THE FUTURE OF PORT LOGISTICS

MEETING THE CHALLENGES OF SUPPLY CHAIN INTEGRATION

Report prepared for

ING

Report prepared by

Universiteit Antwerpen

VIL EMPOWERING LOGISTICS

THE FUTURE OF PORT LOGISTICS

MEETING THE CHALLENGES OF SUPPLY CHAIN INTEGRATION

8 MAY 2017

PUBLICATION PREPARED FOR
ING Bank

PUBLICATION PREPARED BY
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DISCLAIMER

ACKNOWLEDGEMENTS

We would like to express our gratitude to the members of the Editorial Board of this publication for providing valuable input and comments on earlier drafts of this report. The Editorial Board included: Chris Coeck (Port of Antwerp), Kate Verslype (Port of Ghent), Patrick Van Cauwenberghe (MBZ), Dirk Oellibrandt (MPET), Yves Goddefroy (ING), Kris Liesse (ING), Didier Keters (ING), Marc Callier (ING) and Francis Rome (VIL);

Publication commissioned by
ING Bank
Marnixlaan 24
1000 Brussels (Belgium)
www.ing.be

Title: The future of port logistics: meeting the challenges of supply chain integration
Authors: Theo Notteboom and Kris Neyens
Publication date: 8 May 2017

FOREWORD

ING is proud to team up with University of Antwerp and VIL to conduct a sixth extensive study on a maritime/logistical topic.

The goal of these studies is to contribute to a better understanding, development and growth of our transport & logistics ecosystem.

The transport and logistics sector has had a difficult time since the economic crisis, but the economy now seems to be recovering. Entrepreneurs have become more positive about the future. Slowly, the outlook is getting better, but there's no time to lean back. The transport and logistics chains are currently undergoing rapid change and the main question of this study is how ports and port-related companies can handle the ever-increasing needs and challenges of chain optimization, integration and coordination. The study analyses possible new business models, the potential impact of disruptive ICT innovations, and the changing role of traditional players such as industrial companies, terminal operators, 3 PLs, port authorities, etc.

We are convinced that the research and the conclusions are relevant for all kind of maritime companies, port authorities and all the partners and stakeholders of the maritime and logistical business, like ING.

We want to thank Professor Theo Notteboom and Kris Neyens for their energy and brains. The members of the editorial board were a committed and powerful sounding board. Without them, the study would not be as thorough as the actual final result. It was good to have you all on board during this intellectual sail!

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INTRODUCTION

A seaport is a logistic and industrial node accommodating seagoing vessels and characterised by a functional and spatial clustering of cargo transport, storage and transformation processes linked to global supply chains (Notteboom, 2016). Seaport functions are thus diverse in scope and nature and evolve over time. Port roles and functions can be identified through political, geographical (urban and spatial), economic and social perspectives.

From a macro-analytical and public policy perspective ports are viewed as economic catalysts for the regions they serve where the aggregation of services and activities generates benefits and socio-economic wealth. Ports create direct and indirect value-added and employment. Often, port macro-economic impacts focus a lot on national or regional competitiveness, thereby ignoring port impacts on the wider economic space and on international trade and logistics. Ports are often approached as clusters (De Langen, 2002) and maritime industrial development areas (MIDAs). Consequently, they receive a lot of attention as part of national or supranational maritime cluster policy and industrial policy. Other issues of interest to the public policy maker at a macro-level include urban planning and expansion, safety, security and environmental sustainability. Port development is often associated with urban planning. The emphasis here lies on the port-city interface and on waterfront redevelopment and other initiatives to re-establish the link between port area and city. From an environmental perspective, port planning and management should ensure sustainable development. Environmental sustainability of port projects has become as important as economic and financial viability. Ports often form an integral part of coastal management policies. As such ports have adopted a real environmental role and function.

Another perspective is to look at ports from a micro-perspective approach. Port operations are usually oriented towards the two traditional components of ships and cargo. Services to ships include those performed at the sea or waterways side (dredging, pilotage, mooring/unmooring, etc.) and at the ship/shore interface (berthing, repair and maintenance, supply and bunkering, etc.). Services to cargo can be divided into those performed at the ship/shore interface (stowing, loading, discharging, etc.) and those entirely performed in land-side areas such as consolidation, storage and distribution. Key in the micro-perspective approach are the concepts of efficiency/performance and sustainability at the operational level (i.e. a company or terminal).

A third approach consists of a hybrid perspective on port roles and functions combining both macro- and micro-elements. The widely cited port-type generations of UNCTAD (1994) and later port generation models (Van Den Berg and Van Klink, 1995; Flynn et al., 2011) look at port roles and functions, but also institutional structuring and operational and management practices. An evolving new approach perceives ports as business ventures regardless of their institutional, operational or functional status. The wave of corporatisation of port authorities, also in Belgian ports, reflects this increasing business and market-oriented approach to port management. Ports are part of a wider logistics and production system and increasingly performing functions related to the management of information flows. Port functions are extended to trade, logistics and production centres with an extensive portfolio of operations spanning across production, trade and service industries. Changes in supply chains have forced ports and terminals to seek effective

integration in these supply chains when delivering value to shippers and third-party logistics service providers (Robinson 2002; Mangan et al. 2008).

This study analyses the changing supply chain environment in which Belgian/Flemish ports are operating. The central research question is 'how can ports and port-related companies deal with the rising requirements and challenges with respect to supply chain optimisation, integration and co-ordination?'. To answer this question, we analyse the changing market environment of ports, changes in business models, the possible impact of disruptive technologies (e.g. in the area of data gathering and analysis) and the evolving role of market players. By doing so, the study provides insight in the drivers of future port logistics.

In the first part of this report, we discuss the main trends and future outlooks which will determine the future of port logistics and thus the functioning of seaports in broader global production, trade and logistics systems. The discussion is structured in five inter-related parts:

- Global demand and economic development;
- A changing landscape for the global economic system;
- Connecting the world: corridors and synchromodality;
- Supply chains and logistics networks of the future;
- Disruptive key ICT innovations for ports and logistics firms.

The trends and outlooks are analysed using existing studies and insights, with a particular focus on coordination and supply chain integration in a port context.

A large-scale survey conducted in the Belgian logistics and port industry forms the backbone of the remaining sections of the report. The survey questions were deducted from the five themes discussed in part 1 of the report. The survey outcomes are analysed in detail with attention for possible linkages between the answers and differences in the answer patterns among respondent sub-groups. The report concludes with a summary of the findings and a set of recommendations for the business communities in Belgian/Flemish ports.

1 I TRENDS AND OUTLOOK FOR PORT LOGISTICS

1.1 Introduction

Seaports are affected by a wide range of economic, technological and geopolitical developments. The first part of this report discusses the main trends and future outlooks which will determine the future of port logistics and thus the functioning of seaports in broader global production, trade and logistics systems. We discuss the port environment by grouping trends and developments in five inter-related sections. The first section deals with global demand and economic development, followed by an analysis of the changing landscape for the global economic system. Then, the study discusses corridors and synchromodality as key elements in a more connected (transport) world. The fourth section is one of the most comprehensive with a detailed discussion of supply chains and logistics networks of the future, with a particular emphasis on supply chain integration and co-operation and coordination among supply chain actors. The fifth and last section of part 1 focuses on disruptive key ICT innovations for ports and logistics firms.

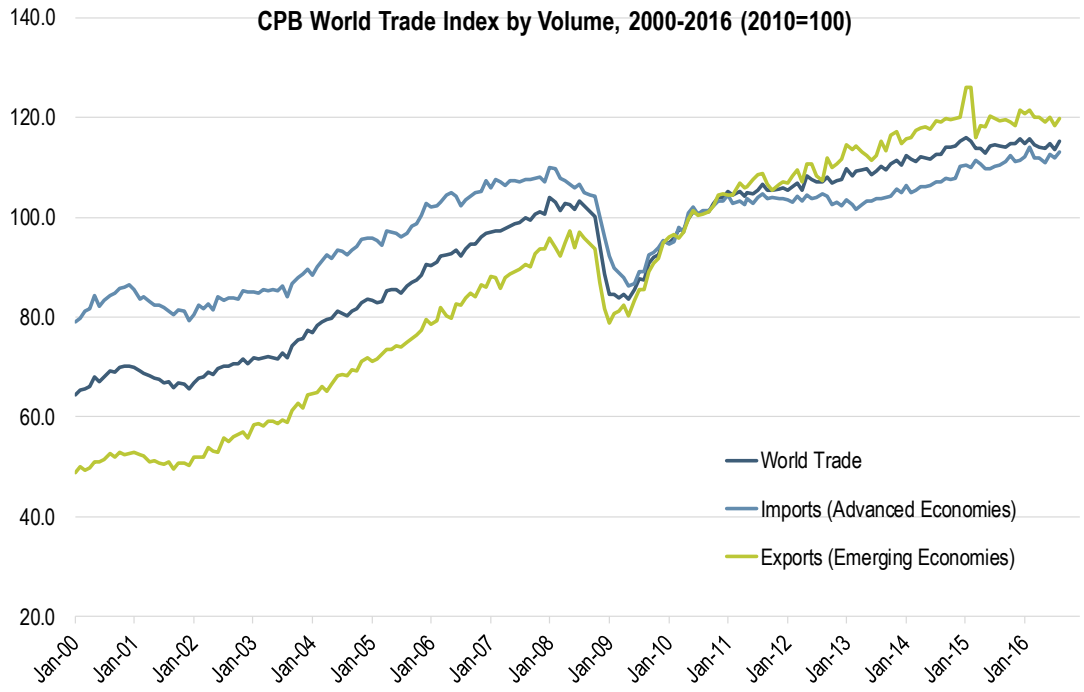
1.2. Global demand and economic development

1.2.1. Main trends in global economic growth and trade

International trade represents a growing share of global output, and growth in trade is expected to outstrip overall growth in output for the foreseeable future. The rising significance of trade is a consequence of the increasing integration of the global economy. Legal and cultural obstacles to trade have been diminishing in the post WWII period. Integration has occurred both at the regional level, through initiatives such as NAFTA and the EU Single Market, and at the global level, supported by the continuing evolution of WTO. In more recent years, the financial and economic crisis which started in late 2008 has made some countries and political pressure groups to reconsider the global free trade model (e.g. the rhetoric of president Donald Trump of the USA) while even the role and function of multi-country trade unions are being questioned (e.g. the Brexit).

