Annex 5
Smart logistics

A-S-I: improve, by allowing more efficient organisation in the logistics sector by, for example, simplifying the administrative burden. Shift, induced by the relative difference in the benefits that improvements in efficiency can bring in transport modes.

Context: transport of goods, all different modes

Time frame: short to medium term. Significant developments are already ongoing; digitalisation is a continuous process.

A5.1 Definition

Logistics is a term that can be used in different contexts. In the business sector, with specific reference to the shipment of goods, it can be defined as 'the process of planning, implementing and controlling procedures for the efficient and effective transportation and storage of goods, including services and related information from the point of origin to the point of consumption for the purpose of conforming to customer requirements and includes inbound, outbound internal and external movements' (CSCMP, 2022). In simpler terms, the logistics sector comprises all operations linked to the flow of goods from a point of origin (e.g. a factory) to a point of consumption (e.g. the final user) to meet different set of requirements.

The application of digital technologies such as those presented in Chapter 3, and in particular information and communications technology (ICT), to the logistics sector has been often identified with the term 'smart logistics' (Geiger, 2016), although that term, as discussed for other technologies, has progressively acquired a more articulated and multifaceted meaning, and a widely agreed definition is still missing (Uckelmann, 2008). Korczak and Kijewska (2019) compiled a detailed review on the topic, and identified three key features of smart logistics: (1) the multiplicity of services that it entails; (2) the different sales channels driving deliveries; and (3) the synchronisation of planning, people, policy and infrastructure. In general, the use of ICT in logistics allows data to be recorded at the source, then be processed and transferred to successive systems in real time and made constantly available (Scheer, et al., 2001). This, by monitoring current states and identifying deviations, can form the basis for better steering of logistics flows.

In the following we use the term smart logistics in line with the definition reported by BCI Global, i.e. 'the effective use of data to improve the efficiency of traffic and logistics' (BCI Global, 2022).

A5.2 Context

Freight transport, as extensively discussed in Chapter 2, is a key sector in the EU economy. The transport and storage sector alone employs approximately 10.4 million people and records an added value of EUR 510.3 billion, excluding satellite activities. This represents 7.9% of those working in the non-financial business economy and 7.4% of the wealth generated in that part of the economy (Eurostat 2022c).

EU-27 demand for freight transport continues to increase, at approximately the same pace as the gross domestic product (GDP). In 2019, approximately 3,392 billion tonne-km were transported, 23% more than in 2000. This corresponds to a compound annual growth rate of 1.8%. By comparison, in the same period overall GDP in the EU-27 increased by 31% in real terms (after removing the effect of price changes; this corresponds to a compound annual growth rate of 1.4%). In 2019, 52.0% of tonne-km were transported by road, 28.9% by sea and 12% by rail. The share of the other transport modes was 4.1% for inland navigation, 3.0% for oil pipelines and 0.1% for air. Meeting such demand has significant environmental impacts, as discussed in Chapter 2, and external costs (see Factsheet 7). For this reason, understanding the effect of applying digital solutions to the logistics sector is of interest: eliminating inefficiencies and administrative burdens can on the one hand bring environmental benefits (e.g. reducing greenhouse gas (GHG) and air pollutant emissions or congestion) and on the other hand further increase the demand for services due to the lower costs.

The logistics sector is complex and includes many actors and processes, with a wide geographical scope and different transport modes involved. A key element of interest in this factsheet is the transport of goods across different nodes of a network or of a supply chain. These movements are associated with the need to exchange a significant amount of information, not only for business purposes but also to demonstrate compliance with transport rules and contractual agreements. Today, according to the European Commission, the vast majority of this information is printed on paper: for example, only 1% of cross-border operations in the EU territory can be carried out in a completely digital manner, i.e. not requiring a physical document at some stage of the transport process. Differences exist if we make comparisons across single modes (i.e. not considering multimodal transport), with aviation being the one with the highest uptake (approximately 40%) of electronic information exchange. By comparison this share is approximately 5% for rail, 1% for road and virtually zero in the maritime sector (Ecorys et al., 2018).

