

Reference

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2. Definitional and Conceptual Framework

Introduction

The logistics and supply chain management literature, as well as practice, offer no uniformity as to the terminology used to define and describe “logistics clusters” or “integrated logistics clusters.” The term “logistics cluster” is often described and characterized in broad terms, setting aside, for example, the question of what are, if any, the geographical or functional boundaries of logistics clusters. Many other numerous terms seemingly synonymous to “cluster” describe the co-location of logistics activities, including “center,” “zone,” “park,” “platform,” “hub,” or “campus.” All, however, could in practice have slightly different meanings depending on context (see table 2.1). Further, terms such as “dry port” and “freight village” are used for zones in which logistics services are clustered, but possibly have slightly different functionalities than in logistics clusters or its abovementioned varieties.

Table 2.1. Select Examples of Concepts Used to Categorize and Define Logistics Clusters

Logistics Clusters through Diverse Perspectives		
	Global	
		Starts from the concept that a cluster is any region with a high concentration of logistics activities relative to the total population or economy. Classification approaches include, but are not limited to, modal orientation, scope, or functionality.
	Maritime	
		Uses a categorization useful in understanding how seaports and hinterland nodes interact, with satellites supporting seaport functions; load centers serving as container feeder points; and distribution centers working to (de)consolidate container loads.
	Hinterland traffic	
		Introduces terms linked to hinterland traffic and the relationship between transshipment facilities and/or nodes.
	Regional development	
		Introduces the perspective of regions rather than that of global trade. The definition excludes logistics activities on general purpose industrial zones, and requires a central management model for the benefit of the transport and logistics companies.
Other Forms of Clustering		
	Cooperation	

		Refers to logistics service providers that join forces with transport service providers aiming to create, among other things, risk sharing joint ventures.
	Structure of the supply chain	
		Extends the concept of cooperation clusters to take advantage of scale economies even if the facility operates in isolation. For instance, this category extends the definition of logistics clusters to include XXL warehouses settled on isolated sites optimized for sourcing and distribution to the markets they serve.
	Sectoral or institutional	
		Includes cooperation and common ground between organizations active in and supportive to logistics services, such as institutes for education, research, development, and the promotion of innovation.

Source: Original table produced for this publication.

The absence of a single widely held set of definitions results from a broad heterogeneity as to, for example:

- The functions included in the cluster. Logistics services clearly include more than transport and transshipment services alone, but should repair of containers be included? Or value-added services such as packaging, labeling or assembly?
- The boundaries most useful to the definition of the cluster. Should the cluster have clear physical boundaries, or even be fenced and gated? Should the cluster be placed under an umbrella organization responsible for management and marketing?

This chapter will assess the categorization of clusters of logistics services more prominent in current academic, policy, and sectoral dialogue. The intention is not to resolve this complexity by arriving at what should be considered a consensus or most accurate or best terminology. Rather, the goal is to exemplify the concepts used, highlight their rationale, and clarify why these distinctions matter. For example, definitions of the abovementioned terms could be incorporated into national legislation or government plans, to make them more transparent and to strengthen accountability. Similarly, the development of clusters and the promotion of investment in logistics clusters could benefit from a comparison of several terms to better describe what the facilities in question will do and thus what kind of financial and economic value they could generate.

Defining Logistics Clusters through Diverse Perspectives

The exploration of recent literature on this subject shows attempts at defining logistics clusters have been approached in various ways, including:

- Seeking for an all-encompassing understanding, from global perspective;
- Understanding clustering from the perspective of maritime shipping; and

- Understanding clustering from the perspective of regional or local development.

Global perspective

Sheffi (2012) defines a logistics cluster as a region with a high concentration of logistics activities relative to the total population or economy. Sheffi observes logistics clusters vary markedly in size. The geographically-bordered cluster formed by the Plataforma Logística de Zaragoza (PLAZA) in Zaragoza, Spain is presented as example, but so are diffuse regions, such as the corridor along the Panama Canal, the Dutch Logistics Corridor, the Southern California cluster around Los Angeles/Long Beach, and Singapore, home to the city-state maritime port, airport, and ancillary service subclusters.

In Sheffi's view, logistics clusters can be amorphous, with no clear borders and no central management. Logistics parks, then, are defined by their ownership and geographic property boundaries, developed by an agency such as a real estate investment trust, private companies, port or airport authority, or government agency. Logistics campuses are a special type of logistics park, where not only the land and buildings are operated by a single entity, but the same entity handles all logistics and distribution activity in the park. An example is United Parcel Service (UPS) logistics cluster in Louisville, Kentucky, that also houses many other customers for which UPS manages supply chain operations. Logistics clusters often contain more than one park as well as a range of other logistics-related facilities.

Sheffi observes various ways of categorizing clusters, while rarely producing mutually exclusive definitions. Possible classification approaches can be based on modal orientation, scope, or functionality.

Modal Orientation

Categories in **modal orientation** include, for example:

- **Air logistics parks**, such as Memphis Airport; Alliance Airport in Fort Worth, Texas; Hong Kong International Airport; Schiphol Airport in the Netherlands; Frankfurt Main Airport; Incheon Airport in Korea; and Changi Airport in Singapore.
- **Port logistics parks**, such as Rotterdam in The Netherlands; Elizabeth, New Jersey; Los Angeles-Long Beach area; Singapore Port; and Dubai Maritime City.
- **Rail logistics parks**, such as BNSF Logistics Park-Chicago and the Union Pacific (UP) Logistics Park in Dallas. These parks are built around large intermodal facilities.
- **Pure trucking logistics hubs**, which usually serve urban areas or supplement industrial clusters dominated by various industries. Freestanding trucking parks typically serve a short radius of approximately 100 miles.

Generally, the modal orientation also implies a service orientation attractive to certain companies. Air logistics parks tend to attract companies dealing with time-sensitive, high-value items, while port logistics parks attract enterprises dealing with the large volumes moved by maritime transport. These air, port, and rail logistics parks also serve as transshipment points between nodes in global supply chains, such as ports serving to move freight between ships and rail and/or trucks.

Scope-Based Categorization

The **scope-based categorization** distinguishes between geographical scales:

- **International**, such as most maritime port- and airport-based logistics parks. Other parks, for example, inland ports, can also serve as distribution hubs for international shipments.
- **Regional**, for handling regional distribution needs, such as PLAZA, the Zaragoza Logistics Park serving the Iberian Peninsula and southwest France, or the Greater Richmond Logistics cluster in Virginia, serving the East Coast distribution needs of its tenants.
- **Urban** distribution parks, typically set up outside large urban areas to manage the pickup and delivery of goods in and out of the urban area. Urban parks are adjacent to many major cities, such as New York, or, on a much smaller scale, Lyon Logistics. By transloading in these centers, truck movements into the traffic congested urban areas can be reduced. Many cities in Europe have regulated access for cargo and restricted servicing to time windows and/or to the use with smaller vehicles. Distribution centers offer cross-docking and some warehousing capacity for that purpose. These centers are typically serviced by road only. Some cities have initiatives in place to create rail-bound connection with other urban agglomerations.

Functional Classification

A **classification along functional** lines produces, for example, types of customs and taxation-advantaged places, including:

- **Foreign-trade zones** (also referred to as free-trade zones, free zones, or similar terms), which have special customs procedures and are often co-located with gateways such as maritime ports and airports. Items that are imported and then re-exported through such locations are not subject to duty.
- **Bonded logistics parks**, which include a subset of warehouses and storage facilities where imported goods can be stored without duties paid until released into the host country. Many logistics parks, typically those near ports and airports, have a bonded warehousing area within the park.

- **Export processing zones**, which are specific areas or sometimes “virtual zones” that provide a set of export subsidies offered by the government to exporting industries.

Other examples include single-commodity logistics parks that focus on particular commodities, such as food, electronics, and chemicals, in support of a corresponding industry cluster and special services logistics parks specializing in cold-storage and distribution or in bulk commodities such as grains, chemicals, liquids, or hazardous materials.

Maritime shipping

Rodrigue (2020) and Notteboom, Pallis, and Rodrigue (2022) introduce the following terms for transport nodes in maritime shipping:

- **Gateway** is the interface between maritime and inland transport (that is, the seaport).
- **Satellite terminal** refers to a facility located at a peripheral and less-congested site that often performs activities too space-consuming and costly for the maritime terminal.
- **Load center** is the inland intermodal terminal servicing a regional market and is the origin or destination region of the containers. Often, these facilities are near centers of economic activity, where cargo is consolidated.
- **Transfer hub** is an inland hub where containers are transshipped between rail services and/or barge services. The rationale for this type of node is to enable optimization of operations by creating a hub-and-spoke system, which is only realistic for long-distance haulage in the hinterland.
- **Distribution center** performs an array of value-added functions to the freight, with transmodal operations dominantly supported by trucking. It can concern transloading between containers and trucks, cross-docking (transloading and sorting) and warehousing, which includes storage.

This categorization is particularly useful to understand how seaports and hinterland nodes interact, with satellites supporting seaport functions (for example, services related to handlings and storage of containers), load centers as feeder points of containers, and distribution centers for (de)consolidation of container loads.

Practice shows that a distinction between these types of inland nodes is not readily evident because nodes typically develop into having more roles. The prime objective of a satellite terminal is relieving the congested seaport terminal, but being devised as such also means container stocks are well available in the terminal and good connections exist with the seaport, such as through frequent intermodal transport services. That makes a satellite terminal attractive as a basis for transport and logistics operators in the hinterland, which provides development opportunities. In a similar way, the load centers have the prime objective of serving as the cargo consolidation

point in the hinterland. They are closer to clients of the maritime shipping services and the volume of traffic attracts shipping lines and seaport operators looking to develop these into container storage points and use container related services. This decentralization will further increase the base load for multimodal transport services, which can become more frequent.

Together, the gateway, satellite terminals, and load centers can be considered the backbone of the container transport services as well as container logistics. Having this backbone creates good potential for developing a wide range of logistics services around them and therefore develops terminals in the hinterland from container transport nodes into clusters of logistics services, which is also what has become common practice.

Separate from the categorization, transfer hubs have become an exceptional node. Europe has numerous trimodal terminals connecting rail, inland waterway, and road systems; however, they are rarely used as hubs for transfer between rail and rail or rail and inland waterways. In practice, the key feature of trimodality for clients is that users have competing routing options (barge and rail) for transport between the inland terminal and the seaport. Few intermodal rail operators have set up a hub-and-spoke network in Europe, striving for wide geographical coverage of their intermodal service network; consequently, the hub-and-spoke strategy has been abandoned. In Europe (and possibly North America) hub functions might still be provided by marshaling yards in which wagon sets are rearranged.

Hinterland traffic

Other sources in the discussion of clusters in hinterland traffic produce the following terms:

- **Inland container terminal** and **intermodal terminal**, which are two terms used for the transshipment facility between road and rail or between road and inland waterways. This definition could also include the space for storage and container related services, but does not include any other logistics services.
- **Inland port**, which describes an inland node connected by rail with a seaport. The term inland port in Europe is used for transshipment nodes for inland waterways. In both definitions the inland port could also accommodate other transport and logistics services.
- **Dry port** has been used to indicate any sort of inland facility from plain inland container terminal to a more assorted platform of logistics services. The term is commonly applied to facilities in middle- and low-income countries, less so in the European Union and North America. As part of a wider effort to promote a network of dry ports in the Asia and Pacific region for efficient exchange of cargo, the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) produced a regional framework for the development, design, planning, and operation of dry ports (UNESCAP 2018). This work finds that dry

ports in this network would need to satisfy basic requirements, summarized as follows:

- Have infrastructure and equipment for the handling, consolidation, storage, and modal transfer of containers and other types of unitized cargo
 - Have the authority, capability and facilities for all border clearance of cargo
 - Be located within, or close to, concentrations of industry generating export and import trade, but can be located remotely from seaports
 - Be connected to railways for long-haul transport from seaports, or indeed from other dry ports, and to roads of adequate quality for local pickup and delivery of cargo
-
- The term **extended gate** is used by the terminal operator Hutchinson Port Holdings, owner of Rotterdam-based ECT, for its (own and third-party) inland container terminals in the Netherlands, Germany, and Belgium, which are connected with ECT's terminal complex in the Port of Rotterdam. The operator connects this network of terminals by scheduled frequent rail and barge services, where the inland terminals act as "extended gates" of the deep-sea terminals. An essential element to the extended gate concept, bundling of container flows on main hinterland corridors into services with a limited number of inland terminals, simplifies the processes in the seaport terminal, enables fast transfer, and avoids stacking. The terminal operator can optimize its flows of containers, full and empty, and maintain high levels of asset utilization. Customs handlings is also moved from the seaport to the inland terminal. Next to streamlining its operations, the concept also improves customer service level because the position of the containers, import and export, are closer to the client base.
 - The **extended gateway**, introduced by VIL (Flanders Institute for Logistics) in Belgium, has a wider societal scope. The essence of this concept, clustering of logistics activities and bundling of cargo flows, must serve the interests of the business community as well as of the society as a whole. It creates conditions for reducing logistics costs and improving logistics service quality, which in turn make the hinterland consistently attractive to other industrial activities. The bundling also promotes more sustainable, multimodal transport solutions and controls the impacts of spatial development. The concept has become the basis for the development strategy of the Port of Antwerp and its Belgian hinterland.

These other terms are consistent with the classification advocated by Rodrigue and Notteboom (2020). Dry ports, extended gates, and extended gateways emphasize the integration of other services next to the transport network features only, particularly the provision of customs services. The extended gateway not only shifts these functions, but also ambitiously develops a balanced and integrated logistics system, supporting maritime trade and maximizing synergies with other development prospects in the port hinterland.

Regional development

Other initiatives give rise to the perspective of regions rather than global trade.

As listed on its website, the European association Europlatforms, well known in Europe, defines a **transport and logistics center (TLC)** as a “center in a defined area within which all activities relating to the transport, logistics and distribution of goods, both for national and international transit, are carried out by various operators on a commercial basis” (<https://europlatforms.eu/Logistic%20CenterDefinition.html>). Some of its key characteristics are specified as follows:

- “It must comply with European standards and quality performance to provide the framework for commercial and sustainable transport solutions.
- It is important that it is managed in a single and neutral legal body (preferably by a public-private-partnership), in order to ensure synergy and commercial cooperation.
- It must allow access to all companies involved in the activities set out above. (This includes railway and barge transport services.)
- The operators can either be owners or tenants of buildings and facilities.
- It must provide the required facilities, equipment and services to the users, as well as public services for the staff.
- It should preferably be served by a multiplicity of transport modes (road, rail, sea, inland waterways, air)” (Europlatforms 2017).

The definition excludes logistics activities on general purpose industrial zones, and it requires a central management model for the benefit of the transport and logistics companies. It must have capacity and ambition to generate synergies and promote improvement and modernization of the transport and logistics sector. Further, it must improve connectivity of the region and promote the use of intermodal services.

A transport and logistics center is referred to as *interporti* in Italy and *Güterverkehrszentren* (GVZs or freight villages) in Germany. In the definition of freight villages (or FVs) by German law, the types of envisaged tenants in the GVZs are specified as transport companies, logistics service providers, ancillary service facilities, and logistics-intensive industrial and trading enterprises.

The entities have stated objectives to promote intermodal transport. The intermodal connections they provide for long-haul transport typically are railway connections—in Europe, attempts for services dedicated to unitized continental cargo transport on inland waterways so far have not succeeded. A majority of the logistics centers in this category are exclusively for continental traffic; others also connect with seaports for maritime containers.

Because they offer land in a zone with clear geographical boundaries, the logistics centers of Europlatforms can be considered logistics parks, according to Sheffi's definition.

The European Union and its member states also promote initiatives from a regional perspective. They cofund projects that stimulate massification of cargo flows to make multimodal transport solutions feasible, and increasingly focuses on identifying common benefits of transport users and on collaboration models. Examples include Clusters 2.0 and Lean and Green projects, which try to bring pairs or small groups of regions and companies together for cooperation. The funding of these initiatives must be seen in the light of policies of stimulating multimodal transport in order to reduce the social burden of the transport system, including different types of environmental pollution, traffic unsafety, and costs of congestion.

Other Forms of Clustering

All abovementioned typologies have intentional geographical components of clustering of logistics services. This section provides examples of clustering by cooperation between companies and clustering by structuring the supply chain.

Clustering by cooperation

An example of clustering by cooperation is the UIRR, the International Union for Road-Rail Combined Transport in Europe. Since the 1970s, European logistics service providers have been joining forces with railway companies in so-called UIRR-companies, which are risk-sharing joint ventures where railway companies retain a minority share. Today, the UIRR includes approximately 35 companies, of which some are terminal operator only. They provide intermodal transport services for unitized continental cargoes in swap bodies and semitrailers between a network of terminals. The difference between the previously mentioned Europlatforms and UIRR terminals is that UIRR terminals are not necessarily surrounded by land reserved for logistics services, even though the logistics service providers, also shareholders, likely have assets—such as warehouses or a transport company—nearby. In addition, operations typically run between densely populated regions, which little open space around terminals. Clustering happens through consolidating road cargoes into full train cargoes, resulting in a more efficient long haul. While the intermodal transport services are open for use to third parties, the shareholders typically provide substantial base loads. Terminals can be owned by the joint ventures or by railways.

Clustering by structuring the supply chain

Originally, UIRR focused on continental cargo, and today, UIRR-companies claim the larger share in continental intermodal cargo, with their business model common in this traffic. Similar joint ventures between logistics company and railway companies not associated with UIRR also exist. Typical terminal layouts and the equipment differ between maritime and continental cargo flows; for example, in contrast to container terminals in maritime chains, continental cargo terminals need only limited space for storage of loading units. Many of the larger terminals have adapted in order to be capable of handling both maritime and continental cargoes. The boundary between

UIRR and Europlatforms initiatives is quite fluid, with UIRR-shareholders making use of Europlatforms facilities and UIRR services open for third parties.

Logistics services providers and cargo owners have such scale that operating in isolation provides sufficient efficiencies and quality. An increasing number of so-called XXL-warehouses have settled typically on isolated sites, often near highway crossings, and are thus served by road only. These locations are optimized for their sourcing and distribution to the markets they serve, for example, distribution for one country or a group of countries. An oft-cited explanation is the increase of e-commerce for consumer goods, which have boosted parcel services with tight delivery windows.

Such isolated large warehouses could still fit in Sheffi's widest definition of logistics clusters if they are, for example, included in a logistics corridor. Their success could fairly be attributed to the benefits of the quality of transport infrastructure rather than to other common characteristics of that logistics cluster.

Sectoral or institutional clustering

The term **logistics cluster** is also commonly used to indicate cooperation and common ground between organizations active in and supportive to logistics services, such as institutes for education, research, and development, along with the promotion of innovation, associations, or other bodies for promoting logistics sectors. The interactions of these organizations with the range of companies involved in the provision and use of logistics services, and the presence of a strong logistics sector—located in clusters or not—is vital to the organizations' ability to contribute to logistics companies. Such ties, however, do not necessarily require geographical proximity.

Why Does a Distinction Between Typologies of Logistics Clusters Matter?

The distinction between types of logistics clusters is not just for observation and registration, but is also important for explaining the development of clusters and forecasting opportunities. The objectives of each type of logistics clusters differ, in the markets and cargo movements they serve, and therefore also differ in the types of stakeholders they likely engage.

The typology of logistics clusters is important in:

1. *Recognizing and defining certain technical characteristics.* For example, clusters for the maritime shipping sector need facilities for container storage, while clusters for air freight need cross-docking facilities, and bonded zones, dry ports, and extended gates need fencing and customs facilities. The scale of operations also defines the size of these facilities.
2. *Defining transport connections.* These connections are preferably large-scale and frequent in port hinterland services; for urban distribution centers connections

are designed for timely entry and exit of urban areas and highly diffused inbound traffic.

3. *Understanding the type, extent, and distribution of the benefits of the logistics cluster.* The rationale of urban distribution centers and FVs is, mainly, to decrease negative impacts of local traffic by reducing and channeling local road transport. However, the impacts are mainly social and efficiency gains to the cargo distributors could be low. A regional hub such as Logistics Platform Zaragoza (PLAZA) in Spain, provides much employment, both direct and indirect. A satellite terminal is space intensive and will not deliver much direct employment, but will improve efficiency and effectiveness of the maritime cargo flows, while its connecting multimodal services save externalities compared to road use.
4. *Identifying stakeholders, potential users, tenants, and potential investors.* The actors involved in logistics clusters vary between the different cluster types. In addition, the level of engagement (user, settler, or developer) will depend on the functionality. Understanding the position of the cluster and its facilities from the user's context is important.
5. *Understanding, in relation to all the above, key success factors and minimum conditions.* Decisions in the design process must always consider the needs. Failure to fulfill vital requirements could result in potential users losing interest.
6. *Understanding, on the basis of these insights, the opportunities and the (distribution of) risks.* Where profitability is likely, the private sector will be interested in initiative and land ownership. Public authorities could accommodate this and, if there are considerable social objectives in play, they could include extra requirements in the permitting process. Depending on the foreseen (distribution of) benefits, public authorities could instead decide on developing the clusters themselves and lease plots for logistics services in a landlord model, decide on tendering concessions, or find other forms of public-private partnership in the development. Understanding these possibilities and risks will help identify the best financing model for each cluster.

The literature and practice suggest no typology is fully “MECE”—that is, mutually exclusive and collectively exhaustive. Characteristics of a specific cluster tend to correspond and overlap with multiple types. Clusters and their environments also develop in an organic way and functionality can change, for example, if certain industries in the region or in connected seaports grow or decline, or if other clusters emerge.

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3. Logistics Clusters in the European Union

Logistics and Multimodality in the European Union

The European Union's economy in brief

From 1993 onward, goods have moved freely between the European Union (EU and its member states, and since the EU has gradually deepened its internal economic ties by also allowing free movement of services, labor, and capital and by introducing single currency (the Euro) in a number of states. The European economy is diverse with respect to production and income. Many refer to the “blue banana,” which is a visualization of a string of regions with highest economic activity, located in the more densely populated and economically active central parts of the EU, covering the London region, the Netherlands, Belgium, Germany, Austria, Switzerland, and northern Italy. These economic centers also function as attraction poles with good transport connections and well-developed logistics services.

EU-level policy framework versus those of individual member states

Decision making over the development of infrastructure networks and of promoting economic development resides with EU's member states. The transport infrastructure in Europe is—grossly—under public ownership, either national or lower levels, and each EU member state follows its own investment and development strategies.

The European Commission (EC)—acting on behalf of its member states and under democratic control of the European Parliament—has a coordinating role and promotes connectivity between member states. Its key instrument is cofunding of investment in the so-called Trans-European network for transport through the Connecting Europe Facility. In order to promote the functioning of the common market, the EC also has defined common technical standards (such as for vehicle dimensions) and standards for access to the market (licenses) and access to the profession in the sector (diplomas and certificates, for example). This has contributed to seamless access to foreign markets and interoperability between the national transport systems, which all have their own development history.

Transport markets in the EU were liberalized in the final decades of the 20th century. Until the 1990s, the national railways in most European member states functioned as monopolies responsible for infrastructure and operations. Reform separated these into infrastructure management companies (generally still government owned) and railway operating companies, which then competed in an open common market for railway operations. The railway freight market attracted new players and the incumbent railway undertakings expanded their operations across national borders. The international inland waterway transport market on the largest and busiest

European river arteries, the Rhine and Danube corridors, had already been open for more than a century. Under pressure by the adoption of Europe's single market for services in 1993, the road transport and domestic waterway transport markets also expanded, while abandoning, for instance, quota systems in international transport and regulations on prices.

The promotion of the logistics sector in the EU

The EU considers freight transport and logistics as a driver of competitiveness for its member countries and the union, and has published the Freight Transport Logistics Action Plan (COM(2007) 607) outlining short- to medium-term measures. The policy initiatives in the action plan must improve the efficiency and sustainability of freight transport.

The list includes removing physical bottlenecks in transport infrastructure; however, the plan does not specifically address the development of major nodal points in the transport and logistics system or any other spatial clustering of logistics services.

Most actions of this plan are soft measures, many in the field of transport facilitation for simplifying administrative requirements in particular. The so-called "e-freight" package must improve the use of information and make freight flows "paper-free," for example, via single windows for one stop-shopping for all administrative needs and single transport documents for accompanying all carriage of goods, irrespective of mode. Further topics include the deployment of intelligent transport systems for better management of infrastructure and transport operations, common regulation on weights and dimension of vehicles, and all sorts of interoperability standards that enhance common markets.

For improving quality of logistics services, the EU, in dialogue with stakeholders, has drawn up minimum qualifications and training requirements for jobs in the sector and provides regulation for mutual recognition of certificates and diplomas between member states.

The action plan also seeks to promote "green transport corridors," which are integrated routes combining short sea journeys, rail, road, and inland waterways, and supports knowledge sharing in urban freight solutions. The plan proposes to support sector developments by monitoring on the basis of a core set of performance indicators and, for example, benchmark performance of intermodal terminals and use the information for promoting best practices.

Multimodality in the EU

The network of intermodal services serves two principal types of trade: the intercontinental seaborne trade in which standard maritime containers are the common load unit and the "continental" intraEuropean trade, which uses semitrailers, swap bodies, or continental containers as load units. These markets are

rather distinguished segments in practice, with not only different technicalities, but also different players. Rail carriers operate in both segments, in about equal volumes, while inland barges provide only hinterland services for maritime containers.

Multimodality is well developed within the core region of the EU (“blue banana”) and in connection with this core regions. A 2015 inventory learned that the Germany–Italy corridor is by far the densest in railborne combined transport. The biggest market exists between these two countries, but traffic with neighboring countries (Belgium, the Netherlands, Sweden, Czech Republic) is quite substantial as is domestic traffic within Germany as well as traffic with Austria and Switzerland, which are inside this corridor.

An increasing number of rail services established in hinterland traffic of medium-sized seaports, with throughputs roughly between 1 and 5 million twenty-foot equivalent units (TEUs), though often with modest frequencies and market shares. To be viable, multimodal services require substantial volumes, and as result, these services are sparsely provided in peripheral regions.

The maximum train length in most of EU (including the most used corridors) is up to 750 meters, but can be as low as 450 meters on some stretches. A 700-meter train corresponds with a 100 TEU capacity. The EU does not allow double stacking. A change of these parameters would involve many investments for safe operation, to a great extent due to the intense use of the network, the mixed use with passenger trains, and most corridors passing through urbanized regions.

The densest network of inland waterway terminals is in Netherlands and Belgium, all connected to Rotterdam and Antwerp. Barge traffic between these ports and terminals along the Rhine river and tributaries, mainly in Germany, is also important. Typical capacity of barges on the Middle Rhine and Rhine Delta is between 200 and 350 TEUs. Container traffic also exists in connection with seaports in France (Le Havre, Marseille) and Germany (Hamburg, Bremen), though in smaller volumes because of waterway infrastructure constraints (from Marseille), and because of lower transport demand.

Multimodality and logistics clusters in the European Union

Logistics services follow demand, and therefore are more present in the more prosperous regions than in peripheral regions. The sector of logistics services providers has expanded significantly in the past three decades due to increases of global and intraEuropean trade, of contracting out, and a shift to more customized production cycles. The trends of contracting out and customization provided opportunity for logistics service providers to engage in “value-added services” as well, for example, packaging, labeling, or assembly. Logistics companies typically used to have assets (such as warehouses and transport means) located in the vicinity of production sites or of consumer markets, for imports and distribution, but their changing role has changed preferences to locations with high quality transport

infrastructure well-connected to a sourced and traded network, often on the global scale, next to requirements such as available labor force and real estate prices.

Another trend has been for logistics service providers to serve larger regions. So-called European, regional, or national distribution centers are set up for multinational companies, providing access to segments of the European market. These centers distribute finished goods to retail outlets and their distribution points.

The abovementioned trends favor integration of logistics service provision around nodes with the multimodal transport network, and therefore are market driven drivers toward logistics clustering. The clusters improve connectivity in all respects: transport efficiency, flexibility, reliability, and sustainability. These benefits derive from shifting modes (from road to multimodal transport), from benefits in the “first-mile” or “last-mile,” and benefits of available third services, such as warehouse space and local transport services for exchanging or combining of cargoes.

The Netherlands: Logistics Corridors and Hotspots

The Netherlands has a long history in the transport and logistics market in Europe, playing an important role in international trade and in transit. The Port of Rotterdam is Europe’s largest seaport complex in bulk as well as in container transport, while Schiphol Airport is one of Europe’s largest hubs in air cargo. The Netherlands has consistently ranked in the top 10 of the World Bank’s Logistics Performance Index (LPI), even though the country is small (approximately 42,000 square kilometers), densely populated (17.2 million inhabitants) and its gross domestic product (GDP) was €774 billion in 2018.