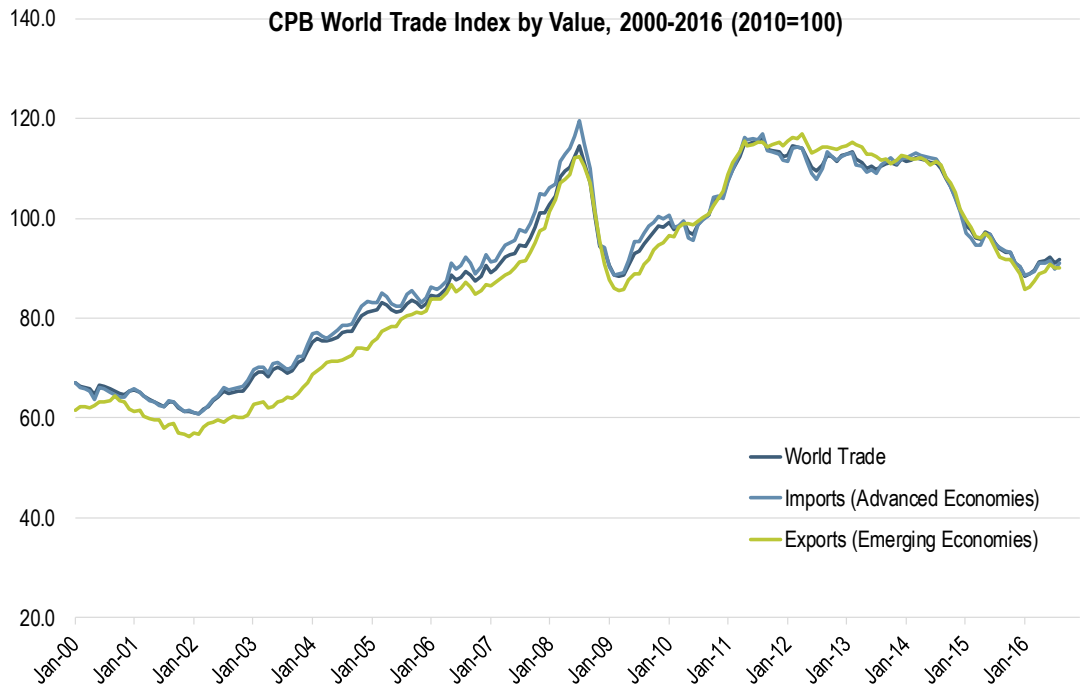
Global trade is peaking in terms of volume (Figure 1.1) while the lower commodity and oil prices of the past few years led to a decrease of world trade in value terms (Figure 1.2). The last three decades have also brought important modifications in international trade flows. The bulk of international trade occurs within economic blocs, especially the European Union and NAFTA. Other significant flows are the ones between Asia / Pacific and North America (especially the United States), between Europe and North America and between Europe and Asia/Pacific. For several reasons, such as geographical proximity (Eastern Europe), energy (Middle East) and colonial (Africa), the European Union has significant trading linkages with the rest of the world. The world economy is increasingly influenced by developing countries and economies in transition. Other regions of the world have seen much faster population growth than Western Europe. Eventually this will lead to economic areas shifting in the direction of these concentrations of people with an increasing income profile. A prime example is the rise of China. In the past 15 years, China posted an annual GDP growth of between 6.7% and 13%. China's relative dependence on export to achieve this growth has somewhat diminished as a growing middle class is having a strong impact on domestic demand and as the economy is slowly shifting from the secondary to the tertiary sector.

Figure 1.1. Index evolution world trade in volume terms (2010 = 100)



Source: based on CPB World Trade Monitor. http://www.cpb.nl/en/world-trade-monitor

Figure 1.2. Index evolution world trade in value terms (2010 = 100)



Source: based on CPB World Trade Monitor. http://www.cpb.nl/en/world-trade-monitor

While demographics have an important impact on the economic growth potential of regions around the world, future economic growth will also be increasingly driven by innovation. The middle class in the developing countries will increase and will drive consumption of technological and luxury products. This will increase the need for raw materials and manufacturing and will also increase global logistics needs for manufactured goods. As Africa will gradually replace Asia as the region with the highest population and economic growth rate, the role of Africa in the world economy will increase.

Economic growth in the EU is somewhat lagging behind the rest of the globe. There are growth differences between the different Member States with Eastern European countries recording the highest GDP growth, partly given their developing economy phase and their linkages with non-EU members. This observation is particularly important in light of the long-term hinterland outlook for Belgian ports and the discussion on the current and future traffic distribution between port regions around Europe (see later in this report). Some manufacturing activities have already moved from Western Europe towards low-cost regions in Eastern Europe, but overall the centre of gravity for production is still situated in core region of the European Union (often tagged as the Blue Banana). Still, the changing economic geography in Europe generates larger bi-directional East-West flows of raw materials and consumer products within the European Union.

Another important trend is that of nearshoring. Nearshoring is the concept of sourcing work to a foreign, lower-wage country that is relatively close in distance and/or time zone. The customer expects to benefit from one or more of the following constructs of proximity: geographic, temporal, cultural, linguistic, economic, political and historical linkages (Autesserre, 2012). It is important to note that the relocation of an outsourced activity from a farshore location to a nearshore location, is also defined as nearshoring.

The motivation for companies to nearshore is more than the sum of cost elements alone. Elements such as quality, market or risk related drivers often lie at the foundation of a nearshore decision. However, many companies still only consider the “total cost of ownership” components, without evaluating the qualitative aspects.

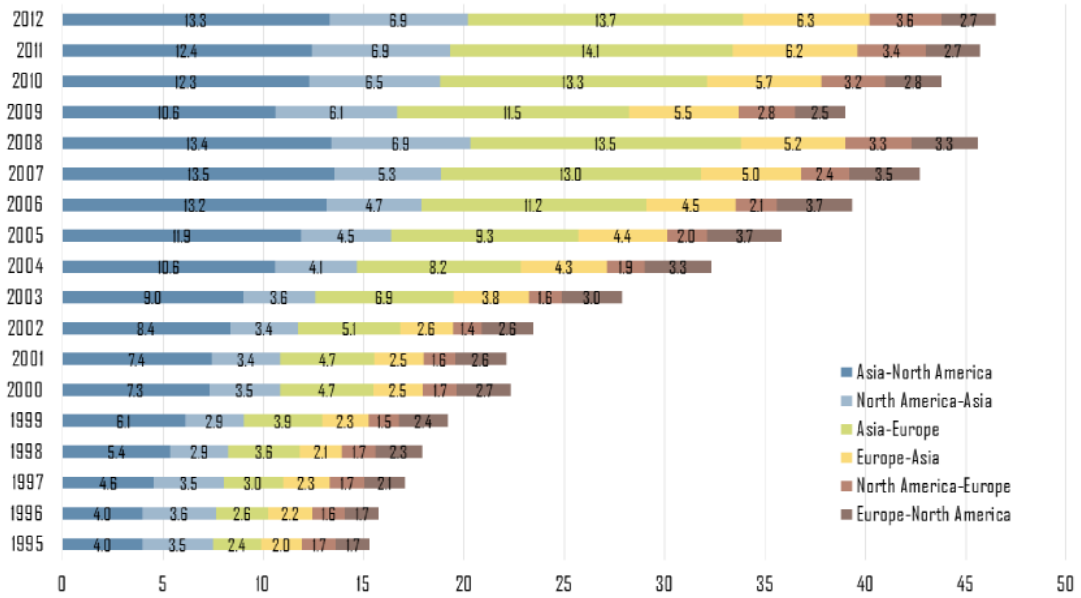
Even though relocation of a part of the production capacity is real, this does not result in a production “renaissance”. Within a further growing global economy this relocation growth even can be superseded by the total growth. It is clear however that evolutions in the Far East, with concepts such as “local for local” or “China plus one” (China offshoring within the Far East and Pacific region) will further develop and impact global supply chains.

Effective opportunities for a nearshoring concept strongly depend on the various industries and its specific characteristics. These characteristics are more or less sensitive to the various drivers for nearshoring and to negative aspects related to offshoring. This means that certain industries are more suited to nearshoring than others. Exploring the specific possibilities to implement a nearshoring concept however remains an individual exercise, and studying “ad hoc” best practices can be inspiring, but nothing more. Innovative concepts need to be checked in a generic model taking into consideration both quantitative and qualitative aspects. This exercise provides an excellent base for shippers and their selected logistics partners to redefine the supply chain, opening the door to new forms of collaboration, including new transport concepts and related services. It is important for logistics service providers to understand this concept and to partner up with principals considering nearshoring as an alternative strategy for their production.

1.2.2. Trade imbalances persist

Trade imbalances remain important. Figure 1.3 provides more insight on the imbalances in containerized trade on the main shipping routes. With the emergence of global trade imbalances, ports and inland transportation are facing acute pressures to cope with disequilibrium in (container) flows. The outcomes are rate imbalances and more complex freight planning. The repositioning of empty containers has become one of the most complex problems in global freight distribution, also in Belgian ports.

Figure 1.3. Containerised cargo flows along major trade routes (in million TEU)



Source: updated from Notteboom and Rodrigue (2011)

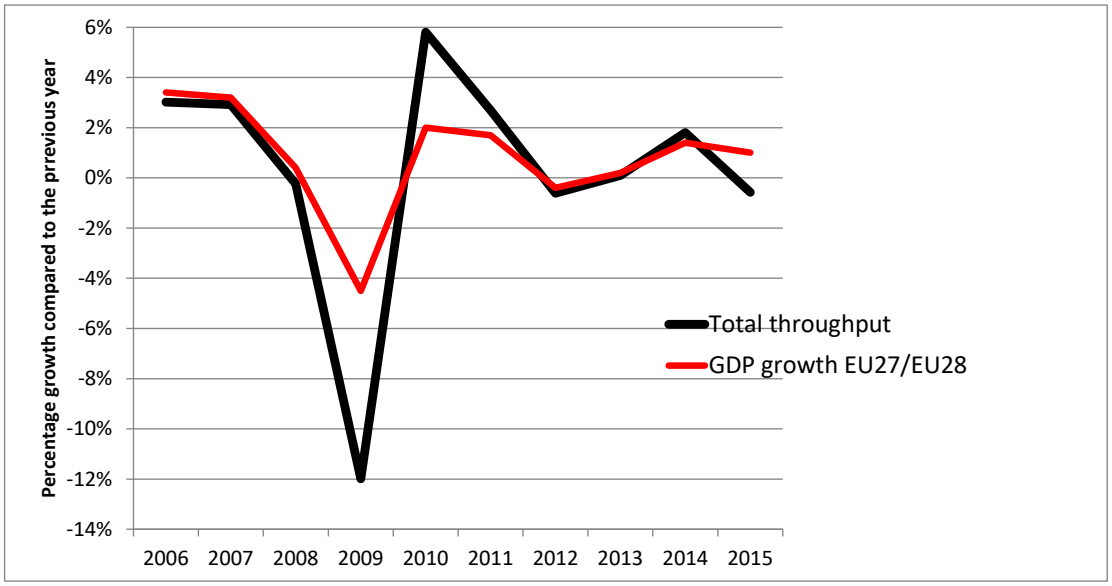
1.2.3. Trade and ports: cargo flows handled in the European port system

It is widely acknowledged that 2008 marked the end of the super cycle in maritime transport where more cargo was shipped than ever before. Developing countries are the drivers of maritime trade: 61.2% of all goods loaded and 55% of all goods unloaded are in relation to the developing countries, showing their resilience to the economic setbacks (figures UNCTAD). The share of the developed economies in global goods loaded and unloaded were 32.4% and 44.3% respectively. Transition economies accounted for 6.4% of goods loaded, and only 0.8% of goods unloaded. This discrepancy underlines the role many transition economies play in bulk exports of raw materials and energy products. Asia continues to dominate, with a share of 41% of total goods loaded, followed in decreasing order by the Americas, Europe, Oceania and Africa. Noticeable is the surpassing of Africa by Oceania as the fourth biggest export region, showing the growing impact of Australian commodity trade, mainly in iron ore, coal and minerals.

