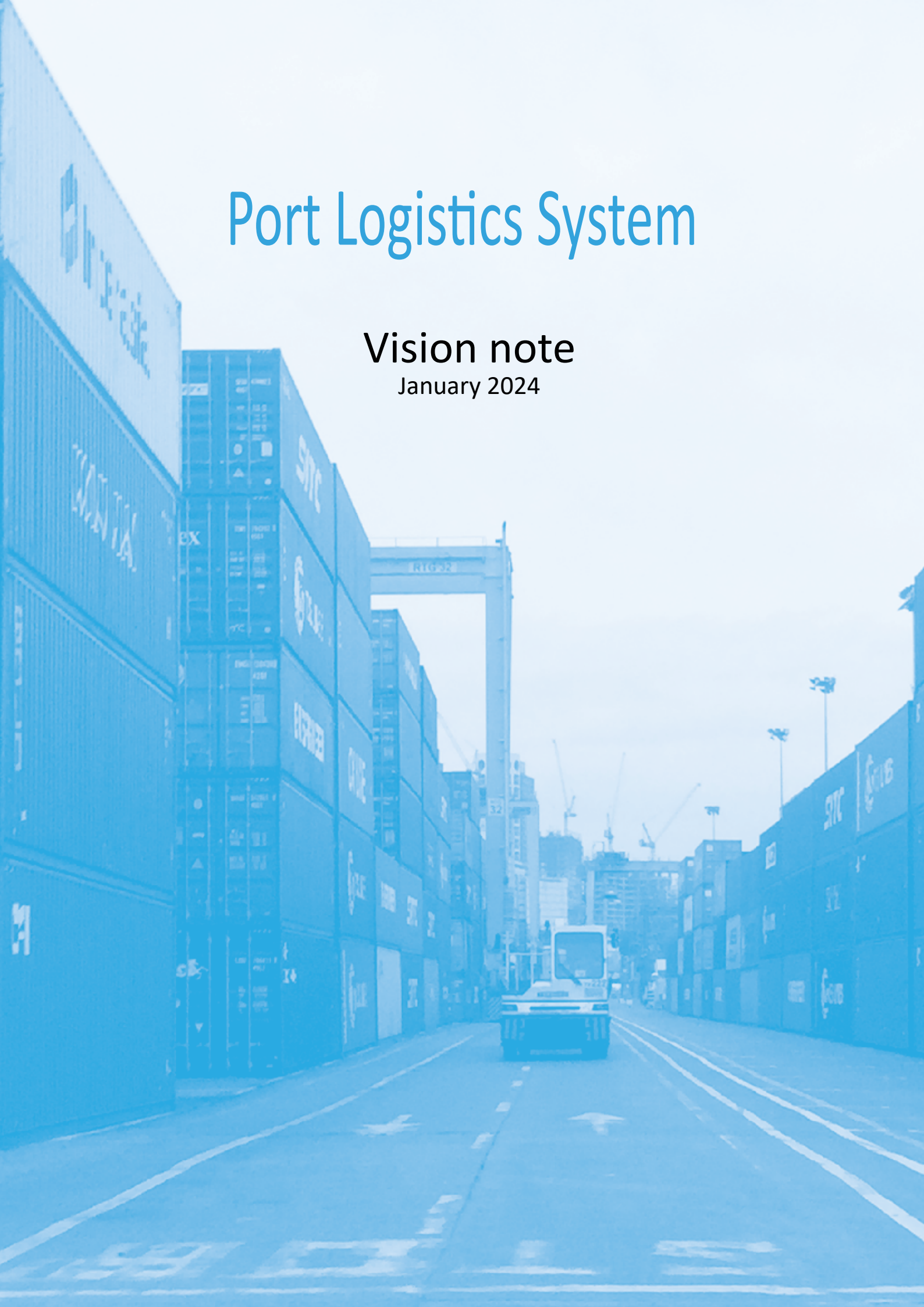
Port Logistics System

Vision note

January 2024



The Extended Gateway
Step towards the Physical Internet

This vision statement outlines the path to integrated port logistics with a comprehensive system approach. This is not about quick successes, but about developing a detailed roadmap for structural refinement and optimization of the current system.

At the basis of this endeavor is a new model, call it a new paradigm for logistics, which drives towards two clear main goals at three well-defined management levels (strategic, tactical, operational): effort reduction and value creation. Data is put forward here as a means, not as an ultimate goal. The various components, focusing either on clustering or bundling and that make up the logistics system, are clearly defined, emphasizing a holistic perspective that brings together disparate disciplines. The approach combines different logistics functions, defines and connects them within a coherent framework, based on the logical principles that govern logistics and transport.

The note starts by outlining the current context and listing future challenges. With the introduction of the smart logistics paradigm, the focus shifts to generating more value at lower costs. Furthermore, the memorandum attempts to bring order to the countless components, disciplines, functions and principles that are integral to logistics, which often suffer from confusion and misalignment. This disarray results in suboptimal solutions at best, leaving countless opportunities unexploited.

This memorandum is based on the key principles on which logistics is based. However, in practice, combinations of functions are often made in logistics, often out of necessity, due to insufficient volume. This often leads to sub-optimality. Perhaps it is time to go back to the theoretical basis of logistics.

Acknowledgements

The authors are grateful to the many stakeholders of the port logistics scene who have somehow contributed to the eventual realization of this paper. Comments and opinions that contribute to the open debate on the topics raised, remain more than welcome.

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The context today

In the current context, transport and logistics is characterized by a chaotic organization with various problems that hinder efficiency and sustainability. The problem is characterized by the following issues:

- Fragmentation;
- Inefficient use of capacities;
- High social costs.

Fragmentation in transport and logistics

There is fragmentation within the transport and logistics sector. This is reflected by the comparatively high number of transportation companies and the spread of business parks and logistics activities across different locations. This leads to inefficiency and suboptimal cooperation between companies and transporters. The lack of centralized hubs and clusters means that more distances have to be covered, resulting in higher costs, longer lead times and a greater ecological impact.

The most significant challenge in port logistics is the fragmentation of activities

Inefficiencies in capacity utilisation and infrastructure

There are significant inefficiencies in capacity utilisation in terms of space and infrastructure. This translates into waiting times, delays and underutilization of resources. For example, congestion on roads and in port areas leads to delays in the delivery of goods. In addition, storage facilities, distribution centers and other logistics infrastructure are not always used optimally, resulting in waste of resources.

Social costs and hindrance

The current transport system entails significant social costs, such as nuisance and hindrance in multiple senses. Traffic jams, noise pollution and air pollution are common problems, especially in port areas where transport activities are concentrated. These problems have negative consequences for the quality of life, people's health and the environment. In addition, the presence of heavy transport on local roads can lead to safety risks and congestion.