Multimodal transport in the Netherlands

As Europe’s busiest seaport, with a throughput of 14.5 million TEUs in 2018 divided over several terminals, the Port of Rotterdam lies in the center of the Dutch multimodal transport network. The Maasvlakte II, the port’s most recent major extension, added capacity for realizing its growth potential and is accessible to the largest container vessels. The port serves as a gateway to the European hinterland as well as a transshipment port, connecting intercontinental and feeder services by sea. Other Dutch seaports (Amsterdam and Zeeland Seaports) also have significant, though more regionally focused, container traffic. All Dutch seaports are located within the delta of the Rhine, Europe’s busiest river.

The Belgian seaport of Antwerp, Europe’s second largest seaport with 11 million TEUs throughput in 2018, is part of the same river delta and is situated less than 100 kilometers away from Rotterdam. The connection between the Port of Antwerp and the Netherlands serves as an important part of the Dutch hinterland transport operations.

In addition, the Netherlands has a network of 39 inland terminals (KIM 2018) outside of the seaports, which includes 31 barge terminal terminals, 5 rail terminals, and 3 trimodal (rail-barge-road) terminals, which together generated an estimated total throughput of 8.2 million TEUs in 2018. The barge and trimodal terminal serve hinterland traffic, all in connection to Rotterdam and/or Antwerp. The distances covered by these barge services are short, with most terminals located within 150 kilometers of each other and some located less than 40 kilometers from the seaport.

Most barge terminals are privately owned, developed by various types of service providers in the transport and logistics sector, typically originating from local initiatives of improving their logistics services in seaborne transport. A modal shift to barge, for example, avoids road operations in the congested region and keeping a small container stock makes the operator more responsive to the needs of its client base. For a barge service to be of value it should run frequently; the rule of thumb is at least twice per week in its initial phase. This implies that steady volumes of container movements are needed for financial viability, which often is solved by seeking cooperative and/or joint ventures.

Rail represents the only multimodal continental traffic in the Netherlands and its most important gateway is Rail Service Center (RSC) Rotterdam, which also handles maritime containers. Continental load units also use nearby terminals in Belgium (in Antwerp and Genk) and Germany (in Duisburg and Cologne) and in recent years some initiatives have also developed rail terminals in the Netherlands; however, the inland rail terminals for continental cargo differ from container terminals.

Road transport is dominant in continental traffic. On short distances its share reaches nearly 100 percent. For long distance, traffic share depends on the corridor. For example, Italy is well served by frequent multimodal services between a range of terminals, while on other connections road transport dominates, even though multimodal transport, if provided, could have lower costs. Road transport has been better capable of absorbing increased demand, despite road congestion and a desirable shift to rail because of its social benefits. This trend has long been expected to change, but progress is slow. New constraints such as an increasing shortage of drivers and more recognition of the environmental component in decision making have applied additional pressures for the shift to rail in recent years.

Logistics clusters in the Netherlands

Stakeholders in the logistics sector apply the term “mainports” to the Port of Rotterdam and Schiphol Airport, because of their size and significance as gateways to the Netherlands and beyond. These mainports, as facilitators of huge volumes of international transport, also serve as landlords of the largest logistics zones in the country, for all types of supporting business and logistics service providers.

With the country's aspirations in international trade, logistics services are also well presented in the hinterland of these mainports. Sheffi (2012) suggests the Netherlands as a whole could be considered as a single logistics cluster. The definition for logistics cluster can apply to a region if a more-than-average share of the working population is active in logistics, and this regional application likely corresponds to the European and/or global context. The logistics area in the Netherlands could easily extend eastward to include Duisburg in Germany and southward to include the Belgian seaports of Antwerp and Zeebrugge, which would also increase the prominence of the logistics sector in the region. Arguments against considering the region as single logistics cluster include the lack of coherence within this logistics region. For example, all parts of the region have strong relations with the seaports of Rotterdam and Antwerp, but the internal relations, such as those between most eastern subregion and central regions, are not well established.

Two Dutch regions with a high presence of the logistics sector are located around Tilburg in the south and around Venlo in the southeast. These regions have large zones for logistics service providers and are centered around inland transshipment terminals with frequent connecting services to the seaports.

Next to these, many other Dutch regions profile themselves as logistics regions. The term "logistics hotspot" is widely used by regions and their business communities and functions as a kind of engine in promoting their logistics profile. Each year, logistics sector representatives vote to informally rank these hotspots based on judgments of many criteria, which include multimodal accessibility, available work force, available land and real estate, cooperativeness of local government in facilitating settlement, and more. However, the term "logistics hotspot" does not describe an official categorization of logistics regions and does not provide any special legal status.

In 2019, the number of participating hotspots totaled 28, which is a high number for the small size of the country, indicating the widespread growth of logistics services.

At the same time, the high number of hotspots indicates clustering of logistics services is a mainstream development and that the logistics sector and public stakeholders recognize benefits of clustering.

Several of the hotspots focus on specific user segments. The region just north of Rotterdam, for example, is profiled as a center for agrologistics, due to the high number of specialized logistics companies catering to the long-established agricultural trade and production in this region. Such bundling of interests from agricultural and logistics sectors is also done in Venlo Greenport, and a similar way of bundling is, for example, with chemical industries in the "Chemelot Park" in southeast Netherlands, often in connection with major chemical sector activities in the Ports of Antwerp, Rotterdam, and Zeeland.

A contrasting trend is also observed with the emergence of an increasing number of very large (XXL-) warehouses, stand-alone logistics buildings preferably located in spots with excellent access to highways. Many of these function as distribution centers for retailers, often for home deliveries related to online platforms. They fully depend on road transport for in- and outbound traffic. This trend displays a large segment of logistics service provision to which benefits of potential synergies of logistics clusters and of multimodal transport do not apply. A recent publication by an advisory commission on spatial quality expressed concerns about the increasing amount of these XXL warehouses, because of their harmful impact to the quality of the Dutch landscape.

The changing role of the Dutch national government in transport and logistics plans

The Dutch government subscribes to ambitions of increasing the country's attractiveness for settlement of industries and considers its excellent transport infrastructure and high quality transport and logistics sector important assets.

As owner of the main infrastructure in the country, the Dutch government takes responsibility of maintaining a good quality network, expanding where needed. An update of the MIRT (multiannual program for infrastructure, space, and transport), which prioritizes infrastructure spending, occurs annually. The MIRT is not a central planning document, but results from negotiation between national and regional governments, and therefore balances between national and regional interests.

The policy prioritizes those infrastructure investments that contribute most to the competitiveness of Dutch economy. In broadlines this means giving top priority to solving accessibility bottlenecks in the Port of Rotterdam and Schiphol Airport mainports. Further priority areas are only briefly identified on headlines, through which a level of flexibility in planning is maintained to follow market developments and interests. The latest MIRT, for example, only identifies the Dutch "brainport" (important technology cluster around Eindhoven) and "greenports," which combine agricultural and logistics development, for example in Venlo.

This flexibility and market responsiveness is effective in the Dutch context, with a mature infrastructure network with increasingly rare restructuring investments. The latest profound investments have been the completion of the railway link for freight between Rotterdam and the German border (namely, Betuwelijn), which opened in 2007, and Rotterdam Port's land reclamation project (Maasvlakte II), which became available in 2013.

This political approach to logistics node development represents a partial shift from central planning, common until the 1990s, to laying responsibilities as close as possible to the market, thus creating room for initiatives from regions and the private sector. This change has taken place gradually over the past 25 years in the Netherlands, in all economic sectors, including in spatial and infrastructure planning.

The plan for developing a hierarchical network of inland nodes and transshipment terminals provides an example of central planning. The network consisted of Rotterdam and Schiphol Airport mainports, supported by five secondary nodes with above-regional significance and tertiary nodes with regional significance. The intention was to connect these five nodes with the Port of Rotterdam by rail services, expecting that barge services would not be competitive at this distance because of long lead times. In practice, however, this hierarchy never manifested: three of the five secondary nodes had difficulties in presenting viable business cases, while the other two nodes were already active before the policies were in place. Meanwhile, in several other nodes not included in the plan, logistics business and multimodal terminals emerged and appeared successful.

The Port of Rotterdam as a policy-making pillar

Because of its magnitude in the economy and in transport, the Port of Rotterdam holds a central place in political decision making. The port is important to the Dutch economy of trading and houses large industrial complexes, for example, in (petro)chemicals. Its gateway function to Europe's overland transport network further creates multiple opportunities for adding value.

Of great importance is understanding the port is simply a node in supply chains, with a critical network of good connections (in the hinterland and overseas). Therefore, accommodating those services for which demand is manifested is only one of the port's tasks; this "landlord" role should always be viewed in the wider perspective of gaining and maintaining a position in supply chains and trade.

Important for maintaining this position, capacity should be upheld and accessibility maintained. However, a great awareness exists that these matters should not be handled within port territories only but also require efforts outside of the port's territory, and should involve all stakeholders in international transport and trade.

The policy-making objectives include bundling of container flows and the use of barge and railway for efficient transport and transshipment operations. The Dutch government has limited instruments for this policy, however, particularly since spatial planning is decentralized and with the national infrastructure network already—mostly—in place. Where needed, national infrastructure for all transport modes should be upgraded to accommodate traffic and promote efficient use. One instrument in the ambition of modal shift has been national cofunding of (relatively small-scale) infrastructure improvements, provided that national significance and modal shift potential could be demonstrated.

The role of the Port of Rotterdam in developing logistics nodes

The Port of Rotterdam's main interest in its hinterland lies in securing its position in supply chains where the port can add value. The port represents one of many potential gateways to the European continent and operates in a keenly competitive

environment. To be attractive, the port must have high quality connections with hinterland regions, meaning connections should comply with the many dimensions of quality, for example, be reliable, secure, efficient, and frequent. This is quite challenging, given the high volume of containers and other cargo passing through the port and the vastness of the hinterland, and can only be realized by using the scale advantages of rail and barge transport.

Within the port's territory actions, for example, a rationalization of the railway network changes a capillary railway system connecting to many short-train clients into a system with fewer railway terminals for shuttles of maximum train length. For containers and other load units, RSC-Rotterdam was established, later followed by terminals in the expansion areas of Maasvlakte.

In addition, barge transport has gone through a continuous process of rationalization. Sea vessels and barges often use the same quays and the principal challenge has been to find slots for inland barges, with typical call sizes of between 1 and 50 containers, in between the handling of ocean vessels, which could have call sizes of several thousands of containers.

For all transport modes, the port has cooperated by developing the port community system for information exchange and more recently, for example, in the Next Logiq initiative, where barge operators coordinate within the transport chain to arrive at more efficient and larger call sizes.

The port also promotes modal shift and bundling of cargoes outside of its territory. As part of the Dutch Logistics Cluster, the port promotes a high level of awareness of the potential benefits of cooperation (and risks of fragmentation) and, as a major stakeholder, provides technical support to all types of private and public initiatives.

The port has no ambitions to take a financial position in hinterland services or nodes and has done so only by exception and on a case-by-case basis. For example, the port invested in Alpherium, a barge terminal located 85 kilometers away. The investment and intervention process involved financial and other interests, which could not be streamlined. The terminal has been in operation since 2010 and the Port of Rotterdam now acts as landlord to the terminal operating company. Beer brewer Heineken was a major driver behind the development of the terminal, which helped to attract other major clients. A similar intervention involved development of Container Transferium in Alblasserdam (opened in 2015), located a short distance from the port, which also risked becoming deadlocked due to financial uncertainties.

All container terminal operators in the Port of Rotterdam are privately owned concession holders. The largest is ECT, part of the global container terminal operator Hutchison Ports, which has up to a 100 percent share in inland terminals in Netherlands, Germany, and Belgium, and offers connecting rail and barge services. ECT's network of inland terminals improves its attractiveness by reducing distance to

its users. Part of this strategy is the provision of European Gateway Services, including repositioning of containers between the seaport and inland terminal without additional customs handling. The objective of this strategy is similar to the port's overall strategy of securing its hinterland.

The focus of Port of Rotterdam—as well as ECT—is on developing nodes with sufficient scale for multimodal transport. To them, this multimodal dimension is key and developing of these nodes into logistics zones will have positive impact on the throughput of the terminals. The port and the seaport terminals, however, do not actively engage in further developing these inland nodes.

Logistics nodes as part of the Dutch “top corridors” approach

The current policy instrument for bundling of hinterland cargo is known as the “top corridor” approach. Two corridors, east and southeast, are the busiest freight transport axes and bring the greatest value to the Dutch economy. The corridors link the Rotterdam seaport with its German hinterland and offer substantial growth potential toward other European regions.

Program organizations have been set up for both corridors. The programs must enhance effectiveness and efficiency in decision making and funding of projects, which together must ensure high-quality corridors and promote flexible interchangeability between water, rail, and road transport modes. As defined in the EU's action plan, the pipeline of projects must be “adaptive and dynamic,” meaning they must be responsive to market developments, opportunities, and threats.

The program organizations manage and support implementation. Lean and with representation from all relevant public layers as well as from the private sector, all organizations have agreed to permanent long-term engagement and taking ownership of challenges, an idea which should, in time, increase private representation. Working on the basis of defined objectives and under supervision of a program council, each organization has set up systems for project selection and advancement as well as measuring progress on the basis of key performance indicators (KPIs).

The first (and current) action plan has the objective of strengthening a selection of six “above average” logistics nodes in these corridors and improve their connectivity and multimodality. This focus on a limited number of nodes must improve the interchangeability between transport modes, and therefore the resilience of the corridor, and is expected to lead to modal shift with improved use of available capacity throughout the transport network.

The stakeholders involved in the program emphasize the importance of reinforcing the role nodes in the Dutch landscape of logistics services, which has become increasingly fragmented in recent decades. Stakeholders accept the widespread

emergence of solitary services as given; however, they also call for more active steering toward clustering of logistics services to improve spatial quality and landscape value, use of infrastructure, agglomeration effects, and sustainability. They state this will require steering on large-scale infrastructure development and logistics zones in the vicinity of multimodal nodes and selectivity in the allocation of space for logistics and other business activities in logistics zones (Ministry of Infrastructure and Water Management 2019).

Logistics as part of the Dutch “top sector” approach

Dutch policies have identified the top sectors, and logistics is among them. Top sectors are considered vital for the national long-term growth aspirations. Top sectors receive support from the national government for initiatives designed to improve capabilities of the logistics sector, for example by promoting, engaging, and cofunding innovative actions and education.

The Dutch approach is cooperation between the private sector, government layers, and often technology and educational institutions, and in this context uses the term “logistics cluster.” In the Dutch context, the logistics cluster comprises a group of entities engaged in promoting logistics capabilities in the country, including all types of stakeholders. However, a logistics cluster does not necessarily have spatial boundaries. A key element is the cooperation between the manifold of private, public, and semipublic entities for achieving common objectives; because of this, initiatives typically include a regional dimension.

The Venlo logistics cluster

The Venlo region generates the highest logistics activities in the Netherlands, apart from the seaports and Schiphol Airport. In the center of this activity is TCT—the trimodal terminal owned by Hutchison Ports. Hutchison established its rail terminal in the 1980s and opened a nearby barge terminal in 2010, which together formed TCT.

Located near the German border, Venlo is one-hour driving distance from the densely populated and economically powerful German city of Ruhrgebiet. Because of this location, Venlo has emerged over the past several decades as an important region for transport and logistics, formerly exploiting its position as a border town and more recently leveraging its logistics capabilities and proximity to the Rotterdam and Antwerp seaports in the west and the European continent on its east.

The Municipality of Venlo developed the 240-hectare Venlo Trade Port around the TCT terminal, with an abundance of available land in high demand from the logistics sector because of Venlo’s excellent location. The logistics zone has continued to expand, with Trade Port East (22 hectares), Trade Port West (207 hectares) and Trade Port North (240 hectares).

These subsequent expansions should not be regarded as phases in a long-foreseen development or master plan, even with an awareness of the development potential. In addition, how far the “logistics cluster” stretches beyond these defined logistics zones has yet to be determined. In the logistics hotspot rankings, the logistics cluster is named Venlo-Venray, including Venray, a city 20 kilometers north of Venlo. In current marketing, an even wider territory, for example, including Boxmeer, 40 kilometers to the north, and Born’s container terminal, 50 kilometers south of Venlo, are included in the cluster. The work force commuting to the logistics companies also commutes from a wider region around Venlo, including many from a 30 kilometer radius stretching across the German border. Hence, the size and shape of the cluster is dynamic and continues to adapt to growth potential.

The trade ports tenants are the main users of the TCT multimodal terminal and benefit from the vicinity and high frequency of railway services, with four trains per day running to and from Rotterdam Port. Currently, the cluster also includes nearby terminal capacity, for container cargo connecting to the seaport and for continental cargoes connecting to other regions of Europe. From a business viewpoint, development of terminal capacity and multimodal connections still continues and has become less risky, because of the potential from the wider client base evolving around the terminals.

Advantages of the Venlo logistics cluster

The Venlo logistics cluster, comprising several subsequently developed logistics zones, accommodates different roles in transport and supply chains, including the following:

- Links transit and functions as a point of (de)consolidation for import and export cargo flows over the seaports of Rotterdam and Antwerp, primarily in relation to neighboring Nordrhein-Westfalen (NRW), the most populous and prosperous German state. One might say that, historically, going back several decades, Venlo has functioned as the main success for the regional logistics sector, well before the establishment of the European single market. Increasingly, Venlo has also assumed that role for regions beyond the NRW.
- Houses several European distribution centers for multinational companies. For inbound traffic, these centers benefit from seamless and easy access from the seaports.
- Facilitates substantial cargo flows from the region, mainly related to agricultural sector but also to, for example, electronics.
- Serves as an important connecting point. Next to the initial links with the seaport, new rail terminals have developed, providing connections to other regions of Europe. Venlo developed itself from “satellite terminal” into a “multimodal hub.”

Venlo’s factors of success are as follows:

- Central location: Approximately 30 million inhabitants live within 100 kilometers of Venlo, and a vast share of the European market can be reached, via truck travel, within a single day.
- Infrastructure, in particular the availability of multimodal connections. Venlo has the TCT and Cabooter terminals, and within a short distance a range of combined transport terminals for multimodal transport to Italy, East Europe, and Central Europe.
- Terminal location. The vicinity of the terminals within Venlo to cross-dock operations and short-term warehousing is particularly important. These operations involve frequent traffic and therefore hold significant cost savings potential if distance between terminal and cross-dock can be kept low. Several logistics service providers own or hire warehouse capacity at the terminal premises to handle part of their traffic. However, terminal vicinity decreases in importance for longer-term storage.
- Availability of a good labor force. Staff is successfully recruited from a 30-kilometer radius around Venlo, though part of the labor force is recruited in Eastern Europe as well. The perception that work force provides manual labor for handling packages is misleading. In fact, the large volume of logistics services implies significant demand for middle and higher management, information, communication, and technology (ICT) and development professionals, and support staff as well.
- Logistics services. The Venlo cluster provides a full range of logistics services, an important feature for attracting tenant logistics services providers and cargo owners. Many companies do not have the means to provide full service; instead of owning a broad range of services, they prefer the increased flexibility and responsiveness to fluctuating demand of subcontracting these services, often renting contractors space in the company warehouse. For large or risky ventures, service providers could seek cooperation, even with companies with similar service profiles. Further, certain specific supporting services are only viable with a large group of customers, which from the client perspective means these services are more likely provided in logistics clusters.
- Long-term stability. Venlo has been able to assure, from a long-term perspective, the long-term advantages, including stability and reliability of its logistics cluster. While essential to the success of any logistics cluster, this factor can be the most challenging.

In addition, the timely engagement of users in the early phases of development and design is critical to overall success of a logistics zone. For example, when designing roads to facilitate the most efficient truck movements in the logistics zone, inputs from future users should be considered. This user engagement would help avoid the problems commonly seen with road design in other communal zones, done at municipality level, which often feature roundabouts too narrow for the intense truck traffic flowing through logistics clusters.

The long-term perspective as key challenge

This long-term perspective is the key challenge of all logistics clusters; its absence is also a failure factor. Fundamental to the challenge is the trust market players place in the logistics cluster to provide a reliable and stable environment.

Tenants must be confident they will have room for expansion when needed. This requires, for example, spaces for additional plots or additional building space on existing plots, vacant warehouse space—for temporary use while expanding original warehouse—along with transport infrastructure free of congestion and/or expandable. The long-term perspective of stable, expandable logistics service provision also provides confidence to potential clients and investors.

Joint business development further contributes to stability, since engagement in developing new business improves sustainability. In Venlo, the logistics cluster liaises with the local agrobusiness cluster, which cooperates in product development and innovation as well as in market development. Contracts signed with the Port Baku in Azerbaijan, which allow Venlo Greenport (part of the trade port) to become a gateway to Central Asia for agricultural exports, provides a recent example of successful joint business development.

Maintaining a well-qualified and motivated labor force is probably the most important factor in creating stability and long-term perspective—and is an action in the continuous progress important for maintaining the attractiveness to logistics service providers. In Venlo, local education institutions are closely involved with the cluster, which actively promotes jobs and possibilities for career development in schools, contributes to developing material for training, liaises with teaching staff, provides positions for internship, and cooperates in closing gaps between education and jobs. Much attention is also given to developing skills for client relations (such as multilingual skills) and for product and process improvements. Human resources offices for logistics cluster employers also have the responsibility of stimulating and maintaining interest in the logistics-related jobs among potential employees. For example, logistics service provider Cabooter acquired a staffing organization and transformed its role from mere labor acquisition and selection into a human resource organization, which also provides career education and development. This type of career development service can involve third-party companies related to the logistics sector and holds clusterwide significance.

In the Netherlands, the number of warehouses and distribution centers has been expanding, with good availability of land and infrastructure, and with service providers benefiting from the availability of qualified labor force. However, such investment could be risky and short-lived, without also actively preserving the labor force and connection with the local community.

The local government taking ownership of logistics zones

The local level government (or governments, where municipal borders are crossed) own most of the land in Venlo Trade Port. The governments set up, own, and steer management organizations of the logistics zones. These organizations lease out plots and serves as landlord; in turn, the leasing contracts provide certainty to tenants, including for the longer term.

In a few exceptions, land ownership lies with tenants, most due to historic ownership before the logistics zones were established. Because ownership in Dutch law does not allow the owner to change how the land is used without consent, tenants are not concerned with either leasing or owning the plot of land. Whether one or the other would be more attractive depends more on financial capacity and structure rather than on business needs. Consequently, land ownership has no demonstrated significant impact on the behavior and performance of the tenant.

The land ownership of the multimodal transshipment terminals remains with the respective governmental bodies. This can be the municipality, Prorail (the national infrastructure management entity for rail), or Rijkswaterstaat (the national owner and manager of waterway infrastructure). The terminals are operated by private sector entities (Cabooter and Hutchinson) through long-term lease contracts. The terminal operator provides the investment in suprastructure (cranes and other equipment, pavements, lightning protection, and security systems, among others).

Except for structures used for public functions (such as zone management and security), all real estate erected on the land is privately owned. Ownership of warehouses lies with logistics service providers for their own use or leasing to third parties or real estate developers.

Formally, the local government initiates and leads development of the logistics zone. In practice, all developments should result from intense dialogue between local government, the business community, and social interest groups at all steps of decision making, with local governments coordinating and formalizing decisions. As defined by the national law (in which the EU legal framework is implemented), the formal procedure steps include demand analysis and cost/benefit analysis, market and public consultation, risks assessments, and environmental impact assessments—if deemed necessary after screening by the competent authority. These and related permitting procedures provide ample room for appeal where needed, and the steps should only proceed with convincing political support and expectation of successful implementation. For example, real estate developer Prologis was engaged to conduct the market assessment for the Venlo Trade Port, before launch of official procedures.

During operations, the local government could also play an active role in the marketing of the logistics cluster, which can help establish trade deals and related logistics demands as well as transport connections. For many potential business partners government-to-government (G2G) deals are more common than business-

to-business (B2B) deals, such as seen in China and other Asian countries. In these cases, ideally national representatives should participate in negotiations in order to maintain equal decision levels across both parties. This would make the Venlo logistics cluster deal-making process dependent on formal government representation. For example, the Dutch national government took a role in setting up a railway link with Xian in China. However, Venlo Trade Port is not as well equipped for this as are other ports, such as Duisport or Port of Rotterdam. The Port of Rotterdam and Venlo do cooperate in international marketing, displaying the advantages of cooperation between the port and the logistics cluster in international supply chains.

Germany: Freight Villages and Hinterland Nodes

Germany is the largest economy in Europe, with a population of 83 million and a 357,000 square kilometer surface area. In 2018, the country had a GDP of 3,344 billion, with a strong manufacturing sector and high volumes of import and export cargoes. As an important trading country, Germany's North Sea ports in Hamburg and Bremerhaven are important gateways, next to the seaports of Rotterdam and Antwerp. Together, these ports are the four busiest container terminals of Europe. The country also has important transit traffic between all these seaports and its neighboring countries to the east and south, and as exporter and importer has good connections with most of EU member states. In addition, Germany has established a strong logistics sector and is home base of many multinationals in the sector, including, DHL and Kühne + Nagel, and consistently ranks at or near the top of the World Bank's LPI benchmarking standard.

Multimodal transport in Germany

Germany, has built an extensive network of multimodal transport services and nodes for domestic as well as international transport, including connections to seaports as well as to continental transport. The more than 100 transshipment terminals for unitized cargoes outside of seaports in Germany, listed in the AGORA-terminal database, indicate the network's broad reach. This database was developed with EU funding in 2012; up-to-date numbers are not available.

The German network of railway-based multimodal transport is dense, with good geographical coverage across Germany. The rail network serves domestic, import, export and transit traffic, with the railway terminal network including numerous container terminals for hinterland cargoes and terminals for swap bodies and semitrailer transshipment for continental traffic. Germany's central position is demonstrated by the fact that a high share of Italy's import and export traffic is routed over the four abovementioned seaports, which are connected to northern Italian terminals by frequent rail services.

Traditionally, state-owned German Railways (DB) has been an important player in the development of combined transport services and of terminal development. Until the 1990s DB, as a near monopoly, had the strongest voice and created a terminal network, which compromised the interests of market demand, political objectives of connecting all regions, and its own objective to optimize railway operations. Key users were either DB subsidiaries (such as Transfracht), operators partly owned by DB (such as Intercontainer for international container traffic, co-owned by European state-owned railway companies; and UIRR-company Kombiverkehr, whose ownership was shared with logistics companies.) On the basis of reciprocity, other operators in international services were also admitted through a code-sharing cooperation.

DB's monopolistic position turned about 20 years ago, first after an EU-intervention ruling the division of the market for multimodal services violated free-market principles, and later after opening the market for railway operations. Early entrants included logistics service providers, maritime operators, and cargo owners who took stake in multimodal transport services and multimodal terminals. The current situation, a diverse landscape of railway operators and multimodal transport operators, shows incumbent DB still controls the majority of both markets.

DB also played a significant role in the early development of the GVZ (*Güterverkehrszentrum*, or freight village) network, where clusters of logistics services center around transshipment terminals. For the development of GVZ, the lower government levels handled the decision making, in cooperation with DB or other terminal operators.

In comparison, container traffic by barge represents a small market segment, however important in absolute terms, and increasingly important in the overall market. A string of container barge terminals is located along the river Rhine and its tributaries, connected by frequent services to Rotterdam and Antwerp. Planned services to connect the German seaport—the waterway links to the Rhine corridor—with Germany's economic centers, do not allow for large barges. Few large terminal operators, such as Contargo, operate both multiple terminals and the connecting barge services. The ownership of barge terminals has undergone many changes, for example, the maritime sector (ocean lines as well as seaport terminal operators) has seen a reduction in ownership of barge terminals over the past few decades. Today, several of the inland waterway transport (IWT) terminals are included in the GVZ network and have embraced the characteristic concept of clustering logistics services around them.

Logistics clusters and logistics policies in Germany

With its high presence of logistics service providers, Germany has developed a high-quality service network, leveraging the characteristics of its economy as manufacturing and trading country, the presence of densely populated regions with high purchasing power, and its central position in the European market. As in the

Netherlands, many regions of the country are classified as logistics clusters under the definition of “above average presence of the logistics sector.” For example, from north to south: the seaport regions of Hamburg, Bremen, and Wilhelmshaven; the Ruhrgebiet, the wider region around Duisburg; and the Frankfurt/Manheim area, with Germany’s main airport and the traffic-intense chemical cluster.

The federal government of Germany recognizes the importance of logistics. The federal government acts on issues holding national or international significance, to ensure interregional connectivity by providing good quality infrastructure. The government’s role also includes safeguarding of environmental concerns, and therefore encourages the use of railways and inland waterways over roads. The instruments for this modal shift policy include federal financial support for terminal development, next to prioritizing railway and inland waterway infrastructure projects. These investments will continue on the basis of viable socioeconomic business cases demonstrating national significance.

Lower-level government, such as municipalities, handle logistics services, which are therefore not under federal government’s span of influence. For example, the government’s commitment to DB’s national master plan for GVZs never moved beyond the approval of co-investment in the transshipment facilities, nor did it engage in land use schemes of surrounding areas.