With a total throughput of an estimated 3.79 billion tons in 2015, the European port system ranks among the busiest port systems in the world. Growth was particularly strong in the pre-crisis period between 2000 and 2008, partly driven by fast growing container throughput, i.e. an average annual growth rate of 10.5% in the period 2005-2008 and 7.7%

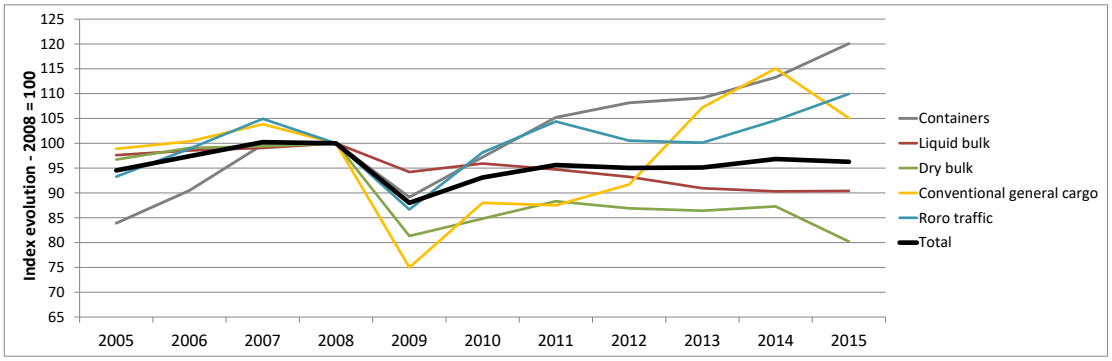
in the period 2000-2005. The economic crisis which started to have its full effect in late 2008 made an end to the volume growth in the European seaport system (figure 1.4). Total cargo throughput in European ports in 2015 amounted to 3.71 billion tons or still 4.6% below the 2008 volumes. Next to dry bulk and conventional general cargo, liquid bulk flows seem to face a hard time to turn the tide (figure 1.5). Only container traffic in European ports has managed to rise above the 2008 level (i.e. 20% higher in 2015 compared to 2008).

Figure 1.4. Year-on-year growth in total EU port traffic (basis = ton) and EU28 GDP



Source: based on statistics Eurostat and individual port authorities

Figure 1.5. Index evolution of total EU port traffic per cargo commodity (2008 = 100, basis = ton)



Source: based on statistics Eurostat and individual port authorities

The differences between the growth paths of the respective cargo groups changed the cargo type distribution in the European port system (Figure 1.6). Liquid bulk still accounts for the largest share, but its relative importance has dropped from about 40.8% in 2005 to 37.1% in 2015. The share of container traffic continues to grow.

Figure 1.6. Distribution of cargo flows in the EU port system

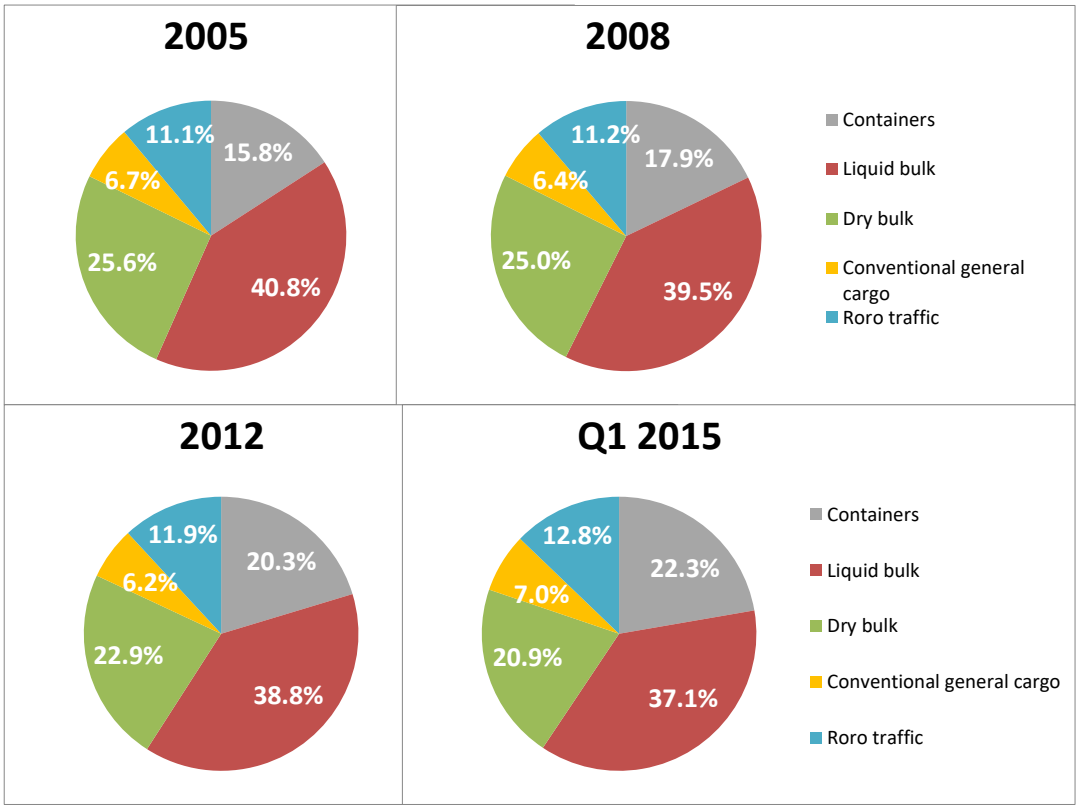
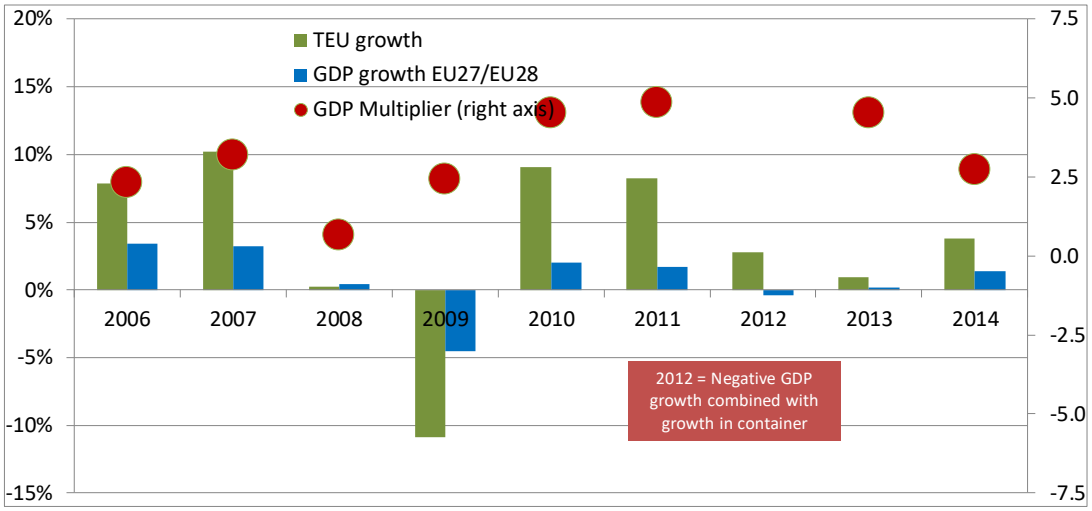


Figure 1.7. The GDP multiplier in the EU container port system



Source: Notteboom (2015)

A comparison of the year-on-year growth figures in the European port system with the GDP growth figures for the EU28 (figure 1.4) reveals that ports continue to overreact to swings in economic growth. When the economy booms, seaports typically show high to very high growth figures. However, an economic crisis has a very pronounced negative effect on cargo volumes in seaports. Figure 1.7 shows the evolution in the European GDP multiplier, i.e. here the ratio between world TEU growth and world GDP growth. The results point to a complex relationship between container port traffic and economic growth in Europe. The highest growers in terms of container throughput can be found all over Europe, including countries such as Greece (Piraeus), Portugal (Sines), Spain (e.g. Valencia and Algeciras) and Italy (e.g. Gioia Tauro) which have been severely affected by the government debt crisis. The weakest performers in terms of growth are also found all over Europe, including in countries with the best economic status in the Eurozone (such as Germany where Hamburg's container volume in 2016 was still 10% below the 2007 volume). In other words, seaports in countries with the weakest economies of Europe do not necessarily underperform compared to seaports in stronger countries. The main reason underlying this observation is that quite a few ports rely heavily on container flows which are not related to the immediate hinterland, but on flows that are distantly generated, i.e. sea-sea transhipment and cargo moving on long distance inland corridors.

1.3. A changing landscape for the global economic system

1.3.1. The growing importance of clusters in the global economy

Multinational enterprises (MNEs), as key drivers of globalisation, have adopted flexible multi-firm organisation structures on a wide variety of markets. They are typically organized to achieve economies of scope, including greater flexibility, rather than to achieve economies of scale by spreading fixed costs. Many of the world's largest MNEs manage extensive networks of globally dispersed inputs through supply chain management practices. China is one of the countries that succeeded in linking foreign investor capital and expertise with a large and low-cost Chinese labour force. Moreover, export-oriented enterprises were encouraged by the designation of a growing number of special economic zones (SEZs), coastal open cities, and economic and technological development zones (EDTZs), all designed to encourage manufacturing exports. Other countries such as Vietnam are following a similar path.

Companies are typically seeking location advantages when deciding on where to set up a production unit, a logistics facility or service centre. Over the last few decades we see an increasing tendency for companies to regroup and relocate forming clusters in the process. Clusters appear in all forms and sizes, from the basic manufacturing industry to high tech productions as regions covering hundreds of hectares to a simple street. An example of a cluster on a more regional scale is the (petro-)chemical industry cluster in Antwerp and Rotterdam.

The initial reason for companies to group together in a certain location is linked to a certain advantage presented by the area in question. This could have been a particular resource, tax advantage presented to a specific type of company or any competitive advantage presented by the area. Resources, technology, capital and other inputs can be efficiently sourced in global markets. The advantage of distances has diminished noticeably and given rise to

overseas investments. Despite these developments, nearshoring decisions remain on the table, mainly driven by given geo-economic, geopolitical and micro-economic forces.

Most companies in a cluster are not direct competitors but instead differentiate in order to attract a particular market segment or are on a different vertical level (supplier, producer, warehousing, etc..). They are thus often linked by input/output relationships. Yet, they share many common needs, opportunities and constraints. The cluster provides the companies with a larger entity when contacting outside investors, be it public or private. The clustering of activities facilitates knowledge transfers and spill-over, creates a local labour market of skilled workers and enhances the possibilities for innovation.

Seaports can be regarded as clusters (De Langen, 2002) since ports typically consist of geographically concentrated and mutually related business units centred around transport, trade and industrial production. Next to the advantages discussed above, port clusters exhibit strong scale and scope advantages linked to physical cargo flows. The concentration of activities opens more opportunities to the bundling of cargo flows via intermodal transport (shortsea, barge or rail) and to achieve a higher connectivity to the rest of the world via frequent transport services.

While particularly industrial activities in ports are often associated with negative effects in terms of emissions and noise pollution, port clusters can exert strong environmental advantages. For example, 'ecologies of scale' are achieved in the (petro-)chemical industry by which companies utilize each other's' waste material or by-products such as heat. It would be far more difficult to achieve this when the plants concerned would be spatially scattered. It is imperative that these 'ecologies of scale' advantages are fully acknowledged in environmental policy. Successful port clusters also face some challenges, mainly in terms of accessibility (congestion) and higher land costs.