In short, the current transport and logistics system is characterized by fragmentation, inefficiencies and social costs. The lack of an integrated approach and coordination between different players in the sector contributes to these problems. To address these challenges, there is a need for greater cooperation and coordination between businesses, governments and other stakeholders. Creating centralized logistics hubs with open access, promoting sustainable transportation, improving infrastructure, and implementing efficient route planning and collaboration mechanisms can help address the current chaotic organization and improve the transportation and logistics industry.

Sustainable port logistics entails much more than just decarbonization

The schematic in Figure 1 below illustrates the current fragmentation of transportation and logistics in and around ports. Many trucks enter and leave the port area. There is little consolidation. In addition to road transport, inland shipping and rail transport are also used for connection with the hinterland. These 'alternative modes of transport' usually have a (too) modest share in the modal split.

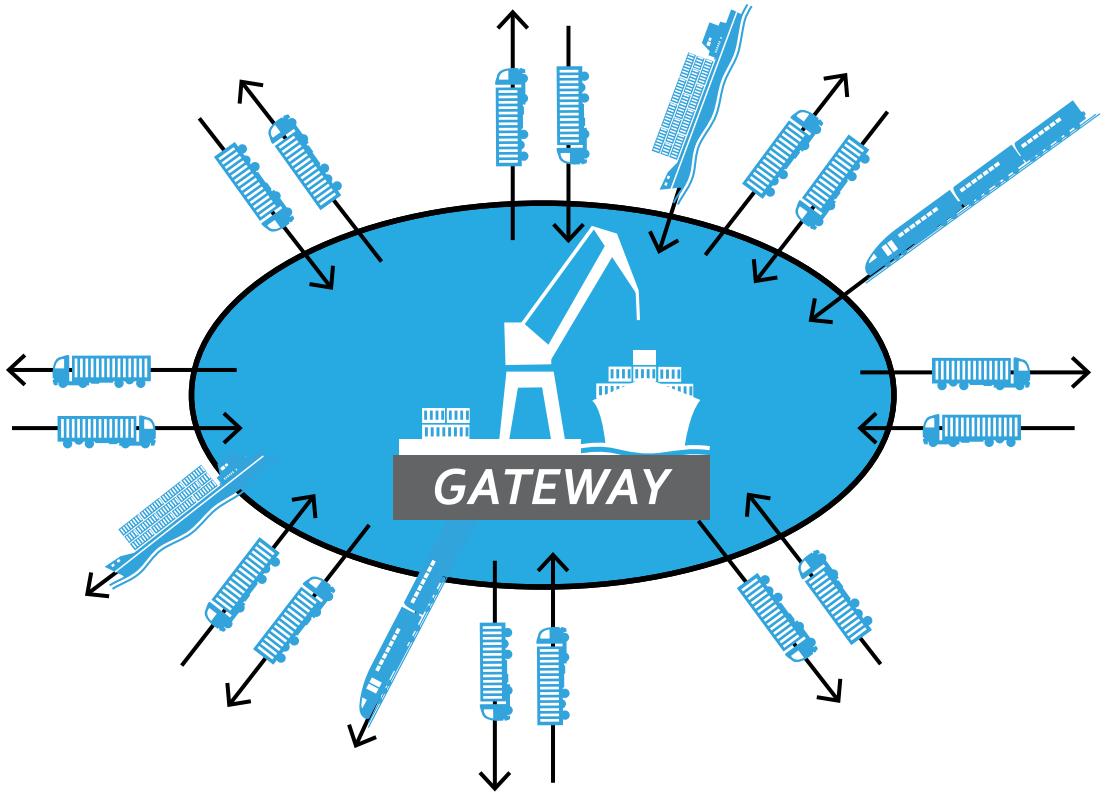


Figure 1: The current hinterland and port operation with a wide variety of hinterland transport services (source: TRI-VIZOR, 2023)

The challenges for the future

In the transport and logistics sector, there are several challenges that need to be addressed to promote sustainability, resilience, efficiency and growth. The following challenges for the logistics of the future are distinguished:

- Sustainability agenda;
- Global supply chains: resilient and agile;
- Smart and efficient gateways;
- Scarcity of network infrastructure, space and human resources;
- Industrial anchoring, door clustering and bundling.

Sustainability agenda

Sustainability is an important point of attention in the transport and logistics sector. There is a need to reduce greenhouse gas emissions, promote energy efficiency, reduce air pollution and minimize the impact on the environment. Boosting sustainable fuels and vehicles, promoting green logistics practices, such as distribution centers and electric vehicles, and reducing empty kilometers are some of the measures being taken to address the sustainability agenda.

Global supply chains: resilient and agile

Increasing globalization has led to complex and extensive supply chains that can be vulnerable to disruptions. Creating resilient and flexible supply chains is critical to respond quickly to disruptions such as natural disasters, political unrest or pandemics. Diversifying supply sources, developing alternative routes and implementing risk management strategies are important aspects to increase the resilience and flexibility of supply chains.

Smart and efficient gateways

Logistics hubs and gateways, such as ports, airports and rail terminals, play a crucial role in facilitating the flows of goods. Improving the efficiency of these gateways through digitization, advanced technologies, optimized processes and collaboration between different actors is essential to increase throughput capacity and reduce lead times.

> *The ambition: achieving sustainable growth at minimal societal cost*

Scarcity of network infrastructure, space and human resources

The growing demand for transport and logistics puts pressure on the existing network infrastructure, space and human resources. Optimizing the available infrastructure, developing new infrastructure, making efficient use of space and addressing the shortage of qualified personnel are crucial challenges. This requires policy action, investment and cooperation between governments and other stakeholders.

Industrial anchoring through clustering and bundling

Creating concentrated industrial clusters and logistics hubs can bring synergies and efficiency benefits. Clustering companies and logistics service providers in the same region can lead to better collaboration, shared use of resources and joint innovation. This can increase competitiveness and improve efficiency.

Logistical ambitions as a region - “achieving qualitative growth at a minimal societal cost”

Regions often have ambitious growth targets, but it is important to achieve this growth with minimal distortion to the environment. This includes reducing congestion, minimizing noise pollution and limiting negative environmental impacts by more consolidating flows. Developing policies and strategies aimed at sustainable growth, combined with smart logistics solutions, is essential.

Addressing these challenges requires adequate policies to promote corridor and node operation. This includes creating partnerships between different players, facilitating data exchange and information sharing, developing infrastructure in strategic locations and driving innovation and sustainability.

These various ambitions are only achievable through a comprehensive and firm approach, that will be developed below.

1 goal
smart logistics

In the face of countless challenges and increasingly complex and fragmented port logistics, the question arises for the most sustainable course. What path should we take to make port logistics sustainable? Should we go all the way for low, even zero-emission logistics, or strive for a lean optimization of defective processes at first?

At the moment, the emphasis is often on climate neutrality and achieving zero emission targets, included in port policy plans. Various restrictions and measures are determined to 'green': e.g. regarding alternative fuels, electrification with shore power, green infrastructure with solar panels, circularity,... While port authorities may advocate this, what they actually face is that those restrictions and measures put pressure on the complex sector, constituting a top-down approach.