Increasingly, the German federal government promotes the competitiveness of the logistics sector, which is regarded as a key asset for sustaining Germany’s strong position in the global economy. The policy package consists of soft measures such as supporting pilot innovation and research as well as improving the sector education system. The Freight Transport and Logistics Masterplan (published in 2008 and never updated), includes a measure to “establish a freight transport and logistics network,” which calls not for a physical network, but for closer coordination between the federal government and industry and trade associations in order to become more responsive to developments.

As Germany’s largest, most populous and most prosperous state, Nordrhein-Westfalen (NRW) has a strong logistics profile with a key position for Duisburg, Europe’s largest inland transport hub. The logistics sector has been of great importance to NRW in its transformation from a region dependent on industries such as steel and coal mining into a service-oriented region. The logistics sector has become one of the region’s largest employers, making the region more attractive to new types of industries.

The government of the German state of NRW emphasizes its strong points—including a central location in Europe, a dense multimodal transport infrastructure network with high quality ports, a well-equipped labor force, and a robust research and education system—and recognizes the need for reinforcing these, for example, by

creating more space for settlement of logistics services, or more transshipment facilities and infrastructure adapted to higher demands.¹

NRW calls for cooperation between all stakeholders. Investors have learned most areas in the state have potential space for logistics; however, these need to be readily available, and the NRW government can help coordinate easy access to potential development opportunities, for example by:

- Maintaining an updated information system for this purpose, which can help investors;
- Cooperating with “NRW.INVEST,” its public body for promoting investment, in monitoring the development of suitable logistics space and supporting development in close cooperation with local-level communities.
- Encouraging dialogue between the public sector and private-sector actors in logistics who have expressed interest in developing locations.

In the longer term, NRW should safeguard the vital spaces needed to facilitate logistics development, mainly by securing land near ports, as the available land will continue to shrink in this urbanized region. In addition, locations near waterways often also have high potential value for residential development. Once urban development approaches these residential sites, environmental legislation will block the development and expansion of nearby transshipment facilities and settlement of related logistics services.

For promoting the use of multimodal transport and safeguarding the social interests of optimal use of infrastructure, NRW will need to actively moderate for port land to be used for port functions, for ports with clear long-term expansion potential to provide development plans, and for municipalities to develop only those dry locations complementary to port logistics systems.

NRW will also engage in marketing and business development, via worldwide promotion and, for example, by engaging in a dialogue with seaports and inland nodes about shifting seaport functions to hinterland locations, and collaborating with its public bodies, such as NRW.INVEST as well as with international counterparts in Eastern Europe for bundling traffic flows and promoting multimodality.

The German GVZ concept

What is a GVZ?

The German concept of the GVZ, or freight village (FV) was introduced in 1985 with the Bremen GVZ. As of 2018, the network consists of approximately 34 GVZ. Some of these GVZ have been greenfield developments, but many have been developed around existing transshipment facilities or industrial terrains. In several instances, establishing a GVZ allowed local-level authorities to fundamentally restructure local

¹ <https://www.vm.nrw.de/>

goods traffic, by relocating often outdated rail cargo facilities from inner city environments to outer areas, thus avoiding related heavy goods vehicle (HGV) traffic.

German law (BMVBW A 14/26.80.00-01, 2001, art II) defines a GVZ as an industrial zone for companies to settle independently. Companies must be transport and logistics service providers, supporting logistics service provision, or manufacturing or trading companies with high logistics intensity. The GVZs must be connected to at least two different transport modes and include a terminal for load unit transshipment, which provides indiscriminatory access to its potential users. The law allows the terminal to be either inside or in the immediate vicinity of the GVZ, and the terrain could be patriated. The law advises the GVZ management entities should also promote the exploitation of synergies within the GVZs. The definition article emphasizes GVZs are only considered functional if integrated in Germany's GVZ network via connecting transport infrastructure, transport and logistics services, and information technology, for which they must cooperate with GVZs in other regions.

The GVZ network must accommodate the increasing demand for transport and logistics services and promote environmental benefits of freight traffic bundling. The locations of GVZ swill be mentioned in national transport plans and planning could be coordinated on the subnational state level, while lower public levels can initiate and develop the GVZs. In order to obtain public cofunding, the demand for logistics services and the multimodal potential must be demonstrated, along with proof of compliance with common planning frameworks. National cofunding concerns only the transshipment facility.

The German GVZ Association (DGG, a membership organization) describes GVZs as logistics centers, linking and bringing together different transport modes (road, rail), transport companies (forwarders, warehousing), supplementary transport service providers (vehicle services, consultancy services) and industrial and trading companies. DGG states GVZ philosophy is based on "spatial proximity promotes cooperation and division of labor of the enterprises on site." The benefits produced by GVZs include increased truck capacity utilization in local transport movements (such as City-Logistics). The DGG also states the GVZ "should be located near urban agglomerations and have a quick access to regional and long-distance traffic."

GVZ in historic perspective

The first GVZ, GVZ Bremen, was established in 1984 and remained the only GVZ until 1995. The Bremen GVZ was developed as a brownfield project and soon became highly successful, using 65 percent of the available land (in 1995), generating a high number of jobs, and increasing social benefits. Located near the Bremen/Bremerhaven seaport allows a large share of its tenants to operate "around containers," mainly in container packing. Increased demand from the automotive cluster (namely, Daimler) around Stuttgart, approximately 650 kilometers to the

south, was sufficient enough to establish frequent and high quality rail services. The GVZ also helped relieve pressure on Bremen's urban road infrastructure.

The Bremen GVZ served as model in the early years of GVZ development, and its cost-benefit ratio provided great optimism and fueled expectations in many regions of the country. The first master plan published by DB called for a network of 40 GVZs, which would provide extensive geographical coverage. However, the plan never received full political support because of the elevated investment costs and, with DB as promoter, investments in railway infrastructure abounded. Further criticism cited the network configuration would be driven by optimizing railway operations, and therefore DB, in a process of transforming into a for-profit organization, would shift its focus from geographical coverage to supporting large GVZs only.

Meanwhile, other regions had become increasingly interested in the concept and number of GVZ climbed, though without a commonly agreed GVZ network strategy. The federal government agreed to cofund GVZs only if the impact demonstrated a national significance. Additionally, the government cofunding covered development of the transshipment facility only.

Diversity in physical characteristics

GVZs differ greatly in design as well as in use, with no one set of blueprints for GVZ layouts. In the earliest years, planners set the minimum size of GVZs at 100 hectares, later adjusting that down to 30 hectares, before eventually abandoning minimums as the availability of free land in Germany rendered minimums unrealistic. For example, the GVZ-concept could not be established in regions such as Munich, the Rhein/Main area of Frankfurt, and Stuttgart, where available land is both limited and costly. GVZ development faced similar problems in the vicinity of major seaports. In addition, if minimum size requirements are a condition of cofunding, they could impede development of GVZs in peripheral or other regions with less demand.

Another debate centers on whether or not to allow for "decentralized GVZs," which would consist of two or more zones because of limited land availability. Depending on the situation, such geographic separation might reduce the foreseen socioeconomic benefits of clustering, for example, with a drastically reduced accessibility of the transshipment terminal by road.

In general, most stakeholders believe GVZ design requirements should not be stringent, instead striving for a case-by-case balance between functionality and practical development constraints. Many also feel the legal obligation of providing multimodal connections should be loosened.

Different roles of GVZ in the logistics network

This report separates GVZs by their profiles, for example belonging to:

- *Industrial GVZs*, mainly for automotive productions, including, for example, those in Wolfsburg, Ingolstadt, Kassel, and Leipzig. These GVZ are centered around the decentralized production sites in automotive supply chains with high container transport volumes between them and the seaports used for exports.
- *Seaport GVZs*, including those in Hamburg, Rostock, Lübeck, and Kiel, which have operate more or less as seaport logistics zones, with a focus on high volumes of transportation services. These GVZs are successful in economic terms; however, the GVZ-philosophy of collaboration and developing synergies has vanished. The only synergies still present lie in the development phase, in procurement of construction, utilities, and disposal, along with a common telematics platform.
- *Inland port GVZs*, including mainly medium-sized ports such as those found in Koblenz, Trier, Well am Rhein, and Hern have succeeded in developing synergies with bulk and other conventional barge cargo. GVZ status has stimulated the process of transforming these inland port GVZs into centers that provide full logistics services portfolios.
- *Urban GVZs*, for example those located around Berlin, cluster logistics activities to reduce the burden heavy goods traffic place on urban infrastructure and environment. An uncontrolled and fragmented development of logistics facilities leads to dispersed HGV traffic with significant use conflicts. From the viewpoint of land-use planning, clustering into zones is the best way to concentrate HGV traffic. The high average number of 1,500 movements of trucks of more than 3.5 tons per day per GVZ explains the magnitude of this challenge. Locating GVZ in the urban periphery provides more room for development of residential and leisure functions elsewhere in the agglomeration and contributes toward making the city more attractive to investors.

Strong and weak points of GVZs—the freight village rankings

DGG, the German Association of GVZs, in 2010, 2015, and 2020 published rankings of FVs, which include GVZs and other similar structures, based on a questionnaire distributed among all FVs in those European states associated with Europlatforms. To participants, this is also a benchmark exercise in which FVs can compare themselves with peers in their own and other countries. The rankings serves as a measure of success for FVs; however, the rankings include an important disclaimer warning that the level of success is estimated on the basis of 40 variables, included in the inventory, along with a weighing process.

The questionnaire collects data about physical characteristics, about tenants and services provided, utilization rates of land and buildings, connectivity and use of multimodal facilities, features of management and ownership, and viewpoints of respondents on the strengths, weaknesses, opportunities and threats (SWOT) for their FV. Based on its latest assessment of the FV market in the Europlatforms community (see table 3.1), DGG published the following summarizing SWOT-diagram of the top-20 GVZs on its website (<https://www.gvz-org.de/de/leistungen/gvz-ranking-2020/>):

Table 3.1. 2020 SWOT Diagram for Freight Villages in Germany

STRENGTHS	WEAKNESSES
<ol style="list-style-type: none"> 1. Centrality/location of the FV 2. Excellent connectivity 3. Intermodal hub function 4. Service package (such as security parks) 	<ol style="list-style-type: none"> 1. Limited space for expansion 2. Quality of infrastructure (highway, power supply, other) 3. Limited local economic potential 4. Poor service package
OPPORTUNITIES	THREATS
<ol style="list-style-type: none"> 1. Development of network or hinterland 2. Land availability 3. Terminal expansion/modernization 4. City logistics initiatives 	<ol style="list-style-type: none"> 1. Labor shortage 2. Overall trade development (trade conflicts) 3. Increased competition from nearby FV 4. Climate-related risks (such as flood risk)

Source: The Deutsche GVZ-Gesellschaft mbH (DGG) 2020 rankings for freight villages. See: <https://www.gvz-org.de/de/leistungen/gvz-ranking-2020/>. Rankings available in German only.

This diagram presents, according to the perceptions of the managers of the highest-ranking FVs, the key factors to their success. The SWOT diagram used in the previous study (2015) shared many similarities. The factors mentioned include the following:

- Location, which to the well-located GVZs is regarded as a key asset. Ideal locations could include an economically powerful region with significant trade potential or on important transport axes with high quality infrastructure connections. a
- Connectivity contributes to the location factor, but also is a factor by itself. A GVZ with a hub function implies connectivity in multiple directions and is an extra indicator of good connectivity. In the DGG 2015 study, strengths related to connectivity were, for example, specified as “high performance intermodal terminal,” “trimodal terminal” (including barge connection) and “private train network.”
- Limited availability of space could be considered both a weakness and a threat because it hinders development of an FV. The limitation could be due to the surrounding terrain being occupied or to potential conflicts of use, for example, if the FV is located near residential areas. The issue of space constraints often concerns FV tenants, who might want to expand their business on or near their plot, or need a temporary solution during peak demand or renovation. Limited space also renders the FV unattractive to potential FV investors considering the long-term perspective.
- Limited availability of real estate was also mentioned as a factor, along with aging assets within the FV.

- The range of services provided was regarded a strength in 2015 for those offering a wide range of services, but as a weakness in 2020 for those offering a less extensive service package. The importance of the range of services depends on, for instance, the level of specialization in the FV. A broader package allows tenants to be more flexible and responsive to fluctuations in their portfolio, although it adds little to those tenants who operate within steady and dedicated production chains.
- The economic potential is a factor in which the FV is mainly dependent on external factors. FV are likely to flourish in well-developed and growing environments and have difficulties under opposite conditions. For FV in areas with low economic activity, good connectivity can help attract business; however, such connectivity is a necessary, though not sufficient, condition for success.
- Competition is seen as threat. This competition can be from another FV establishing in the same market environment as well as from settlement of logistics companies outside of the FV.
- The presence of a strong, qualified labor market was mentioned, however, as a threat, which is sign of the current tight market conditions in many parts of Europe.
- Managerial issues also were identified as a contributor to success or failure. FV manages considered international networking important for securing business, and for pursuing common tenant's interests, quality standards and International Organization for Standardization (ISO) certification, engagement of stakeholders, and effective decision making. Belonging to a cluster of logistics companies was mentioned as an opportunity, for example, for common initiatives such as "greening logistics."
- Finally, miscellaneous (mainly negative) and typically local points completed the list, for example, factors concerning environmental restriction and cumbersome administrative regulation.

The top-ranking GVZs in 2020 and 2015 included well-known successful FV, such as:

- GVZ Bremen, Germany's oldest FV
- Interporto Quadrante Europe in Verona, Italy, a logistics zone surrounding Italy's largest gateway terminal, with high-frequency multimodal connections to terminals in Germany and other Northern European countries
- Logistics Platform Zaragoza (PLAZA) in Spain, which is a relatively new logistics zone set up in a greenfield environment. The zone is well-connected to railway infrastructure; however, the number of available multimodal services is comparatively low.

DGG commented on the most recent ranking, stating that well-performing FVs have become more widespread in Europe. Whereas German and Italian FVs have traditionally dominated the rankings, FVs from other Europlatforms-associated countries have been steadily climbing the list.

The impacts of GVZs

The anticipated impacts of GVZs in German law indicate clustering will increase the use of multimodal transport and reduce negative impacts of freight traffic to its environment, while synergies will improve transport efficiency.

On the first point, success is clearly visible. The GVZs have succeeded in setting up a multimodal transport network and generated an estimated 2.3 million TEU railway traffic volume in 2010, a 47 percent share of the total German unitized cargo transport by rail—quite impressive given the traditionally strong presence of multimodal transport infrastructure and services outside of the GVZs. This modal shift as impact must, to a large extent, be attributed to the establishment of the transshipment facilities, imposed by law and cofunded by national resources. Without this regulation and support, the number of terminals would certainly have been lower. The clustering of logistics service around the terminal obviously benefits the competitiveness of multimodal transport and tenants will be aware of and accustomed to the multimodal transport option. Practice in many GVZs, however, is that a substantial share of traffic is not related to the logistics zone.

The GVZs are also a success when it comes to their impact on local traffic. HGV traffic can severely exacerbate congestion levels as well as local air and noise pollution exposure; GVZs help to contain this negative impact, by not only bundling logistics services and long-distance transport, but local freight traffic as well. In turn, the bundling improves the effectiveness of specific measures designed to divert freight traffic over less invasive routes. The location of the GVZs versus the urban environment is an important determining factor for the magnitude of this benefit.

When it comes to exploiting synergies, the impacts are less evident. Research from University of Bremen (Falk 2012) concluded little evidence existed of benefits from synergies and cooperation between similar types of companies. The use of services from third-party logistics companies within the same GVZ appeared to particularly benefit smaller companies; however, only on a small scale. Examples of such synergies include short-term leasing of facilities for cold storage and other storage space, and leasing of trucks or chassis fleets. Also, the expectation that logistics companies would cooperate by combining their cargoes to save costs did not materialize. Such savings were expected to be found in traffic with lower volumes and truck utilization rates; sharing of truck space could improve both. Business practice, however, shows many companies do not regard their neighbors as potential partners, but rather as competitors.

Several GVZs have been involved in research and development programs cofunded by national or EU-level resources. These projects typically aim at promoting innovations for better or greener transport with new technology (such as electric vehicles) or new concepts (such as collaboration in inner-city deliveries). An example of successful city logistics project, retailer Karstadt in Hamburg succeeded in reducing truck movements by rearranging its deliveries. These same benefits were, however, also reported in cities without a GVZ.

A GVZ, through its management organization, is well equipped for channeling this type of pilot project and for accelerating the diffusion when proven successful. In early years, the success rate was modest; DGG confirmed in an interview² that such initiatives are far from “self-rolling.” Recent years provide a reason for optimism, since all stakeholders—all public levels plus the private sector—have further clarified their commitments to reducing emissions.

Ownership and the role of government in GVZs

Europlatforms and national associations indicate public-private partnership (PPP) is the most typical business model for FVs.

Most commonly, PPPs in GVZs have tenants as partial shareholders. Ownership would primarily concern the management and development organization and its assets, and not necessarily land or other real estate. The shareholders typically include logistics service providers, the terminal operator (often a DB affiliate), public institutions, for example, those promoting economic development of the region and, if relevant, port operating companies. The weight of different shareholders differs between GVZs, with some having a stronger presence of the terminal or port operators and at others logistics service providers or municipalities take stronger roles. The balance often is the result of initial ownerships, and is therefore historic. Occasionally, shippers co-own GVZs and/or the management company. For example, in GVZ Wolfsburg, Volkswagen owns part of the land and is the most prominent user. Dominance of single parties in ownership, however, is rare, because it can lead to conflicts of interests in decision making, where the interests of the larger shareholder prevail over common interests.

The management and development entity will be responsible for arranging basic infrastructure provision, including power, water, sewage, lighting, transport and/or truck parking facilities. In the construction phase these tasks could also include joint procurement of goods and services. In the exploitation phase the entity could take a role in procuring common services, such as security, waste collection, fire protection and certain insurance coverage. The entity also supports tenants in obtaining building rights and building permits, subsidies, and in the procurement of plots, illustrating how the supporting role of this entity versus its tenants continues after the leasing or procurement agreement has been finalized. The entity typically also takes care of networking and promoting the GVZ and could represent the GVZ in developing multimodal connections or initiating other types of activities in the tenants’ interests.

Sometimes, land is put under partial ownership of this entity and revenues from land lease or sale is used to cover costs of abovementioned tasks. In one funding option, the municipality liaises with property developers to find property and use revenues from its lease or sale to fund the start-up phase and/or the management entity. In a

² Available at gvz-org.de

few examples, the GVZ has leased out warehouse capacity and parking lots for this purpose.

The advantage of this type of PPP-construction above public ownership is that the early commitment of tenants improves cash flow and reduces risks to municipalities. It also avoids the need for large prior investment, and the uncertain returns and engagement of private stakeholders common in the early development stages, until the exploitation phase—which also helps to improve the quality of the decisions.

No GVZ has adopted “institutional PPP” as its business model, where the PPP would have the development and exploitation publicly tendered, with terms concluded in a concession agreement. In an interview, the German GVZ association shared that this business model is considered too rigid and too cumbersome. The rigidity stems from functionalities and events difficult to predict and address in a long-term concession agreement, as opposed to transshipment terminals, for example. This difficulty also makes tendering cumbersome, with an uncertain outcome. Both points are even more apparent with larger terrains. Not surprisingly, because evidence does not support the effectiveness of this PPP instrument, developers are less likely to choose it.

The interview also discussed the diversity of practice in Europe when it comes to plot ownership. In Germany tenants commonly own their plots, while in France, Italy, and Spain leasing is often the only option, with these variations growing out of different traditions in land use politics across Europe. Also, in German GVZs, where plot ownership is offered to tenants, private sector generally holds no preference for land ownership over leasing, as the best choice differs case by case, based on property characteristics as well as the tenant’s internal financial considerations.

In considering the keys to a successful GVZ, DGG points to the capabilities and mandate of the management and development entity. The entity must not operate as a traditional landlord, but instead be active and proactive in handling all challenges. In sum, the management entity:

- Act as a neutral actor and moderator in problem solving and must cope with a diversity of needs and challenges, with tasks expanded when needed
- Provides the GVZ with its identity
- Protects the breadth of service provision within the GVZ and promotes development of additional services, which contribute to a stronger GVZ profile and make the GVZ more competitive
- Anticipates needs for expansion and restructuring
- Secures the long-term dimension and the long-term interests of the GVZ as a whole in decisions and in actions, for example, maintaining the attractiveness to future tenants and future investments, which upholds the value of land and assets in GVZ
- Be involved in attracting multimodal connections
- Focus its marketing on target groups and communicating the GVZ portfolio

- Influence political decision making in support of the GVZ's interests.
- Secure its own funding through a sustainable financial model, with revenues sufficient for the entity to conduct its tasks

DGG further emphasized government recognition of GVZs and their essential role in the transport network. The government must put the appropriate incentives in place for developing the connecting infrastructure, including the transshipment facilities. For GVZs, Germany's cofunding instrument for these facilities has been of vital importance. In Poland, for example, the freight village concept and multimodal connectivity have not been supported by national government concerted action. As a result, logistics service provision in Poland has become a highly fragmented market, mainly dependent upon connections via road transport; developing competitive and viable multimodal transport services is challenging, due in part to the dispersed locations of potential clients along the country's dense railway network.

The Duisport multimodal transport hub

The Duisport multimodal transport hub owns the land, quays, and other infrastructure in the Port of Duisburg, which has the highest throughputs of any inland port in Europe. Duisburg has held the position as largest inland port for decades, even as its business has changed dramatically. Until the turn of the century the port mainly handled bulk cargo related to heavy industries (such as coal mining and steel) in the surrounding region called Ruhrgebiet. An important share of this heavy industry came to a close, a process that started in the 1980s, bringing with it the inevitable need to reorient the economy. As a consequence, the Port of Duisburg experienced a vast decline in the bulk cargoes it had previously relied upon and the threat of bankruptcy loomed.

An opportunity for its redevelopment arrived with the vastly increasing container traffic on the Rhine. As an important inland port, Duisburg already had excellent waterways and quays, and good railway infrastructure, and was connected to the four largest European container ports at distances between 200 kilometers (Antwerp, Rotterdam) and 400 kilometers (Bremerhaven, Hamburg). Meanwhile, many operators in ocean shipping and the logistics sector, eager to develop their inland network, also recognized Duisburg's potential.

Today, Duisport functions as a trimodal logistics hub, connected to the European multimodal network by rail, barge, and trimodal terminals as well as to the China-Europe rail landbridge, primarily via the Trans-Siberian corridor through Russia, Belarus, and Poland. Currently, Duisport operates nine terminals with two under development. In 2019, the port processed approximately 25,000 calls from rail services and 20,000 from barges, handling about 4.1 million TEUs, including conversion from semi-trailers and swap bodies. Twenty years ago, Duisport provided few rail services; 2019 marked the first year the number of rail calls exceeded barge calls. The port accommodates 220 hectares of warehouse space, with a total surface of logistics and industrial zones totaling around 1,400 hectares.

The logport concept

In 1998, the port's marketing company introduced the logport concept, with the goal to transform brownfield sites into multimodal logistics centers. The first project aimed to transform the former 265-hectare site of the former Krupp Steelworks in Duisburg-Rheinhausen, now named Logport I. The Duisport hub expanded the former factory port and adapted infrastructure to establish large-scale transshipment. Soon after its launch, major logistics companies like NYK, Rhenus, DB Schenker, and DHL leased space in Logport I. In 2002, the trimodal terminal DIT opened, later followed by two other terminals (D3T and DKT). By 2009, most of the area had been leased, with more than half operational. In 2012, the major global logistics service provider Kühne + Nagel established its worldwide largest complex, covering 18.5 hectares in the Logport I site.

Other developments followed:

- Logport II, on the opposite side of the Rhine, with 35 hectares of logistics area. The site includes the Gateway West terminal, jointly owned by Duisport Group with Imperial Group, and a heavy goods terminal. Logport II has become a major basis of intercontinental exports for tenants Audi, Volkswagen, and Daimler.
- Logport III occupies the land of a former marshaling yard, which had become a rail/road transshipment terminal. The zone, connected to the Chempark Krefeld-Uerdingen, has been developed into a major terminal for chemical products.
- Logport IV is a 240-hectare former mining site set to become an industrial zone, jointly developed with RAG Montan Immobilien, an affiliate of a major mining company tasked with redeveloping brownfield sites.

Logport V and Logport VI are currently under construction, with start-up planned for 2021 and 2021. The 30-hectare Logport V is being developed together with RAG Montan Immobilien and fresh trader, EDEKA, will be the main tenant occupying its central warehouse. Logport VI sits on a 40-hectare site of the former Walsum paper factory and will have a trimodal connection. Meanwhile, plans are under way for the redevelopment of additional locations in the region.

The first logport sites were located inside Port of Duisburg territory; more recent development projects are located short distances outside of Duisburg. The selection of sites strongly depends on availability, given the high occupancy of land in the region, due to its dense population and economic activities. The expansion of logport sites is not a phased implementation in the port master plan, but rather based on case-by-case evaluation of their contributions to the multimodal logistics hub, along with their marketing potential. This criterion implies the site must generate traffic to increase the use of the multimodal transport facilities in the port and, ideally, include a multimodal terminal on site, which will then be integrated into the port system.

Duisburg's logistics cluster, therefore, is a group of logistics zones with fluid borders. The owners look to develop and maintain a coherent cluster, making optimal use of

space and infrastructure. Remote zones or zones with specific functionality will certainly benefit from the multimodal connectivity; however, other synergies are not as evident. In addition, many tenants and terminal operators consider Duisport part of their internal logistics system, for example, terminal operator Neska runs the Duisburg Rhein Rhur Terminal (RRT) Home Terminal as well as several other terminals encircling Duisport.

The impact of logport

The main intention of the launch and rollout of the logport concept, together with supporting initiatives developed by Duisport, was to secure the region's economic potential. The ongoing closure of many heavy industries has led to high unemployment and loss of purchasing power throughout the region. The Logport served as a means to attract logistics business, and through it also become an attractive location for traders and manufacturers operating in global supply chains.

As such, Duisport and its logport developments must be seen as the engine in the economic restructuring of the region, rather than a bundling of existing logistics activities. However, some activities in the segment of containerized cargoes were already ongoing, for example, Duisburg Container Terminal (DeCeTe), which had already started in 1984, though on a more modest scale comparable to many other terminal locations along the Rhine River.

Therefore, the success of the Duisport as a logistics cluster should be measured mainly in terms of its contribution to employment and GDP. While no comprehensive and conclusive study has evaluated this, Duisport's own indicators show 300 companies with focus on logistics are based in the region of Port of Duisburg, employing about 47,000 people—20,000 more than when Duisport started. The estimated added value is €3 billion per year. In the Duisport organization, employment has increased from 210 in 2001 to 1,500 employees in 2018 and is expected to increase to 2,800 within a few years. According to statistics mentioned during Duisport's 20th anniversary celebrations, employment in Logport I had exceeded employment numbers for the Krupp Steelworks, once a vital part of the regional economy.

Division of asset ownership between the public and private sector

In 1998, Duisport was created as independent company by its owners: the federal government of Germany, and the governments of Nordrhein-Westfalen and Duisburg. In 2013, the federal government transferred its shares to NRW, because ownership of inland ports did not align with national policy principles.

For its rollout of the logport concept, Duisport acted as a private company, using loans where need instead of public investment. Additionally, Duisport owned infrastructure and land, selling some of these assets for the purpose of capital accumulation, for example, plots too small for viable exploitation of port or logistics functions, but still interesting to housing or other developers. This initial capital base was expanded

through revenue streams from realized projects, which enabled subsequent expansions projects—the current financial rating of Duisport is excellent, and thus borrowing conditions for future projects are also excellent.

The federal and NRW governments, as well as the EU, had invested a cumulative amount of €133 million in the first 20 years of the logport initiative, related to infrastructure with above-regional significance. Federal support also included cofunding the realization and expansion of the transshipment terminals, as part of the German program for developing the multimodal transport network.

Duisport has no blueprint approach in developing its logistics zones; rather, it decides on a case-by-case basis which role Duisport should take and which role should be assigned to private sector investors or other public entities. The same applies to the multimodal terminals.

While the earliest logistics zones belonged to Duisport, and the development and operation of land plots for logistics service providers was Duisport's sole enterprise, the transshipment facilities were joint ventures between Duisport and the private sector. Logport IV became the first site with private sector participation in developing the logistics zone as a whole. The private partner for the project, RAG Montan Immobilien, an affiliate of mining enterprise RAG Montan, was established for the purpose of transforming its former sites for new purposes. The successful joining of forces combined the interests of Duisport, as landowner, with those of RAG Montan when the land became available. In a recent initiative, however, RAG Montan decided to redevelop its brownfield site into a logistics area without Duisport's involvement, showing the limitation to Duisport's position of having to accept the possibility of third-party initiatives, though the zone development must be compliant with (generally defined) land-use plans. The risk of such private initiatives, expressed from Duisport's viewpoint, is that the logistics cluster could become fragmented, leading to more road congestion and lower use of multimodal transport.