1.3.2. Towards a circular economy

The transition to a circular economy, in which the value of products is maintained within the economy for the longest possible time whilst minimizing the generation of waste and using them as possible alternative raw materials as input for new production (feedstock concept), and the concept of Cradle to Cradle, a new business model developed by Michael Braungart and William McDonough, in which products are designed for safe and recyclable use, are gaining ground, both in production processes, thus impacting consumption behaviour and patterns, and in the "extended logistics chain".

The main driver for this shift consists of the short supply of raw materials and the subsequent soaring commodity prices. Transitioning towards a circular economy also protects companies from major and unexpected market fluctuations and geopolitical risks (Kuipers, 2015).
Consumer preferences are also shifting away from the ownership concept towards models where they are willing to share or use products instead of owning them outright (MacArthur, 2014).

Therefore, this shift from a linear economy towards a circular economy should lead to the recuperation of used materials and resources at the end of the lifecycle of products, and this with a minimum of loss of quality. It requires the reverse supply chain to be completely closed.

Businesses and consumers are of course key in driving this process, and the European Commission for one, has adopted a "Circular Economy Package" laid down in an action plan "Closing the loop – An EU action plan for the Circular Economy", that next to a set of legislative proposals on waste to stimulate Europe's transition towards a circular economy, also includes a specific action plan aimed both at production (business) and consumption (consumers) and that needs to be carried out before 2020 .

The impact of logistics herein is often underestimated. Even if it is clear that a strategy for product and process innovation with a closed loop of materials might be technically realistic, it will require logistics to support and achieve this. As long as the logistic chain cannot be closed in an efficient way, the circular economy model will not be "sustainable":

- Efficiency: the benefits of re-using materials replacing raw materials have to supersede the collection costs
- Effectiveness: collection needs to be organised in an effective way ensuring substantial volumes can be recuperated
- Ecological: the ecological impact of the collection of recyclables should be lower than the ecological gains attributed to recycling.

In other words, a true Cradle to Cradle concept comprises both production and logistic processes.

In reality, however, logistics often struggles with the collection of materials because of volume and cost constraints, as well as regulatory complexities.

Considering seaports can be considered to be clusters, and that as such they harbour mutually related businesses around transport, trade and also industrial production, it is only logical that they present a unique platform to attract material flows and develop a portfolio of recycling activities, for example in the case of the (petro)chemical cluster.

For seaports, developing a clear circular economy strategy, of which smart and innovative logistic concepts are an integral part, will secure their position in an ever more integrated and circular supply chain reality, and will leverage their competitiveness and attractiveness to invest.

Therefore it is of utmost importance that:

- Ports think 'circular' with the primary objective of being more 'sustainable'.
- Ports develop a strategy (plan) to become a logistics hub for the circular economy.

1.3.3. A changing energy mix

The majority of the required energy for the coming decade will still be produced from fossil sources. The largest growth rate, however, will be seen for renewable energy sources. Based on an increase of oil price in the long-term, the trend for exploration of fossil energy sources will continue to offshore locations rather than onshore and to deeper waters and harsher environments. More complex energy sources such as tar sands or methane hydrates will also be exploited. Energy production on offshore wind farms will significantly increase and also other water-based energy production devices using wave and tidal current energy will have a larger market. These developments will lead to a large increase in renewable energy, particularly in Europe. It will also result in a significant increase in production and transport of clean fuels such as LNG, shale gas and hydrogen.

The World Energy Outlook 2016 of the International Energy Agency (IEA, 2016) summarizes the main issues affecting the longer term global energy mix:

- The world's energy needs continue to grow. The IEA main scenario points to a 30% rise in global energy demand to 2040. Still, a higher energy efficiency and a growing use of cleaner energy sources worldwide should help to curb energy-related CO2 emissions.

- Renewable energy is expected to see the fastest growth. Natural gas is expected to be the strongest grower among the fossil fuels, with consumption rising by 50% by 2040. Coal use saw strong growth in recent years, but for the future no further growth is expected. Growth in oil demand is expected to slow to 103 million barrels per day (mb/d) by 2040. By the mid-2030s developing countries in Asia are expected to consume more oil than the entire OECD.

- The objectives of the Paris Agreement on climate change, which entered into force in November 2016, can only be met when transformative change takes place in the energy sector. Countries are generally on track to achieve, and even exceed in some instances, many of the targets set in their Paris Agreement. While these efforts are sufficient to slow the projected rise in global energy-related CO2 emissions, they are insufficient to limit warming to less than 2 °C. Therefore, the EIA underlines the importance of the five-year review mechanism, built into the Paris Agreement, for countries to increase the ambition of their climate pledges. This should include actions in the field of (1) the acceleration of the deployment of renewables, nuclear power and carbon capture and storage; (2) greater electrification and efficiency across all end-uses; and (3) clean energy research and development effort by governments and companies.

- The main scenario in the EIA study shows that about 60% of all new power generation capacity to 2040 will come from renewables. The majority of renewables-based generation will be competitive without any subsidies. Therefore, EIA expects that by the 2030s global subsidies to renewables will start declining. However, cost reductions for renewables will be insufficient to secure an efficient decarbonisation of electricity supply. Structural changes to the design and operation of the power system are needed to ensure adequate incentives for investment and to integrate high shares of variable wind and solar power.

- Despite the above ambitions and expectations on the use of renewables, fossil fuels such as natural gas and oil will continue to form the backbone of the global energy system for many decades to come. By 2040 oil demand is expected to return to the levels of the late 1990s while the use of coal will move to levels last seen in the mid-1980s. Only gas will see an increase relative to today's consumption level.

The energy outlook presents a number of challenges to seaports. Partly as a result of the presence of energy production plants and large petrochemical and chemical sites in or near seaports, the liquid bulk market is the largest cargo handling segment in the European port system, at least when expressed in metric tons handled. Overall, the oil-based industries in ports are likely to face a more volatile development in the future, partly affected by geopolitical tensions, the impact of US tight oil output, the growth of oil refining capacity in source countries and growth markets such as Asia and increased competition with gas and renewables. At the same time, this volatility increases speculation in the market with

traders becoming more asset-based (i.a. by co-investing in tank storage facilities in seaports).

The expected growth in the gas market (LPG, LNG but also piped gas) combined with an increased focus on LNG as a ship fuel offers opportunities for seaports to position themselves as gas energy hubs. Many ports have already invested in gas terminals and LNG fuel facilities in the recent past. The gas comes in either via vessels (LNG carrier) on specialized deep sea terminals or via pipelines which land in the seaport area. The largest reserves of natural gas are found in Russia, Iran and Qatar. Large new LNG terminals have been built or are being planned all over Europe. Currently, there are existing LNG regasification terminals or new terminals under construction in ports of Portugal (Sines), Spain (Bilbao, Gijon, Huelva, Cartagena, Sagunto and Barcelona), France (Fos and Montoir), Belgium (Zeebrugge), the Netherlands (Rotterdam), UK (Teesside, Milford Haven and Isle of Grain), Italy (Brindisi, La Spezia, Rovigo and Livorno), Sweden (Brunnswiksholme) and Greece (Revythoussa). A dozen additional LNG terminal projects are under consideration in countries such as Croatia, Cyprus, Germany, Ireland, Poland, Lithuania, Estonia, Finland, France and Romania.

Growing trends in electricity production include plants that produce electricity based on gas, pellets, waste or biomass. Stations powered by these fuels present economic advantages, are often faster to build and are more environmentally friendly, when compared to electricity production from other (fossil) fuels. There is also an increased interest in wind energy. While most wind farms are installed offshore (mostly on sand banks) or in open plots in the hinterland, a number of seaports are also home to wind farms. These wind farms are typically installed on breakwaters or on narrow stretches of land close to the sea thereby benefiting from favourable winds in coastal areas.

Finally, the chemical industry is actively incorporating strategies to deal with a gradual transition away from fossil fuel based production methods. At the moment, the chemical industry can be divided in four main categories. First, there are the basic chemicals which includes polymers (e.g. polyethylene (PE), polyvinyl chloride (PVC), polypropylene (PP), polystyrene (PS) and man-made fibres such as polyester, nylon, polypropylene and acrylics), bulk petrochemicals and intermediates (i.e. primarily made from liquefied petroleum gas (LPG), natural gas and crude oil used for the production of ethylene, propylene, benzene, toluene, methanol, styrene, etc.), other derivatives and basic industrials (e.g. synthetic rubber, surfactants, dyes and pigments, resins, carbon black, explosives), inorganic chemicals (e.g. salt, chlorine, caustic soda, soda ash, acids) and fertilizers (phosphates, ammonia and potash chemicals). Second, there are the life sciences which include differentiated chemical and biological substances, pharmaceuticals, diagnostics, animal health products, vitamins and crop protection (herbicides, insecticides and fungicides). These products tend to have very high prices and require a lot of investment in research and development. The third group concerns the specialty chemicals such as electronic chemicals, industrial gases, adhesives, sealants, coatings, cleaning products and catalysts. The fourth group consists of the consumer products that are directly sold to the consumer such as soaps, detergents and cosmetics. The changing energy mix will have an impact on all four main categories, although the reach and intensity of the transition will have different ramifications in each category.

1.4. Connecting the world: corridors and synchromodality

1.4.1. Intercontinental maritime and land corridors

Corridors have become the main arteries of world trade. Strategic points along maritime corridors such as the Panama Canal, Suez Canal, the Straits of Malacca and the Straits of Gibraltar function as important turntables in extensive hub-and-spoke and relay/interlining activities. Many of the world's larger ports can be found near these key locations: e.g. Port Said and Damietta near Suez Canal, Algeciras and Tanger Med near the Straits of Gibraltar and Singapore and Tanjung Pelepas near the Straits of Malacca.

Shipping lines have designed liner services with slow steaming large vessels connecting a limited number of global ports on each side of the trade routes. Maersk Line, MSC and CMA-CGM are among the truly global liner operators, with a strong presence also in secondary routes. The networks are based on traffic circulation through a network of specific hubs. However, shipping lines do not necessarily opt for the same hubs. There is an upper limit to the concentration of flows in only a few hubs as shipping lines have commercial reasons for not bundling all their cargo in one port (i.e. not all eggs in one basket). For instance, Maersk Line and MSC did not opt for one European turntable, but several major hubs.

The opening of new larger Panama Canal locks in 2016 (allowing container vessels of up to 14,000 TEU) opened opportunities for shipping lines to reintroduce equatorial round-the-world container services. This could pull some direct calls away from major port regions such as North Europe and the North American East Coast to transhipment hubs on the maritime beltway of the world. Furthermore, the almost monopolistic position of the Suez route on many trade routes is being scrutinized by an ever-changing geography in world trade patterns. The Cape route could in the long run serve as an alternative to the Suez option on trades between Asia and South America, Asia and West Africa and South America and East Africa (Notteboom, 2011). The flows related to the first two trade lanes now typically pass through the Suez Canal and are interlined in hubs such as Algeciras, Tanger Med or even in more northern ports such as Rotterdam (Maersk Line) and Antwerp (MSC). The expected emergence of the Cape route should be seen as the embodiment of a promising development of south-south trade volumes between Asia, Sub-Saharan Africa and South America.