In addition, there is a risk that after the implementation of zero emission guidelines, existing problems, such as traffic jams, delays and congestion, will remain unchanged. Although emissions in the port will decrease, these problems remain a stumbling block for the increased efficiency and the reduced societal hindrance (congestion, liveablility) of the port, albeit now 'greened'.

Resolutely achieving 'more with less' logistics

An alternative strategy is to strive for 'smarter' in addition to 'greening', whereby logistics becomes smart both to 'reduce' efforts and to generate more value. This represents a new paradigm for logistics: no more, no less, but resolutely 'more with less' logistics. This means delivering more performance with the same capacity, more deliveries with fewer kilometers, more movement in less time, and more handling with fewer people. This results in a higher return from the same investments. Not necessarily growth in absolute terms, but margin and productivity growth and growth in relative value creation.

Making this smart logistics a structural reality is only possible by tackling the system. A vital aspect for making logistics smarter, is to reduce the fragmentation. Probably the most efficient way to do this, is to redesign the logistics system as a network of nodes and connections (see Figure 2 below).

Consolidation takes place in the nodes and bundling in the connections (Figure 2).

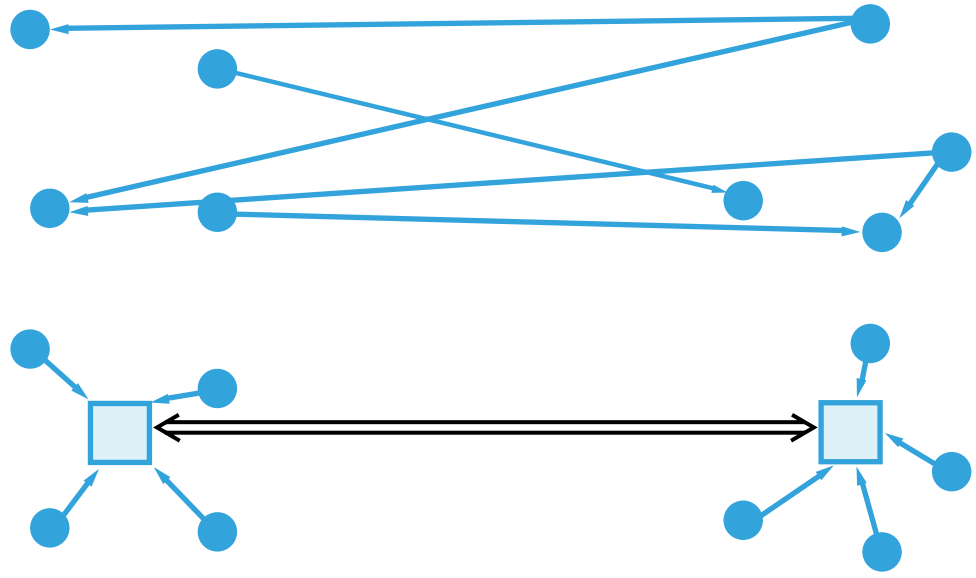


Figure 2: From fragmentation to clustering and bundling

2 objectives
minimize costs - maximize value for all stakeholders

Various objectives are pursued within the logistics sector, some of which are difficult to reconcile. Significant flexibility or fast delivery times are often required, and this at a very competitive price. These requirements often put logistics players in a difficult position, as such services are difficult to make profitable.

Minimal costs and maximal value for all stakeholders

The numerous goals in logistics can be divided into two main categories: minimizing contribution or costs and maximizing value creation for everyone involved. The stakeholders in port logistics include not only the various logistics actors and their customers, but also governments and civil society. All stakeholders should benefit from it, aiming for a win-win situation. In this way, truly sustainable solutions can be achieved, where the 'return on investment' or 'benefit over cost' in the broadest sense is maximum for the entire port ecosystem.

3 management layers of an integrated, port logistics

It is important that the three levels at which policy can be conducted, strategic, tactical and operational, are distinguished, but of course also integrated into one consistent whole.

The port logistics system is developed at the tactical level, in accordance with the vision and plans drawn up at the strategic level. Within the developed port logistics system, the aim is operational excellence. The latter is mainly the task of market players. The public authority only plays a facilitating role here. They should provide the framework within which the market can excel.

Strategy	**Data management** **Standards and protocols**	Modeling strategies/scenarios	Clear vision and concrete plan on freight flows/ logistics - integrative, inclusive and fair
Tactics		Modeling design of system(s)	Holistic (multi-layer) urban logistics system - zoning and clustering - nodes and corridors - smart and obvious
Operations		Modeling optimization options	Operations excellence - efficient, effective and sustainable

Table 1: Three management layers: strategic vision and plans, tactical system approach and operational excellence

Data as a tool

Data is crucial, both to implement adequate policies and for optimized operations. Data is not an end in itself, but a necessary means. Through digitalization data becomes available.

To this end, data must first be brought together at different levels, at strategic, tactical and operational levels. That cannot be achieved straightforwardly. Actors are often not inclined to just share their data with everyone. By the way, data sharing can sometimes lead to unauthorized practices and go against competition regulations (e.g. cartel formation).

Today, many parties are still connected for the purpose

Connecting stakeholders to a governed datasharing platform

of data sharing in a one-on-one approach. This requires a huge number of connections and ultimately no integrated connectivity. The flow of data and information through the chain is intermittent and irregular.Chain integration remains difficult. A lot of data simply remains unused.