Transshipment terminal ownership does not include land. Instead, the terminal operating company invests in buildings and equipment, but, when inside the port region, Duisport retains ownership of the land, quay walls, and other vital port infrastructure. Most of the transshipment terminals are joint ventures of private companies, originating from ocean shipping lines, logistics service providers, and by railway, barge, multimodal, and terminal operators. Duisport holds a share in some of the terminals, including the terminals in Logport, with ownership divided as follows:

- Duisburg Intermodal Terminal (DIT) in Logport I is 60 percent owned by Rhenus (Contargo), 30 percent by Duisport, and 10 percent by Hupac.
- Duisburg Trimodal Terminal (D3T) in Logport I is 40 percent owned by CMA-CGM, 40 percent by NYK, and 20 percent by Duisport.
- Duisburg Kombiterminal (DKT) in Logport I is fully owned by Bertschi Group.
- Rhein Rhur Terminal (RRT)—Gateway West in Logport II is fully owned by Neska.

- Chempark in Logport III is fully owned by SvdM (Samskip/van Dieren Maritime).

Ownership relations develop over time, for example, Duisport recently took a 21 percent share in DeCeTe, which previously was fully owned by Hutchison Ports. However, ownership of terminals is not an objective for Duisport, which applies a cost plus fee principle where it participates.

Warehouses are privately owned, by either the user (logistics company) or real estate company for leasing, long- or short-term.

Nothing indicates logport tenants would be concerned about owning the land. Interviews with Duisport conducted for this report corroborate that most tenants have little interest in the maximum level of ownership, because this also means bearing the full risk. Duisport encourages partnerships that include risk-sharing arrangements with tenants, while allowing significant space for private developments if other investors wish to assume the risk.

An important argument in support of Duisport holding stake is to guard the interests of the port system as a whole. A good balance in ownership prevents certain private interests from dominating. Such dominance could lead to an undesirable dependency situation for Duisport or groups of tenants, and could become an obstacle in long-term development.

Duisport's interests are best served by a full-service portfolio to support the presence of supply chains for all its tenants. For most services, this is a natural process that only needs accommodation by Duisport. Occasionally, when services are not provided by private sector, the port has intervened by taking over ownership. For example, the port invested in Duisport rail for the unprofitable last-mile shunting by rail. Leaving this to the market would have meant the services would not be provided, thus making the port less attractive.

The other side of the same coin is that Duisport tries to avoid leasing space to tenants who have no relationship to the port system. A certain level of "profile contamination" is difficult to avoid, but too much could reduce the efficiency of the port system.

From Duisport's perspective, investing in the port system demonstrates its confidence in the future, which will naturally encourage tenant confidence. In contrast, not investing could discourage tenant investment.

Duisport as an entrepreneurial port

The development of Duisburg into Europe's main inland multimodal hub and its expansion of logistics terrains since the establishment of Duisport have been remarkable. In the 1990s, when authorities recognized the need for drastic measures

and massive opportunities, the owners appointed the current three members of the Executive Board to lead the transformation process, improve performance, and create profitability. For these efforts to succeed, owners chose outsiders originating from business communities to take the lead. The CEO's self-acclaimed motto is "Don't talk, take action"—also a good summary of Duisport's own approach to development.

One of the fields in which Duisport has been active is in improving its multimodal connectivity by developing routes, to attract business in transport and logistics, improve the port's attractiveness to all players in supply chains, and make the port resilient to business cycles of economic sectors. Duisport's role goes beyond general promotion activities and includes support for developing business cases and deal making.

The development of rail services in cooperation with China represents another significant achievement for Duisport. Started in 2011, the rail line includes nearly 35 services per week and should soon expand to 100 per week, generating 850,000 TEU traffic per year. To accommodate this traffic, Duisport is planning construction of the Duisburg Gateway Terminal, to be commissioned in 2022, in joint venture with Chinese transport companies COSCO, Hupac, and HTS. In this continuing development phase, Duisport offers the knowhow and facilities as well as the ability to mobilize the community for back loads in order to strengthen the business case of the service—a role other logistics nodes cannot offer.

Similarly, Duisport also participates in Minsk terminal, holding a 30 percent share as part of a 9,000 hectare development. The location is strategic for trade with China as well as Russia and Belarus and the logistics zone will be asset in developing additional trade routes to China.

Duisport, together with its counterparts, is also exploring alternative route options for expanding this trade and safeguarding its position. These routes could include the TransCaspian transit corridor and the newly-completed Baku–Tbilisi–Kars rail corridor via the Caucasuses and Turkey.

Duisport also initiates and engages in innovation projects. For improving the process efficiency, the port has adopted the use of an optical character recognition (OCR) gate for its railway system, to make information exchange with the port more accurate and enable immediate processing. For its tenants, Duisport has helped develop ergonomic crane cabins and ergonomic handling devices for cranes, and freely shared the newly designed cranes with its tenant community. Further initiatives include sharing its knowledge of crane management system, providing guidance for tender specifications, supporting the building permit process, offering several training and education programs, and more. Knowledge sharing and software are often free of charge, provided tenants cooperate in providing statistical and other information.

With this type of support, the port tries to safeguard its position for the long-term. One reason behind the port's engagement in ergonomics is to promote safe, healthy

working conditions and improve staff retention, an important consideration when finding employees can be challenging in the current labor market.

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4. Logistics Clusters in the United States

The Context of Multimodality in the United States in Brief

The United States is the world's leading economy in terms of gross domestic product (GDP), generating US\$20.5 trillion in 2018, with a population of 327 million, and a diverse geography and economy. Population density and economic production are highest in the eastern half and in the southwest of the country.

U. S. gateways

The main U. S. gateways for maritime-borne trade of containerized cargo with East Asia—the highest-density intercontinental containerized trade corridor—are the Pacific Ocean ports of Los Angeles/Long Beach (LA/LB, both located in the same bay), which handled a total throughput of 19.5 million twenty-foot equivalent units (TEUs) in 2018, followed by Seattle/Tacoma Alliance and Oakland, a distant second and third with throughputs of 3.8 million TEUs and 2.5 million TEUs respectively. This traffic includes trade with Oceania and America's west coast. The Pacific Ocean ports are generally preferred for the vast territory coverage of the United States, including central as well as many eastern regions.

The Atlantic Ocean Port of New York/New Jersey with a 7.2 million TEU throughput is the most important gateway for trade with Europe, the second important continent for maritime container trade, and with America's east coast, Africa, and South Asia. Other gateways for this traffic include Savannah (4.4 million TEUs), Hampton Roads (2.9 million TEUs), and five additional medium-sized Atlantic Ocean ports with between 1 and 2.5 million TEU throughput.

The maritime route through the Panama Canal provides an attractive alternative option if the overland distance between the U.S. gateway port and the inland location is too high. For example, for trade with Europe the canal route is not attractive, it is attractive for trade between Southeast Asia and the eastern United States.

This partition of trade gateways between Pacific and Atlantic coasts implies long hinterland travel distances, for example, the highly dense traffic between Chicago and LA/LB, over a distance of around 3,200 kilometers.

U. S. multimodal transport system

Multimodal transport in the United States accounts for approximately 25 percent of revenue for major U. S. railroads, which makes it the largest of market segments. The number of units carried in 2018 reached 14.5 million, consisting of containers (92 percent) and truck trailers (8 percent) on wagons.

In domestic traffic 53-foot containers have become the main loading unit. These replaced much of the earlier truck trailer traffic on rail and, because of improved competitiveness, also attracted traffic that had previously gone by road. In 1990, only 47 percent of intermodal traffic was transported in containers. The 53-foot containers are not compatible with maritime traffic, and therefore common practice transloads cargo between maritime and 53-foot containers in the vicinity of the seaport. This improves multimodal transport efficiency in the hinterland and keeps maritime containers close to the ports and better available for the ocean carriers.

The railway system consists of railways divided into classes based on their revenues. The largest, Class I operators, are the involved in long-distance intermodal transport services, whereas Class II operators are most often regional lines, and Class III operators have local significance only. Seven Class I railway companies are currently active in freight transport in North America; two of these are Canadian owned. The share of Class I operators generate more than 90 percent of the total revenues from rail freight. Together, the Class I networks provide good coverage of the U.S. territory and connect all major seaports. The railway network, designed for and mainly used for freight, is suited for mass transport. For example, the Burlington Northern Santa Fe (BNSF) Railway route between Los Angeles/Long Beach and Chicago allows for double stack trains up to 2.4 kilometers in length.

The two main railway operators for intermodal transport are BNSF and Railways Credit Union (CU), which operate in the western part of the country and CSX Transportation for the eastern part. For land bridge services or other services extending beyond individual networks, railway operators work cooperatively.

Intermodal rail traffic in 2017 totaled 8 million TEUs around Chicago, followed by the region of LA/LB and San Bernardino (5.2 million TEUs) and then, on distance, by Atlanta and Dallas (1.4 million TEUs).

The region around Chicago serves as a hub in the system where most railways are present and where much of the transloading between networks takes place, either using rail-to-rail transshipment or connecting drayage services.

The other important node in the intermodal network is the LA/LB port complex, with a combined throughput of 19.5 million TEUs. LA/LB is a west coast gateway with a hinterland stretching out to the country's east coast. Railways provide a competitive hinterland transport alternative to regions east of the Rocky Mountains—more than a one-day drive from Los Angeles by truck—a vast share of LA/LB's traffic. These high throughputs and the gateway role bring revenues to the region, but also place significant pressure on the transport system in the vicinity of the port. To help relieve this pressure, the ports have taken the following measures:

- Established large-scale intermodal onsite facilities to increase efficiency of transshipment between ocean vessels and full-length trains; and

- Joined forces in developing the Alameda corridor, a dedicated 32-kilometer rail cargo “expressway,” opened in 2002, through the urban environment, to connect the ports with the BNSF and CU networks.

The practice of transloading between maritime 40-foot containers and continental 53-foot containers (and vice versa) typically takes place in the vicinity of the port. For example, traffic in the immediate hinterland passes through a facility in which cargo is transloaded, making railway transport over the “continental leg” even more efficient. The transloading could be cross-docking, involve warehousing, or (mainly for imports) could include value-added services to the cargo.

U. S. Transport Policy Framework

The transport policy in the United States is designed to leave as much as possible for initiative and decision making to the private sector and to local (municipal) governments. Federal involvement is present in the road infrastructure, airports, and waterways, though not in municipal-owned seaports and privately owned railways.

While the national highway system is an interstate system, for long-distance transport the network is maintained by each state, which could initiate changes to the network with federal approval. Within states, infrastructure ownership is divided between the state and municipal level governments, depending on the function of the infrastructure. Though not widespread, private ownership of road links with general economic significance (toll roads, for example) also occurs.

The planning framework assigns a modest role to the federal level. The overarching objectives of U. S. transport policies, for example, include improving of competitiveness and safety; however, the federal government does not engage in national master planning and infrastructure prioritization. A few federal instruments for steering and accelerating road infrastructure development are available, for example:

- The Transportation Investment Generating Economic Recovery, or TIGER program, and its follower, Better Utilizing Investments to Leverage Development, or BUILD, provide grants for planning and capital investments in surface transportation infrastructure. These grants are awarded on a competitive basis for projects that will generate a significant local or regional impact. The current BUILD funding supports roads, bridges, transit, rail, ports or intermodal transportation. BUILD projects will be evaluated based on merit criteria that include safety, economic competitiveness, quality of life, environmental sustainability, state of good repair, innovation, and partnership.
- The Infrastructure for Rebuilding America (INFRA) grant program provides funding for projects that address critical issues in the national freight system. INFRA grants support all levels of government and the private sector to fund infrastructure, using innovative approaches to improve processes, increase accountability, and promote safety solutions.

- The 2015 Fixing America's Surface Transportation Act (FAST) Act operates as a federal intervention for urgently needed improvements in the U.S. infrastructure network. The FAST Act provides long-term funding certainty for surface transportation to states and local governments for critical transportation projects. The law also includes improvements for streamlining approval processes, or removing red tape, for new transportation projects. The FAST Act specifies that a portion of a state's freight formula funds can be used for multimodal freight projects, an amount capped at 10 percent for each fiscal year. These multimodal projects should be designed to improve connections with multimodal facilities on critical freight corridors. Federal cofunding is allowed up to 80 percent.

On the state and municipal levels, the governments take responsibility of their respective transport networks. For example, Illinois, home to perhaps the nation's principal inland transport hub, with an extensive multimodal freight system, in 2017 developed the Illinois State Freight Plan (<https://idot.illinois.gov/transportation-system/transportation-management/planning/illinois-state-freight-plan>). The plan's actions align with federal-level instruments, for example, by promoting projects most suited for receiving funding from FAST or other programs. The United States Department of Transportation (DOT) has defined district and corridor programs after identifying the needs of key routes for clusters of Illinois industry. The DOT also provided institutional and financial support to the Chicago Region Environmental and Transportation Efficiency (CREATE) Program, which is a US\$3.2 billion project combining public funds from state, the aforementioned federal sources, and the municipal level, together with private funding from railway companies, for removing railway related bottlenecks and improving connectivity with intermodal facilities. The plan comments that the 10 percent cap on allocation to multimodal projects does not adequately address the needs, considering the size of the state's multimodal network and the amount of freight that originates, terminates, or passes through Illinois.

U. S. seaports are typically owned by the respective municipalities. The typical structure is that of the Los Angeles and Long Beach ports, where municipalities created independent ventures for port development and operations, thus separating port business from municipal responsibilities. Ports create their own revenue streams to cover capital investments and operational costs.

Railways in the United States are almost entirely privately owned, with railway companies owning, building, and maintaining their infrastructure as well as rolling stock. Combined, America's freight railroads spent more than US\$710 billion, between 1980 and 2019, on investment and maintenance expenses related to locomotives, freight cars, tracks, bridges, tunnels, and other infrastructure and equipment. The networks of these Class I railways together provide good geographical coverage of the United States, often cooperating in operations with Class II and Class III operators.

The government provides railway infrastructure only by exception, as seen with the previously mentioned Alameda Corridor. The project was initiated by the Southern California Association of Governments in 1981, in response to growing concerns surrounding the ability of the ground transportation system to accommodate increasing levels of traffic in the Los Angeles port area.

These local governments established the Ports Advisory Committee (PAC) with representation of stakeholders, such as local elected officials and representatives of the Ports of Los Angeles and Long Beach, the U. S. Navy and Army Corps of Engineers, affected railroads, the trucking industry, and the Los Angeles County Transportation Commission (LACTC). The PAC first dealt with highway access and later commissioned studies for railway solutions. The committee concluded that consolidating all trains on an upgraded Southern Pacific San Pedro Branch right-of-way would be the most cost-effective alternative. The Alameda Corridor Task Force (ACTF) was created, which expanded the PAC by adding the California Public Utilities Commission (CPUC) and representatives from each of the cities along the proposed corridor. This task force created the Alameda Corridor Transportation Authority (ACTA), a joint powers authority with design and construction responsibility for the Alameda Corridor. The line opened in 2002, with ACTA functioning as operator.

Multimodal Transport and Logistics Clusters

The multimodal transport network is the domain of maritime ports and railway companies.

Seaports, as entry points of the North American railway-based multimodal transport network, handle carriage of maritime containers and the larger (53-foot) domestic containers, after transloading between maritime and domestic containers. When these transloading facilities are close to the seaport, the cost advantages of using the domestic container for the inland haul can be optimally exploited. As such, transloading facilities are important nodes in import and export flows, and with the considerable amounts of goods passing, make attractive locations for a variety of supporting logistics services.

The massive traffic flowing between seaport and transloading facility creates an opportunity for developing multimodal transport services. However, the short distance covered could handicap the multimodal transport's competitiveness. For example, even though a high presence of logistics services and transloading terminals operate around Los Angeles and throughout the nearby Inland Empire region to the east, multimodal services between LA/LB and these facilities do not exist. The potential for such services has been recognized and with the Alameda Corridor, railway infrastructure is readily available, but neither the Class I operators BNSF and Union Pacific (UP), nor short-line operators have followed up by investing in a transshipment terminal to cover this short-distance traffic.

The Virginia Inland Port (VIP) provides a well-known example where short-distance rail service has succeeded. The VIP is owned by the Port of Virginia—also called Hampton Roads—the third largest seaport complex on the U. S. Atlantic coast, which handled nearly 3 million TEUs in port throughput in 2018. Hampton Roads launched the VIP with the idea of bringing the seaport closer to the hinterland to increase the seaport’s competitiveness.

The railway companies own the railway infrastructure and suprastructure in the terminal, usually also on procured land. Many of the intermodal railway facilities owned by the Class I operators are large scale, with rail track lengths between 1,200 and 2,400 meters, allowing full trains to be handled without the need for marshaling operations.

Increasingly, transshipment terminals have become integrated with the logistics systems of their users. For example, Class I railway BNSF distinguishes between the following systems:

- **Logistics centers**—including Hudson, Oklahoma City, Fontana, and Sweetwater—where BNSF offers plots for industries to develop rail-based business, typically bulk cargo; and
- **Logistics parks**—including Stockton and San Bernardino, both near Californian seaports; AllianceTexas in Fort Worth; Kansas; Chicago; and Memphis, all BNSF intermodal facilities adjacent to large third-party logistics zones.

In its logistics centers, BNSF initiates the development, constructing the railway connection and offering land plots for lease to industrial companies reliant upon the railway connections, typically for bulky cargoes rather than containerized goods.

The logistics parks function via cooperation between BNSF and other entities. BNSF provides the intermodal facilities and the rail connection to the main network, while third parties initiate the logistics zone development. The most well-known and most sizeable ventures include AllianceTexas in Fort Worth and the Centerpoint Intermodal Centre in Chicago, which will be described in the next subsections.

Virginia Inland Port

The VIP was established in 1989 by the Virginia Port Authority (VPA), an independent public corporation created by the Commonwealth [State] of Virginia to handle all port operations. The VIP was developed with the purpose of bringing the port closer to the customer, extending the seaport’s reach into the hinterland, and securing traffic through the seaport. The inland port acted an instrument in the competition between the Port of Virginia and other seaports for export cargoes and helped convince ocean lines to include the Port of Norfolk in their sailing schedules. The ocean lines’ abandonment of the Port of Baltimore in the 1980s, an obstacle in international trade potential of hinterland regions, also prompted the VIP development.

Though not initially the main reason for development, the VIP also contributes to alleviating congestion and supporting capacity for handling and storage at the seaport facilities—where space for expansion is limited—as well as to reducing the environmental burden of hinterland traffic.

The VIP fully targets on international trade, with cargo transported in maritime containers, accepting and delivering containers under ocean carriers' multimodal bills of lading. The site is also a U. S. Customs port of entry. As such, the VIP can be considered a "satellite" facility of the Norfolk marine terminals.

Located at Front Royal, on about 64 hectares, the VIP includes a transshipment facility of five tracks of about 520 meters length, owned and operated by the VIP, and with railway services provided by Norfolk Southern (NS) railway company. The VIP is about 350 kilometers by road from the coastal facilities of Port of Virginia and a relatively short distance to Washington, D.C. (approximately 100 kilometers) and Pittsburg (around 300 kilometers). The facility is well-connected to interstate highways I-66 and I-88, with NS providing daily rail services between the VIP and Norfolk International Terminals (NIT; annual capacity of 1.4 million TEUs) and Virginia International Gateway (VIG; annual capacity of 1.1 million TEUs) in Portsmouth, both part of Port of Virginia.

The distance by rail between the VIP and NS is about 650 kilometers, just under double the distance by road, which is a competitive disadvantage to railways. Despite that, NS offers competitive rates to its users, however only for the targeted container traffic and not for train-loaded trailers. Train capacities for container operations provide much better load rates than trucks on train and trains with containers mixed with trucks would require different handling techniques in the VIP as well as in the seaport terminals, which would increase complexity, resulting in increased costs.

The planning process for the VIP started in 1984 by engaging representatives of ocean lines, railways, and the trucking industry as well as shippers and freight forwarders in order to set up a seamless and integrated concept, preventing bottlenecks in operations as well as in customs and administrative procedures. Also, the VPA engaged customs authorities from the beginning—considering the inland customs post, and therefore the possibility of container traffic passing the seaport without delay—is a vital element of the VIP concept.

In 1987, the VPA and NS reached agreement and they proceeded to examine alternative site locations, together with local authorities. The VIP site in Front Royal was selected because of the easy road and the vicinity of NS territory and because of the lower costs for land acquisition. The initial concept was to run a dedicated NS train three days per week between the seaports and the VIP, anticipating an annual traffic of 20,000 international containers. The initial studies of the likely traffic showed a potential for 100,000 containers per year, demonstrating the VPA's cautious approach in designing the VIP.

The VIP became operational in 1989 and reached its targeted level of 20,000 international containers for the first time in 1999. Later the VIP's throughput expanded rapidly, reaching 35,000 containers in 2005 and 38,000 in 2018, corresponding with 65,000 TEUs. Current estimates show more than 90 percent of traffic through the VIP represents new traffic to the Port of Virginia, indicating the VPA has succeeded in its mission. The transshipment capacity of the NS railway terminal is 78,000 TEUs per year. Plans call for an expansion to eight tracks, which will increase capacity to more than 100,000 TEUs. This capacity expansion aligns with the port's strategy to further increase its already high share (35 percent) of railways in its hinterland traffic to 40 percent in 2022, for which the port has invested heavily in getting the required rail infrastructure in place.

The services provided through the VIP support the multimodal transport chain, which include the following:

- Services supporting the transport operators, such as repair and maintenance of transport assets, chassis pools, refrigeration units, and their generator sets;
- Services supporting the transport and trade process, including all customs handlings, inspections of cargoes and vehicles, veterinary, and the United States Department of Agriculture (USDA) inspections; and
- Services supporting logistics, which include warehousing and cold storage facilities as well as bonded warehousing.

The approximately 64 hectares of the VIP also house several logistics service providers who invested in warehousing and retailer distribution facilities surrounding the transshipment terminal. In hindsight, the VIP acquired an inadequate amount of land for clustering of logistics services and main shippers using the facility, and therefore much of the traffic passing through the inland port relates to a wider region. For example, Home Depot's distribution center, established in 2003 at a 12-kilometer distance from the VIP has been an important contributor to the port's success.

Cargo moving through the VIP on a multimodal bill of lading to and from locations in neighboring states must also be considered as the VIP's hinterland.

Funding the VIP came together rather easily after legislation was passed in 1986 to create a Transportation Trust Fund; the inland port was constructed with money entirely from this trust fund. The original US\$10.75 million and subsequent US\$2.25 million was paid on a pay-as-you-go basis, through which the VPA could avoid incurring debt in the construction phase. Since 1994, the VIP has been self-sufficient and operating at a profit.

The foreseen expansion will use US\$15.5 million from the federal BUILD program, next to US\$27 million from VPA's budget. The funding will be used for infrastructure—including a capacity expansion from five to eight tracks and removal of a nearby crossing—and for the acquisition of terminal equipment, such as straddle carriers.

AllianceTexas in Fort Worth

The Alliance Global Logistics Hub, an ILC in Fort Worth—60 kilometers from Dallas—features logistics zones around a dedicated cargo airport. Alliance was initiated in the early 1980s, as the first large-scale ILC development in the United States., when the Perot Group acquired almost 5,000 hectares of land north of Fort Worth. At the time, the regional office of the Federal Aviation Authority (FAA) was looking to transfer aviation activity away from the congested Dallas-Fort Worth (DFW) airport and recognized the potential of the Alliance site for this purpose. After the FAA had committed to pursue this greenfield development, the Perot Group took the upfront financial risk as well as the lead in designing and constructing of the airport. The airport opened in 1989 and soon benefited from the settlement of a major aircraft maintenance facility of American Airlines (AA), anchoring AA's air traffic and related businesses.

The development decision for the Alliance property had already been taken when BNSF joined and built a large-scale intermodal facility, which opened in 1990. A looming expiration of their land lease agreement Dallas provided a motive for BNSF to relocate to Fort Worth, along with the promise of a major distribution and manufacturing park being co-located on the Alliance hub property. This park was established, on modest pace, throughout the 1990s; significant settlers included the southwest hub of Federal Express (1993), and cellular phone manufacturer Nokia who opened a distribution center (1994) and then a manufacturing center (1995).

Property developer Hillwood, owned by the Perot Group, is responsible for marketing and exploitation of the logistics and industrial zones. Hillwood sells land to tenants, who then finance and develop their own facilities. For about half the zone, Hillwood has entered into long-term leases with first class tenants and then used these leases to privately finance and develop warehouse and distribution space.

Due to legal requirements, ownership of the cargo airport lies with the City of Fort Worth. In order to arrange this, Perot Group and the city officials agreed to partial in-kind ownership swaps, in which Alliance Air Services (a Hillwood subsidiary) maintains a long-term operation contract.

The initial investments for the development of the airport and logistics zone, therefore, have been mainly privately funded as follows:

- By in-kind swaps by the Perot Group, who provided 320 hectares of land;
- By the initial anchor investors, including American Airlines (US\$350 million), FedEx (US\$300 million), and Nokia (unknown amount); and
- By BNSF, which fully funded its BNSF Alliance Intermodal Hub and the connecting rail infrastructure (US\$50 million).

Public investments came from:

- The State of Texas, who contributed to the project by creating three major interchanges to provide interstate highway access to Alliance;
- The City of Fort Worth, who contributed by constructing local roads and utility infrastructure, such as water, sewer, electrical and gas; and
- The FAA, through a US\$85 million grant from its Airport Improvement Program.

The AllianceTexas cargo airport has developed as the world's first purely industrial airport designed for cargo and corporate aviation and is now the most prominent pull for logistics business development in the hub, with many tenants of the logistics zone depending on aviation services for their distribution. In 2004, about 170 hectares of plots were occupied, about 50 percent by regional distribution centers, 20 percent by other logistics services, and 20 percent by manufacturing and assembly. Later, other important logistics companies as UPS, CEVA, DSC, and Exel—and recently also Amazon—located a distribution center in the Alliance ILC. The development also created subclusters, for example, with tenants from the automotive industry including, for example, Hyundai, Audi, General Motors, Ford, Bridgestone, Firestone, Tucker Rocky, and Enkei, and electronics industry leaders such as LG Electronics, Texas Instruments, AT&T, and Motorola.

Major retailers and importers such as Walmart and Home Depot were among the first and largest users of inland facilities such as the AllianceTexas ILC, with a steady trend of consolidating multiple distribution centers into a smaller number of hubs with adequate logistics capacity. For example, J.C. Penney created its national distribution center at the AllianceTexas site, replacing its former distribution centers on the East and West Coast.

The BNSF Alliance Intermodal Hub has succeeded in gradually building up its intermodal traffic and has a current throughput of around 600,000 load units, benefiting from its position in the ILC. The BNSF facility also attracts much of its cargo from its gateway position to the larger region around, including the Dallas-Fort Worth metropolitan area and many other regional urban communities, such as Oklahoma City, Houston, and San Antonio.

CenterPoint Intermodal Center

CenterPoint Intermodal Center (CIC) Elwood-Joliet is an ILC located on 1500 hectare of land approximately 60 kilometers southwest of downtown Chicago. The CIC is a combination of the CIC-Elwood, home to the BNSF Logistics Park, operational since 2002, and the extension toward the north, home to UP's Joliet Intermodal Terminal, in operation since 2010. Combined, the CIC-Elwood and CIC-Joliet create the largest master-planned integrated logistics center in North America.

The CIC is the largest inland port in the United States with annual handling volumes of around 4 million TEUs. If maritime ports are included in this port ranking, CIC would

still be the third largest logistics complex in the United States, after LA/LB and New York/New Jersey.

As the major freight hub in the United States, the Chicago area serves all modes of freight transportation, with a significant amount of U. S. rail-based intermodal traffic flowing through Chicago. Chicago is also congested, particularly for freight moving by truck and rail; for example, rail freight can take a full day just to get through Chicago. The CIC is one of the developments that stems from the objective of alleviating this congestion.

The CIC was built on a site, formerly a military arsenal, declared excess U. S. Army property in 1993; legislation approved its conversion into a variety of civilian uses in 1996. Several ideas emerged for the brownfield development, for example, building Chicago's third airport. In 1995, the State of Illinois established the Joliet Arsenal Development Authority (JADA), tasked with planning the site development, seen as the engine of local economic development.

JADA subsequently produced a strategic plan, which considered conclusions from earlier studies conducted by the Government Accountability Office (GAO)¹ indicating that Illinois needed long-term solutions to alleviate congestion and capacity constraints in the Chicago transportation system and that new infrastructure should include a multi-user intermodal terminal that would permit rail-to-rail connections. The U. S. Department of Transport, supported by this GAO report, had recommended a site outside the city in order to alleviate inner city truck congestion. JADA's strategic plan considered the arsenal site well suited for such intermodal facility, because it was near two interstate highways and networks of two Class I railroads, BNSF and UP. The site is also exceptionally well buffered from conflicting land uses.