A number of other routing alternatives are being planned or are in operation to accommodate part of the trade volumes between Europe and Asia (Figure 1.8), but their market shares are expected to remain low compared to the Suez route. First there is the Northern Sea Route (NSR), a set of all-water shipping lanes between the Atlantic Ocean and the Pacific Ocean along the Russian coast of Siberia and the Far East. Future ice cap reductions would open new possibilities for commercial shipping on this route. Despite the attention NSR received in the past decade, the route receives a very limited number of ships per year: only 19 ship transits in 2016 representing about 0.21 million tons of cargo (data of Northern Sea Route Information Office). The record year is 2013 with 71 ships and 1.35 million tons of cargo. For reference purpose, the Suez Canal welcomed 17,483 ships in 2015 while the Panama Canal received 12,383 ships in 2015 (figures of Suez Canal Authority and Panama Canal Authority). In cost terms, the NSR route is less favourable due to the need for ice-classed ships and ice breaker assistance, non-regularity of the liner services, slower sailing speeds, navigation difficulties and Russian transit fees. Kiiski (2016) shows that, unlike destination traffic to and from some ports in the Russian Arctic, the NSR as a seafaring connection between Europe and Asia is highly unlikely to become economically

viable for commercial shipping for a (very) long time, and its impact on global shipping is expected to remain (very) marginal. In North America, the Northwest Passage provides a similar artic maritime transport alternative, but also there the prospects are rather limited, partly because the large-scale activation of the route is expected to have significant impacts on local environment and wildlife.

Secondly, North South land corridors could develop as land bridges from the Persian Gulf via Iran to Russia. Third, the east-west Eurasian rail corridors, a set of railway lines connecting East Asia and the western part of Russia with the Eastern part of Russia, are becoming more commercially interesting. The main arteries are the Trans-Siberian Railway, the Trans-Manchurian Railway, the Trans-Mongolian Railway and the Baikal Amur Mainline (BAM – opened in 1991). Also Belgian ports are benefiting from improved land bridge connections. For example, in the Spring of 2011, the Combinant terminal in the port of Antwerp established a rail service to Chongqing in China passing via Duisburg. Rail land bridges in principle offer lead time advantages to shippers, but capacities remain low compared to container liner services. As discussed in the next section, the OBOR initiative has the potential to give a boost to rail volumes on the Eurasian land bridges.

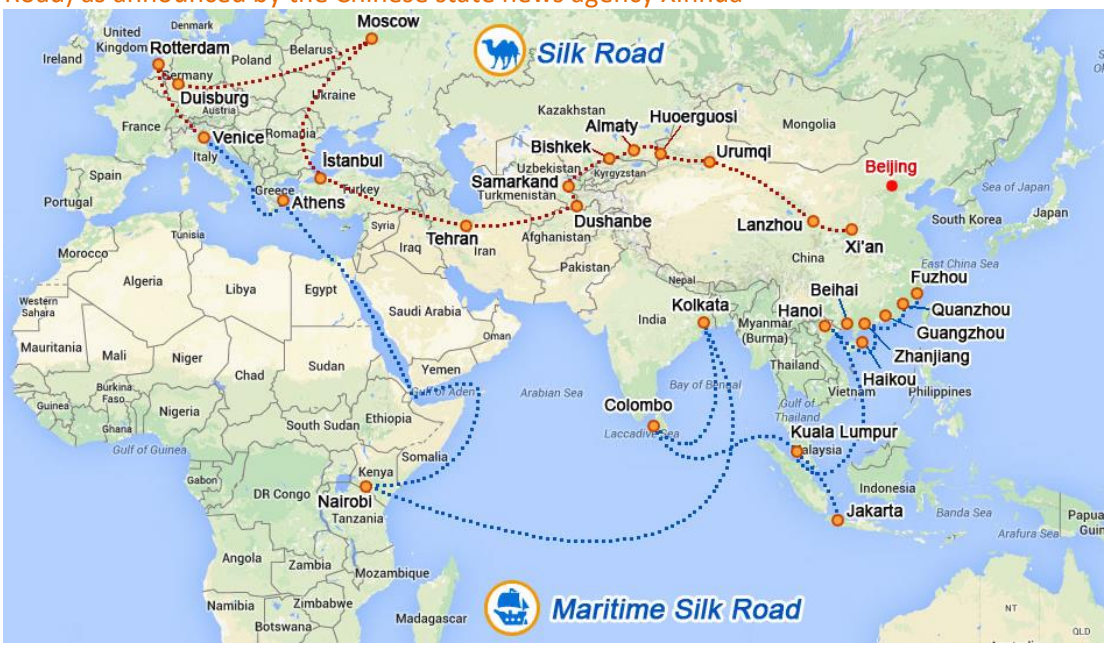
Figure 1.8. The main routing alternatives between East Asia and Northern Europe

Source: Notteboom and Rodrigue (2011b)

1.4.2. Maritime and land corridors in the 'One Belt One Road' initiative (OBOR)

The 'One Belt One Road' initiative (OBOR) was launched in September/October 2013 by President Xi Jinping to foster economic co-operation from the Western Pacific to the Baltic Sea and to break the connectivity bottleneck in Asia through infrastructure investments. The OBOR program is a centrepiece of Xi Jinping's foreign policy and domestic economic strategy. In March 2015 the Chinese government unveiled an OBOR initiatives action plan (Kennedy and Parker, 2015). The initiative covers a land-based (in essence rail-based) Silk Road Economic Belt (one Belt) including a zone of influence on both sides of the Belt, and a 21st century Maritime Silk Road (one Road). Figure 1.9 shows the routes of the OBOR initiative as presented by the Xinhua News Agency in early 2014. The land-based Belt begins in Xi'an in central China before stretching west through Lanzhou (Gansu province), Urumqi (Xinjiang), and Khorgos (Xinjiang), which is near the border with Kazakhstan. The Silk Road then runs to Duisburg in Germany via Iraq, Syria, Turkey, Bulgaria, Romania, the Czech Republic, and Germany. From Duisburg it connects to major north European ports such as Rotterdam, Antwerp and Hamburg. The Belt runs south to Venice in Italy where it meets up with the Maritime Silk Road. The Maritime Silk Road will begin in the port of Quanzhou in Fujian province, and also calls at Guangzhou, Beihai (Guangxi), and Haikou (Hainan) before heading south to the Malacca Strait. Then it connects to India/Pakistan and East Africa before entering the Mediterranean with key stops in the port of Piraeus in Greece and in the port of Venice. In the meantime, the number of routes has been extended and now covers six economic corridors: the China-Mongolia Russia economic corridor, the New Eurasia Landbridge economic corridor, the China-Central Asia-West Asia economic corridor, the China-Pakistan economic corridor, the Bangladesh-China-India-Myanmar economic corridor and the China-Indochina Peninsula economic corridor. Since the announcement of the OBOR initiative, the number of countries involved keeps expanding (already 60 countries with a joint population of 4.4 billion people).

Figure 1.9. The Silk Road Economic Belt (one Belt) and 21st century Maritime Silk Road (one Road) as announced by the Chinese state news agency Xinhua



Source: based on Chinese map of Xinhua News Agency (base map from Google Maps)

The OBOR initiative is supported by a range of funds and financial institutions. The Silk Road Fund (USD 40 bn), China Development Bank (CDB – USD 50 bn) and the Export-Import Bank of China (China Eximbank) all have a key role to play. CIC Capital, a subsidiary of China's sovereign wealth fund, will also finance OBOR projects, as will other commercial banks. The state-owned conglomerate CITIC Ltd. has announced that it would mobilize up to USD 113 bn to support the OBOR development (Zhang and Miller, 2015) while the Bank of China committed USD 100 bn. Also the multilateral Asian Infrastructure Investment Bank (AIIB) with a registered capital of USD 100 bn (of which USD 50 bn from China) and 57 founding members will have its role to play to finance infrastructure in Asia.

China's motives to launch the OBOR initiative are of a cultural/historical, geo-economic and geo-political nature. The geo-economic motives are mainly linked to: (a) China's search for (renewed) economic growth, also in its more western and central provinces (see 'Go West' policy); (b) to develop stronger economic ties with trading partners and emerging nations in Asia, Central Asia and Africa; (c) to help to resolve the overcapacity situation in various industries within China, for example in steel, cement and alumina (Roland Berger, 2015); (d) to streamline/channel foreign investments of Chinese companies (Hanemann and Huotari, 2016), and (e) to enhance capital convergence and currency integration of the Chinese Yuan (RMB).

The geo-political motives relate to China's ambition to increase its zone of influence and to adopt a leadership role in the world by making stronger use of economics in shaping diplomatic relationships.

While the OBOR initiative offers great potential for economic co-operation and development, its implementation is not without risks. Some of the key regions involved face politically instability. Infrastructure development faces some governance risks such as the need for financial discipline, careful budgeting and fair tender procedures to avoid any waste of resources. Another key issue is the need for a further development of knowhow and expertise on infrastructure planning and financing in some of the less developed regions along the Belt and Road.

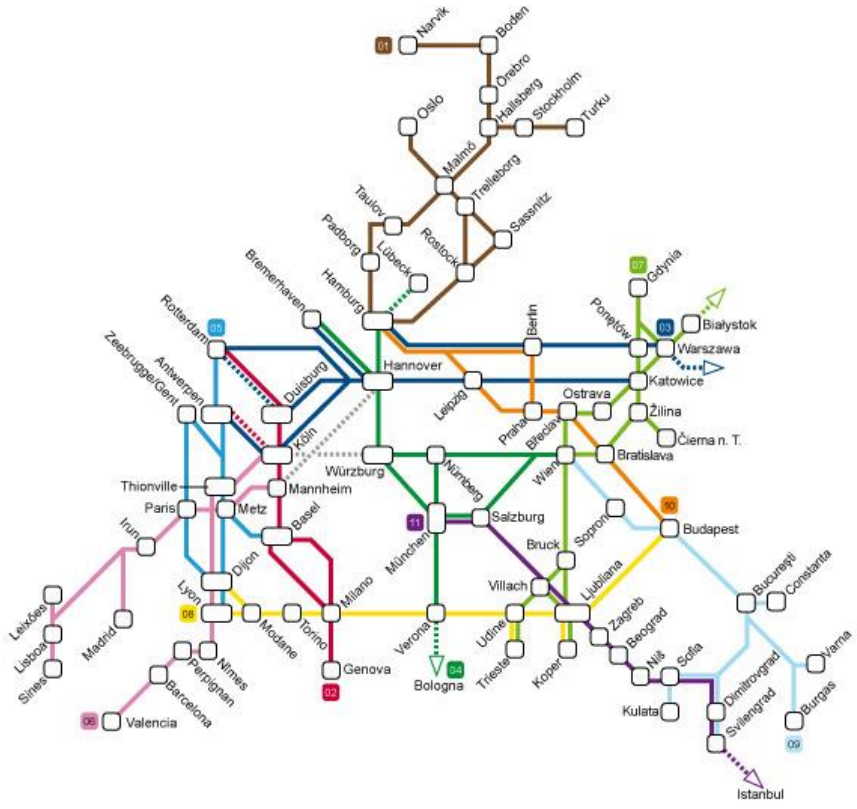
1.4.3. European land corridors

On a more European scale, existing transport corridors by rail, road and inland navigation between the core of the EU, the Baltic, the Mediterranean, East and Central Europe and third countries are likely to grow in importance, whereas a number of new corridors will emerge to deal with growing transport volumes between Member States. The development of these corridors is enhanced by EU policy on the creation of the Trans-European Transport Network (TEN-T) and initiatives of rail operators, megacarriers and other market players to extend their European transport networks. Corridors are created by economies of scale formed by the clusters in question. When compound demand in clusters reaches a critical mass, cargo can be consolidated, allowing other modes of transport and creating (multi-modal) corridors. Corridors act in a way that (large) gateways face less 'resistance' in reaching the natural hinterland of other ports. Major contestable hinterlands are increasingly being served not only by the ports of one region, but by several gateway regions as was discussed earlier in this report. The performance profile of each of the corridors in terms of infrastructure provision (capacity), transport operations (price and quality of the shuttle services) and the associated logistical control (i.e. the management in a supply chain context) is a key attribute for port competition in Europe.