Data is crucial, both to implement adequate

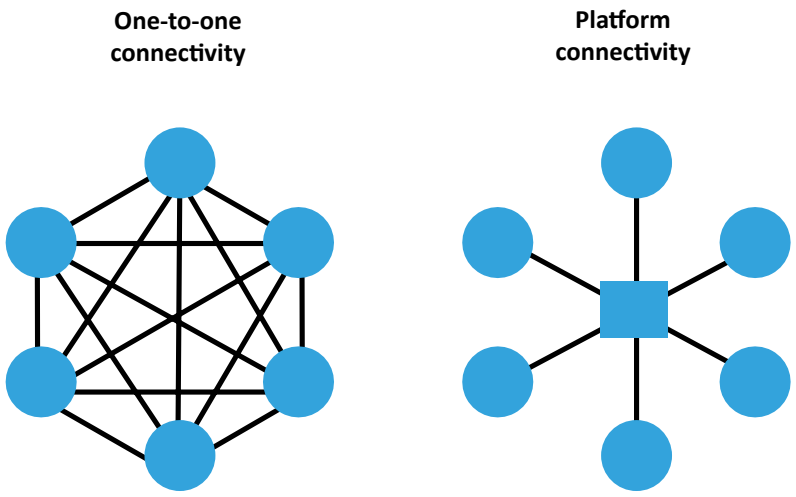
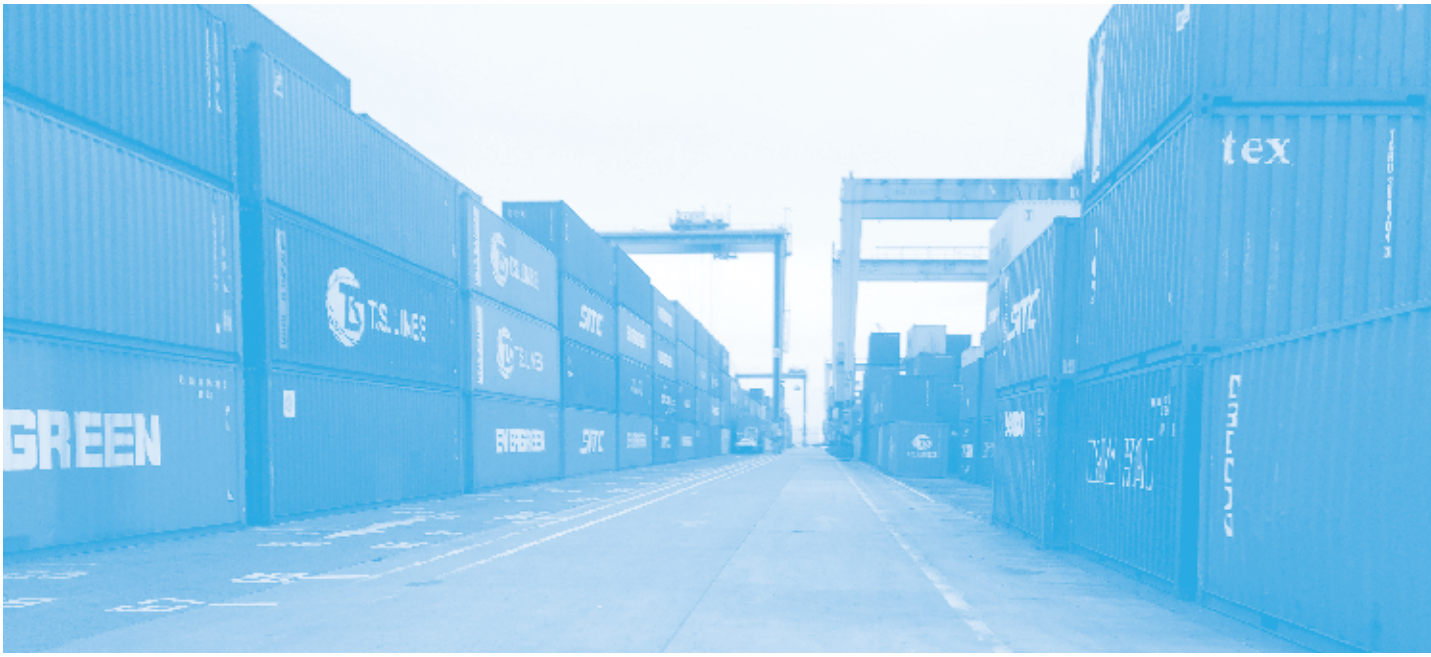


Figure 3: From one-to-one towards platform connectivity (TRI-VIZOR, 2023)

To collect the data in an adequate and secure manner, it is best to set up a (data) platform. This means fewer connections anyway (see schemes on Figure 3). All actors involved can connect to the open platform and have access to that (processed) data in accordance with their role and the associated authorization, adhering to the principle that individuals are only permitted to access information relevant to their roles or within the scope of their authorized responsibilities.For example, for the strategic level, but also for the tactical level, aggregated data is more appropriate. The platform is responsible for aggregation and translation to the many target groups.

It is evident that setting up and managing such a data platform for port logistics requires the right structure and organization.

The intended data platform has a layered structure. In the first layer, 'connecting', the various actors involved are connected via the platform. At the second level, the exchange of data takes place, both structured and informal. The third level involves processing this data into useful information, which is then used for targeted applications, both in real time (for example for order processing, tracking & tracing, and visibility) and offline (including simulation, scenario exploration and policy preparation).



4 components of a port logistics system

The following components must be distinguished in a port logistics system:

- The Gateway or port as a hub, the international node;
- The Extended Gateway (EG) as a hinterland cluster or (regional) node;
- The corridor as a multimodal connecting transport axis;
- The Gateway Access Point (GAP) as an access point and transhipment point.

The figure below schematically clarifies the role of the different components (Figure 4).

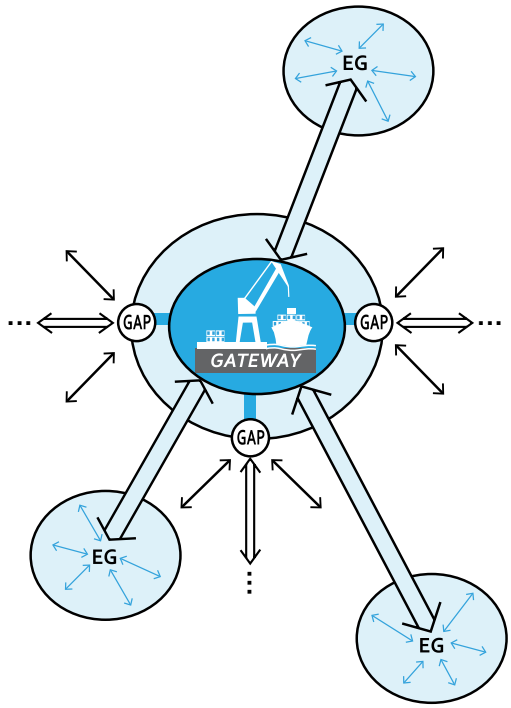


Figure 4: Port Logistics System - 4 components

These components each contribute to the efficiency and effectiveness of the goods flows. Further clarification will be given on each of the mentioned components.

Gateway or port as hub, international node

The port functions as the beating heart of the logistics system. It is not only a location for the receipt and shipment of goods, but also an international hub where different modes of transportation converge. Complex logistics processes take place here, such as loading, unloading, storage and distribution. The port serves as a crucial hub for international trade and transportation.

Extended Gateway (EG) as a hinterland cluster or node

The Extended Gateway is an extension of the port to the hinterland. It is a cluster or node connected to the port and acts as a link between the port facilities and the wider hinterland.

This can consist of distribution centers, transport platforms, production sites and logistics hubs that ensure the smooth flow of goods to and from the hinterland.

Corridor as a multimodal connecting transport axis

The corridor is an essential part of the logistics system and functions as a multimodal transport axis. It includes roads, railways, waterways and possibly even air links working together to ensure a seamless flow of goods. The corridor facilitates efficient and integrated logistics by connecting and integrating different transport modes (synchromodality or co-modality).

Gateway Access Point (GAP) as an access point and transhipment point

The Gateway Access Point (GAP) is a specific point within the logistics chain where goods gain access to the port facilities. It functions as a gateway on the edge of the 'port area' and also serves as a transhipment point or transferium where goods are transferred from one mode of transport to another or more broadly from one system, namely long-distance hinterland transport to another system, namely intraport transport. This optimizes logistics flows and increases the efficiency of the transport process. The transporter does not have to suffer delays and congestion in the port area. The cargo is delivered (export) or picked up (import) at the edge of that port area.