Private owner and property developer CenterPoint acquired the land, totaling 890 hectares, promising to use its own capital to transform the site into a major intermodal facility. In 2000, the U. S. Army transferred a signed memorandum of agreement and deed, which included provisions for property cleanup, ownership, development, and fiscal incentives. Before the construction could start, more than 1,200 separate structures on the property had to be demolished on this superfund site, which required environmental cleanup of the polluted land. The project obtained funding from the Illinois Department of Commerce and Community Affairs (DCCA) to replace the site's water and sewage system. DCCA, in conjunction with the Illinois Department of Transport (IDOT), also financed improvements to the site's access roads. Finally, the industrial park would be annexed into Elwood and a tax incremental financing (TIF) district was created, which provided CenterPoint with tax incentives for developing the land.

For goodwill purposes, CenterPoint donated land to nearby users, including 30 hectares to the Forest Service, 24 hectares to a wetlands conservation project and 4 hectares to the City of Elwood. By donating land, CenterPoint expected to gain a level

of acceptance for any impacts in quality of life that might occur by the development and use of the site.

In October 2002, the 310-hectare BNSF Logistics Park-Chicago (LPC), which includes a BNSF warehouse and distribution area, and the CIC-Elwood logistics park opened. This was followed in 2010 by the opening of the 320-hectare Union Pacific's Joliet Intermodal Terminal (UP-JIT), located only 3 kilometers north of CIC-Elwood. CIC-Joliet had earmarked 185 hectares for industrial facilities such as warehousing, distribution, and manufacturing, and 160 hectares for container management yards. The CIC Elwood-Joliet is also zoned for a third Class I intermodal facility.

CenterPoint Properties Trust, the master developer of the CIC-facilities, leases parcels to tenants on which they can operate and manage their freight and logistics activities. Major tenants include Walmart, DSC Logistics, Georgia Pacific, Potlatch, Sanyo Logistics, Partners Warehouse California Cartage, and Maersk.

The development of CIC Elwood-Joliet has been successful; both UP and BNSF sought an opportunity to build greater capacity into their system and thus better accommodate the strong growth they faced in global container traffic. An important success factor also has been the proactive role of government, in particular JADA, as vehicle, coordinator, and facilitator of this development. After the completion of CIC-Elwood-Joliet, JADA has continued as dialogue partner with multiple stakeholders, now that the surrounding region is increasingly faced with new challenges related to local mobility—caused by the volume of truck traffic generated by the facilities and at-grade rail crossings.

Note

1. The Government Accountability Office (GAO) is an independent, nonpartisan government agency that examines how taxpayer dollars are spent and provides the U. S. Congress and federal agencies with objective, reliable information to help the government save money and work more efficiently.

5. Logistics Clusters in the Republic of Korea

The Republic of Korea (hereafter referred to as Korea) has made rapid economic progress during the last sixty years. Its average gross domestic product (GDP) per capita increased from a mere US\$61 in 1961 to US\$30,600 in 2018, as the country transitioned from one of the poorest countries in the world to a high-income nation with the world's tenth largest economy. While several factors have been critical to Korea's rapid economic growth, one of these key factors is the timely construction of efficient transportation and logistics infrastructure to enable the rapid movement of both people and goods.

Investments in transportation infrastructure have been central to Korea's periodic, national five-year economic development plans. These investments span the construction of the transformational Gyeongbu Expressway in 1970—which reduced the travel time between Seoul and Busan from 8 hours to between 4 and 5 hours—to systematic and consistent transport and logistics interventions under a balanced regional framework, as established in the Comprehensive National Territorial Plan. This strategic vision of transport and logistics was paired—in accordance to laws and regulations—with (1) sector-specific plans for ports, airports, roads, railroads, logistics, and metropolitan-area transportation; and (2) special accounting standards for transportation facilities to provide stable resources for the installation and management of the nation's transportation infrastructure.

Korea's rapid pace of economic growth in the 1980s and 1990s led to a substantial increase in import and export volumes. The average growth rates for Korea's imports and exports were 12.1 percent from 1980 to 1985 and 13.5 percent from 1985 to 1990. The existing initial investments quickly proved insufficient to handle the demand (table 5.1).

Table 5.1. Korean Import and Export Container Volumes, 1980–90

TEUs, thousands

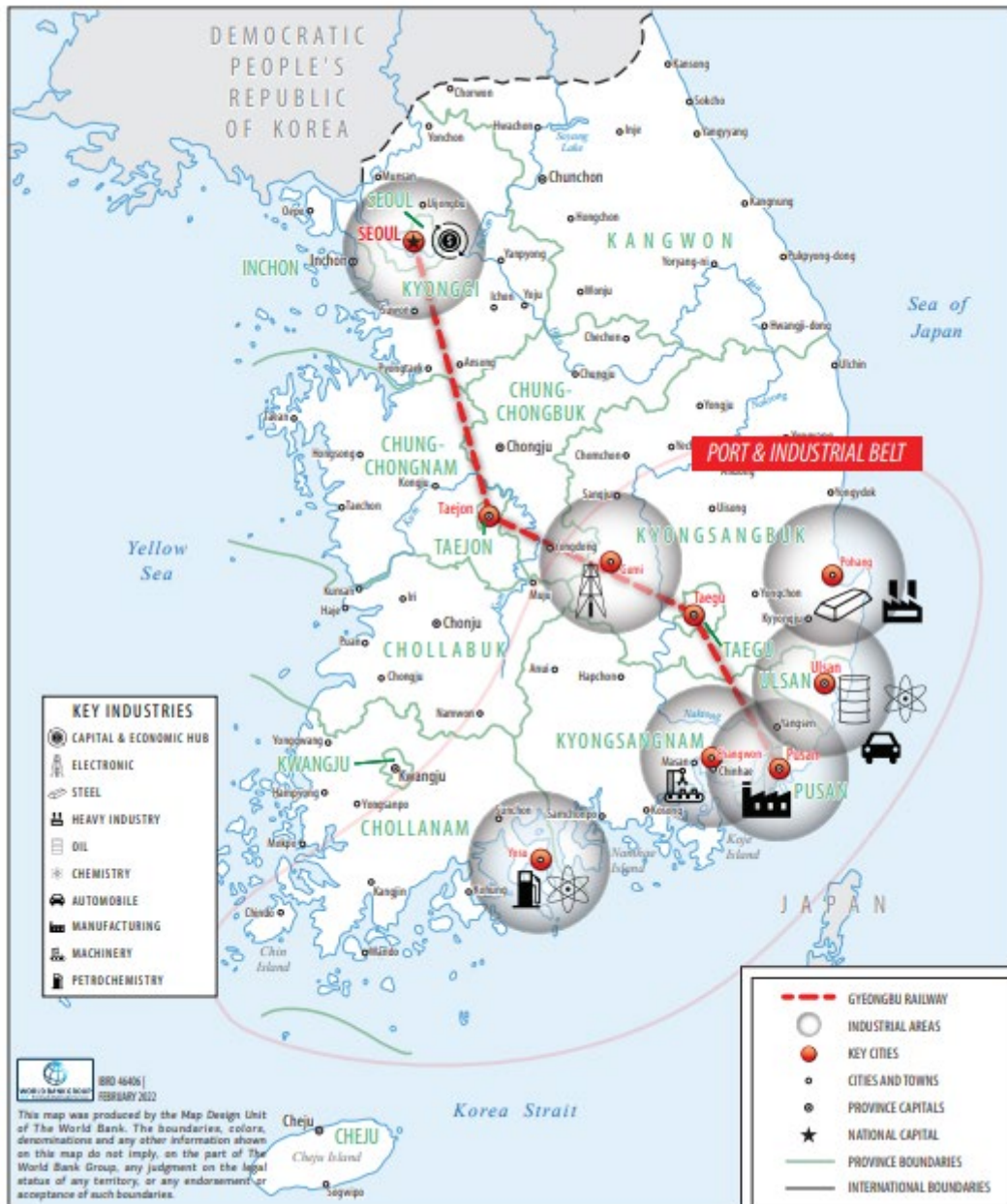
Classification	1980	1985	1990	1980–85 average growth rate	1985–90 average growth rate
Export	403	714	1,348	12.1%	13.6%
Import	289	544	1,056	13.5%	15.6%

Source: Korea Economic Planning Board 1991.

The Spontaneous Emergence of Off-Dock Container Yards

In 1990, the Port of Busan was the only import and export logistics facility equipped with a large-scale wharf with the additional challenge that heavy industrial complexes were concentrated in the port's Busan-Gyeongnam area (figure 5.1).

Figure 5.1. The Gyeongbu Line and Busan Industrial Areas of Korea



Source: Authors own elaboration.

At that time, the Port of Busan was handling 2.3 million TEUs, or 95.1 percent of the total volume of import and export containers nationwide. Moreover, the destination of the cargo handled was highly concentrated with major regions along the Gyeongbu Expressway, such as Gyeongin, Busan, and Daegu, concentrating 1.7 million TEUs (76 percent of the traffic). About 63 percent of the 824,000 TEUs of inland import and export containers between Seoul's Capital Area and the Port of Busan were moved through road transport (tables 5.2, 5.3, and 5.4).

Table 5.2. Export and Import Container Handling Status by Port, in 1990

TEUs, thousands

	Total	Busan	Incheon	Other ports
Volume	2,469	2,349	112	8
(%)	(100)	(95.1)	(4.6)	(0.3)

Source: Korea Economic Planning Board 1991.

Table 5.3. Distribution of the Port of Busan's Import and Export Container Volume by Region, in 1990

TEUs, thousands

	Total volume	Gyeongin area	Busan area	Daegu area	Other
Export (%)	1,293 (100)	515 (39.8)	402 (31.1)	96 (7.4)	280 (21.7)
Import (%)	980 (100)	309 (31.5)	246 (25.1)	163 (16.6)	262 (26.8)
Total (%)	2,273 (100)	824 (36.3)	648 (28.5)	259 (11.4)	542 (23.8)

Source: Korea Economic Planning Board 1991.

Table 5.4. Distribution by Transport Mode for the Busan to Seoul Capital Area Route, in 1990

TEUs, thousands

Total	Road	Railroad	Maritime transport
824 (100%)	519 (63%)	290 (35.2%)	15 (1.8%)

Source: Korea Economic Planning Board 1991.

The concentration of Korea's import-export container traffic at the Port of Busan and on the Gyeongbu Expressway caused numerous socioeconomic problems and made evident the limits of the existing transport and logistics infrastructure. Private, spontaneous solutions started to emerge.

As there were no container yards in the conventional pier at the Port of Busan, private off-dock container yards (ODCY) spontaneously developed—with a 1,190,082 square meter capacity among 31 locations—to handle such functions as container storage and customs clearance, among others.

This spontaneous development and use of ODCYs in Busan led to profound inefficiencies in the handling of import and export containers. Import and export containers that went through these ODCYs faced an additional cost premium of at least 50,000 to 70,000 Korean won (approximately US\$45 to US\$60) per TEU. An additional effect occurred, in that it took up to 15 to 17 days for the imported containers to be delivered to shippers, while approximately 6,500 container trucks per day passed through the main arterial roads around the ODCYs, on average.

The concentration of Korea's import and export container volumes at the Port of Busan also led to severe road traffic issues on the Gyeongbu Expressway between Busan and Seoul's Capital Area. With the double-digit increase of trade traffic, the transport time for containers between Busan and the Seoul Capital Area increased sharply, from 7 hours in 1986 to 14 hours in 1990. The increase in lead times caused logistics and transport companies to increase their numbers of delivery vehicles, which subsequently led to further increases in the number of container and cargo trucks on the road. This eventually led to more road congestion that disrupted logistics companies' timeliness; these companies had to then move their cargo around the port in advance as their timely transport became difficult, which intensified the congestion around the Port of Busan.

Further, the congestion caused by the increase in container and cargo trucks on the Gyeongbu Expressway led to increased logistics lead times and additional costs, resulting in the decreased quality of import and export logistics services.

Against this backdrop, the Korean government set out to develop an inland logistics base concept, framed with a centrally designed policy process, to support a multimodal transport and logistics system.

Policy-Making Process to Develop Logistics Facilities in Korea

The government of Korea recognized the need for a systematic, government-level national logistics plan to properly support the logistics industry in accordance with the nation's rapid economic growth. Based on this need, the government established two national logistics plans: A Basic Plan for National Logistics (see table 5.5), and a

Comprehensive Plan (see table 5.6) for the Development of Logistics Facilities. The former was a master plan for essential national logistics, while the latter was established in conjunction with the initial Basic Plan. In other words, Korea's national logistics plan was a system in which the former and the latter were organically connected.

Table 5.5. System for the National Logistics and Development Plans by Logistics Facility

Top plan	Basic Plan for National Logistics			
Upper plan	Comprehensive Plan for the Development of Logistics Facilities			
Individual plans	Comprehensive plan for port complex development	Mid- to long-term comprehensive plan for airport development	Separate plan for agricultural and marine products distribution center	"Inland container depots (ICD)" "Integrated freight terminal (IFT)" "Logistics complex"
Facility name	"Port hinterland"	"Airport hinterland"	"Agricultural and marine products distribution center"	"General logistics terminal"

Source: Korea Transport Institute (KOTI).

The Basic Plan for National Logistics was established in 2001 in accordance with article 11 of the Framework Act on Logistics Policies. This statutory plan presented a comprehensive direction for development and a promotional strategy for Korean logistics facilities. This was also a basic but top-level plan that took precedence over other logistics-related plans established under other laws and regulations. Therefore, the Basic Plan for National Logistics covered all land, sea, and air logistics sectors while presenting a comprehensive developmental, directional, and implementation strategy for Korean logistics facilities.

The Korean government initially implemented its Basic Plan for National Logistics to cover at least a twenty-year period, with a revised plan to reflect changing conditions every five years. However, as internal and external environments continued to rapidly change, the Korean government implemented a rolling plan to re-establish its ten-year basic plan every five years, beginning in 2006. After its first Basic Plan for National Logistics (2001–20) was announced and established, the government of Korea provided two basic revisions to the Basic Plan for National Logistics (2016–25).

Currently, Korea's logistics facilities are being developed based on the Third Comprehensive Plan for the Development of Logistics Facilities Until 2022 (CPDLF). The key feature of this plan emphasizes the rational development of an efficient national logistics network through a systematic supply of logistics facilities, a natural

sequel to the focus of the first two plans: preventing redundant and excessive investments. The CPDLF also embraces the establishment of policy directions to supply and manage logistics facilities to address changing policies and industrial environments.

Table 5.6. Content of the Comprehensive Plans for the Development of Logistics Facilities

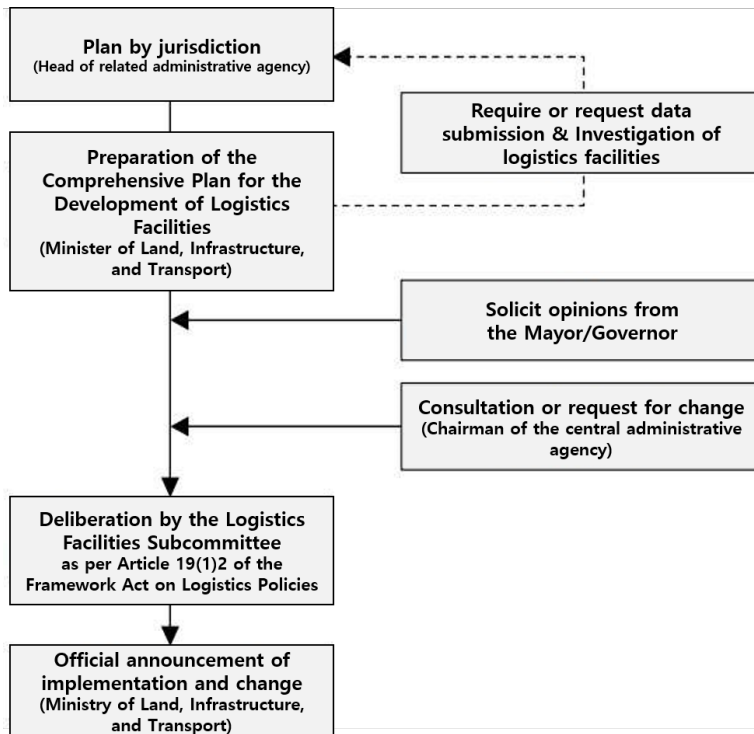
Classification	1st	2nd	3rd
Legal basis	Article 4 of the Act on the Development and Management of Logistics Facilities		
Purpose	(1st, 2nd)	<ul style="list-style-type: none"> – Search for ways to prevent redundant and excessive investment in logistics facilities and to build an efficient logistics network through the systematic supply of logistics facilities 	
	(3rd)	<ul style="list-style-type: none"> – Rational development for the distribution of logistics facilities and efficiency of logistics systems – Establishment of policy directions for the supply and management of logistics facilities over the next 5 years, in order to meet the changed policies and industrial environments 	
Period	2008–12 (5 years)	2013–17 (5 years)	2018–22 (5 years)
Major contents	Matters related to: <ul style="list-style-type: none"> – The supply policy of logistics facilities – The development and designation of logistics facilities – The functional improvement and efficiency of logistics facilities – The collective grouping of logistics facilities – The construction of a transport network for domestic and international logistics facilities – The environmental conservation management of other logistics facilities 		

Source: Korea Transport Institute (KOTI).

The Ministry of Land, Infrastructure, and Transport (MOLIT) is responsible for preparing the CPDLF based on the plans individually prepared by each jurisdiction. Once assembled, MOLIT refines the emerging version of the CPDLF by requesting additional data and research on the development of logistics facilities by jurisdictions as necessary. In addition, the comprehensive plan is subject to consultations with key agencies, such as the special metropolitan mayor, a metropolitan city mayor, a special self-governing city mayor, a province governor, and/or the governor of the special self-governing province (referred to as the mayor or governor hereafter). This version of the CPDLF is then deliberated by the Logistics Facilities Subcommittee, in accordance with article 19(1)2 of the Framework Act on Logistics Policies, prior to

announcing its implementation (figure 5.2).

Figure 5.2. Procedure for Establishing the Comprehensive Plan for the Development of Logistics Facilities



Source: Ministry of Land, Infrastructure, and Transport (MOLIT).

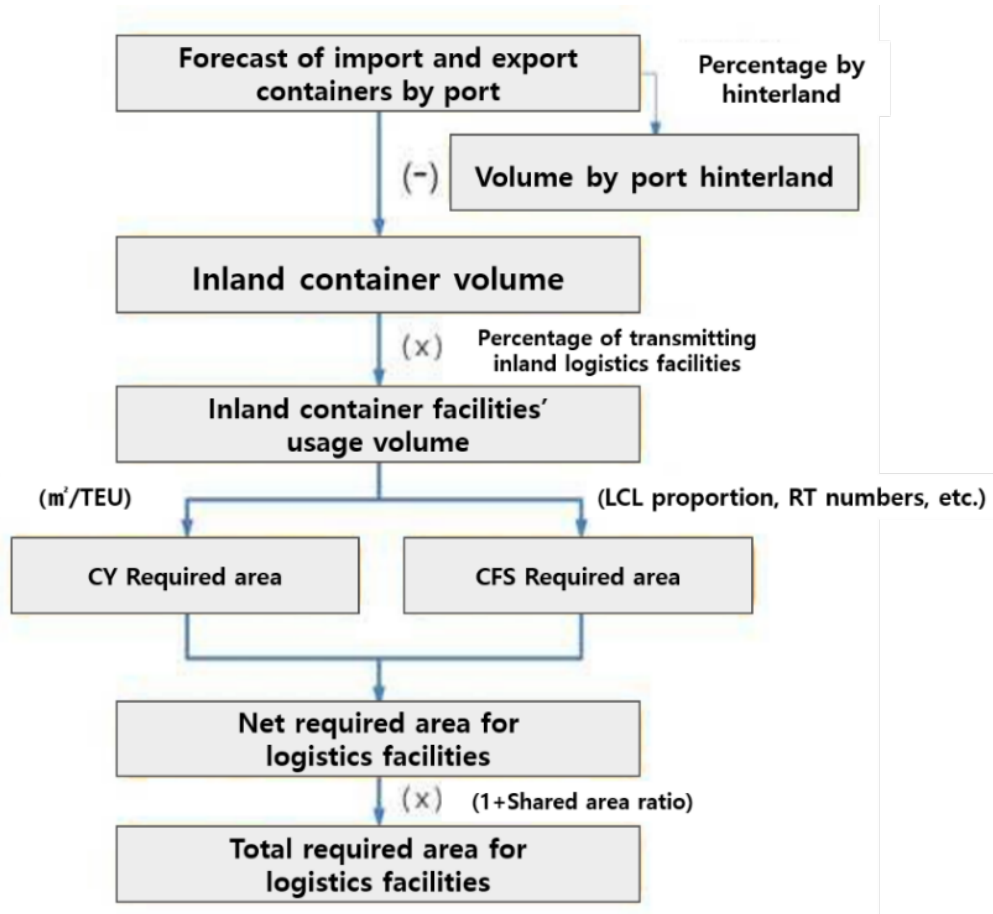
The CPDLF includes an estimation of the supply and demand of logistics facilities, including (1) international logistics facilities, such as port or airport hinterlands; (2) integrated logistics facilities, such as inland container depots (ICDs), integrated freight terminals, logistics complexes, and agricultural and marine product distribution centers, among domestic logistics facilities; and (3) stand-alone logistics facilities, such as rail container yards. Stand-alone logistics facilities are similar to integrated logistics facilities in their functions, such as container handling, and are thus included as logistics facilities subject to supply and demand, because they affect the demand for logistics facilities.

The supply and demand estimates for international logistics facilities build on individual plans' demand forecasts and existing reported supply as well as the demand forecast for the facilities to be supplied centrally. These estimates are used to predict the demand for integrated logistics facilities and stand-alone logistics facilities. All results take as a framework Korea's regions, carefully classified by

separating the 16 cities and provinces into 42 regions according to the National Transportation Database's 250-zone division system by city, county, and district.

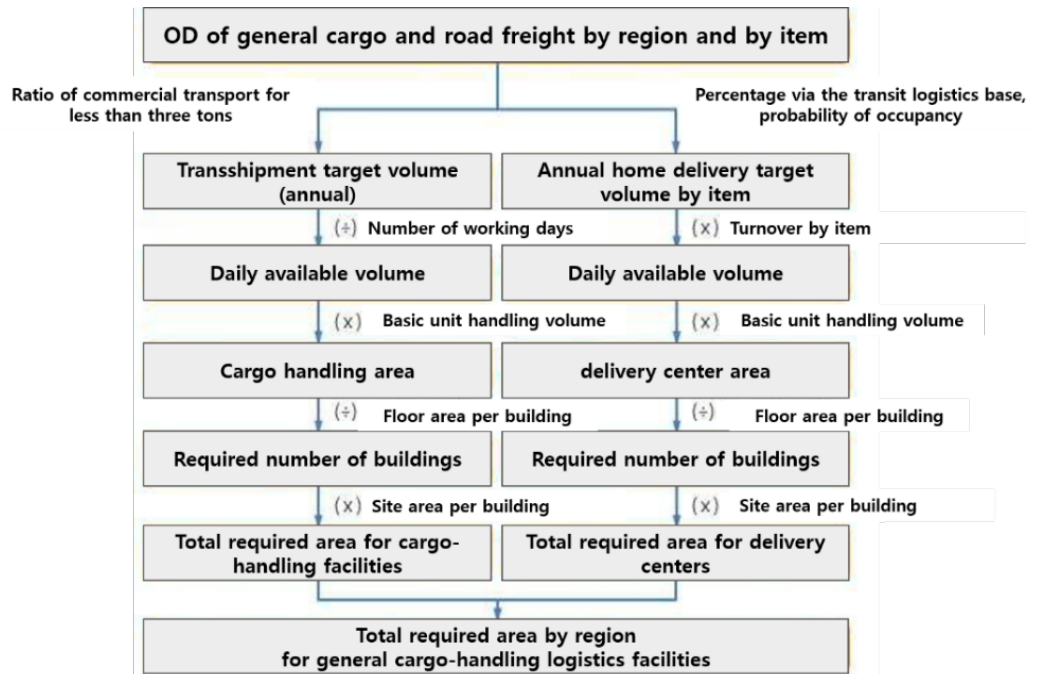
Additionally, the demand and required areas for the ICDs and general cargo-handling facilities have been estimated (estimates procedures are detailed in figure 5.3 and figure 5.4).

Figure 5.3. Procedure for Estimating the Required Area for Inland Container-Handling Facilities



Source: Ministry of Land, Infrastructure and Transport (MOLIT).

Figure 5.4. Procedure for Estimating the Required Area for General Cargo-Handling Facilities



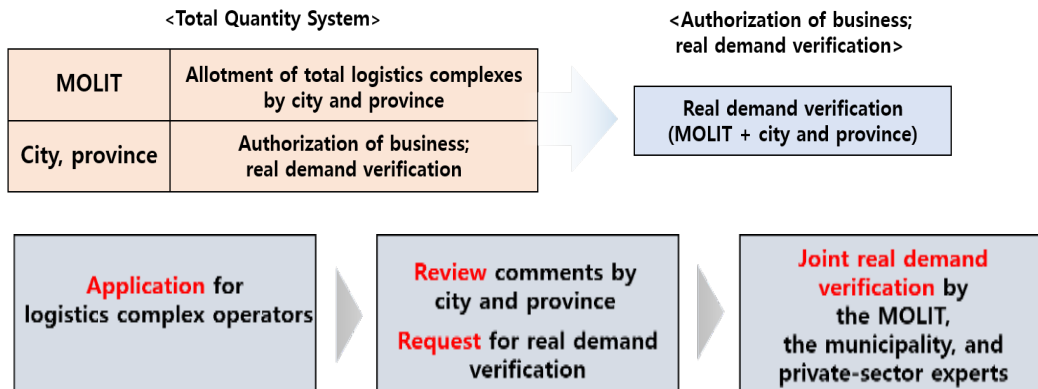
Source: Ministry of Land, Infrastructure and Transport (MOLIT).

A regional supply plan is then established by categorizing the logistics facilities as regional or local. This excludes the already available supply area from the total required area for inland container- and general cargo-handling facilities. Planned supply target facilities should be established around integrated logistics facilities by considering the groups of international and domestic logistics facilities. As the unit facilities are logistics facilities developed in accordance with market economy principles, quantitative planning management is impossible; supply plans can only be offered for some facilities, such as railroad container yards, which could functionally overlap with ICDs.

Prior to the June 2014 abolition of Korea's total quantity system, the total number of logistics complexes by city and province was determined for five years through the CPDLF. Additionally, the total number of logistics facilities by city and province was calculated by subtracting the supply forecast for logistics facilities from the five-year demand forecast based on the National Transportation database. However, problems occurred when the total five-year supply by city and province was set in advance—including an inability to meet demand in a timely manner, oversupply, problems in development, and unsold volume—due to the lack of verification of real demand. After the total quantity system for logistic complexes was abolished, the real demand verification system for logistics complexes was introduced to only construct logistics complexes when real demand could be verified. Simultaneously, the city- and provincial-level authorization of businesses, which had operated based on the total

quantity system, was also abolished (figure 5.5).

Figure 5.5. Policy Changes in Logistics Complexes' Development



Source: Ministry of Land, Infrastructure and Transport (MOLIT).

The real demand verification system for logistics complexes aimed to induce real end-user development and minimize the damage to local residents and the public caused by excessive business promotions or speculative development, among other factors. The most important part of the real demand verification system is its move-in demand and implementation capabilities; important factors among its implementation capabilities include the determining of land status and financing capabilities.

ICDs and general logistics terminals estimate their demand and create supply plans based on the CPDLF. The cargo demand and required area are determined in accordance with the standards set by the government, which then creates regional supply plans. Consequently, logistics complexes can respond flexibly to demands due to the introduction of the real demand verification system. As such, the Korean government actively manages the development of its logistics infrastructure, as it can manage and regulate its supply.

The government of Korea further developed its supply of logistics facilities by legislating the Act on the Development and Management of Logistics Facilities to provide a basis for related administrative and financial support. Administrative support under this law include a simplified authorization agenda and authorization process. In accordance with articles 21 and 30 of this act, authorizations for changes to land, such as its shape and quality, are deemed to have been granted under the National Land Planning and Utilization Act. MOLIT, city mayors, or provincial governors can then authorize any construction or modification for the logistics terminal operator or logistics complex designee; alternatively, they can consult with the head of the relevant administrative agency or announce such construction project

or modifications. Additionally, the logistics complex can be designated and developed by applying the Special Act for the Simplification of Authorization and Permission Procedures for Industrial Complexes in accordance with article 59(2) of the National Land Planning and Utilization Act. Such a procedure allows for the pursuit of 29 matters related to authorization and approval through an integrated review that can be completed within six months.

The Inception of Inland Logistics Bases in Korea

In the face of congestion issues, inefficiencies, and socioeconomic challenges derived from a rapid increase in import and export containers and cargo concentrated along a one-country development axis, the government of Korea pursued both port expansion and the construction of a network of multimodally connected ICDs. The purpose was to improve the container transport system's efficiency through the Social Indirect Capital Investment Coordination Committee under the Economic Planning Board (currently the Ministry of Economy and Finance).

The government of Korea also pursued further development of the Ports of Busan and Gwangyang to expand these maritime facilities. It also invested ₩186.2 billion in Korean won (approximately US\$150 million) to improve the Port of Busan's container-handling capacity, and completed the third and fourth stages in its development in 1991 and 1994 respectively. Such developments secured the nation's ability to process an additional 2.2 million TEUs.