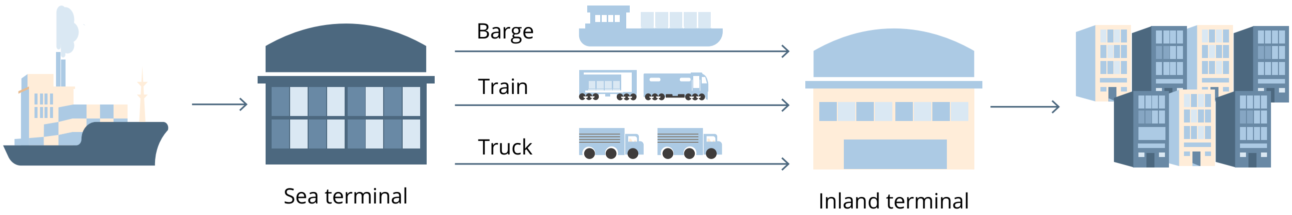
The reasons for this situation lie in the legal and technical barriers preventing an efficient and secure exchange of information based on trust between operators and authorities. Indeed, legal provisions in some Member States require that, in order to fulfil regulatory requirements, transport documents requested by public authorities need to carry handwritten signatures (e.g. Belgium, Bulgaria, Italy Luxembourg, Slovenia and Spain). More generally, there is no consistent rule across modes and for all EU-27 Member States on the acceptance of electronic transport documents (Ecorys et al., 2018) indicating a fragmented legal framework. From a technical standpoint the situation is similar. Although, for some modes, protocols for electronic documents exist (e.g. UNECE electronic consignment notes: e-CMR for road transport and e-AWB for air transport), for others the situation is less clear and no accepted standard yet exists. Moreover, how these protocols will work across modes is still unclear. The situation becomes even more complicated when the digital solutions implementing such protocols are considered. Indeed, in the past 20 years, many public or private platforms to support the sharing of data for business or compliances processes have been developed. In general, although these have certainly contributed to local efficiency gains in specific modes, there is a significant concern among stakeholders about the lack of interoperability and interconnectivity across these tools. Indeed, it should be mentioned that the costs of switching from one platform to another are likely to be high. Most efforts in this digitalisation domain remain mode specific and this is also due to historically separate regulations.

Since 2015, the European Commission has organised and coordinated the Digital Transport and Logistics Forum (DTLF), a platform where policymakers and the stakeholders in the transport and logistics sector can interact and cooperate to support the development of relevant legislative initiatives and programmes. Its main target is achieving full-scale digital interoperability and data exchange in a shared, secure and trusted transport and logistics data space (EC, 2022q). One of the main outcomes of the work done in the forum was the preparation of Regulation (EU) 2020/1056 on electronic freight transport information (eFTI) (EU, 2020). This regulation entered into force in 2020 and will become fully applicable from 2025. It establishes a legal framework for information exchange across the whole sector. The DTLF supports the implementation of the eFTI Regulation across four different domains: (1) the data requirements (e.g. which data are necessary to collect and exchange); (2) the rules and procedures for access to data and platforms (e.g. how authorities will be able to obtain information and where/how operators will make this available); (3) definition of the technical architecture of the system; and (4) the certification of platforms and service providers (e.g. for security reasons). This initiative will build upon and work together with others such as the EU maritime single window environment (EU, 2019f) and the EU single window environment for customs (EC, 2020e). The first establishes the legal and technical framework for electronic transmission, through harmonised interfaces, of the information necessary to comply with reporting obligations for ships calling at an EU port, while the latter aims to streamline customs control and facilitate trade across EU borders, also by means of improved digital tools and cooperation.

Another relevant initiative under the DTLF is the realisation of 'corridor freight information systems', aimed at creating a common ground for information sharing across multiple modes and logistics chains. The idea is to realise a federated network in which it will be possible to integrate existing or new platforms for data exchange in logistics. This will be structured in line with the following principles: (1) to allow stakeholders to connect and share data according to predefined agreements and procedures, in a 'plug and play' manner; (2) to ensure interoperability across different platforms within the federation even if built on different technologies; and (3) to be trusted, safe and secure (EC, 2022q). This initiative is supported by two different EU-funded projects: Federated and FENIX, described below.