By accurately distinguishing and integrating these components, a well-coordinated port logistics system is created that is able to move goods in a fast and cost-effective manner, both within the port and between the port and the hinterland.

5 disciplines of a port logistics system

Five disciplines or policy domains can be distinguished in port logistics policy:

- Spatial planning
- Infrastructure
- Market of demand and supply
- Business development and branding
- Innovation

Spatial Planning

Clusters or logistics hubs refer to areas where related industries or activities are concentrated on the corridor. These clusters can foster collaboration and specialization. Connections pertain to the physical infrastructure and transportation routes that link different areas within the corridor.
Ports are key entry and exit points for goods on a corridor. The hinterland refers to the area surrounding a port, which is influenced by and influences the port's activities. Effective integration between ports and their hinterlands is crucial for efficient logistics.
Spatial planning must comply with the principle of the so-called 'deconcentrated bundling', serving as a nuanced compromise between economic dispersion and consolidation. It implies, foremost, that not all value-adding activities should be centralized within the ports. Certain activities are more strategically positioned in various key locations within the hinterland.

Multimodal Infrastructure

The term multimodal infrastructure encompasses the tangible facilities and transportation modes within the corridor, essentially constituting the 'hardware,' so to speak. It includes roads, railways, waterways, airports, and intermodal terminals and dry ports. The seamless connectivity of these modes (called synchro-modality) can enhance the efficiency of transportation within the corridor.

Considering the characteristics of freight flows and the surrounding natural context, rail transport emerges as the primary alternative transport mode to road haulage. For rail, even more so than for road, achieving a balanced freight flow in both directions is paramount.

Market of Demand and Supply

Understanding the patterns of demand and supply for goods within the corridor is essential. This involves analysing the movement of goods, identifying where they come from and where they are destined. In an ideal scenario, there is a match between the supply and demand for transportation and logistics services and resulting in balanced freight flows in both directions of the corridor.

> *Port logistics needs a multi-disciplinary approach*

The public sector may facilitate the market, ensuring its openness and neutrality. The corridor should be accessible to all potential users under equitable conditions. This open-access approach is the most effective assurance of maximizing corridor capacity utilization.

Business Development and Branding

This dimension involves creating awareness among businesses and stakeholders about the corridor's potential and opportunities. It also involves aligning the interests of various businesses and organizations within the corridor to foster collaboration and mutual benefit.

Building a community or eco-system among the businesses and the various stakeholders within the corridor can lead to better cooperation, resource sharing, utilization of capacities and shared goals.

> *Reduction of vehicle-kilometres is beneficial for logistics operators prioritizing profit over turnover growth*

Corridor steering groups, facilitated by an engaged corridor community that unites diverse stakeholders, can effectively coordinate business development initiatives and establish a distinctive corridor brand.

Innovation

Corridors need to stay innovative to remain competitive. This includes exploring and implementing new concepts in transportation, logistics and business practices.

Continuously improving and optimizing processes and operations within the corridor can lead to increased efficiency and reduced costs.

Maximizing the use of infrastructure and resources is crucial. This can involve (new) technologies and strategies to enhance capacity utilization.

Platooning or road trains (multiple vehicles travelling in close proximity to each other, autonomously coordinating their movements) might be an innovation in transport. New transhipment techniques in the nodes or the dry ports or terminals might be another way to

6 functions of a port logistics system

Various functions or tasks are performed in logistics, with transport and storage serving as essential pillars. The aim of transport is to move goods from the origin to the destination, where we make a distinction between the origin and destination regions. The six distinct functions or tasks are as follows:

- Connecting: transporting goods between regions;
- Collecting: the fast and flexible collection of goods within a region - the first mile;
- Distributing: the effective distribution of goods within a region - the last mile;
- Repositioning: moving goods to a more suitable location;
- Combining: creating added value in logistics through consolidation;
- Storing: buffering, managing inventories and storing goods.

Various logistics functions should be decoupled

Nowadays, several functions are often combined. Point-to-point connections are usually easy to organize, but are often not efficient, effective or sustainable leading to fragmentation (Figure 5). That is why different deliveries are necessarily combined, which actually means that logistics functions such as collection, connection and distribution are mixed. This results in suboptimal performance of the relevant functions or tasks. Ideally, logistics tasks should be kept separate. This can only be achieved by decoupling (see Figure 5). This means that both sides of the decoupling point can be fully deployed on the various logistics tasks.

Figure 5 shows the various functions or tasks in a logistics system schematically.