In parallel, the government of Korea pursued the construction of ICDs that would have the same effect as port expansion, but relatively less expensive and over a relatively shorter time. The construction of ICDs was also advantageous, in that it could increase the rail transport rate among import and export containers. Thus, the government simultaneously built the ICDs while expanding its railway infrastructure.

Inland logistics depots were completed at the Uiwang and Yangsan ICDs in the Seoul Capital Area and in Busan, respectively, to serve as major facilities to handle the Port of Busan's cargo volume. The Uiwang ICD in the Seoul Capital Area reorganized what was originally a rail freight base in southern Bugok, and started operations in the second half of 1993. The government of Korea started construction of the Uiwang ICD's Terminal 2 in December 1994—which opened it in January 1997—to expand the import and export handling capacity in Seoul's Capital Area; the Yangsan ICD construction started in December 1994, with operations beginning in April 2000.

The government of Korea adopted its third sector development method to ensure its expertise in developing and operating inland container depots. This development method involves the government's purchasing of necessary land; it then selects a third single operating entity, which will be guaranteed the right to operate for a certain period of time before returning it to the government after this period expires.

The third sector development method took the form of a public-private partnership (PPP), through the build-operate-transfer (BOT) approach in particular, which was a somewhat unfamiliar implementation format at the time. Additionally, the government of Korea laid the foundation for an integrated import and export logistics services system by granting customs clearance and financial functions to ICDs and integrating its computer system with the Port of Busan. The government supported the ICDs so they could operate as not only ODCYs, but also as import and export logistics facilities that perform some port functions (similar to the extended gateway concept discussed in the European context). For example, by constructing the Uiwang ICD, import and export cargo for the Seoul Capital Area could be directly delivered to Uiwang from the Port of Busan, and vice versa, while also receiving custom clearance services at the ICD instead of the port. Moreover, the Yangsan ICD was allowed to collect import and export cargo from the Yeongnam and Honam regions and perform customs clearance. In constructing the Yangsan ICD, it was possible to eliminate Busan's 31 private ODCYs, resolving regional traffic problems and reducing logistics costs in the process.

The Current Level of Logistics Facilities in Korea

According to article 2 of the Act on the Development and Management of Logistics Facilities, "logistics facilities" refer to: (1) facilities for transport, storage, and unloading; (2) facilities that relate to transport, storage, and unloading, and intended for processing, assembly, classification, repair, packaging, labeling, sales, and information and communications activities; (3) facilities for the common dispersion, automation, and informatization of logistics; and (4) the logistics terminals and logistics complexes (that is, *clusters*) where the aforementioned facilities are gathered. Additionally, the act specifies these facilities can be classified by function as either unit, integrated, or related logistics facilities. This section will explain the current status of both unit and integrated logistics facilities.

Stand-alone logistics facilities

A stand-alone logistics facility is the smallest facility that conducts individual logistics activities, and includes rail container yards, general logistics terminals, home-delivery centers, and warehouses, among other facilities. This section discusses the operational status of warehouses and rail container yards, which are the most representative of stand-alone logistics facilities.

Warehouses

Regarding the current status of logistics facilities as per the National Logistics Integrated Information Center, 3,635 companies in logistics and warehousing were registered as of February 25, 2020 (<http://nlic.go.kr/nlic/WhsStatsWarehouseLocation.action>). Of these, 1,312 warehousing companies were registered under the Act on the Development and Management of Logistics Facilities (table 5.7), while 2,323 warehousing companies were registered under other laws, such as the Harbors Act, Customs Act, Chemical Control Act, Food Sanitation Act, Livestock Products

Sanitary Control Act, and Food Industry Promotion Act. According to the distribution by region, 1,689 (46.5 percent) and 1,946 nonmetropolitan areas (53.5 percent) were in the Seoul Capital Area and non-Seoul Capital Area respectively, with most concentrated in the former. Regionally, Gyeonggi-do had the most warehousing companies, with 1,216 (3.5 percent), followed by Gyeongsangnam-do with 429 (1.8 percent). Warehouse registration indicates the Busan and Incheon metropolitan areas had 347 (9.5 percent) and 345 (9.5 percent) such companies respectively, while Gyeonggi-do had the largest distribution of logistics warehouses among all regions (figure 5.6). This is due to not only the high demand for warehouse handling logistics facilities in the Seoul Capital Area, but also the relatively lower costs to establish warehouses in Gyeonggi-do than in Seoul.

Table 5.7. Operational Status of National Logistics Warehouses, 2020

Location	National Integrated Transport System Efficiency Act	Harbors Act	Customs Act	Chemical Control Act	Food Sanitation Act	Livestock Products Sanitary Control Act	Food Industry Promotion Act	Total	Ratio (%)
	Warehouse	Port warehouse	Bonded warehouse	Storage warehouse	Refrigerated warehouse	Livestock storage	Refrigerated warehouse		
Total	1,312	209	603	153	515	519	326	3,635	100
Seoul	671	52	320	71	232	264	79	1,689	46.5
Other	641	157	283	82	283	255	247	1,946	53.5

Source: Korean National Logistics Integrated Information Center.

Figure 5.6. Regional Logistics Warehouse Registrations



Source: Korean National Logistics Information Center.

As of 2020, the 1,312 logistics warehouse businesses registered in accordance with the Act on the Development and Management of Logistics Facilities covered a total of 14,708,758 square meters (see table 5.8); the total warehouse area in the Seoul Capital Area covered 8,000,412 square meters, accounting for 54 percent of Korea's total warehouse area; and Gyeonggi-do accounted for 6,827,782 square meters, or 85.3 percent of the Seoul Capital Area's warehouse area. Further, Gyeonggi-do accounted for 46.4 percent of Korea's total warehouse area, and was the largest among all regions. Chungcheongbuk-do accounted for 1,181,271 square meters, followed by Gyeongsangnam-do with 1,085,805 square meters.

Table 5.8. Logistics Warehouses by Area

Classification	No. of Businesses	Ratio (%)	Total area (㎡)	Ratio (%)
Seoul	35	2.7	354,151	2.4
Busan	25	1.9	203,816	1.4
Daegu	23	1.8	137,721	0.9
Incheon	100	7.6	818,479	5.6
Gwangju	32	2.4	228,954	1.6
Daejeon	21	1.6	642,435	4.4
Ulsan	24	1.8	154,506	1.1
Sejong	15	1.1	523,925	3.6
Gyeonggi-do	536	40.9	6,827,782	46.4
Gangwon-do	47	3.6	233,096	1.6
Chungcheongbuk-do	53	4.0	1,181,271	8.0
Chungcheongnam-do	57	4.3	506,947	3.4
Jeollabuk-do	39	3.0	310,268	2.1
Jeollanam-do	60	4.6	902,869	6.1
Gyeongsangbuk-do	67	5.1	521,316	3.5
Gyeongsangnam-do	158	12.0	1,085,805	7.4
Jeju Island	20	1.5	75,417	0.5
Total	1,312	100.0	14,708,759	100.0

Source: National Logistics Integrated Information Center.

Rail Container Yards

Korea has 31 rail container yards (958,851 square meters), with a representative rail container yard located at Busanjin Station (table 5.9).

Table 5.9. Status of Rail Container Yards

Classification		Area (m ²)	Start of operation	Handling capacity (TEUs, thousands per year)	Remarks
Obong	No.1 Terminal	274,008	7/20/1984	921	
	No. 2 Terminal	145,042	1/1/1997	487	
	Rail yard	9,326	11/6/1909	31	
	Subtotal	428,376		1,439	
Busanjin	Complex 1	74,413	18/9/1972	250	
	Complex 2	17,730	28/4/1993	59	
	Complex 3	30,307	12/5/1988	101	
	Subtotal	122,450		410	
Dongsan		15,630	23/1/1989	52	
Sapgyo		16,500	28/11/1908	55	
Bugang		7,003	14/1/1994	23	Rail transport suspended
Dongiksan		16,500	21/5/1911	55	
Maepo		4,233	1/11/1906	14	Rail transport suspended
Sintanjin	Complex 1	10,190	13/5/1913	34	
	Complex 2	9,600	1/9/1917	32	
	Subtotal	19,790		66	
Okgye		8,834	30/7/1916	29	
Heungguksa	Korea Express	4,750	29/12/1994	16	
	KORAIL	650	29/7/1906	2	
	Subtotal	5,400		18	
Yakmok	Yakmok	7,508	3/2/1995	25	
	Chilgok	28,632	1/2/1905	96	
	Subtotal	36,140		121	
Chungju	Kukbo	8,942	9/19/1995	30	Rail transport suspended
	KORAIL	8,687	1/1907	29	Rail transport suspended
	Subtotal	17,629		59	
Jungju		7,664	1/15/1907	25	
Okcheon		5,449	1/10/1996	18	
Ulsan Port		10,846	3/15/1996	36	
Gaya		13,683	4/1/1996	45	Rail transport suspended
Sinchangwon		18,980	1/10/1997	63	Rail transport suspended
Onsan		19,060	10/1997	64	Rail transport suspended
Apo		4,516	7/1/1998	15	Rail transport suspended
Sojeongri		5,017	12/17/1999	16	
Gunsan		16,500	2/18/1908	55	
Doojeong		12,568	7/1/1902	42	
Seokpo		1,500	3/7/1903	5	
Gwedong		12,740	9/10/1909	42	Rail transport suspended
Donghae		1,611	5/30/1910	5	
Incheon		6,380	10/4/1911	21	Rail transport suspended
Busan Sinhang		17,210	11/1/1912	57	Rail transport suspended
Gwangyang Port		59,657	12/30/1998	200	Rail transport suspended
Singwangyang Port		9,500	7/8/1910	31	
Munsu		3,530	6/10/1913	11	
Hanam		33,935	11/20/1913	114	Rail transport suspended
Total		958,851		3,206	

Source: Internal data provided by the Korea Railroad Corporation.

Integrated Logistics Facilities

Integrated logistics facilities involve two or more stand-alone logistics facilities installed together. It includes an integrated freight terminal (IFT), ICDs, and a logistics

complex.

Inland logistics base

The inland logistics base (figure 5.8) is a logistics facility capable of connecting two or more modes of transportation, such as roads, railways, ports, or airports. It has the same import and export clearance facilities as ports while connecting railway-road modes of transportation to include ICDs and IFTs. The ICD is an inland logistics base that provides storage and handling services for containers. Further, the IFT is equipped with a cargo-handling center, delivery center, and multiple warehouses, and handles such domestic general cargo as home shopping and parcel products. Approximately 10.7 million square meters of goods have been supplied through the nation's five major inland logistics bases in the regions of Seoul Capital, Busan, Honam, Central, and Yeongnam.

Figure 5.8. Korea's Five Largest Regional Inland Logistics Bases



Source: Korea Transport Institute (KOTI).

The Uiwang ICD and Gunpo IFT were established in the Seoul Capital Area and are currently in operation (table 5.10). The Uiwang ICD supplies containers to the Seoul Capital Area, and is Korea's core hub in charge of the customs clearances for export-import containers involving cargo transport, storage, and unloading. It is the largest container base in the Seoul Capital Area, and can handle 1.37 million TEUs per year.

The Gunpo IFT is a logistics hub in the Seoul Capital Area that handles domestic cargo at an optimal delivery point which could host a broadband delivery network. In the Busan area, the Yangsan ICD and ITF were built to operate in connection with the Port of Busan, which is the nation's largest port for imports and exports. As an inland port connected to the Port of Busan, the Yangsan ICD is the area's largest integrated container and cargo logistics base that performs such functions as customs clearances, the storage and arrangement of cargo, and inland transportation, among others. Additionally, the Yangsan IFT supervises a wide delivery area in the southeast region, including the cities of Busan, Ulsan, and Gyeongnam. Although inland logistics bases were created in the central region, the Yeongnam and Honam regions lack bases to handle containers; thus, the demand for services from private logistics companies has recently increased to handle increased courier volume seen among all regions.

Table 5.10. Status of Supply and Operation of Inland Logistics Bases

Area: TEUs, thousand square meters; container handling capacity: TEUs, thousands per year

Classification	Terminal name/operating company	Handling capacity	Operating performance				
			2014	2015	2016	2017	2018
SCA	Gunpo IFT/Korea Integrated Logistics (Corp.)	Area: 304	79.8% (243)	87.7% (266)	93.2% (283)	96.7% (294)	98.1% (298)
		Area: 311 ^a	96.3% (300)	98.5% (307)	99.3% (309)	99.4% (310)	99.6% (310)
	Uiwang ICD/Uiwang ICD(Corp.)	Container: 1,370	73.6% (1,008K)	71.9% (985K)	68.5% (939K)	64.9% (890K)	64.6% (885K)
BMA	Yangsan IFT/Korea Integrated Logistics (Corp.)	Area : 177	78.9% (140)	89.9% (159)	89.8% (159)	96.9% (172)	94.2% (167)
	Yangsan ICD/Yangsan ICD (Corp.)	Container: 1,369	13.0% (139K)	12.3% (131K)	15.0% (160K)	15.1% (161K)	13.9% (149K)
Honam	Honam IFT and ICD/Korea Integrated Logistics (Corp.)	Area: 44	87.0% (80)	94.6% (87)	95.8% (88)	99.6% (91)	99.5% (107)
		Container: 340	17.6% (62K)	23.2% (81K)	17.1% (60K)	15.3% (53K)	15.4% (54K)
Central	Central IFT and ICD/Korea Integrated Logistics (Corp.)	Area: 92	80.0% (35)	76.7% (34)	77.7% (34)	94.6% (42)	95.7% (42)
		Container: 350	—	—	1.6% (5K)	2.2% (8K)	1.2% (4K)
Yeongnam	Yeongnam IFT and ICD/(Corp.) Yeongnam Area Integrated Freight	Area: 146	100.0% (146)	80.1% (117)	87.4% (127)	91.8% (134)	87.0% (127)
		Container: 330	3.6% (12K)	4.6% (15K)	1.2% (4K)	0.6% (2K)	0.4% (1.4K)
Total	IFT operating rate	Area: 1,069 ^b (excluding Gunpo expansion: 758)	87.8% (943)	90.3% (970)	93.2% (1,001)	97.0% (1,042)	96.4% (1,035)
	ICD transport results	Container 3,759	35.3% (1,220K)	35.0% (1,212K)	33.8% (1,168K)	32.2% (1,114K)	31.6% (1,093K)

Source: Ministry of Land, Infrastructure and Transport (MOLIT).

Notes: ICD = inland container port; IFT = integrated freight terminal; KFT = SCA = Seoul Capital Area; BMA = Busan Metropolitan Area; K = thousand; TEU = twenty-foot equivalent unit.

a. Including Gunpo expansion; b. Not considering changes in ICD usage.

The demand for general logistics facilities, such as delivery centers, has increased due to the increased demand for everyday logistics, such as e-commerce and parcel services. Thus, as port hinterlands expanded—such as in Busan’s New Port—IPTs’ operating rate soared, from 87.8 percent in 2014 to percent in 2018; in contrast, the ICD operating rate decreased, from 35.3 percent in 2014 to 31.6 percent in 2018.

Logistics complex

In addition to the inland logistics base, the representative integrated logistics facility includes the logistics complex, or land with a group of facilities designated and developed to collectively install and foster logistics complex facilities and support facilities. This complex provides various transportation, collection, unloading, classification, packaging, processing, assembly, customs clearance, storage, sales, and information processing, among other functions. The objective is to improve efficiency in Korea’s logistics system through the collective grouping of logistics facilities.

As of February 2020, 47 logistics complexes were in operation (16 public and 31 private), with 7 under construction, and 17 that have passed a verification process (table 5.11). All logistics complexes that have successfully passed this process are private investment projects related to the rapidly increasing designation of logistics complexes in the Seoul Capital Area, as the demand for everyday logistics in urban areas has rapidly increased. Domestic logistic complexes have been increasingly developed by private rather than public developers since the 2010s; of all domestic logistics complexes, 66 percent have been developed using private capital.

Table 5.11. Status of Logistics Complexes

Classification		Number
Capital	Progress status	
Public	Under construction	1
	In operation	15
	Subtotal	16
Private	Passed verification	17
	Under construction	6
	In operation	8
Subtotal		31
Total		47

Source: Korean National Logistics Information Center.

General Logistics Terminals

Starting with the Dongbu Logistics Terminal in Seoul in the 1970s, 34 locations were designated as general logistics terminals by 2012, with a supply area of 1.531 million square meters of total site area and 498 square meters of building area (table 5.12).

Table 5.12. Operation and Development Status of General Logistics Terminals

No.	Area	Name	Area (m ²)	Architectural area (m ²)	Construction approval date (m/d/yyyy)	Operator
Total		34 Places	1,531,579	498,088		
1	Seoul	Korea IFT	96,017	24,792	3/31/1990	(Corp.) Halim
2	Seoul	Seobu Truck Terminal	112,111	41,640	9/29/1979	(Corp.) Seobu Truck Terminal
3	Seoul	Dongbu Logistics Terminal	19,463	4,465	8/10/1975	(Corp.) Shinsegae
4	Busan	Busan Logistics Terminal (Corp)	85,667	11,753	11/12/1992	Busan Logistics Terminal (Corp.)
5	Daegu	Seobu Logistics Terminal	70,022	15,991	1/12/1996	(Corp.) Daegu Logistics Terminal
6	Daegu	Bukbu Logistics Terminal	9,878	2,016	4/21/2001	(Corp.) Gyeongbuk Distribution Industry
7	Daegu	Dongbu Logistics Terminal	34,510	7,822	1/20/2006	(Corp.) Dongdaegu Cargo Terminal
8	Incheon	Yeongchang Cargo Truck Terminal	30,460	5,474	2/16/1983	(Corp.) E-tech Construction
9	Incheon	Incheon Hanjin Logistics Terminal	43,538	12,983	4/12/1994	(Corp.) Hanjin
10	Incheon	Incheon Truck Terminal	45,985	1,879	2/4/1999	(Corp.) HJLogistics
11	Gwangju	Gwangju Cargo Terminal	35,765	5,997	3/4/1983	Gwangju Cargo Terminal (Corp.)
12	Gwangju	Pungam Logistics Terminal	39,304	18,994	7/29/2004	(Corp.)LST
13	Daejeon	Jungbu Daejeon Logistics Terminal	59,556	22,074	12/3/2001	Jungbu Daejeon Logistics Terminal (Corp.)
14	Daejeon	Daejeon Cargo Terminal	60,242	36,561	9/20/1990	CJ Korea Express (Corp.)
15	Ulsan	Ulsan Cargo Terminal	41,593	13,456	5/18/1995	(Corp.) Ulsan Cargo Terminal
16	Gyeonggi	Hanjin Cargo Terminal	9,395	3,331	9/1/2001	(Corp.)Hanjin
17	Gyeonggi	Ansan Cargo Terminal	42,946	19,359	4/14/1995	Daekyung TLS
18	Gyeonggi	Ansan Logistics Terminal	35,592	3,826	12/8/1999	(Corp.) Hanjin
19	Gyeonggi	Pyeongtaek Logistics Terminal	16,473	4,076	4/29/2009	Moorim Transport (Corp.)
20	Gyeonggi	Jungbu Cargo Terminal	160,086	98,767	1/7/1999	(Corp.) Jungbu Cargo Terminal
21	Gyeonggi	Sihwa Cargo Terminal	50,841	8,513	7/3/1997	(Corp.) Korea Express
22	Gyeonggi	Hansaem Logistics Terminal	60,086	47,845	10/17/2012	(Corp.) Hansaem
23	Gyeonggi	Seobu Cargo Terminal	16,500	4,822	7/15/1996	(Corp.) Seobu Cargo Terminal

24	Chungbuk	Chungju Cargo Terminal	19,654	4,776	7/8/1989	(Corp.) Chungju Cargo Terminal
25	Chungbuk	Boeun Cargo Terminal	13,127	568	1/24/1996	(Corp.) Hyeongje Industrial
26	Chungnam	Asan Logistics Terminal	21,475	545	7/10/1997	(Corp.) Asan Shipping Cargo Loading
27	Chungnam	Jungbu Logistics Terminal	33,896	9,821	5/4/1999	(Corp) Jungbu Cargo Terminal
28	Jeonbuk	Iksan Integrated Cargo	23,924	4,674	1/9/1999	(Corp.) Siniksan Cargo Terminal
29	Jeonnam	Yeochun Cargo Terminal	11,131	2,155	3/16/1999	(Corp.) Yeochun Cargo Transport
30	Jeonnam	Yeochun Truck Cargo Terminal	16,518	4,565	12/29/2000	(Corp.) GS Caltex
31	Jeonnam	Yeosu Logistics Terminal	51,268	39,260	5/20/2011	(Corp.) City Industrial Development
32	Gyeongbuk	Samil Logistics Terminal	109,833	5,845	6/7/2011	(Corp.) Samil
33	Gyeongbuk	Gumi Logistics Terminal	33,148	6,716	3/25/1996	(Corp.) Gumi Cargo Terminal
34	Gyeongnam	Jinju Cargo Terminal	21,575	2,727	1/31/1987	(Corp.) Jinju Cargo Terminal

Source: Korean National Logistics Information Center.

Joint Collection and Delivery Center

The Ministry of Trade, Industry, and Energy designated three joint collection and delivery centers under the Distribution Industry Development Act: Pyeongtaek Doil, Ulsan Jinjang, and Yongin Dongcheon (table 5.13). Pyeongtaek Doil and Ulsan Jinjang are located in logistics complexes, and are currently in operation. However, the designation for the Yongin Dongcheon joint collection and delivery center was revoked in March 2018, six years after receiving the designation, due to its nonconformity with facility standards and usage criteria. The Incheon Logistics Center in Oryu-dong received its designation as a joint collection and delivery center in 2016, and was built in the Incheon Ara Waterway Logistics Complex.

Joint Wholesale Logistics and Distribution Centers for Small- and Medium-Sized Distribution Enterprises

As of December 2018, Korea had 39 joint wholesale logistics and distribution centers, with a total gross area of approximately 10,000 square meters (table 5.14). Of these 39 centers, 35 are currently operating and 4 are under construction: Jeonnam Goheung, Chungnam Seosan, Gyeongnam Gimhae, and Gyeongbuk Pohang. Most are operated by local supermarket cooperatives and supply goods to local supermarkets.

Table 5.13. Status of Joint Collection and Delivery Centers

Name	Location	Site area (m ²)	Operator	Designation date (m/d/yyyy)	Business period	Hosting facility
Pyeongtaek Doil	Doil-dong, Pyeongtaek, Gyeonggi-do	201,975	Pyeongtaek City Hall	8/5/2005	2005–07	Inside the logistics complex
Ulsan Jinjang	Jinjang-dong, Ulsan	27,554	(Corp) KCC	1/8/2010	2010–11	Inside the logistics complex
Incheon Oryu	Oryu-dong, Incheon	25,510	Daeshin Jeonggi Shipping (Corp)	21/9/2016	2016–18	factory, loading dock, warehouse, or other facility

Source: Ministry of Trade, Industry, and Energy.

Note: Five collection and delivery complexes (Busan, Daegu, Gwangju, and Seoul Capital Area Zones I and II) were created in October 1988 under the Five-Year Plan for the Promotion of Wholesale and Retail Businesses, and are currently in operation.

Table 5.14. Status of Small and Medium-Sized Distribution Centers by City and Province

Area	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Gyeonggi	Chungbuk	Chungnam	Jeonbuk	Jeonnam	Gyeongbuk	Gyeongnam	Gangwon	Jeju	Total
No. of centers	1	3	1	1	1	1	8	3	3 (1)	5	3 (1)	4 (1)	4 (1)	-	1	39 (4)

Source: Joint Wholesale Logistics and Distribution Centers for Small and Medium Distribution Enterprises.

Note: The number of centers under construction are denoted in parentheses.

6. Lessons Learned from the European and North American Experience

The Different Types of Logistics Clusters

The term **logistics clusters**, as used in the title of this publication, has no commonly accepted definition, though “cluster” implies a high presence of logistics services provision. Some interpret cluster to be related to a certain area while others interpret it as group of organizations involved with logistics. In literature and practice, many alternative terms and definitions are applied, for example for logistics zone or center, inland port, freight village, and logistics hub, and often interchangeably.

In order to include important lessons in the most comprehensive way, this lessons learned chapter will not follow a strict definition. The prime focus, however, will be on the “territorial” interpretation, and for that reason the term **logistics centers** is used. A logistics cluster refers to bordered territories under a specific management entity. The focus here, as in the study, will also be on **integrated logistics centers** (ILC), which are logistics clusters well-connected to the multimodal transport network, and therefore also to inland locations. This excludes the often sizeable logistics territories adjacent to maritime ports and international airports and logistics cluster connected only to road infrastructure.

The main distinction between ILCs lies in their functions and ambitions in serving supply chains. On one end of the spectrum, the inland hubs and inland gateways for international trade have roles reaching far beyond the needs of their immediate region. Seaport satellite ports and other inland ports are also part of international supply chains, adding capacity to seaports and support them by reducing road traffic in the ports during congested hours. On the other end of the spectrum are logistics centers, serving primarily the needs of the surrounding region, such as consolidating and distributing local freight. The most common ILCs, in urban areas, serve local interests by reducing heavy goods vehicle traffic and avoiding conflicts of land use. ILCs designed to serve a specific industry of a region and connect to regions active in the same supply chains provide another example, specifically in the supply chains of automotive and chemicals industries.

A common principle shared by all logistics centers is their role in the (de)consolidation of cargo flows. It is important to recognize the different positions in supply chains—such as adding value or distributing imports versus channeling exports—in the transport systems. In addition, distinctions between ILC roles are fluid and ILCs could have the characteristics of more than one type.

How to Ensure Multimodal Connectivity

The foundation of the ILC's multimodal connectivity is the presence of a good transport infrastructure network. Even though this criterion seems obvious, in practice this network is not always sufficiently addressed. On a most basic level, it is necessary to verify path-of-way dimensions for multimodal traffic in the connecting infrastructure. In the European Union (EU) for example many rail routes are not suited for certain types of multimodal cargo, mostly because of the height of loading units (high cubes and high-volume semitrailers) on wagons. Also, in some examples, bridges appear to be too low for barges carrying more than three layers of containers, or become a constraint with high water levels or when using high-cube containers.

A second important aspect is the layout and capacity of the transshipment facilities, on both ends of the multimodal journey. In the ILC, rail terminals capable of receiving full trains are highly preferable above suboptimal solutions, which require shunting between the terminal and a marshaling yard. This makes multimodal transport operations more competitive, improves the capacity of the terminal, and avoids fragmented traffic on the railway stretch between the terminal and marshaling yard. In the recent past, many rail yards with multiple short loading tracks closed down and were replaced by facilities outside of the urban areas. Several of the freight villages (FVs) in Germany, for example, originated in such relocation.

Transshipment facilities in the ILC must coincide with the facilities on the other end, usually seaports. Shorter train lengths in the ILC will compromise the efficiency of entire multimodal service. If differences are extreme, an intermediate deconsolidation in a marshaling yard will be needed, which adds to costs and travel times and is a risk to punctuality. The compatibility with seaport infrastructure needs to be assessed case by case. For example, the Port of Los Angeles has a near dock facility for full trains of up to 2,400 meters length, which excellently serves few large-scale inland locations, such as the CenterPoint Intermodal Center (CIC) near Chicago. The downside, however, is that the Port of Los Angeles cannot optimally serve shorter trains, which would be attractive for calls at smaller inland terminals and for shuttle services over short distance. The Port of Rotterdam and other European seaports have rationalized their internal railway networks and concentrated container transshipments into a limited number of railway terminals, which resolved bottlenecks in the ports internal railway systems. These ports discourage the use of short trains, because it would negatively affect their infrastructure utilization rates.

Inland barge traffic presents a particular case in seaports. Barges could be served on dedicated barge quays; however, more common is that they use the same quays and handling equipment as the ocean vessels. Heavily utilized seaport terminals lead to long and unpredictable waiting times for inland barges. With ocean and barge traffic steadily increasing, the Port of Rotterdam has almost continuously sought solutions to handle this problem, together with stakeholders in the transport chain. One of the more effective solutions involves increasing the call sizes of barges to reduce the

number of barge calls, which addresses hinterland operators to (de)consolidate container batches from and into barges in inland terminals.

Land is often scarcely available and, in such case, it will be important to prioritize the locations for transshipment in transport planning. This is, for example, done by the German state of Nord Rhein Westphalia. The state actively engages all municipalities adjacent to core infrastructure to prevent developments near pre-identified terrains that could lead to conflicts of use with logistics activities, for which expansion is inevitably needed. In a similar way, the Dutch corridor-approach supports only those spots holding long-lasting development potential for multimodal transport services and logistics services.