The advances brought by digital technologies are not only limited to the transition to a fully digital transfer of information but digitalisation can also intervene at different levels in the logistics system. RIS and ERTMS are examples at the single mode level. RIS (River Information Service) provides information on how and where inland ships navigate on the network. This, among other things, facilitates the invoicing of sail duties and reduces waiting times. ERTMS (European Railway Traffic Management System) improves interoperability between EU rail systems via a European automatic train protection system that replaces the national systems and a communication system between train and track or central operators. It has been estimated that such a system can increase capacity on the rail network by up to 30-40% (Alstom Transport et al., 2022).

Figure A5.1 Illustration of synchromodality



Source: Karimpour and Ballini (2018).

At a broader level, synchromodality is a typical example (Figure A5.1). It can be defined as the 'provision of efficient, reliable, flexible, and sustainable services through the coordination and cooperation of stakeholders and the synchronisation of operations within one or more supply chains driven by information and communication technologies (ICT) and intelligent transportation system (ITS) technologies' (Giusti, et al., 2019). It is based on the real-time sharing of information between different stakeholders and across transport modes (Acero et al., 2021), and it is ultimately achieved by assigning shipments to a multimodal network in real time, depending on the conditions (ACEEE, 2021).

A5.3 Time frame

The development of digital technologies for logistics applications is a continuous process. As discussed, this has led in recent years to the realisation of many different platforms and technologies to support data exchange, strategic planning and optimising the flow of goods. For example, transport as a service (TaaS) in freight road transport, a concept similar to mobility as a service, explored in detail in Factsheet 4 and Annex 4, is based on digital load matching, i.e. the process of matching shipping demands with transport capacity via digital technologies. In the US it is projected to grow from USD 1.2 billion in 2019 to USD 79.4 billion in 2025, a growth rate of approximately 39% per year. TaaS could represent more than 10% of the US trucking industry market share within a few years (ACEEE, 2021).

Digitalisation and automation are expected to bring changes to the freight transport sector that, as we have discussed in Factsheet 3 and Annex 3, will have to face the double challenge of the sustainable transition and, at the same time, the shortages in the labour market. Cimini et al. (2020) reviewed some of the technologies expected to bring changes to the sector in the future, although the impact these will have on the environment is yet to be understood. Policy will play a key role in this context.

The push for a modal shift away from road and towards less GHG-intensive transport modes should be accompanied by a progressive improvement in air pollutant emissions standards in these other transport modes (e.g. maritime and inland waterways shipping). This is to mitigate externalities caused by increased emissions of nitrogen oxides (NOx) and particulate matter, including black carbon.

Lastly, the policy framework is, as described, evolving rapidly and with the ambition of enabling easy and effective data sharing across the whole freight transport sector. This is explored through two different pilot projects described below: Federated and FENIX.

A5.4 Expected environmental effects

Using the taxonomy set out in Chapter 3 the following higher order environmental impacts of smart logistics can be identified.

A5.4.1 Indirect effects — efficiency effects

It is generally complex to evaluate quantitatively the environmental benefits that digital technologies applied to logistics can deliver. This is due to the variety of the potential applications discussed above and to the significant rebound effects associated with gains in efficiency. Ideally, smart logistics will have a positive effect on the environment the moment it will be able to (1) promote a modal shift to the more sustainable transport modes such as rail and short sea shipping and (2) eliminate inefficiencies and administrative burdens that cause congestion, delays and additional emissions. However, while it is true that shipping has generally lower CO_2 emissions per tonne-km transported, NOx and particulate emissions, including black carbon, are higher than those of other transport modes, with effects on global warming effects (EC, 2017b; EEA, 2022e). If a significant portion of freight transport traffic is to be shifted to shipping, improved emissions standards should be developed in parallel to handle these additional pressures.

Through the eFTI Regulation the Commission estimates that the administrative costs in the transport and logistics sector can be reduced by EUR 27 billion over a period of about 20 years (2018-2040), compared to a baseline scenario in which no action is taken. Smaller scale initiatives in the passenger transport sector have demonstrated that the transition to electronic documents and certificates can reduce the administrative burden and realise cost savings. An example is the e-Albania platform: among other things, it simplifies Albanian citizens' access to public administration services in transport through the transition to digital documentation. Estimated savings in 2021 are in the order of EUR 16 million (Albania, 2022; Albania GDRTS, 2022).