RailNetEurope (RNE), which groups the rail infrastructure managers in Europe, has developed corridor management along a set of European rail corridors in view of planning international train paths and of shaping corridor infrastructure capacity according to market requirements. Corridors C02, C03 and C05 are particularly important to the Delta (Figure 13). Most progress has been made on corridor C02 that starts from Rotterdam and goes down all the way to Genoa covering a number of the most important economic regions in Europe. Its catchment area comprises 70 million inhabitants and operates 50% of the north-south rail freight.

The European Commission is also working on the creation of a number of international freight-oriented corridors. The Belgian ports face the fact that no new major corridor infrastructures have been developed in the recent past and that the full reactivation of the Iron Rhine link between Antwerp and Germany has still not been effectuated. The focus has therefore been on stretching existing capacity on the corridors via advanced traffic management systems and the implementation of effective cargo bundling and cargo coordination systems in and outside of the seaport areas. While measures to optimize the use of existing capacity are obviously the right way to go, there are limits to the 'stretching' of the use of existing capacities. In Eastern Europe and parts of Southern Europe the focus is more on developing the much-needed corridors in the first place.

Figure 1.10. RNE corridors



Source: www.rne.eu

Corridors are also found in inland waterway infrastructure network. The main axes include (a) the Rhine and its tributary rivers (Main, Neckar, Mosel), (b) the river system in the Benelux and northern France, including main canals such as the Albert Canal between Antwerp and Liège, (c) the Rhône-Saône basin, (d) the Northern network around the Elbe

and Weser and associated canals, (e) the Rhine-Main-Danube linking the Alpine Region to the Black Sea. The Rhine-Scheldt Delta is strategically located on most of these corridors.

The Seine-Nord project is among the most significant infrastructure projects with potentially structural effects on port competition and cargo routing in the Benelux and Northern France. In eastern Europe ships have the possibility to reach the Danube from the Rhine, opening up the larger industrial areas in Austria, the Czech Republic, Hungary, Croatia, Serbia, Romania and Bulgaria. Via the Elbe and the Oder the industrial areas in Austria, Germany, Poland and the Czech Republic are within reach. For this region an impressive attempt to improve the network is the connection of these two waterways (Elbe and Oder with the Danube) in order to create a new trans-European shipping lane. Vienna will in that case become the most important inland shipping centre in Central Europe. Other countries in Europe which boast inland shipping are Italy, Finland, Sweden, Russia and the Ukraine. However, these pertain to isolated national waterways networks which (except maritime) have no connection with the European network.

1.4.4. The growing importance of inland ports and logistics zones

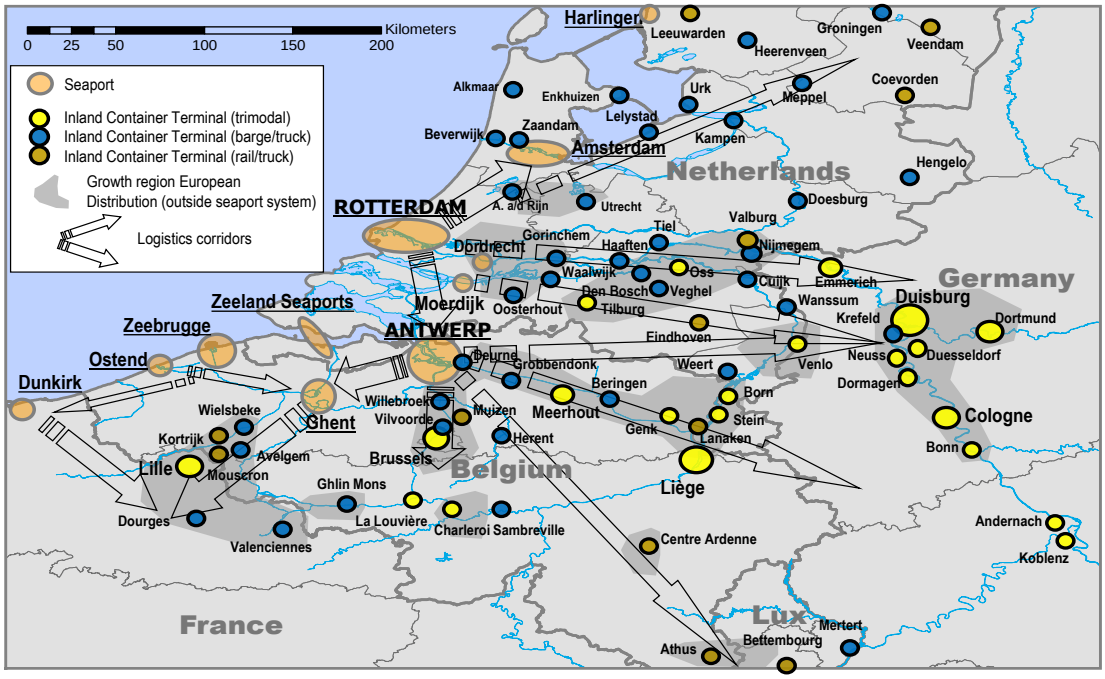
In the past decades, the dynamics in logistics networks have created the right conditions for a large-scale development of freight villages and inland ports throughout Europe. The range of functions presented by inland logistics centres is wide ranging from simple cargo consolidation to advanced logistics services. Many inland locations with multimodal access have become broader logistics zones. Not only have they assumed a significant number of traditional cargo handling functions and services, but they also attracted many related services, a.o. distribution centres, shipping agents, trucking companies, forwarders, container-repair facilities and packing firms. The concept of logistics zones in the hinterland is now well-advanced in Europe: e.g. 'platformes logistiques' in France, the Güterverkehrszentren (GVZ) in Germany, Interporti in Italy, Freight Villages in the UK and the Zonas de Actividades Logisticas (ZAL) in Spain. Logistics zones are usually created within the framework of regional development policies as joint initiatives by firms, intermodal operators, national, regional and or local authorities, and or the Chambers of Commerce and Industry.

Quite a few of these logistics zones are competing with seaports for what the location of European distribution facilities and value added logistics (VAL) are concerned. Shortage of industrial premises, high land prices, congestion problems, the inland location of the European markets and severe environmental restrictions are some of the well-known arguments for companies not to locate in a seaport.

Corridor development enhances the location of logistics sites in inland ports and along the axes between seaports and inland ports. The interaction between seaports and inland locations leads to the development of a large logistics pool consisting of several logistics zones. This trend towards geographical concentration of distribution platforms often occurs spontaneously as the result of a slow, market-driven process. But also national, regional and/or local authorities try to direct this process by means of offering financial incentives. Belgium is a prime example. There are now large concentrations of logistics sites in and around the inner port of Liège, along the Geel-Hasselt-Genk axis and the Antwerp-Brussels axis, and in the Kortrijk/Lille border region. Apart from the Liège area, also other parts in Wallonia are becoming logistics hotspots. The existing geographical concentration of logistics sites has stimulated the development of inland terminals in these areas.

In the future, a further integration of intermodal transport and supply chain management will undoubtedly lead to new value-added services in inland locations. This will enhance the provision of logistics services at key transfer points and the organisation of distribution patterns around such nodes. The availability of fast, efficient and reliable intermodal connections is one of the most important prerequisites for the further logistical development of inland terminals.

Figure 1.11. Logistics polarisation and logistics zones in the Rhine-Scheldt Delta



Source: updated from Notteboom (2010)

1.4.5. The rise of synchromodality

The European port system has witnessed significant advances in inland transportation. Modal shift and 'co-modality' policies have been implemented by supranational, national and regional governments aimed at stimulating the use of barges, rail and shortsea shipping. In March 2011, the European Commission published its White paper on the future European Transport Policy entitled 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system' (COM(2011) 144 final). One of the key points in the paper on transport is a 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport, combined with a new legislation for a further liberalisation of rail passenger transport for 2012. This can only be accomplished by drastically increasing the availability and use of the intermodal network present in Europe. The configuration of rail and barge networks proofs to be of crucial importance to the European port system. A certain level of traffic concentration in a seaport system is required in order to allow a virtuous cycle of modal shifts from road haulage to high-volume transport modes. But even port systems with a low degree of concentration have embraced intermodal transport. Extensive cargo concentration on a few trunk lines opens possibilities for economies of scale in inland shuttles, but even more likely for higher frequencies. Smaller ports and new terminals often seek connection to the extensive hinterland networks of the larger ports.

In the meantime, the terms modal shift and co-modality have made room for the notion of 'synchromodality'. The Platform Synchromodality defines this notion as "the optimally flexible and sustainable deployment of different modes of transport in a network under the direction of a logistics service provider, so that the customer (shipper or forwarder) is offered an integrated solution for his (inland) transport". A key characteristic of the concept is that not one single kind of party is leading in finding and implementing a synchromodal solution. Shipping lines, terminal operators, inland terminals, inland transport operators, 3PL companies, shippers and public authorities all have their role to play in the development of synchromodal solutions. Also, a synchromodal approach assumes that the shipper books a-modally thereby leaving the decision on the mode(s) of transport to be used to logistics service providers. This renders the whole transport system more flexible in terms of mode choice. In addition, synchromodality makes it possible to consolidate consignments of cargo, thus achieving additional efficiency benefits. Synchromodal transport especially has potential on corridors and in regions where sufficient volumes are present; this allows for highly frequent transport by rail and barge. Belgium and its immediate hinterland qualifies as a region where a synchromodal approach makes sense.

1.4.6. The evolving hinterland dimension in port competition

A large part of the volumes in dry and liquid bulk products is relatively captive to the discharging port region since the customers are typically located in the port region or in vicinity of the port (steel plants, power plants, oil refineries, chemical companies, etc..). The gateway function for major dry and liquid bulks of the Belgian ports mainly involves one traffic direction (incoming seaborne cargo), a limited number of market players and a few nodes, i.e. the port and a limited number of destinations in the hinterland. Changes in the traffic position of the Belgian ports as a whole in dry bulk and liquid bulk are therefore to a large extent linked to (1) economic cycles - demand, (2) terminal and inland transport supply in the Delta, also taking into account the environmental space such as the carbon footprint profile; (3) energy policies in the Benelux and Germany and (4) location decisions of major steel and chemical companies for which competition plays at a global scale.

For containerised cargo, however, the hinterland profile involves numerous origins and destinations dispersed over a vast hinterland (and thus more competitors), a large number of economic players and two traffic directions. Therefore, the captive nature of container cargo for the Belgian ports is much smaller than for bulk cargo. Also, container flows are partly entwined with re-export and EDC activities in the region.