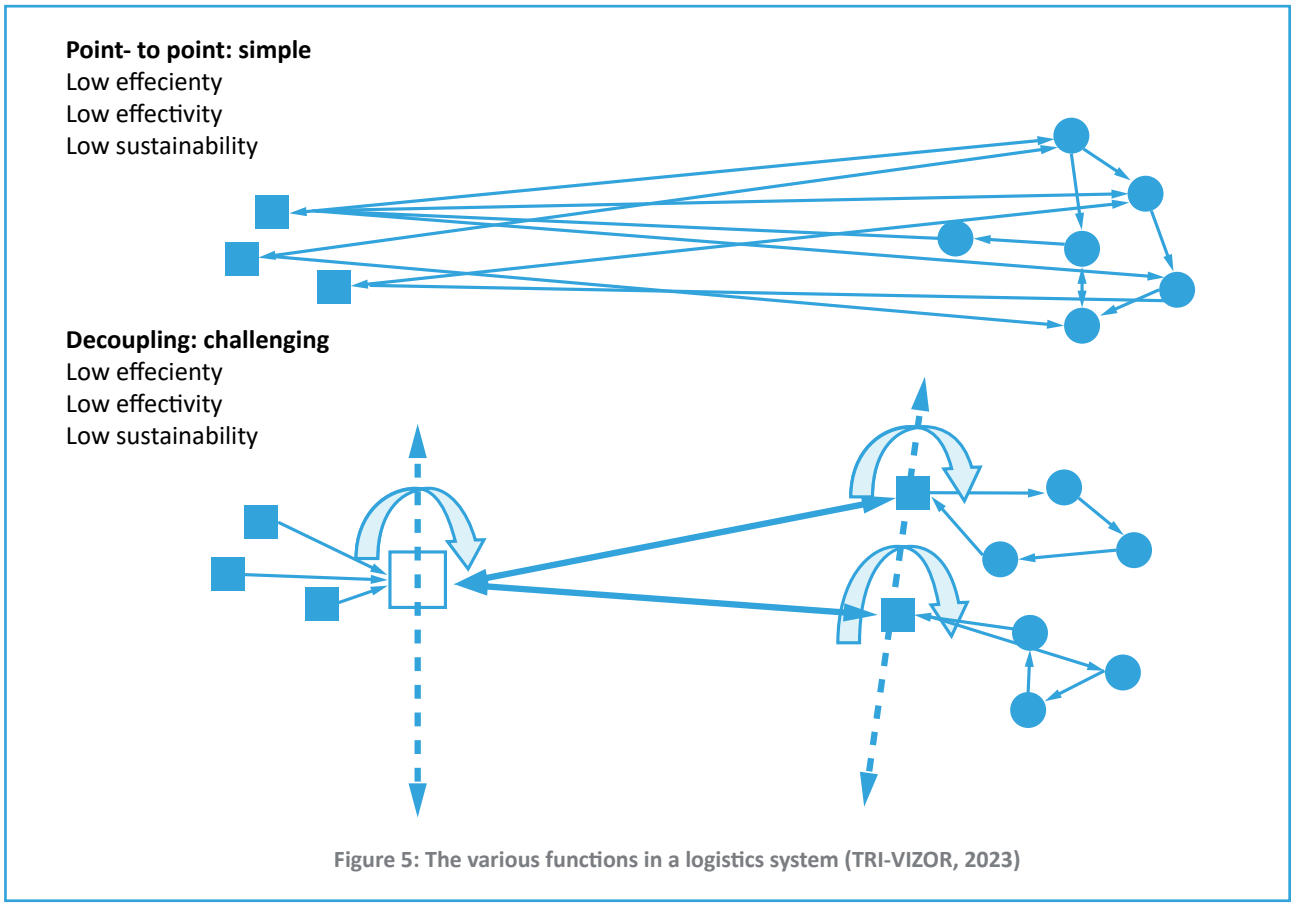


Figure 5: The various functions in a logistics system (TRI-VIZOR, 2023)

The functions are further characterized in Table 2 below, including the control principle. Connecting and repositioning should ideally be supply-driven, while the other functions are more demand-driven.

In a supply-driven function, focus can be placed on efficiency through automation and optimization. An essential condition here is sufficient volume. A stable transport service with sufficient frequency can only be set up with sufficient scale, e.g. a barge or train shuttle service with high utlization rates in both directions.

Supply-driven functions, like repositioning and connecting, might be developed with a strong support of the public sector and serve the public interest due to their open nature (open access, see below). After all, the more volume consolidated on the corridor or in the repositioning transport system the less hindrance and impact of that transport on the environment.

Logistics Function	Characteristics	Driver principle
To connect	Transport from A to B – interregio - scale – efficiency – balance between both directions	Supply-driven
To collect	First mile – fast and flexible - effective	Demand-driven
To distribute	Last mile – fast and flexible – on demand - effective	Demand-driven
To (re)position	Robust – scale – frequency – general interest	Supply-driven
To combine	Value adding logistics and services (VAL & VAS)	Demand-driven
To store	Buffering	Demand-driven

Table 2: Characteristics of the various logistics functions

7 principles that make sense logistically

The fundament of a strong system are a number of logistical principles. These principles must make sense, must be logical. These principles are neither new nor unique. They not only applicable in port environments, they also apply in other environments (e.g. city logistics). An integrated logistics system for port logistics is best built on the basis of the 7 principles below, which are explained below.

- Consolidation
- Decoupling
- Multimodal
- Connectivity
- Accessibility
- Public-private
- Orchestration

Consolidation

Collaboration and consolidation leads to the generation of scale, and this holds true for logistics as well. When goods flows are consolidated in corridors, activities are clustered in hubs or nodes, and resources are shared, operations can be conducted on a larger scale, resulting in increased efficiency. In this way, more can be accomplished with less use of capacities.

Efficiency improvement through the bundling and clustering of logistics activities has been a longstanding goal for the logistics sector. As a result, logistics actors have expanded in size considerably. Consolidating volumes within a single company is already a common practice, but extending this consolidation across different companies is less straightforward, as it involves collaborating with competitors.

Decoupling

The primary objective of decoupling processes is to facilitate consolidation by bringing together, regrouping, and bundling loads. Decoupling also plays a crucial role in the transition to different loading units or transport modes, more suitable for the various areas to be transported through.. Moreover, it opens up opportunities within the logistics process by allowing the integration of lean and agile strategies.
Before reaching the decoupling point at the edge of the port, e.g. at the GAP (see below) large quantities can be efficiently supplied (lean approach). Beyond this point, flexibility and responsiveness to the wishes and needs of end customers become possible (agile approach). The last mile delivery focuses on agility and maneuverability. By decoupling in the logistics process, supply-driven operations (before the decoupling point) are combined with demand-driven logistics (after the decoupling point).

Decoupling can be effectively achieved by adopting a modular approach, streamlining operational transfers. For instance, the tractor, vessel, or locomotive can disconnect from the trailer, loading bodies, or wagons, enabling immediate return or onward journeys. Utilizing standardized modules offers greater flexibility for regrouping without the need for unloading, transferring, or reloading.

In logistics, decoupling involves creating buffers or stock points between different steps in the supply chain to reduce inter-process dependency.
Moreover, decoupling can be viewed from a technological standpoint as well. At the outskirts of the port, people are transitioning from one technology (e.g., hydrogen-based propulsion) to another technology (e.g., electric propulsion).

Multimodal

Meeting the growing future demand requires a collaborative effort involving all available resources. In the port transport system, every mode of transportation will have a role to play. The key is to select the most suitable transport modality for each component in the chain, comprehensively covering the five primary transport modes within a multimodal system: road, rail, water, underground and air.

This integration demands careful coordination and synchronization both within individual chains (vertical) and between different chains (horizontal), a concept known as synchromodality. It allows for real-time switching between modalities, ensuring the most sustainable option is always chosen. As a result, the entire system becomes robust and capable of adapting to varying circumstances.
In passenger mobility, the STOP principle in the smart planning of a mobility policy is often used, emphasizing the priority of “by foot” first, followed by “by bike,” then

Public Transport, and finally individual passenger or private cars. This principle can also be applied to freight mobility, aiming to enable the utilization of the most suitable transport modality for goods flows.

Back to basics: logistics based on logical principles

Connectivity

Connections must be made on various levels. Disconnected processes must be reconnected. The various components in the broad system of port logistics must be connected in an Internet of Things (IoT) concept.

Connectivity manifests itself on three levels: the strategic level involving stakeholders, the tactical level encompassing IT systems, and the operational level dealing with logistics operations.

Logisticswill be more and more embedded and integrated in a hyper-connected network of nodes (hubs) and connections (corridors). If a connection (corridor) or node (hub) encounters issues, there is still an alternative route.

Open access

To achieve maximum consolidation, it is essential to open up infrastructure and logistics services. The goal is to create an open system where all interested parties have access to the infrastructure or logistics services. This concept is often referred to as a neutral or white label system. By sharing capacities extensively, optimal utilization can be pursued, leading to effective deployment of resources (effectivity).

Public-private

Port logistics encompasses various aspects such as mobility, economy, spatial planning, quality of life, and safety. Given the wide-ranging impact, it is evident that public actors, i.e., governments, have a stake in this domain. However, an approach based solely on imposing or prohibiting measures may not be the most effective, as it can put the private sector on the side (e.g., in the case of imposing zero emission requirements). Finding a middle ground and uniting the interests of both the public and private sectors is crucial. Striking a well-balanced approach between these two entities poses a significant challenge but is vital for successful port logistics planning and implementation.