Karam et al. (2021) highlight that, due to the high degree of market fragmentation typical of the freight sector, transport inefficiencies are relevant. In 2018, trucks were running empty for 12.3% of the total distance travelled between EU countries. This reached 15-30% in some Member States. This has significant environmental impacts, such as air pollutant and GHG emissions, noise and congestion.

A5.4.2 Indirect effects — substitution effects

The increase in efficiency likely to be induced by the eFTI Regulation, is expected to facilitate multimodal transport, with the net effect of inducing a modal shift away from road transport. This has been quantified to be in the order of 0.2-0.3%, corresponding to a reduction of 1.3 billion tonnes of CO_2 in the 2018-2040 period and compared to a baseline in which no action is taken. This is equivalent to a EUR 74 million saving of external costs and up to EUR 300 million saving of congestion costs. These figures account for the increase in NOx and particulate matter externalities induced by an increase in waterborne transport (EC, 2017b).

A5.4.3 Structural and behavioural effects — direct rebound effect

As discussed, digitalisation in logistics has the potential to realise significant efficiency gains, especially if a fully integrated system across modes becomes a reality. However, this is likely to induce a further increase in demand. This, if not properly managed, risks counterbalancing if not completely offsetting the environmental benefits realised through the implementation of the technology. The European Commission has estimated that this effect could be in the order of 0.3-0.4% in 2030 compared to a baseline in which there is no coordinated uptake of digitalisation in logistics (EC, 2017b).

A5.4.4 Structural & behavioural effects — transformational changes

Digital innovations in logistics can also have relevant consequences for the wider economy, with for example, significant impacts on the labour market. Full-scale deployment of electronic documentation is likely to impact the large number of jobs nowadays related to the processing and acceptance of paper documents. At the same time, it is expected that the demand for ICT professionals, ICT providers and IT platforms will increase, with competition leading to reductions in system costs for the transport operators, and possibly for the authorities.

A5.5 Policy corner

At the EU level, a policy framework to enable the creation of 'a seamless European transport system' is under development (EC, 2022q). Digitalisation has the potential to enhance cooperation across supply chains, improve their visibility and realise the real-time management of cargo flows. This is likely to reduce the administrative burden and improve the efficiency of existing infrastructure and resource use. However, it is important that such innovation will not translate into an increase in the demand for transport that will ultimately erode any environmental benefit achieved through efficiency gains. Implementing measures to internalise external costs, similar to those described in Factsheet 7 and Annex 7, will be complementary to the deployment of smart logistics tools. Promoting the conditions for data sharing and horizontal collaboration will be key conditions for realising the benefits discussed in the factsheet. Cooperation with competitors will require a new way of thinking, focused on trust and the advantages of cooperation instead of competition (Karam et al., 2021).

The digitalisation of the freight transport sector and the transition to a paperless way of exchanging information will require the prevention of cyberattacks and the capability to ensure the continuity of operations and disaster recovery. Ensuring cybersecurity and the privacy of commercially sensitive data remains complex (EC, 2018d). Some of these challenges are further detailed in Chapter 6.

Digitalisation in freight transport has the potential to realise a modal shift to less GHG-intensive modes such as railway and maritime or inland waterway shipping. However, ships have generally higher emissions of air pollutants such as NOx and particulate matter, including black carbon, with adverse effects on both human health and the environment. For this reason, it will be important to support the technological evolution of logistics with more stringent emission standards and advanced monitoring techniques such as those described in Factsheet 9 and Annex 9.

For society, the automation and digitalisation of the logistics sector will bring further challenges, as also discussed in Factsheet 3 and Annex 3. Changes are expected in the type and number of jobs required. The mechanism through which workers could be redeployed in higher value tasks is, however, uncertain. This will largely depend on the way each company is structured.

A5.6 Bottom line

Digitalisation has the potential to make logistics more efficient, facilitate multimodal transport, promote a modal shift away from road transport, and realise both environmental and economic gains. However, it is of utmost importance that this does not translate into a significant increase in the demand for transport, which would be likely to nullify any benefit for the environment. This will require appropriate management measures such as those discussed in Factsheet 7 and Annex 7. It is also important to mention that, although there is a significant interest in shifting goods always from road transport, some of the alternative modes, such as maritime shipping, have higher emission factors for some relevant pollutants such as NOx, particulate matter and black carbon. These not only have an impact on health and air quality but also may have direct or indirect effects on global warming that will require attention.