Before investing, a convincing business case should prove viability of the foreseen multimodal transport services, with no clear rule deciding on, for instance, the minimum distance between seaports and inland terminals. Literature refers to break-even distances for multimodal transport solutions of 700 kilometers in Europe and 700 miles in the United States; to become competitive, multimodal solutions should, in theory, be situated further apart than these stated distances. Practice, however, proves otherwise. The largest client of the Virginia Inland Port, Home Depot DC, is located approximately 12 kilometers from the terminal, while a direct road trip to Virginia's seaport complex is about 300 kilometers. In Europe, many of the multimodal services in connection with seaports, railways, and barges, are far closer than 500 kilometers. None of the terminals in the Netherlands lies more than 250 kilometers from the Port of Rotterdam. An extreme example is the Alpherium terminal, through which the brewing company Heineken routes its exports. The terminal is 13 kilometers by road from the brewing facility, while the direct distance by road to the seaport's terminals is just over 70 kilometers.

These examples show that feasibility of multimodal transport solutions in connection with seaports is determined to a large extent by features other than door-to-port cost comparison. These sample cases have almost entirely eliminated delays caused by congestion from their operations. Many ports value reliability above speed; moreover, terminals—and the adjacent warehouses—often act as buffers in the supply chain, between production and dispatch or between seaport release and distribution.

The multimodal solution for Heineken was not a result of market forces only; the redesigning of the logistics processes also involved many stakeholders and even persuaded Port of Rotterdam to co-invest in the inland terminal. The port invested because the proposed solution contributed to reducing the port's congestion. Therefore, understanding both the context and the stakeholder interests are important for assessing a solution's potential. The multimodal solution would not even be considered if the seaport were already free from road congestion or if the client had only a small number of containers for export.

An important comment to the lessons from ILCs in Europe and North America: Their successes are mainly found in ILCs connected with seaports with high throughputs. The examples include Port of Virginia, which currently handles about 3 million TEUs per annum, while all other seaports under study had throughputs well above 5 million TEUs. This reflects the reality of European and North American practice, where smaller seaports have lower success rates in developing multimodal transport to the hinterland. Possible explanations include that these smaller ports are less often confronted with land-use constraints and seaports players are less inclined to shift part of their businesses to inland locations.

How to Ensure Local and Supply Chain Integration of the ILC

The optimal situation would be to set aside land for logistics services in the direct vicinity of one or more cargo terminals, to avoid extra costs from longer drayage distances and congested traffic around the terminal. This could work quite well in the greenfield solutions for AllianceTexas and CIC. Logistics service providers tend to prefer locations near cargo terminals outside of urban centers, rather than locations near city centers and central business districts.

In cases where land is scarce, logistics sites should be well-connected to the terminal to facilitate access to heavy goods vehicles. Travel distance between the LOGISTICS CLUSTER and the terminal is more critical if the distance covered by the multimodal transport service is short. When an ILC has a hub function with onward multimodal transport, facilities for cargo cross-docking need to be located as close as possible to the terminal.

If land is scarce, an ILC can be subdivided into multiple sites, as done in Duisburg. In practice, many clients of the inland terminals are located at some distance outside of the logistics center, which supports this idea.

Several soft measures are important to the success of the seaborne multimodal transport chain, including the following:

- The inland location should have the potential to handle customs and multimodal transport documents, such as bills of lading. Together, these imply containers could move uninterrupted between the inland facility and the overseas location. This trade and transport facilitation comprises a vital part of what makes an inland terminal attractive to clients. Without it, multimodal transport solutions will lose much of their competitiveness to road transport, since clients prefer to avoid seaport-based customs procedures and the handover of cargo ownership, which increases container dwell times and adds to seaport congestion problems. This facilitation of trade and transport is common in the EU and is also key to the success of the Virginia Inland Port (VIP).
- Communication between all stakeholders in the logistics chain must be efficient and effective; ILCs and their inland terminals have a role in this. If the ILCs absorb

functions previously performed in the seaports, for example, the previously mentioned customs procedures and transport facilitation, they must also align with existing information and communication protocols in the logistics chains—such as single windows for customs and port community systems for information exchange and administrative handlings between business and government authorities. In addition, ILCs must meet stakeholder requirements in supply chains and offer the desired visibility and traceability of load units and cargo. With digitization a work in progress, it's especially important for ILC to fully comply with these guidelines.

- On an operational level, ILCs should optimize and manage local heavy goods vehicle (HGV) traffic, such as using booking and reservation systems to avoid congestion at terminal gates. Lessons can be taken from systems applied in seaports.

How to Promote ILCs and the Use of Multimodal Transport Connections

ILCs and their multimodal connections will sell themselves once they offer conditions for efficient and high-quality logistics operations. Moreover, tenants and users are also stakeholders, who also have an interest in good utilization of ILCs. Other players in the supply side of the multimodal transport chain have intrinsic motives for success as well as the connected seaports (reducing congestion), seaport terminals (preferring large scale operations), ocean lines (reaching into the hinterland), road operators (avoiding congestion) and society as a whole, which benefits from the reduced negative impacts of transport (air pollution, greenhouse gases, noise, traffic accidents, and congestion) and from increased gross domestic product (GDP) and employment.

Because governments fund infrastructure, they can to some extent control the shift toward the desired multimodal supply. The EU and European member states prioritized the improvement of railway and inland waterway transport infrastructure, because of their social advantages. For example, the national government of Germany will cofund the construction of transshipment terminals, provided the project proposal presents a solid business case. American federal programs also prioritize cofunding of road infrastructure in connection with multimodal transport services, though railways in North America are privately owned and therefore not part of these programs. The Netherlands prioritizes investments on two pre-identified corridors providing the most contributions to the dual national interests of improving connectivity and expanding multimodal transport supply—which also means investments on other corridors will likely not receive cofunding from national sources.

The set of policy instruments that could further promote the use of multimodal transport facilities is limited in both the EU and the United States. For example, interventions in pricing (such as operational subsidies and levies) are not applied, because they have no legal basis in the context of the market economies. Even if

legally possible, such measures risk removing incentives for efficient operations, which in the long term would affect competitiveness.

Local-level governments shine in local infrastructure and land use, with local authorities deciding on the location of the ILC and providing adequate road access to the proposed facility. For example, many of the German FVs are initiated by municipalities, with the goal of improving their connectivity to the multimodal transport network, while also reducing heavy goods traffic in vital parts of their urban infrastructure. Consequently, clustering of logistics services in locations some distance away from other urban functions serves as a tool for cities to minimize conflicts in land use.

Cooperation between Public and Private Sectors

The ILCs assessed here all received significant, lead-role contributions from various layers of government entities as well as from the private sector. In the case of the two largest ILCs in North America—AllianceTexas and the CIC—private entities took the leading role in development, while the business development in the VIP was led by a public initiative. In all European examples, the lower government levels have held the dominating roles in the development, however all operated in close coordination with higher public levels and with the private sector.

Both mainly private-driven, the large-scale AllianceTexas and CIC were developed, respectively, on greenfield and brownfield territory, with abundant land availability and low acquisition costs. The projects could establish when transport demand became apparent. For AllianceTexas, the initial lot concerned air cargo handling—transferred from a neighboring airport—followed closely by a Class I railroad forced to relocate its facility away from a nearby urban location. The venture, therefore, provided a welcomed solution to a much-needed restructuring of already existing traffic in the region, along with the capability of starting operations with substantial traffic volumes. Meanwhile, the connectivity created by the airport and the rail transshipment terminal became key factors for the many logistics service providers choosing to settle in the ILC. The development of CIC outside of Chicago included a major expansion of rail transshipment capacity in the region, and can be viewed as part of a major restructuring project for alleviating congestion in the urbanized region, together with capacity expansion and efficiency improvement of the railway services connecting to the west coast seaports.

In order to firmly embed the facilities in their respective regions, the Texas and Illinois projects required cooperation and coordination with many layers of government to secure and maintain good road connections for drayage services, and obtain acceptance and permits for the facilities which, because of their scale, have substantial impacts on their environment. The local and higher-level governments, as owners responsible for road and other infrastructure, were motivated to facilitate these developments because of their great social advantage, such as the alleviation

of urban traffic, the improved connectivity of the region, the attractiveness to logistics companies to settle, and the knock-on effect to other industries.

In the European examples, governments have assumed larger roles. An important explaining factor, the developments take place in urbanized environments with major space constraints. In these environments, any investment in transshipment capacity and in logistics zones would have great impacts on the use of road infrastructure, causing congestion, and on the environment. They are also likely to encounter potential conflicts of use and thus block development options for residential, leisure, or nature purposes. The lower-level governments have taken a cautious approach and sought close cooperation with all stakeholders. In Germany and the Netherlands, rather than a top-down approach from the national level, the local governments typically take the lead, as they are most aware of local interests and development opportunities.

In the example of Duisburg, the publicly owned Duisport organization has been leading the development. Duisport, principally a commercialized version of the previous port authority, was established to revitalize the Port of Duisburg and then develop the port into an important logistics hub, with the objective of restoring and enhancing employment. The port had to cope with the decay of the steel and mining sectors, its most important clients. Decision makers had reasons to be confident of the port's potential, based on the excellent location in relation to seaports and economic centers, excellent infrastructure connections, and the availability of land. The first objective of Duisport was to attract new business and establish new multimodal connections, along with the subsequent, and successful, internal strengthening of the port. The role Duisport took was exceptional in the European contexts in which, at the time, inland ports tended toward more passive marketing. Instead, Duisport chose to follow a single strategy where multimodal transport is central and serves as the focus of the port's long-term development potential. The main role of Duisport, then, is to create optimal conditions for multimodal and transshipment companies to establish and operate. The port strives to develop logistics zones near or well-connected to transshipment facilities and to maintain a high level of coherence within the inland port system. Investments in logistics assets such as warehouses, terminals, and transport, are covered by the private sector. Only by exemption does Duisport step in, for example, to finance port-strengthening services not provided by the private sector.

Duisport's entrepreneurial approach is combined with a long-term social responsibility to sustain the strong position of the port; impacts of investments and other decisions are measured against long-term and socially agreed objectives. For long-term sustainability, Duisport also engages in securing the presence of a qualified work force, in encouraging safe operations, in innovating projects, and providing support to tenants in securing required permits, and sometimes even in supporting tenants' business development. Duisport also leads missions and closes deals with counterparts in corridor development.

The Dutch ILC in Venlo also has the advantage of good infrastructure connectivity. Until recently, its multimodal connections have been mainly westbound, via the Port of Rotterdam, though east- and southbound connections are increasing. The region has a long history of logistics services providers, well rooted in the region, and the ILC has been successful in attracting, for example, several companies that use Venlo as bases for European distribution. The increase of logistics services in Venlo also provides the foundation for further expanding the multimodal connections.

The approach in Venlo has many similarities to Duisport, except on a smaller scale. The municipality of Venlo, and in latest expansions jointly with neighboring governments, created management companies out of their logistics zones, tasking them with development, marketing, and management during the exploitation phase of the terrain. Though publicly owned, these entities do have institutionalized dialogue platforms (for example, Smart Logistics Centre Venlo) in which stakeholders from the logistics and other business communities are represented. These platforms support the ILC management entity in its mission, for example, by activating their own business networks. The cooperation also works on broader challenges, such as promoting relations with the educational sector for securing a strong, prepared labor force, and on social responsibility for the purpose of local goodwill. All are meant to provide confidence to current and potential tenants about the ILC's current competence and their long-term commitment to the ILC's success.

The Netherlands has about thirty self-proclaimed logistics hotspots and even more inland transshipment terminals, indicating the strong presence of the transport and logistics sector in the country. It is also an indicator of the manifold number of developments in the country, all facilitated by the respective local public authorities, though not centrally planned or coordinated. The competition between hotspots encourages the sector to improve, but has the disadvantage of fragmentation and the possible shift of transport back to road-based solutions. The national government together with Port of Rotterdam, the country's main stakeholder, advocates clustering of hinterland transport and has recently formalized a corridor approach, which prioritizes and provides funding support for initiatives on only two corridors.

Cooperation and coordination between the public and private sector have been key to the success in the ILC developments discussed in this report. Several persons interviewed for this report emphasized the importance of being aware how ILCs and ports function as nodes in (often global) supply chains, and in a highly dynamic environment. Decision making could be local, but decision makers should identify the context in which they operate and seek coordination and commitment from a wide group of stakeholders.

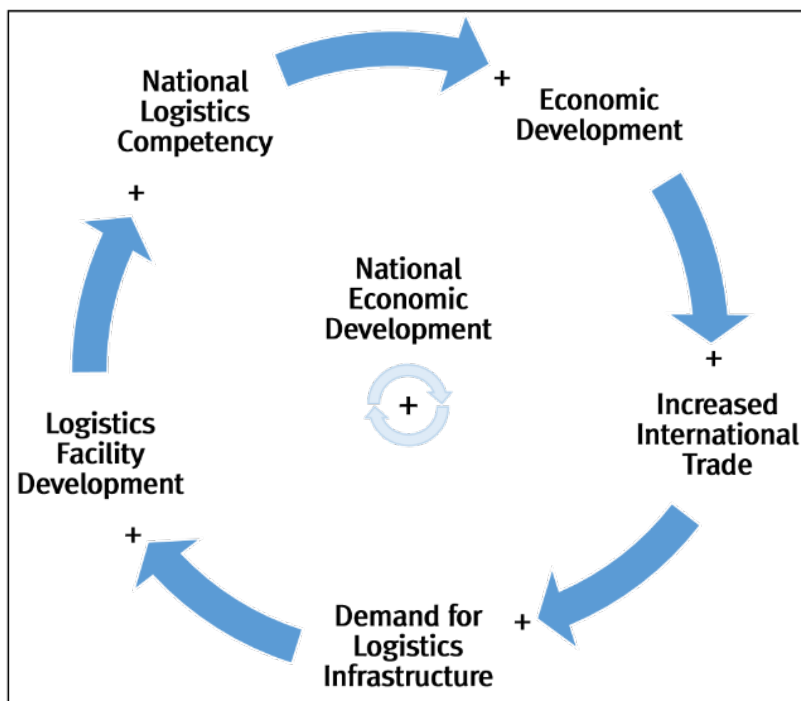
7. Lessons Learned from the Korean Experience

Implications of Combining Development Policies and Development Issues

A virtuous cycle of logistics facility development and economic development

The sharp increase in import and export volumes due to Korea's export-led economic development presented both an opportunity and challenge for the Korean economy. The Korean government grabbed the opportunity to develop a *centrally planned competitive logistics system* with the deployment of various logistics facilities, such as inland container depots and, more generally, inland logistics bases. This strategy led to a virtuous cycle in which planned logistics interventions supported economic growth (figure 7.1).

Figure 7.1. A Causal Loop Diagram of the Virtuous Cycle of Logistics Facility and Economic Development



Source: Korea Transport Institute (KOTI).

Realizing the importance of this centralized approach to logistics and development, the government of Korea established a structural institutional setting to systematize the experience, shelter, and fortify the created logistics systems and—importantly—guarantee full coordination and alignment of the growth and evolution of the logistics systems and the nation's development plans. The institutions and carefully crafted

mechanism include elements in the legal systems, establishment of the Basic Plan for National Logistics in connection with the CPDLFs, enactment of the Act on the Development and Management of Logistics Facilities to provide administrative and financial support in developing logistics facilities, and a legislation-based administrative financial support system.

The combination of centrally planned facilities carefully protected and guided by harmonic policy and institutional context allow Korea to, first, make logistics a central element of its development and global competitiveness, and second—and more importantly—create a virtuous circle in which logistics clusters and economic and social development reinforce each other organically.

Innovations in logistics facility development and expansion of the favorable cycle structure

Korea's current logistics industry faces new and different changes and challenges in line with recent developments in the nation's Fourth Industrial Revolution. Therefore, the government of Korea must promote innovation in its logistics facility development support system.

The core of the Fourth Industrial Revolution is the convergence and fusion of science and technology fields such as nanotechnology, robotics, and biotechnology, based on information and communications technology (ICT). The Fourth Industrial Revolution has created both social and economic changes, and the consequent ripple effects are also affecting the logistics industry. Amid such changes, the logistics industry has begun to shift from being a labor-intensive industry to a technology-intensive industry.

Logistics companies have begun expanding their business fields to reflect these changes, and have shifted from providing existing logistics services to developing logistics technologies. At the actual logistics site, the introduction and utilization of innovation-based logistics technologies, such as robots and autonomous vehicles, is rapidly expanding. Therefore, the Korean government's policy to develop logistics facilities should reflect the changes in the importance and necessity of logistics technologies in the industry.

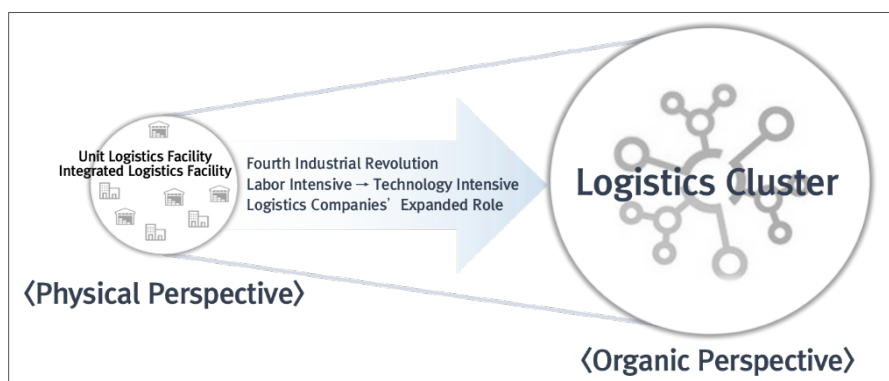
Additionally, the paradigm shift in the manufacturing industry following the Fourth Industrial Revolution has changed the role of logistics companies. Traditionally, logistics services have been linked to the next stages of production, distribution and sales, and consumption. Therefore, logistics companies' primary business areas were represented by transportation, storage, unloading, and packaging departments. However, some global companies have outsourced most of these functions given the development of information technologies and maturing of globalization, with the exception of planning, research and development (R&D), and design functions.

Logistics companies previously responsible for product distribution and delivery are

now engaged in demand forecasting and inventory management, both business areas previously kept in-house by global companies. Ultimately, the scope of the connection between logistics companies and global companies has expanded to include both production and supply chain management. Therefore, and in addition to recognizing the importance of logistics technologies, the government should consider expanded logistics companies' role within the supply chain when contemplating policies to support them.

A change in government policy perspectives is also necessary for the government of Korea to produce innovative policies geared toward developing logistics facilities following the Fourth Industrial Revolution. In other words, the government's policy perspective on the development of logistics facilities should be expanded from a focus on the physical facility—such as the stand-alone or integrated logistics facility—to a clustered, organically aggregated concept (figure 7.2), due to the difficulty of expecting a synergy to occur between facilities-turned-clusters via simple accumulation. Moreover, many cluster-development methods have contributed to the evolution of technology-intensive industries. Representative examples include Silicon Valley in the United States, Kista Science Park in Sweden, Oulu Cluster in Finland, and Aichi Prefecture's automobile cluster in Japan.

Figure 7.2. Paradigm Shift in the Development of Logistics Facilities



Source: Korean transport institute (KOTI).

These clusters have been evaluated as representative because technology-intensive companies, public-private research institutes, and regional universities have gathered to create technological developments and add value. As such, clustering is the most effective way to build industrial ecosystems and create such value. Therefore, it could be posited a necessary method to transform the logistics industry to be more technology intensive involves developing logistics clusters to achieve more organic combinations.

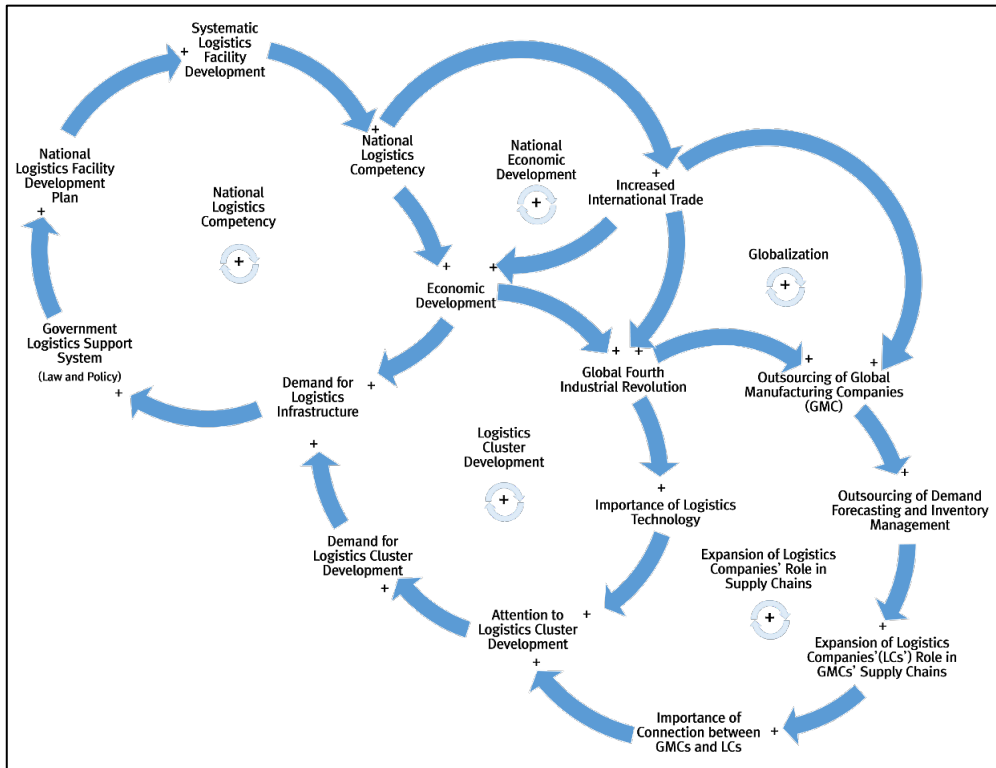
From the cluster perspective, Korea's current logistics facility development method is closest to the simple cluster type, where each integrated logistics facility has two or more logistics facilities concentrated in one geographic region, along with several logistics companies gathered around them to utilize them. In most integrated logistics

facilities, several small- and medium-sized companies will likely collaborate in using the facilities, rather than being operated by larger companies. Additionally, these facilities' operations are limited to traditional logistics service activities, such as storage and unloading. Therefore, low-level innovation and technological advancement occurs within these facilities' simple, repetitive activities. Moreover, because employees focus on the facility's operations, they exhibit low degrees of cooperation. The range of services offered are also limited to logistics services, and thus, little change occurs.

Interactive organic activities and smooth communications to facilitate innovation seemingly are not performed among members of integrated logistics facilities. Therefore, the integrated logistics facility in the cluster-development stage can be considered in an intermediate stage between an informal and organized cluster. Accordingly, a transition should be made to support the clusters' development, with the Korean logistics facility's policies expanded to include the cluster-development perspective.

Meanwhile, the government of Korea has served as a control tower for the development of logistics facilities to meet market demand, given the former's systematic planning and legislative policy support. However, the government now faces another challenge in developing logistics facilities due to the accompanying socioeconomic changes following the Fourth Industrial Revolution. Thus, the Korean government must consider an expanded role for technology-intensive logistics companies in global supply chains; the government can use the paradigm of logistics facility development to evolve clusters with an organic perspective. Therefore, by systematically implementing steps toward a logistics cluster-development policy based on its experience with developing logistics facilities, the Korean government could help the logistics industry leap forward and contribute to industry growth (figure 7.3).

Figure 7.3. A Causal Loop Diagram of the Favorable Cycle of Expanding Economic Growth from Logistics Facility Innovations



Source: Korean Transport Institute (KOTI).

Overall Reflections

The government of Korea supported export-driven economic development through the timely development of its logistics facilities in the 1990s, when Korea was a developing country. Korea consequently experienced a virtuous cycle by developing its logistics facilities to spark economic development; the country could then establish a systematic support system to further develop its logistics facilities. This system has allowed the Korean government to serve as a control tower for the development of logistics facilities.

However, the logistics industry is experiencing another change with developments as a result of the Fourth Industrial Revolution. As logistics changes from a labor- to technology-intensive industry, this shift emphasizes the importance of R&D in logistics technologies. Additionally, the scope of the connection between logistics companies and global companies has expanded to include production and supply chain management, as global companies are increasingly outsourcing more functions in these fields.

Thus, the logistics industry faces different changes and challenges in line with the Fourth Industrial Revolution. The Korean government should address the different changes facing the logistics industry based on its past experience with developing logistics facilities. Therefore, a paradigm shift in how logistics facilities develop is needed: The existing physical unit-development perspective must evolve into an organic cluster perspective, since cluster development is more suitable for developing technology-intensive industries in which the R&D function is important. It can also be effective in strengthening connectivity with the manufacturing industry's complexes.

Therefore, the government must expand its virtuous cycle of logistics competitiveness and economic development by creating more innovative logistics facilities through a development paradigm shift. Ultimately, to meet this goal, the Korean government must implement policies to promote the development of logistics facilities from a cluster perspective.

8. Guiding Questions for Policy and Decision Makers

Through which operational channels do logistics centers promote multimodality and efficiency in logistics? What is their broader economic and logistics cost impact?

The first operational channels through which logistics centers promote multimodality and efficiency in logistics is the vicinity to the developed multimodal services. Multimodality is a means to achieve better efficiency and quality. Efficiency and quality are among the objectives of all players in logistics service provision because they improve competitiveness and profit margins.

Integrated logistics centers promote multimodality—and hence efficiency—because tenants are located near the terminals. All logistics centers are clusters of logistics service providers, supporting companies, and sometimes cargo owners. Mutual vicinity creates opportunities for efficient procurement of services, from full logistics service packages to specific tasks, such as trucking, usage of warehouse space, warehousing, and repair and maintenance of trucks or other assets. This procurement of services is done from one of two positions in the business column—*vertical cooperation*, with cargo owners procuring logistics services and freight forwarders procuring truck services; or from a corporate policy of hiring at partial capacity, via *horizontal cooperation*, with the short lease of extra warehouse space and truck operators cooperating for geographical coverage.

The mechanism in logistics centers for seaborne trade

For the group of logistics centers connected with seaports, multiple drivers promote multimodality. From the perspectives of different stakeholders in the chain, these include, for example:

- Port authorities prefer multimodal transport because it contributes to several objectives. First, accessibility of all parts of the seaport can be provided more effectively by rail and barge services than by road. A high share of road transport in hinterland transport places increased pressure on road transport infrastructure in the port area—frequently facing existing capacity constraints and traffic congestion. Second, the external effects of road transport are more negative than those of multimodal transport, because of greenhouse gas (GHG) emissions, air pollution, traffic safety risks, noise, and the road congestion, which also affects other users of the road infrastructure. Minimizing these external effects encourages social acceptance within the port region as well as in the hinterland. To most port authorities, improving sustainability is another important objective. For instance, the port in Los Angeles and Long Beach (LA/LB) support the Alameda corridor, while Rotterdam and Antwerp engage in inland terminal development and improving multimodal connectivity inside the port.

- Terminal operators within the port prefer multimodal transport options, because terminals are better equipped for handling large call sizes than single-container calls by road operators; container handling in seaports is inherently a large-scale operation. Operators can also avoid congestion in the stacking space by holding a portion of the containers in the hinterland. Connecting services with multimodal terminals in the hinterland also contributes to competitiveness of the seaport terminal, for example, the European gateway services provided by ECT, part of the global container terminal operator Hutchison Ports.
- Logistics service providers can save transport costs if multimodal transport costs remain below road transport costs. This is typically the case for long-haul operations, where multimodal transport tariffs are often below road transport tariffs, for example, between LA/LB and Chicago. To those located on shorter distance from seaports, transport cost comparisons tell only part of the story because other advantages in logistics, related to costs and quality, become apparent, for example:
 - Road operations in relation to seaport terminals are more difficult to control, and with low punctuality, because of the high risk of congestion on the road and at the terminal gates. This volatility has implications for costs, for example, the number of trips a driver and truck could make in this traffic would be lower than the total trips over the same distance in other directions.
 - Logistics companies benefit from inland terminals because the terminals keep a stock of empty containers and store loaded containers. Inland empty container stocks prevent empty container hauls and improve responsiveness to client or beneficial cargo owner (BCO) needs. Inland terminals can hold cargoes for just-in-time delivery to consignees in import and to ocean liner services in export.
- Shippers, or cargo owners, typically in cooperation with logistics service providers, have engaged in setting up multimodal chains, for several advantages, including improved supply chain control, such as Heineken providing base load in barge terminals, and BASF as a shareholder in terminals.
- Ocean shipping lines, the container owners, tend to keep inland loops short, though some also expand their client base, through their presence in the hinterland, by holding container stocks in inland terminals. Next to low-cost transport in supply chains, the multimodal services also provide for low-cost repositioning of containers when needed, for optimizing use of the container fleet. Around the year 2000, when multimodality experienced rapid expansion in Europe, ocean lines held shares in European inland terminals, but withdrew after the market matured.
- The carriers in multimodal transport, namely railway and barge operators, hold a direct interest, with multimodal transport serving as their main revenue stream. In the United States, Class I railway operators also build and operate their own inland terminals. In Europe, some of the terminals are also owned and operated by the rail or barge operators, while others are owned by logistics service providers.