The local or immediate hinterland of the Belgian ports remains very important. Even large European gateways such as Antwerp have a high proportion of container flows that is generated by the port city and its immediate surroundings. The high share of rather local traffic is partly linked to the role of the Belgium in EDCs and re-exporting activities. Belgium and the surrounding regions are home to a large number of EDCs. A large portion of the containers flows by truck leaving Belgian ports is destined for EDCs or other logistics centres in the immediate hinterland. Containers arriving in these EDCs are typically stripped and after some value-adding manipulations the cargo is regrouped to reach the final destinations - even in the more distant hinterland – mostly by truck in a conventional non-containerised form. While road haulage has always played a major role in reaching the core hinterland regions, intermodal transport is slowly but surely acquiring a strategic role as well. Zeebrugge has developed a strong orientation on rail shuttles. Antwerp and Ghent heavily rely on barges to reach water-linked hinterland regions. Most ports have achieved a

considerable modal shift in hinterland container transport, although the shift to rail remains a challenge.

The Belgian ports are strategically located in relation to the area of the European Union with the highest concentration of main economic centres, i.e. the so-called 'blue banana' reaching from the southern part of the United Kingdom over the Benelux, central and eastern France to northern Italy. The 'blue banana' is the core hinterland of the Belgian ports but competition for cargo to this blue banana is fierce. The Belgian ports compete heavily with the Dutch ports, with Le Havre for French cargo and with Bremen and Hamburg for traffic to/from Germany, the Alpine region, northern Italy and Central and Eastern Europe. Major hinterland overlap regions characterized by intense port rivalry are the Rhine-axis (the German Ruhr Area in particular), northern France, northern Italy and the east-west corridors from the Benelux ports to the hinterland.

An increasing number of ports gain direct hinterland access to the 'blue banana' area. This development has broadened container port competition and altered spatial hierarchy, in the sense that Belgian ports are increasingly facing competition from container ports in other European port ranges (Baltic, Adriatic and Med) particularly for cargo related to the four coloured hinterland areas in Figure 1.12. These contestable hinterlands are increasingly being served not only by the ports of one gateway region, but by several multi-port gateway regions.

Figure 1.12. Gateway traffic (inland traffic excl. sea-sea transhipment) in major multi-port gateway regions in Europe (in TEU)

Source: Notteboom (2015)

Gateway ports in the west Med have gained a much better connectivity in the global shipping networks than before, which gives these ports the opportunity to benefit from a higher critical mass and economies linked to larger vessels. But so far, they seem to have difficulties in substantially extending their hinterland reach north through rail services (Gouvernal et al., 2005). In practice, only Spanish Med ports have been successful in large part due to the strong economic growth in Catalonia and Madrid, while Italian and French Med ports lag behind in growth. While Spanish ports are slowly entering the French market using rail shuttles (despite the difference in rail gauge), the north-south paradox for North-Italian cargo is mainly linked to a weaker intermodal organizational performance for intra-Italian rail products, and existing differences in port efficiency between Northern ports and North Italian ports. One of the main obstacles to Med ports is that the hinterland volumes are a lot smaller than in the Rhine-Scheldt Delta, which implies that frequent intermodal services are hard to maintain and sometimes disappear soon after introduction (see circles in Figure 1.12). This concentration of flows largely explains why the range and diversity of the intermodal service offer of large Delta ports is still far bigger and more established than in their Mediterranean counterparts.

1.5. Supply chains and logistics networks of the future

The classic view on supply chain engineering was very linear. In recent decades, supply chain thinking and logistics networks have become far more complex. Macro-economic changes like globalisation and containerisation have contributed to the emergence of reverse logistics, the decoupling of order and delivery and the creation of transport networks instead of chains. Logistics is a rapidly evolving market and is under more intense customer pressure than ever before. Many factors are shaping the future supply chains. It will be important to understand the trends, the changes they will bring and the opportunities they represent. These trends will be discussed in the next two sub-sections. Then, we discuss some of these trends in greater detail.

1.5.1. General logistics trends

Based on The Lombard white paper “the choreography of change: the future of logistics”, the main trends can be summarized as follows:

1. Massive re-engineering of supply chains in favour of modal shift and synchromodality (see earlier for definition). Companies will have no choice but to perform in the most environmentally sustainable way possible; one because the political and legislative will is inexorably driven that way; two because the consumers want it; and three, because reducing waste and fuel reduces cost.

2. Changing realities in economies like China where costs and inflation keep rising, and with their “China plus one” scenario in which China will transition from an export producing towards a consumption driven economy, have a major impact on the complexity and challenges of current supply chains. Combined with risks related to manufacturing in the Far East such as time to market or responsiveness, import duties, skilled labour force, synergies with ecosystems, cost of energy, automation, this means that more sub-assembly and manufacturing will return to Europe and surrounding countries.

3. More horizontal collaboration between transport companies and logistics service providers will be needed to deal with the need for shorter, more sustainable and cost efficient supply chains. This will entail its own complexities, mainly where it concerns mutual trust concerning data-sharing protocols and protection of one's competiveness.

4. A growing skills shortage is a distinct possibility in the logistics industry. Logistics companies must start to think about how they will be able to recruit sufficient young talent to keep numbers healthy and how they will train and develop them. Considering the digitalization of all parts of society, including logistics, the requirement for new skill sets will further intensify this shortage. In addition, the targeted labour force might be attracted by other, more high-profile sectors.

5. The streamlining of supply chains through segmentation and standardization using advances in data analytics and visibility. This will lead to a 'plug-and-play supply chain' (DHL, 2016) which can be described as finely-tuned, agile supply chains consisting of core standardized, easily replicable solutions, augmented by standardized, process-proven bolt-ons that are tailored to unique segment or market needs. These supply chains need to be supported by intelligent, data-driven decisions around customers, markets and profitability.

6. Focus will be on more local and sustainable supply networks in which clean forms of transport will meet all shippers' expectations as to cost and efficiency KPI's. Goods will have to be transported in an economically, environmentally and sustainable manner. To this extent, shippers will expect an orchestration function from service providers in which operational excellence is supported by the ability to obtain a greater convergence between physical and data processes.

7. Consolidation in the logistics sector will result in a smaller number of companies that will empower the supply chain with the support of ever more performant ICT systems. The data component will leverage performant and pro-active service providers to transform into companies that have a new outlook on the term of logistics services. Next to an increasing number of traditional activities being outsourced such as transport, warehousing and various types of value added services, the presence of collaboration platforms will capacitate certain service providers to develop new types of logistics services.

8. A systematic use of greener alternatives for logistics will need to be developed as environmental pressure from society as a whole will increase. This will result in the development of sustainable hubs and corridors along which new sustainable supply chain networks will need to be developed. This will impact the way ports operate and will be able to link into this grid.

9. Also in the European transport market a consolidation is to be expected as sustained overcapacity cannot last. This consolidation should allow these larger transport companies to become fully fledged partners within collaborative networks in order to support operational interconnectivity.

10. Industry 4.0 and such methods as additive manufacturing (3D printing) will challenge existing business models. This trend will affect transport and logistics demands as more manufacturing will be regional, be it in local factories, independent manufacturing farms

or even a new role for logistics service providers that will offer production services and integrate them with their transport, storage and distribution services.

11. Considerable growth in demand or consumption products is to be expected, especially in Eastern Europe. This will affect the physical flow of goods such as containerized transport, but also links into the changing reality of Industry 4.0 and the relocation of production sites based on proximity to market for economical, ecological and societal reasons.

12. An important part of the success of the circular economy will hinge on the way smart logistics will enable the transparency needed to set up efficient and integrated fully circular supply chain networks. Next to the physical aspect of integrating supply chain flows to maximize circular economy opportunities, end-to-end integration of supply chain processes will be crucial. Thus, the circular economy will certainly offer new opportunities for shipping and logistics service providers but will also challenge them to enter into close collaboration with the industry stakeholders.

13. Security of supply will become increasingly important. Resilience of the supply chain is becoming a crucial element in dealing with ever more present supply chain disruptions as a result from local political instability, natural disasters, acts of terrorism, etc. There are examples in abundance that happened over the last few years and events such as the 2011 earthquake and ensuing tsunami in Japan, not only had massive implications for society and humankind but also for the global supply chain (think automotive parts or semiconductors). Supply chains will need to have redundancy built in. Again the development of data-driven models will enable such re-engineered supply chains. Supply chains will be designed for resilience. This will result in increased supply chain visibility and data sharing between supply chain stakeholders.

14. According to the European Technology Platform ALICE, Alliance for Logistics Innovation through Collaboration in Europe, the supply chain will evolve towards an open global logistic system founded on physical, digital and operational interconnectivity, through encapsulation, interfaces and protocol design, aiming to move, store, realize, supply and use physical objects throughout the world in a manner that is economically, environmentally and socially efficient and sustainable. This thesis is most certainly supported by the mid to long-term trends described earlier. It will require full standardisation of internationally recognised consignment codes in order to communicate throughout the physical reality of the chain. The various transport systems and ICT platforms will have to integrate horizontally and vertically in order to become an open ICT infrastructure for the total logistics sector. In other words, the globally independently developed logistics networks will have to be connected enabling shippers an overall view. Maximal standardisation will be the open infrastructure's lubricant.

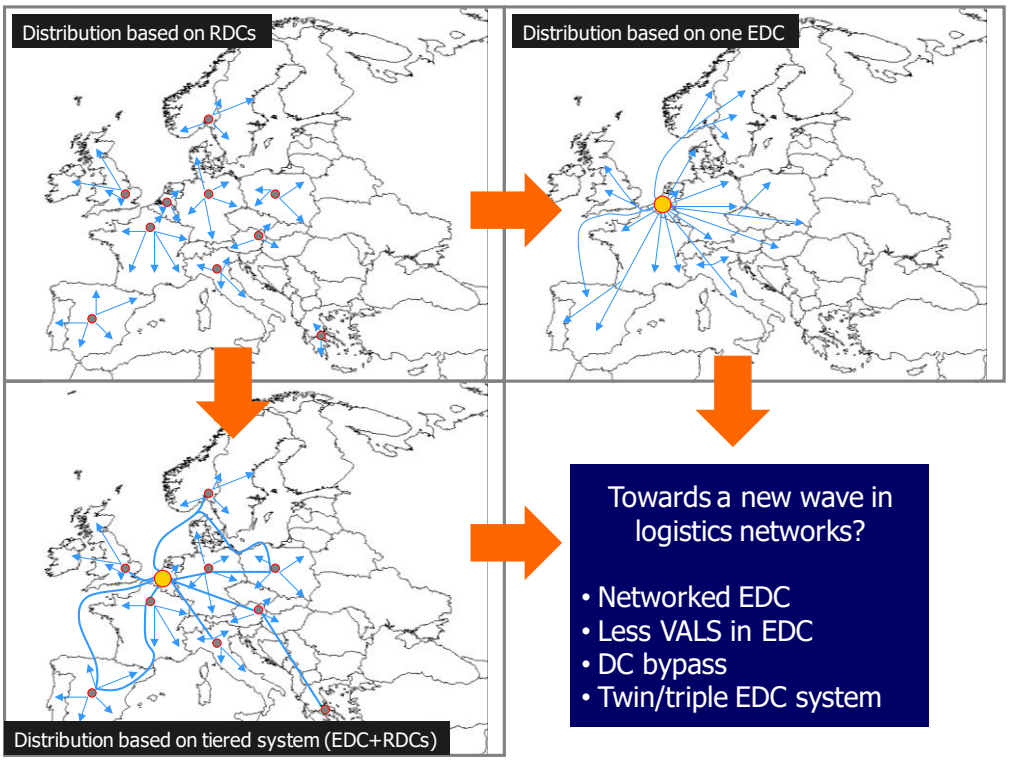
1.5.2. Dynamics in logistics networks throughout Europe

Before 1993, most companies set up a distribution structure based on a network of distribution centres in major countries in which they were present. Since cross-border transactions have increased drastically after the creation of the European Internal Market in 1993 and the fall of the Iron Curtain, most companies consolidated their national distribution centres to European distribution centres (EDC) covering all of Europe. When it comes to overseas goods not all companies have the same distribution structure. It stands

to reason that not all goods can be handled and distributed in the same manner. Companies can opt for delivery without the use of a distribution centre, distributing through an EDC, distribution through a group of NDCs (National Distribution Centres) or RDCs (Regional Distribution Centres) or a tiered structure with one EDC and several supporting NDCs/RDCs. The choice is mainly influenced by the type of product and the frequency of delivery. In the fresh food industry for example, EDCs are not common because the type of product (perishables) dictates a local distribution structure. In the pharmaceuticals industry, EDCs are common but RDCs or local distribution centres are not present, because the pharmaceutical products are often manufactured in one central plant and delivery times are not very critical (hospitals often have own inventories). However, in the high tech spare parts industry, all of the distribution centre functions can be present because spare parts need to be delivered within a few hours and high tech spare parts are usually expensive (which would require centralised distribution).