The crucial challenge is to determine which aspects of logistics should be publicly organized and which should be left to market parties. Figure 6 gives an overview of the different levels in the logistics market. The first level (layer 1: the economy, trade) logically seems to lie with market actors. The lowest level (layer 4 – infrastructure or hardware) is most often in the public sector. However, there is less consensus concerning the intermediate levels. Some argue that nodes, including hubs, parcel vaults, lockers, and collection points, as well as the transport system with vehicles (layer 3), should be in

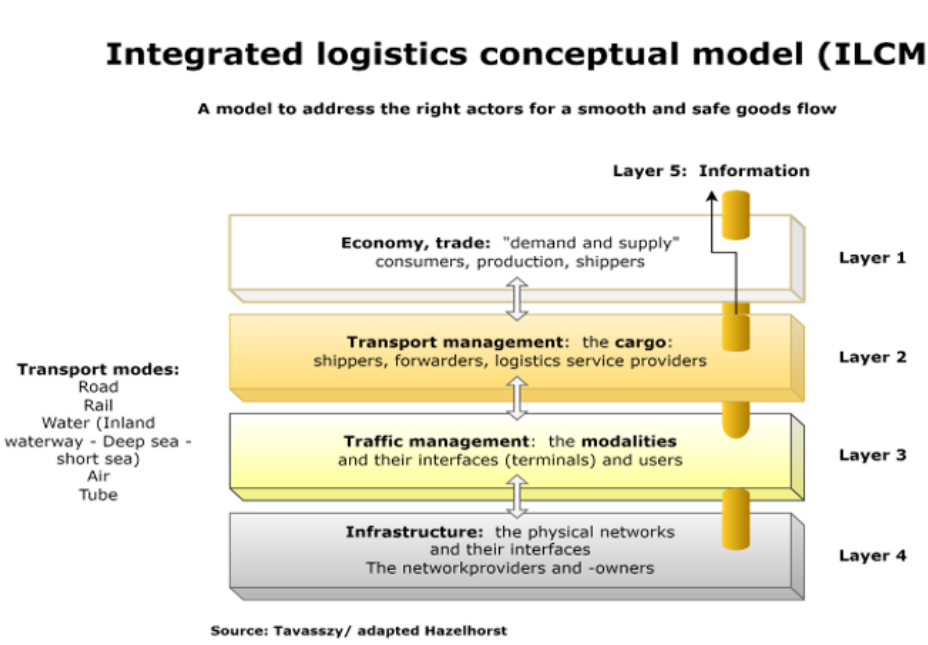


Figure 6: Integrated Logistics Conceptual Model (ILCM)

the public domain. The rationale behind this viewpoint is that increased access to a specific infrastructure or service by multiple actors leads to greater efficiency. Others advocate to let the market play at that level of the transport system…

Orchestration

To ensure that everything runs smoothly, both in the preparatory phase and in the operational phase, a neutral orchestrator, some call it a director, is involved. In the preliminary phase, he fulfills the role of architect. In the operational phase, this orchestrator primarily act as a trustee.

The primary responsibility of this neutral party is to ensure proper and equitable setup and smooth functioning of the entire port logistics system. A port logistics-wide monitoring system is useful for this purpose. Ideally, the orchestrator operates in a port logistics community or ecosystem. This is a community of stakeholders that has been set up with a covenant or a multi-stakeholder agreement or commitment statement.

The orchestration role fits within the so-called governance of port logistics. This encompasses a comprehensive framework of policies, rules, mechanisms, processes and structures that are applied to regulate and manage logistics activities in port areas aiming to enhance their efficiency, effectiveness, and sustainability.

Promoting awareness about sustainable logistics and providing educational programs to both public and private sector actors, such as logistics and transport companies, can help to bring about behavioral change and promote the adoption of efficient and sustainable logistics solutions. This pursuit of broader support is also part of orchestrated governance. Instead of a top-down approach, the focus is on working from the bottom up to bring about positive changes. This

Connectivity as a common thread

seems to be the best guarantee for the stakeholders to perceive the system as **fair**
The foundation of the Internet of Things (IoT) rests on the exchange of data and communication (see earlier), but above all on connectivity. Connectivity is the common thread in the development of a future-proof port logistics system and is considered thé critical success factor. Without adequate connections, the basis for data exchange, optimization and therefore smooth, streamlined, efficient, effective and sustainable logistics is lacking!

Key principle for urban logistics	Motivation - clarification	Main goal
Consolidation	Bundling, clustering and pooling – asset or capacity sharing – collaboration - “more with less”	Efficiency
Decoupling	Transhipment – replenishment & last mile & last-last mile – modular – buffering - from supply-driven towards demand-driven	Agility
Multimodal	Combination of various transport networks (road -incl. bike and foot, rail, water, undergroud and air) – various vehicle types – integration – transhipment - synchronization	Robustness
Connectivity	City of Things (cf. IoT) – hub & spoke – hyperconnected network – data sharing – community or ecosystem design	Integration
Open-access	Standards and harmonization – protocols - infrastructure on public domaine - neutral assets – white label – common assets	Effectiveness
Public-private	Urban logistics deal – alignment – multilateral agreement – multi-stakeholder covenant	Equitability
Orchestration	Governance – organization of collaboration – community or ecosystem building and management - monitoring	Fairness

Table 3: Logical principles for port logistics (TRI-VIZOR, 2023)

A strong and logical **logistics system for the port**

A system of nodes and corridors

The principles, functions, disciplines, components, policy levels, goals and paradigm or model introduced above, come together in an integral port logistics system with nodes and corridors. This is how logistics also takes place inside and in the captive area of the port. The components are respectively named Gateway(s) and Extended Gateways (EGs), hinterland connections or corridors and Gateway Access Points (GAPs).

We can speak of “the Extended Gateway” to encompass the complete, holistic port logistics system.