- Society benefits from reduced external effects, as mentioned above. In the hinterland regions the logistics centers can divert heavy goods traffic away from populated or environmentally vulnerable areas.

All players in the chain provide services with the potential of improving logistics efficiency. For example, terminal operators do so by container transshipment, inevitable in multimodality, which is their core activity, and offer additional services to promote multimodality, logistics efficiency, and their own profits, for example:

- For the benefit of the cargo owners in the region and their logistics service providers, they keep a stock of empty containers and store loaded container terminals. This also benefits ocean lines if it reduces their overrun on terminal dwell times in the seaports.
- For the benefit of local clients, they provide drayage services or provide chassis for rent.
- For the benefit of container owners, they clean, maintain, and repair containers.
- For the benefit of all, if the terminal operator is the same entity as the multimodal operator, they might improve service level of the multimodal link by increasing frequency or improve the time schedule.

These terminals provide opportunities to other service providers in the supply chains of containerized cargoes as well as to their suppliers and clients to cluster around the terminal, through which overall logistics costs can be further reduced. In this type of logistics center, multimodality has helped drive efficiency and creation of logistics services, rather than the other way around.

With no blueprint of the role division of development of terminals and of multimodal transport services, the following examples illustrate how services were established through stakeholders pursuing their own business interests in the global supply chains:

- Around the turn of the century, ocean lines were leading in developing terminals along the Rhine. For example, P&O Nedlloyd, later part of Maersk, took stake in a terminal in a trimodal in Duisburg; however, this was later sold again.
- Between 1980 and 2005, ECT, part of Hutchison Ports, created a small network of its own inland terminals for rail and barge, to secure traffic over its terminal complex in the Port of Rotterdam. Similarly, DP World, a multinational logistics company based in Dubai, has owned the Worth barge terminal in southern Germany.
- Most barge terminals in the Netherlands were developed by logistics service providers, which strengthened their position in external trade. Many of these have become public terminals, meaning that third companies have access to transshipment and barge services.
- Non-vessel operating common carriers (NVOCCs) such as Kühne + Nagel, hold shares in inland terminals.
- Since the market of barging containers is mature, many barge operators (some under partial ownership by other stakeholders) maintain ownership in terminals.

- In the United States, railway operators own and operate the inland transshipment terminals and are the sole providers of the multimodal transport services in the port hinterlands. However, they often choose to outsource these functions to subproviders.

In the European context, the ownership of inland terminals and multimodal transport services is far from stable, which indicates changing priorities in various phases. For example, ocean lines are interested in using good facilities in the hinterland; however, when these are readily available, ownership does not necessarily add value and capital could be redirected elsewhere in the organization.

Seaport authorities of mainports such as Rotterdam and Antwerp function as important engines in promoting multimodal transport initiatives. Most typically, the authorities engage by providing advice and technical support, for example, in planning procedures, by coordinating initiatives and matchmaking between stakeholders in business development, or by identifying funding possibilities. Another important role: supporting projects to accommodate multimodal transport, either through physical interventions in the port or through information technology (IT) solutions, such as port community systems, to improve traffic management and administrative handling.

In earlier stages, when the offer of multimodal transport services was still modest, port authorities made efforts to create awareness of the need for a modal shift among logistics service providers and their clients. The campaigned arguments included the infrastructural limitations for accommodating increased road transport with the threat of gridlocks as well as the need for lowering external effects of transport, which had become socially unacceptable. These promotional efforts were often financially supported by national governments and channeled through associations of logistics services providers and cargo owners.

In later stages, when multimodal transport had demonstrated its viability, other logistics advantages became visible to all stakeholders; in Europe, this visibility led to wide engagement of the private sector and across all governmental levels in development initiatives. For example, the business community, together with government layers in the Dutch province Brabant, located a short distance from Rotterdam, initiated intense business development and promotional activities for setting up a multimodal transport infrastructure and several forms of cooperation, which resulted in a major modal shift.

As part of the new awareness, business activities with high transport demand could best be located near waterways—and some near railway infrastructure—where transshipment terminals could emerge. Initially low-cost and low-volume terminals, they later expanded when business grew. The clustering of logistics services around these multimodal transport initiatives evolved as a natural process of seeking the optimal use of the available land. Access to multimodal transport infrastructure

became an important criterion for municipalities when developing new industrial zones, and tenants became increasingly aware of the advantages, and therefore the value, of these locations.

The mechanism in logistics centers for continental trade

In continental trade the stakeholders include logistics service providers (clients of multimodal transport), traders (such as distributors and retailers), those involved in multimodal transport service provision, and society. Mechanisms promoting multimodal transport are similar to those used in maritime borne hinterland transport, with some key differences:

- With terminals integrated in logistics centers, the lower drayage distances generally contribute to stronger competitiveness of multimodal transport.
- As seen in the United States, storage of load units such as 53-foot containers or semitrailers is common and provides similar benefits to owners as to maritime related chains, namely, responsiveness and fleet optimization. However, in the European Union (EU), terminals in continental multimodal transport have only limited space for storage, which means logistics service providers located in the logistics centers or elsewhere must use their own premises for parking semitrailers or storing swap bodies.
- In Germany, the GVZs (*Güterverkehrszentren*, or freight villages) by law must promote multimodality. All GVZs must be well-connected to the multimodal network, with regular services. This obligation to uphold a good service level requires active engagement in multimodal transport development. Not all GVZs generate long-distance traffic sufficient to support solid business cases or offer strong competitive multimodal services. Without obligation the effort to create viable solutions would probably be less. GVZs are quite successful in upholding their multimodal connectivity. Similar to GVZs, the *interporti* in Italy are connected by rail, but only a handful maintain a strong multimodal transport portfolio, as domestic interconnectivity in Italy is generally limited. Some other EU countries have developed similar concepts, though with fewer FVs and low multimodal transport volumes.
- Another way for these FVs to promote efficiency is through internal cooperation. These centers strive for a wide range of tenants, and this provides advantages related to the clustering, that is, the good availability of all types of supporting services, including drayage, storage, repair and maintenance, banking, and more, which provide opportunities for the focus and division of labor.

Broader economic and logistics cost impacts of logistics centers

The broader economic and logistics cost impacts of logistics centers include the following:

- Reduced overall transport costs, depending on the distance between origins and destinations as well as other factors.

- Improved proximity to the markets in the hinterland when container storage for seaborne cargo is decentralized.
- Reduced risk of extreme congestion results in fewer significant, short-term delays in transporting seaborne cargo, lower costs associated with delays and related to scarcity, and improved attractiveness of the port cluster, and therefore, avoids a loss of market share with its subsequent multiplier effects.
- Better utilization of transport assets, resulting in fewer empty hauls and higher load rates.
- Greater opportunities for horizontal collaboration, generating more sharing assets and sharing clients
- Lower container storage costs, as mentioned above.
- Increased benefits provided by multimodality, as opposed to road transport, to the environment, GHG, traffic safety, and road congestion in the corridor.
- Increased risk of road congestion around the terminals.
- Reduced fragmentation of transport, which is especially advantageous in urban environments.
- Improved attractiveness of the region for manufacturing, trade and distribution, leading to more gross domestic product (GDP), employment, tax revenues, and other benefits generated by logistics centers with wide service portfolios.
- Improved redistribution of employment across regions.
- Increased opportunities for the use of electric vehicles provided by the shorter hauls.
- Increased ability, thanks to multimodality, to cope with driver shortages when the labor market is tight.

How feasible is it to centrally plan and guide the development of logistic clusters to foster competitiveness?

Many developing countries lack multiple regional economic poles and/or private sector champions to support the decentralized and organic emergence of logistics clusters. Consequently, many policy makers find themselves asking: How to deploy their typically scarce fiscal resources in a targeted fashion to craft industrial policy around logistic facilities development? Many island states, coastal countries, and strategically located landlocked countries face this exact challenge and struggle to identify viable solutions.

Korea offers a unique example and lesson, with institutions as the key. The combination of centrally planned facilities carefully protected and guided by harmonic policy and institutional context allowed Korea to first, make logistics a central element of its development and global competitiveness, and second and more importantly, create a virtuous circle in which logistics clusters and economic and social development reinforce each other in an organic way.

Two other examples in East Asia mirror Korea's experience: Malaysia and Thailand

have been successful in developing logistics clusters for electrical and electronic products. Malaysia also serves as a successful global cluster for rubber and rubber products. In all three cases, cluster development benefited from central government planning and investment and institutional approaches that brought in private sector input and expertise. In Malaysia, development plans for logistics and regional development, including logistics clusters, have been routinely informed by “deep dive” planning exercises where leaders from industry and government collaborate to agree on goals, policy direction, specific interventions, and key performance indicators (KPIs). Singapore is another notable example. The Port of Singapore and adjacent facilities comprise one of the world’s most important logistics clusters, critical to the facilitation of global trade. The planification of capacity and services expansion at the Port of Singapore in the long term—over decades—is government-led, with both the port and the port operator itself are government-owned. And Vietnam, even though positioned earlier in its development trajectory compared to Thailand, Malaysia, and Singapore, provides another example of successful development of logistics clusters—including in textiles and apparel, furniture, and electronics—in a planned manner. In the case of Vietnam, however, institutional strengthening is essential, and required for incorporating private sector considerations in government planning.

An open question remains to be addressed by further research: Would this model work for large, continental, and/or heterogeneous developing countries outside of East Asia, such as Mexico, Turkey, or South Africa?

What role should government—at various levels, whether regional or international, national or subnational—assume in the planning, investment, execution, and regulation cycle of logistics center development? How should this be done?

With no formal blueprint of role divisions, the objectives of logistics center development and the contexts of that development, can be very different.

A well-working general principle, as also applied in the European and U. S. experience, demonstrates the layers of government that should be most prominently involved are those receiving the most impact, in benefits and costs. In almost all logistics center developments, these layers are the lower government levels such as municipalities, districts, or provinces. Some logistics centers have national significance, in which case national-level agencies should be given a stronger role, as is done, for example, for ports and airports.

In North America and Western Europe, national-level public sector entities typically provide framework conditions, such as regulatory framework for land use, transport planning, and infrastructure finance, coordinating developments, for example, by their priorities in cofunding investment projects. In the United States, as well as in EU member states, the national level does not generally get involved in developing or

cofunding logistics centers, except for EU states' cofunding of transshipment terminals. The lower political levels typically acts as project promoters and have the final say in project completion.

Within these principles, great variation occurs in the observed roles of government layers:

- Municipal and other subnational governments act as initiator or, probably more typically, co-initiator with the local business community for developing logistics zones. Cities will also promote the project and throughout the process will continue to cooperate closely with public and private stakeholders. Regions actively involved in hinterland traffic will also have more say from players in seaborne supply chains. Other regions will have different priorities, for example, strengthening the position in certain supply chains, such as chemical clusters and agroclusters, or pursuing primarily local interests, for instance, banning heavy goods vehicle (HGV) traffic from urban zones.
- Most logistics centers in Europe are open, public-owned structures, developed and managed by organizations established for this purpose, comparable with port authorities. These organizations will often allow any company settle into the logistics center, as long as they comply with the desired logistics or logistics-intensive business profile. Some logistics centers allow tenants to buy land; however, the dominant structure is to lease the land. The role of the management entity depends on the ambitions and objectives of the logistics center, though the core functions include acquiring tenants and providing and maintaining basic infrastructure. More ambitious logistics centers, such as those in Duisburg and Venlo, also assist in developing multimodal connectivity, promoting and exploiting synergies, innovation, and all types of actions to secure long-term attractiveness of the integrated logistics center (ILC).
- Logistics centers in the United States are typically privately owned. The two examples in the U. S. case studies presented in this report were promoted, owned, and managed by private property developers. The investment, ownership, and operation of the transshipment facilities lie with the private railroad companies (BNSF and Union Pacific).
- National governments generally adopt transport policies focused on connecting all regions sustainably and safely. The Netherlands and German also have a strategy to promote the capabilities of the logistics sector, because they consider logistics as a key asset for exploiting their strategic locations, and therefore, for their economy. These countries support the companies involved in logistics service provision by cofunding research, development, and education, for example, but do not intervene in the establishment of logistics centers.
- National governments own national road infrastructure and are responsible for developing and maintaining these networks. Lower-level governments assume similar roles for the infrastructure they own. Because logistics centers influence the need and use of infrastructure, from this perspective governments also act as stakeholders in the development of logistics centers.

- Across Europe, the national governments own the railway infrastructure companies, tasked with developing and maintaining a good quality network and allocating railway capacity to users. Therefore, the governments function as partners in terminal development, connecting terminals with the network and accommodating generated traffic.
- Railway infrastructure in the United States is privately owned, with developing and maintaining a good quality network of infrastructure and services as their core business. The railway companies cooperate if rail operations go beyond their own networks.
- The United States and all EU member states follow national regulations and planning frameworks for land use. These include provisions for safeguarding the environment, such as compulsory environmental impact assessments and related permitting procedures, and safeguarding the interests of all citizens, such as procedures for development consent, which include public consultations and compensation rules.
- Municipal governments make medium- and long-term plans for land use and infrastructure development. These plans are legally binding and provide certainty to all stakeholders, including residents and project developers, on the plans' main features and development directions. The plans result from consultation processes and will be politically endorsed and updated when needed. Planning cycles usually fall between five and ten years.
- Higher-level government layers take coordinating roles. For example, in the EU, EU-level and national-level governments only cofund projects that contribute to national (or European) interests. In the Netherlands and Germany, the national government cooperates with lower layers as well as with the private sector to promote the provision of sufficient service levels while avoiding overcapacity and fragmentation. They often rely on soft instruments, for example, technical assistance, research, and consultative.
- The EU has no or only a marginal role in investment in logistics clusters. At the European level there can be cofunding (less than 20 percent) of investment in hubs with international impacts. This is also for rail or waterway infrastructure connecting these hubs to the "Trans European Network." The EU has cofunded many projects for promoting logistics efficiency and greening of transport, which includes recent projects for promoting "massification" and, for example, the greening of local distribution and promoting collaboration. Europlatforms and its members have often been beneficiaries of this financial support.
- All levels of government are also often landowners and become contracting partners in development. Government could also procure land for speeding up a foreseen development, such as a logistics center.

How many integrated logistics centers can a country's hinterland(s) justify, and how could this number be determined?

The amount of logistics services provided by the ILCs depends on too many factors for a clear-cut answer. However, the answer relates to the ILCs' positions in supply chains, and can vary from the assembling of car parts to consolidating urban deliveries for retailers.

Further, the ILCs themselves also vary greatly, for example, the 1,300-hectare PLAZA, a logistics platform near Zaragoza, Spain, is one of the largest ILCs, and while it has rail infrastructure connections, PLAZA generates less multimodal traffic than several Dutch barge terminals surrounded by only a handful of logistics facilities.

When approaching this question from the perspective of multimodality to hinterland regions, the following parameters apply:

- Traffic volume between the seaport and hinterland region(s);
- Minimum frequency of an intermodal transport service needed to attract clients;
- Minimum volume for an intermodal transport service to render;
- Minimum size of an inland terminal to render; and
- Minimum size of a terminal to entice logistics service providers to co-locate.

One rule of thumb is that frequency of service should be at least twice per week for long-distance travel and up to daily, or five times per week, for nearby terminals. A daily service in Europe totals about 35,000 twenty-foot equivalent units (TEUs) in annual traffic, which can be considered the minimum size for a modest terminal.

Other issues:

- Smaller container seaports often have only a regional function, and multimodal solutions can be difficult to sustain due to low financial viability. Distances to the hinterland are too low for a competitive offer versus road transport and volumes are not sufficient for offering frequent multimodal services.
- Midsized terminals, with throughputs of 2 million TEUs, also appear to have a low share of containers moving on trains or barges into the hinterland. Many of these terminals struggle with similar challenges as those faced by small terminals, as mentioned in the previous point. In addition, midsized terminals could have a larger share of throughputs in which cargo is (un)loaded from the container in the seaport and not in the hinterland. In the United States, cargo is often transloaded between maritime International Organization for Standardization (ISO) containers and domestic 53-foot containers or trailers, which makes road transport more competitive and could lower inventory carrying costs through inventory postponement strategies.
- France's largest container port, Le Havre (2.9 million TEUs), has long faced struggles in setting up and maintaining intermodal connections with the hinterland. The port provides an example of the previously mentioned container

(un)loading in the seaport. The main contributor to this situation is that high land prices and road congestion are a greater constraint in the Paris Region—by far Le Havre’s dominant hinterland region—than in the port of Le Havre.

- The distance between LA/LB and Chicago totals approximately 2,000 miles or 3,000 kilometers), which creates the opportunity for an inland transfer point near the seaport for transloading cargo between maritime and continental containers, because of higher capacity—surface space, cubic space, weight, pallet spaces—of the latter.
- Seaports with little congestion or constraints in land availability, offer less incentives to maritime sector players to encourage multimodal transport.
- If port hinterland traffic is spread over multiple hinterland regions, a transfer hub could be desirable for maintaining sufficient service frequency. For example, the significant connecting drayage traffic between the BNSF facility, near Chicago, and facilities with connections to the East.
- The transfer hubs, such as Duisburg, have additional opportunities when hinterland regions are connected to multiple seaport terminals.
- Some seaports could have constraints that make adopting a multimodal approach more difficult. Rotterdam and Antwerp promote multimodality, but at the same time face continuous pressure to accommodate this multimodal traffic. Both ports combat barge congestion—barges use the same facilities as ocean lines—and they have investments heavily in more efficient rail access within the port areas. The Alameda Corridor should also be seen in this light of creating port capacity for hinterland transport.

For nonintegrated logistics centers, namely those without rail or waterway connections, the comparison should focus on the following factors:

- Cost savings if containers are (un)loaded in the hinterland, with its cheaper and more readily accessible land for container storage, lower-cost labor for handling, and other advantages.
- Service improvements, for example, more reliable, more secure, faster, if the container is (un)loaded in the hinterland.
- Conversely, cost savings if containers are (un)loaded in the seaports, for example, when the load capacity of trucks exceeds the load capacity of maritime containers.

The approach from the perspective of logistics services is even more complex. A market study must provide insight into the added value of an logistics center before the current services providers and the potential for new logistics services will settle.

In sum, the safest answer to the question is:

- If a country has no ILCs yet, it should start with one ILC by studying feasibility, including a consultation of all stakeholders in the logistics chain, to ideally find a way to commit private sector to co-investing in such a venture.

- If a country already has ILC, then the process should start from there, by understanding further needs, learning from its experiences, and other considerations.
- It would be a mistake to make a master plan for developing an ILC network on the basis of transport forecasts, even if these forecasts are complemented with brief market surveys. An assessment of the potential for inland terminals, however, is a good start and will support the dialogue with sector players.

The international experience with master planning of ILCs is mixed at best:

- For its national planning in the 1990s, the Netherlands used a hierarchical system to establish the mainports at Rotterdam and Schiphol airport. However, the additional five secondary inland nodes and tertiary inland nodes appeared to be ineffective and the hierarchical system was abandoned before the end of the decade.
- In Germany, the national railway, Deutsche Bahn (DB), conducted GVZ planning in the 1990s as a central planning exercise. Partially based on railway optimization rather than logistics needs, DB's GVZ master plan did not receive official political approval, and was never funded. The idea of central planning was abandoned and GVZ became a joint enterprise between lower public levels and other stakeholders, including DB.

How should logistics center locations be determined, by who, or under which process, and with which economic and operational rationale?

Logistics centers, and in particular ILCs of national or above-national significance, need to be well-connected to a high-quality infrastructure network. A successful ILC should have the following functions:

- A transport hub function, which means the producer and consumer markets are not necessarily in its direct vicinity. The location of the transport hub can be quite flexible, as long as it has excellent and available infrastructure connections, which provides added value and helps attract logistics services to settle; however, the hub's main role is providing connectivity. A region can benefit from a hub's connectivity, and for this reason regional development prospects should be considered in location choice. With such development scenarios in mind, adequate space should be reserved to accommodate future development.
- A gateway function to a region or city, which must have good road connections within its region as well as multimodal connections throughout the national transport network. Gateways make good locations for regional or urban distribution centers.
- A logistics hub function, which requires similar excellent connectivity as well as a strong presence of the logistics industry. A strong labor market is essential, to provide for all levels of the work force. To ensure its sustainability, the logistics hub needs to liaise with institutes for education and innovation, which, ideally, are already well presented.

Logistics centers should be developed based on demand. A “bottom-up” process is most effective.

Transport hubs are most effectively initiated by a transport carrier, who also holds the highest stake. In inland networks, these stakeholders are most often railway operators, though air carriers are also vital for developing cargo hubs in aviation.

Typically, lower-level governments will promote gateways and logistics hubs, as follows:

- Taking into account the expected benefits and costs, the community of logistics service providers and/or their clients will often function as lobbyists for development.
- Initiating development with decent market research and consultation.
- Developing a strategy to ensure adequate land availability and room to accommodate increased traffic and space for logistics assets.
- Facilitating and ensuring awareness of development opportunities and constraints of the network, essential tasks especially for any integrated clusters entities representing railways or inland waterways.
- Exploring or exploiting national or EU cofunding possibilities.
- Seeking out any type of risk-sharing arrangement with property developers, banks, investment funds, and other potential investors.
- Taking the required steps in permitting process, as large interventions require environmental impact assessments, subject to possible appeals. Smaller interventions also have certain procedures required for building permits of smaller projects, with the possibility of appeal.

What sorts of financing mechanisms are better suited to logistics center development?

Financing should cover investments in:

- The planning phase, which includes studies needed for building permits, such as market and feasibility studies, cost-benefit analysis, public consultation, and design studies;
- Land acquisition;
- The construction phase, the provision of basic infrastructure, which for logistics centers consists of land preparation and infrastructure for utilities and transport;
- Some logistics centers might also include construction of buildings and fencing;
- For ILCs, financing includes the construction of transshipment facilities;
- During operations, the costs of logistics center management, marketing and maintenance.

The suitability of a particular financing mechanism is principally a case-by-case decision, dependent upon:

- From which perspective the development should be viewed, whether societal, governmental, or private-sector promotor;

- The starting position, such as who is landowner? What needs to be done?; and
- The development's ambitions, objectives, prospects, and risks.

All European interviewees—Duisport, Smart Logistics Centre Venlo, and the German Association of *Güterverkehrszentren* (DGG)—preferred a central role for the public sector investment for the following reasons:

- Guarantees public interests, including those related to socioeconomics, as seen in Duisport and Venlo for helping to attract business and employment, or related to reducing externalities, for example, with *Güterverkehrszentren* (GVZs) helping to reduce urban traffic.
- Creates more sustainable logistics centers with a longer-term perspective, starting with the long breath needed for development; time between idea and realization is often measured in years.
- Helps to maintain synergies within the logistics center as well as across its overlap with other sectors. To do this successfully, logistics center managers must remain alert. Examples include Duisport providing loss-giving rail services, Venlo connecting with agroindustry, and GVZs initiating innovations.
- Using public-private-partnership (PPP) models for the development and construction phases only, for example RAG Montan Immobilien in Logport IV, where the private company owned the site.

These interviewees also agree the venture should be an independent enterprise, which generates sufficient resources to cover its operational costs and repay the upfront investment. With substantial contributions to other social objectives—for example, environmental benefits and reduced unemployment—other public funds (from EU, national, or lower-level government) could subsidize.

Investments in local connecting railway and waterway infrastructure follow procedures of the respective infrastructure management entities and are not part of the logistics center project. The infrastructure users pay any user charges.

Venlo, Duisburg, and most GVZs operate in densely populated environments with many potential conflicts of use. Large-scale private ventures are difficult to realize in such circumstances, and are therefore rare.

The United States offers examples of mainly private initiatives. AllianceTexas in Fort Worth is one example in which a private investment company acts as the risk holder and funder in all phases. Measures of success in documentation are mainly financial, and these are positive for the investor. A largely private venture, AllianceTexas was a greenfield development with a cargo air hub as main asset. The role of lower-level government was to provide the connecting road and other infrastructure, for example information and communication technology (ICT), utilities, and the like, typically funded from annual budget possibly supported by higher government layers.

How to attract tenants to and grow the volume of freight handled at logistics centers?

Tenants are attracted by targeted marketing, mainly using existing business networks of stakeholders, complemented by promotional activities, for example, on industry fairs and business missions (see the Duisport discussion in chapter 3). Identification of potential tenants starts in the early phases of development, through market studies and consultations.

Increasing volume is the key interest of all tenants; each will do their part to attract volumes. The logistics center management promotes and advertises the center's capabilities, to attract business and develop multimodal connections.

What sorts of regulations, performance monitoring, planning practices, and other forms of core public sector practices should be in place to implement and sustain a logistics clusters strategy at all levels of geographic and place granularity, and at all levels of government (national and subnational)?

Within performance management, what makes a logistics center “high-performing”? How can this be measured? Should this be measured by the public sector?

Logistics cluster policies in the Netherlands and Germany include soft instruments for promoting the quality of the logistics sector, for example, through education and research.

For geographic clustering, governments have developed policies to concentrate freight traffic along corridors, such as those in the Netherlands, east and southeast, and Nordrhein-Westfalen (NRW) around the Rhine, avoiding fragmentation and securing long-term expansion potential. These policies focus on transport infrastructure with mainly soft supporting actions (coordination, communication), and prioritize the cofunding of infrastructure projects in these corridors.

With no special regulation in place and planning practices no different from their common planning practice, performance monitoring of logistics centers does not exist other than a low-level of data sharing for statistical purposes, which generally relies on data related to transport movements collected by other business sectors. Those with financial shares in logistics centers—such as NRW and the City of Duisburg in Duisport, the City of Venlo in Tradeport Venlo—will request financial reporting, in a level of detail as agreed between the entities. For example, the financial accounts of Duisport are published annually and provide insight into public spending and revenues. Other logistics centers also produce such accounts, which are generally public though not formally published.

Europlatforms makes lists of “top freight villages,” based on a voluntary questionnaire circulated among its members. Highly ranked GVZs, or freight villages (FVs) have an implied high score on performance indicators such as multimodal traffic and share of space in use as well as, for example, the available room for expansion. In this list a low rank does not necessarily mean the FV is underperforming; an FV with narrow scope, say on city logistics only, would never be ranked high, but would still be considered successful if it satisfies its objective.

“High performing” should always be regarded in relation to objectives, and objectives differ largely between logistics centers. Evaluation studies could be commissioned to verify the extent logistics clusters have met expectations. However, robust evaluations are rarely done. For the purpose of their promotion and acceptance by the regional public, logistics centers voluntarily publish statistics on issues such as labor force, freight volumes handled, surface space in use for logistics activities, and so on.

In Europe, FV owners can determine if performance management would add value. Any national obligation would result in more red tape. In the United States, where logistics center ownership is more private, with no public regulation for measuring performance or sharing results with the general public, the situation will not be different.

What is the role of logistics clusters in improving supply chain environmental sustainability and operational resilience?

While warehouses play a role in creating operational resilience, this function is not related to the clustering of warehouses and other logistics functions in logistics clusters.

The role of logistics clusters in improving supply chain environmental sustainability includes the following:

- For ILCs, multimodality provides clear benefits to the environment as opposed to road transport, as related to GHG and local pollutant emissions, traffic safety, and road congestion in the corridor.
- In theory, horizontal collaboration between tenants creates opportunities for improved utilization rates of transport assets, with fewer empty hauls and higher load rates. However, in practice, this has not been very successful.
- Clustering creates better opportunities for piloting and advancing innovations. Examples include the introduction of electric vehicles, developing IT platforms for coloads in urban distribution, coordination in urban delivery, such as in areas with short time windows. Pressure for such innovation has increased in the past decade. For instance, the EU has experienced increased pressure to curb HGV externalities in urban regions, and many municipalities now regulate through strict environmental rules and bans on “unsustainable heavy goods vehicles.”

The role of logistics clusters in improving operational resilience in supply chains include the following:

- Multimodality creates resilience, and multimodal supply chains have lower risk of congestion in ports and urban areas. Without multimodal connections with ILC, congestion increases, particularly in seaports, which results in significant delays and affects reliability of the logistics chains, and thus supply chains as well.
- Logistics clusters offer opportunities for horizontal collaboration, such as sharing assets and clients, which creates room for absorbing demand peaks and prevents bottlenecks in the supply chains.
- An active logistics center management and community have an eye for the long-term and anticipate developments that go beyond capabilities of single logistics service providers. Examples of this foresight include the Duisport and Venlo logistics centers, which work together with regional education institutes and set up programs to stimulate jobs in the logistics sector, by developing training material, providing internships, promotional events, and other recruitment resources. They also liaise with the research and development community to encourage innovation and with other sectors to support business development.
- A well-rooted ILC provides confidence and certainty to potential clients and all stakeholders that service level will keep pace or even be ahead of increasingly stringent supply chain requirements.
- A well-rooted ILC serves as a major employer and engages by showing social responsibility that contributes to social acceptance. This is particularly important in the logistics sector and its many externalities.
- Logistics centers are typically better at anticipating when plots become scarce and have more influence if improvements in public infrastructure are needed.

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