If policymakers succeed in putting in place a framework (fiscal and regulatory) to avoid efficiency gains being used only to cut prices and increase volumes (rebound effect), smart logistics will be able to provide environmental gains.

A5.7 Case study 5.1: Federated and FENIX projects

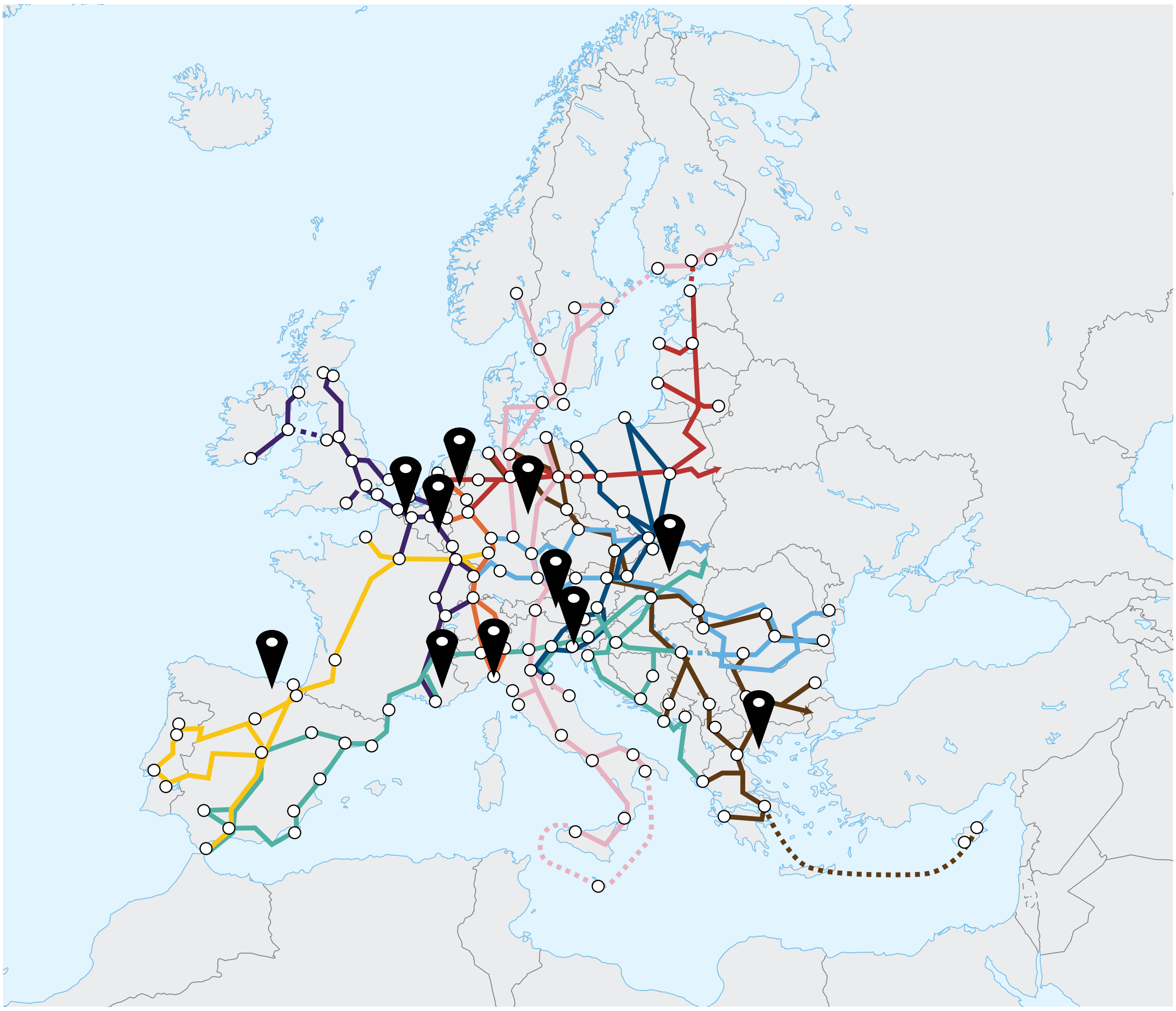
The Federated (FEDeRATED 2022) and FENIX (FENIX Consortium 2022) projects are EU Connecting Europe Facility-funded projects, aiming to support the work done in the DTLF to develop and validate technical solutions for corridor freight information systems, and to support the implementation of the eFTI Regulation.