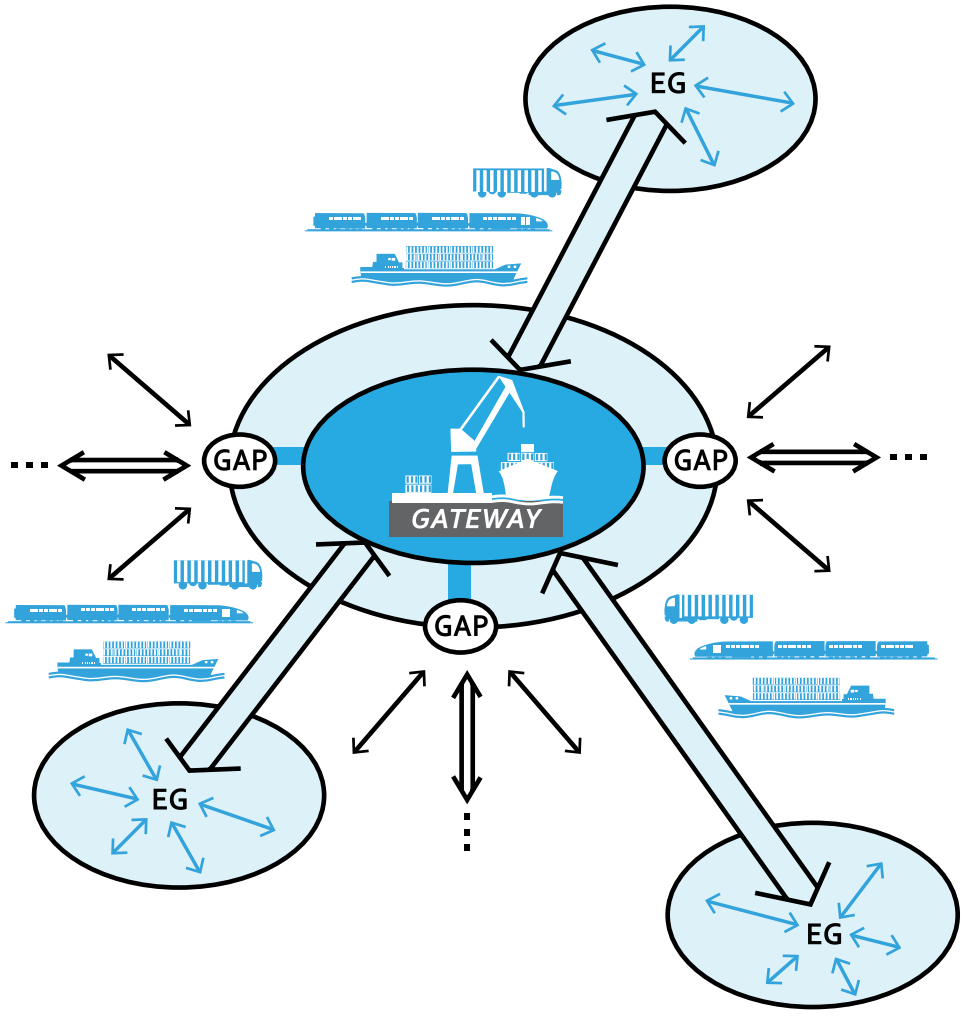


Figure 7: The system of Gateways and Extended Gateways with hinterland shuttles (TRI-VIZOR, 2023)

The Extended Gateway – step to the physical Internet

In this note, we have taken an in-depth look at the Extended Gateway or port logistics system using a holistic approach, considering several aspects.

1 new logistics model or paradigm: smart or “more with less” logistics;

2 goals: cost reduction combined with value creation;

3 management levels: strategic vision and plans; tactical systems and operational excellence;

4 components: the gateway, the extended gateway (EG); the gateway access point (GAP) and the hinterland connection or corridor;

5 disciplines: spatial planning, multimodal infrastructure, market of supply and demand, business development & branding and innovation;

6 functions or tasks that shape transport and logistics: connecting; collect; to divide; reposition; combine and store;

7 logical principles for the logistics of the future: consolidation; decoupling; multimodal; connectivity; accessibility; public-private and orchestration.

This holistic approach represents a significant step towards ‘The Physical Internet (PI)’ for ports, a system of nodes where activities are grouped and of connections where flows are bundled.

This vision note is based on the key principles on which logistics is based. However, in practice, combinations of functions are often made in logistics, often out of necessity, due to insufficient volume. This often leads to sub-optimality. Perhaps it is time to go back to the theoretical basis of logistics. Only through more and structural collaboration in logistics with the intention of bundling, clustering, sharing and pooling, the theoretical optimum can be achieved or at least approached. This is only possible with the dedicated commitment of a wide and diverse group of stakeholders. Together one can make this real.

By researching and further developing the system at all levels and dimensions, we strive for an integrated and optimized approach. In this way we can realize a system that is comparable to the efficient operation of the current Internet for information and data traffic. This forms the basis for an innovative and sustainable future for port logistics.

The Authors

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Bart Vannieuwenhuyse is MSc in civil engineering (K.U.Leuven, 1993) and master of engineering in industrial management (K.U.Leuven, 1994). He started his career as a teaching assistant at the University of Ghent (RUG). In 1997 he came back to K.U.Leuven, "Centrum voor Industrieel Beleid" (Centre for Industrial Management), where he started his PhD research in the domain of transport and logistics. In March 2002 he obtained his doctoral degree in Applied Sciences with a script titled 'Strategic Logistics Management through Rational Transport Mode Choice'. Afterwards Bart worked as senior consultant at Transport & Mobility Leuven (TML), a spin-off of the K.U.Leuven for two years. From July 2004 on Bart Vannieuwenhuyse works as expert (2004-2007) and as Research Manager (2007-2008) at the Flanders Institute for Logistics (VIL). He has coordinated the research in the fields of Multimodal Transport and Extended Gateway. Bart Vannieuwenhuyse is the author of several publications on logistics, multimodal transport and decision support systems. He is also a frequent speaker at various conferences and a lecturer at several Belgian universities, high schools and knowledge institutes. In November 2008, he has co-founded TRI-VIZOR NV, as a spin-off company of the University of Antwerp. As the World's First Cross Supply Chain Orchestrator®. Its mission is to offer specialized knowledge and solutions to create, support and orchestrate flow bundling and horizontal partnerships in transport and logistics, along the supply chain from port to city. With TRI-VIZOR, Bart has been involved in various projects over the past decade in both industry and the public sector. Given his role at various universities and colleges, he is very adept at a triple helix approach. Beside improving the utilization of current logistics capacities, Bart is preparing the future as one of the initiators of future proof transport initiatives (FPTI).

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As a professional, but also as an academic, Alex's key experience is in Supply Chain Management (SCM) and Logistics. He was former partner and practice leader SCM at KPMG, a worldwide leading consultancy company. He acquired exceptional experience in the setup of supply chain strategies and the conception and implementation of decision support systems. Subsequently in his job as independent advisor, he was hired by major companies to supervise and to provide expert guidance for their Supply Chain strategy and logistic optimization projects, most often at board room level. Alex is also co-founder of the Vlaams Instituut voor de Logistiek (Flanders Institute for Logistics). Between 2003 and 2008 he was the first managing director of that institute. Alex is also the inventor of the Extended Gateway® concept. It's an innovative and powerful concept to connect regions with natural advantages for European distribution to international gateways. The idea and the challenge behind the concept is the creation of additional logistics prime locations (i.e. minimal total cost locations) for added value logistics along the corridors of the integrated multimodal hinterland network. In 2014, he was awarded the price of Logistics and Supply Chain Professional of the year by the European Logistics Association (www.elalog.eu). As part-time academic, Alex teaches Supply Chain Management and Logistics at the Universities of Leuven and Hasselt and at the management schools AMS (Antwerp), EMLV (Paris) and IESEG (Paris).