Federated involves 15 partners located across six EU Member States from both private sector and public administration. The main objective is to develop future-proof federated networks of platforms that will enable seamless data sharing throughout the freight transport sector. This is achieved by practical experimentation on the ground, in the form of living labs in which approaches and technologies can be tested in real-world small-scale conditions. The project will run until 2023, when a final report is expected to be delivered.

FENIX involves 45 members, two implementation bodies and two Member States, with the objective of developing the first EU federated architecture for data sharing serving the European logistics community of shippers, logistics service providers, mobility infrastructure providers, cities and authorities. Map A5.1 shows the 11 pilot sites on the Trans-European Transport Network (TEN-T) that have been identified and will be used to demonstrate the operational feasibility and benefits of the technology.

As a part of this project, a survey to identify gaps and future opportunities in multimodal freight transport has been performed. Most of the respondents from the European transport industry identified the following three aspects among the most desirable for intermodal logistics: (1) less paperwork and more exchange of digital information (79%); (2) increase efficiency, agility and real-time exchange of information (75%); and (3) a wider application of existing standards (70%). Interestingly, only slightly more than half of the participants (56%) identified increased horizontal collaboration between manufacturer and retailers as a desirable aspect. The main barrier identified in a wider implementation of existing standards is the lack of knowledge about the standard itself and the perception of the risks associated with the change.

Map A5.1 The 11 pilots of the Fenix project



FENIX pilot site | Baltic — Adriatic corridor | Orient/East Mediterranean corridor | Atlantic corridor
North Sea — Baltic corridor | Scandinavian — Mediterranean corridor | North Sea — Mediterranean corridor
Mediterranean corridor | Rhine — Alpine corridor | Rhine —Danube corridor

Source: FENIX (2022).

A5.8 Case study 5.2: Smart ports

Digitalisation of ports is seen as an important measure to increase the resilience of our logistics system and crucial supply lines. Smart port logistics will increase efficiency and improve the allocation of resources (UNESCAP, 2021) and are expected to become not only logistics hubs but also energy hubs (SEArica Intergroup, 2022).

The main characteristics of smart ports can be summarised as follows:

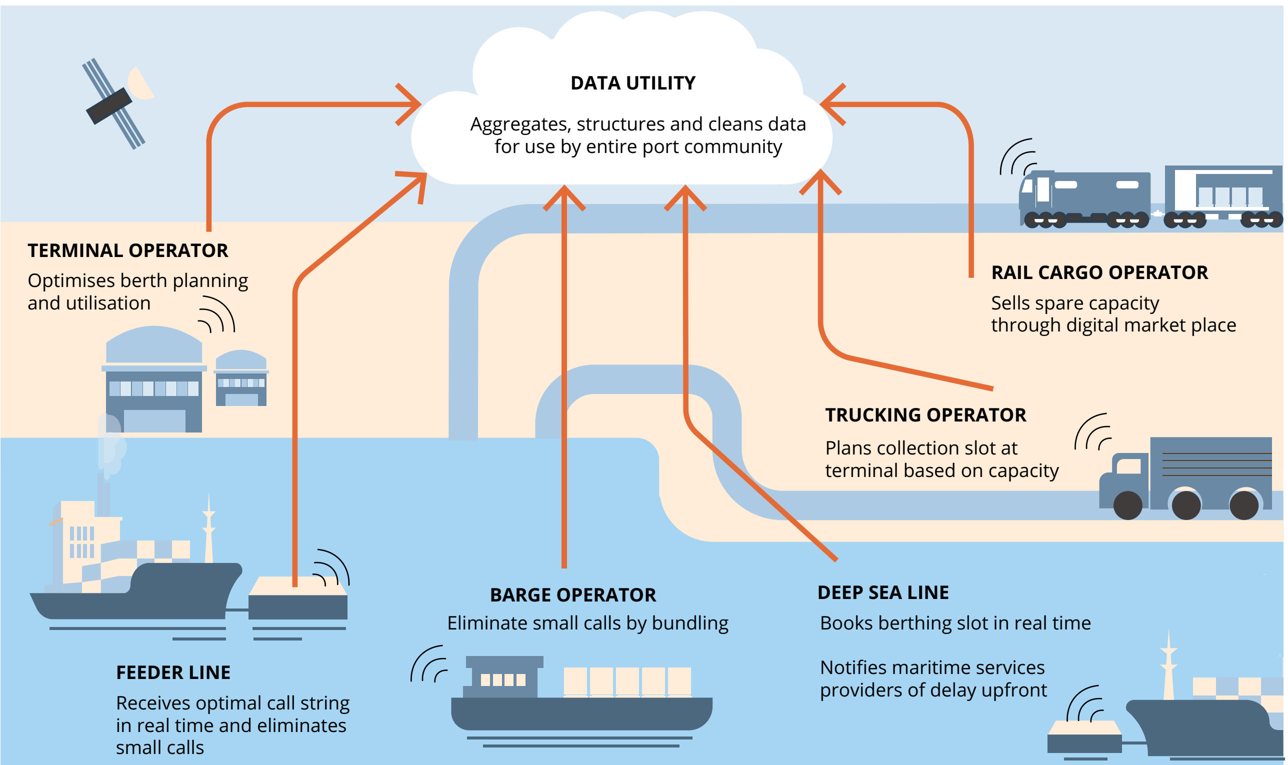
- The combination of technology and the collection and distribution of data and information helps the management of operations inside and outside the port.
- Information is shared with operators, the port community and stakeholders.
- The port is integrated with the territory surrounding it (city, region, country) and with smart transport (roads, rail, rivers) and energy infrastructures (for the distribution of new energy carriers).

Smart ports can realise benefits in different ways (Figure A5.2). By improving port operations, they can speed up of the transit time for goods, reducing costs and the time required for cargo loading, unloading, stowage or storage. They can reduce the administrative burden and facilitate compliance checks through the exchange of digital information. At the same time, by providing real-time data about, for example, the status of cargo and the working condition of the port facilities, they can facilitate strategic planning and communication with customers and stakeholders.

Different examples of development smart port capabilities can be identified throughout Europe. Rotterdam is the largest European port. Its smart port programme has three focus areas: smart logistics, smart energy and industry and future-proof port infrastructure. It aims to create a digital twin of the whole port to optimise its actual, near future and future use. It has been estimated that, by reducing ship waiting times and cargo handling times and streamlining the use of terminal yards, shipping companies using the Port of Rotterdam could save about USD80,000 per call (UNESCAP, 2021). The ambition of the Port of Rotterdam is to evolve to a fully automated port with automated ships, smart containers and autonomous cranes (Port of Rotterdam, 2022).

The Port of Hamburg is the third biggest port in Europe, after Rotterdam and Antwerp. It handles 20% of European exports. Through its smart port programme, it plans to reduce the cost of port operation by 75% and port congestion by 15% (UNESCAP, 2021).

Figure A5.2 Some benefits of digitalisation in maritime port areas



Source: Courtesy NxtPort in DocksTheFuture Consortium (2020).

The European Corealis project carried out an energy assessment for the Port of Pireas. The study conclusions were that it would be possible to supply energy at competitive prices of EUR 60/MWh including battery storage to cope with load demand and renewable energy production peaks (see also Factsheet 6 and Annex 6). The overall load of the port, including electric vehicles and onshore power supply, is approximately 55GWh and could be covered through 46MW of renewable energy generation and 30MWh battery storage. Self-sufficiency would exceed 85% with renewable energy that emits 25g CO_2/kWh compared to the current levels of 1,167g CO_2/kWh. Furthermore, substituting the entire fleet of diesel-powered yard vehicles with electric vehicles could save a significant amount of fuel annually, while the impact on electricity consumption would be limited. The additional need is estimated to be equal to 10% of the current electricity demand. Indeed, the port could even become a net exporter of renewable electricity due to excess generation (Cardone, 2019; Corealis Consortium, 2021).