At present a certain degree of decentralisation takes place where EDCs are combined with lower tier RDCs, cross docks and rapid fulfilment centres in order to offer the best results in terms of a high service level, frequency and cost control. When multiple products are delivered by the same company, a hybrid distribution structure is an option allowing the slower goods to pass through the EDC and the faster goods with a shorter life cycle through RDCs. However, there is a downside to the hybrid system. Total handling and operations costs are quite high compared with the other options. To solve this a new, slightly altered, structure is on the rise: the networked distribution centre. The EDC system loses its fulfilment function and gains importance as a network control centre, hence networked distribution centre.

Figure 1.13. Future trends in the configuration of logistics networks in Europe



Contemporary logistics networks are characterised by a few main developments (Figure 1.13). First, the evolution from EDC to a networked EDC reducing labour requirements but demanding higher skills. Second, less value added services (VALS) are performed at the central distribution centres as these are decentralised or moved to low cost production facilities or even overseas to the source. Third, the EDC can be bypassed altogether by cross docking, merge in transit or adequate consolidation at the supplier transport hub. Fourth, a shift in location takes place caused by market dynamics (distribution follows demand) and logistics trends (a shift from push to pull logistics). This can lead to a decoupling of one EDC serving the whole European market to two or even three EDCs of similar status spread over Europe (twin or triple EDCs). Fifth, specific sectors require EDCs for their supply chain like basic processing industries (chemicals, food, etc..), sectors with a low logistics cost (pharmaceutical, medical) and Asian SMEs with new emerging global brands from China. These trends could cause a stagnation in EDC investments and growth. The fifth trend does not offset the others. Existing EDCs will be transformed to networked EDCs reducing employment possibilities. This does not mean that investments in new specialised EDCs in ports is not possible. For the aforementioned sectors or transporters requiring sea-sea trades these distribution centres are still required.

The future distribution system configuration obviously has an impact on the cargo routing patterns in Europe. EU enlargement up to now has not had a huge impact on the location of EDCs in the blue banana as this zone still offers the best access to the EU's core markets and infrastructure. However, road congestion, increasing labour costs and scarcity of land may encourage companies to search for alternative distribution structures. High potential candidates for RDC location are northern Germany and Finland for northern access, Hungary and Austria for central access, northern Italy and the north Adriatic region for southern access and the Czech Republic and Poland for eastern access.

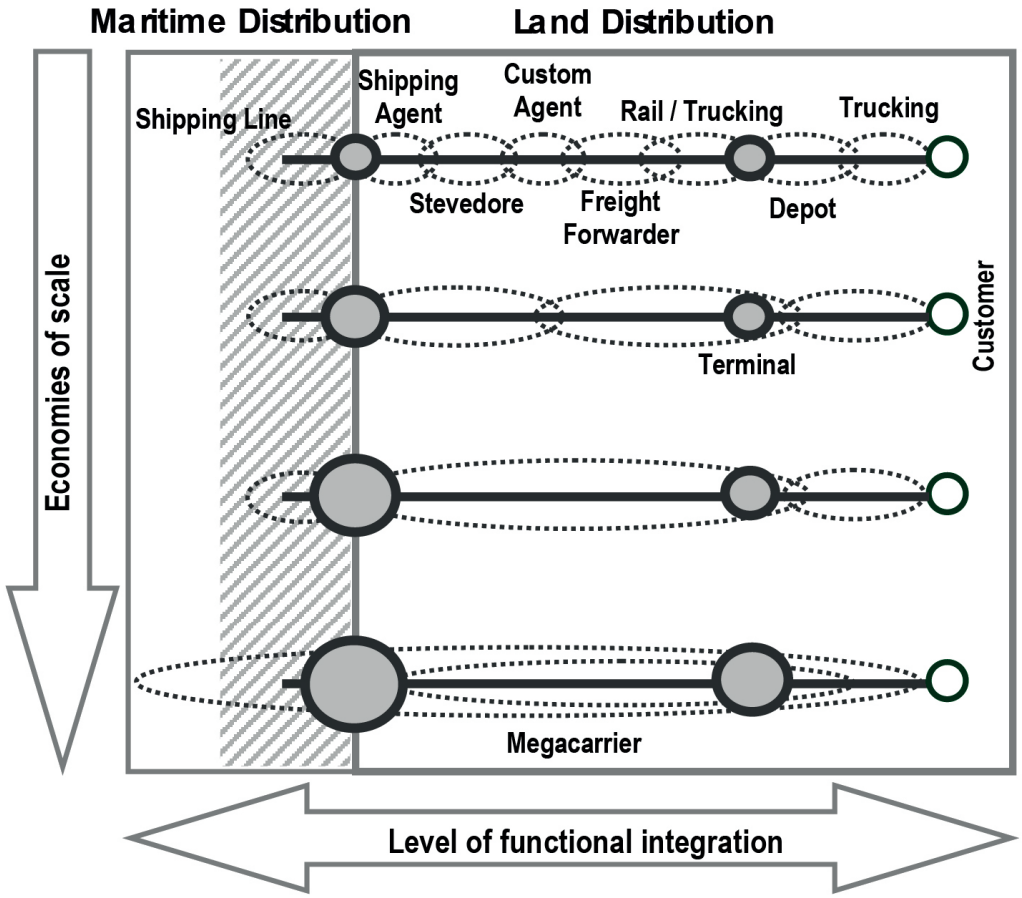
Land and maritime corridors (see earlier in this study) might prove to be crucial to support the further development of efficient European distribution network configurations. However, efficient long-distance corridors can also have a downside to well established EDC regions such as Belgium: they make it easier for logistics service providers to move distribution facilities inland closer to the customer base without having to sacrifice a good accessibility to the maritime gateways.

1.5.3. Market players: increased logistics integration and coordination

Globalisation and outsourcing open new windows of opportunities for shipping lines, forwarders, terminal operators and logistics operators. Manufacturers are looking for global logistics packages rather than just basic shipping or forwarding. Global logistics is the name of the game. Most actors in the supply chains have responded by providing new value-added services in an integrated package, through a vertical integration along the supply chain.

The level of functional integration of land distribution is increasing rapidly. Many distribution functions which used to be separated are now controlled by a single entity or are coordinated between parties. Mergers and acquisitions have permitted the emergence of large logistics operators that control many segments of the supply chain: the megacarrier. The megacarriers meet the requirements of many shippers to have a single contact point on a regional or even global level (the 'one-stop shop'). Technology also has played a particular role in this process namely in terms of IT (control of the process) and intermodal integration/synchromodality (control of the flows). The crisis has forced a lot of companies to reconsider these integration strategies and to focus more on their core activities.

Figure 1.14. Functional integration of supply chains



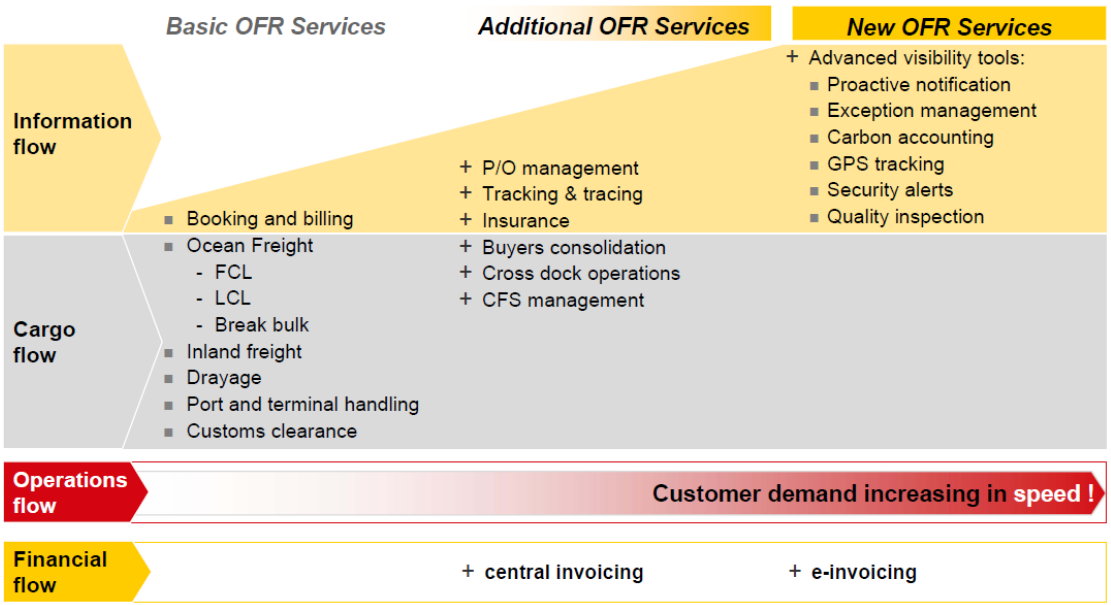
Mergers and acquisitions shape the contemporary business environment. They are not only driven by companies searching for take-over candidates, but also by companies who have decided to divest aspects of their businesses and are consequently looking for buyers of these businesses. The logistics challenges emerging from mergers and acquisitions stretch from a proliferation of customer service policies to multiple, overlapping distribution networks and infrastructure overcapacity.

Consolidation and vertical integration strategies have created a logistics market consisting of a wide variety of service providers ranging from megacarriers to local niche operators. Not only the geographic coverage of the players differs (from global to local). Major differences can also be observed in the focus (generalist versus specialist), in the service offering (from single service to one-stop shop) and in asset-orientation (asset based versus non-asset based).

The growing trend of outsourcing logistics activities in a wide variety of industrial sectors has led to a surge in the field of third party logistics (3PL) and the creation of very large logistics groups. Many of these 3PL players are based in Europe, but have networks of offices and freight handling facilities that stretch around the world. Competition between logistics service providers is no longer focused only on services to the cargo flows: advanced

services in the management of information flows are increasingly key to gaining a competitive advantage in the market (figure 1.15). These advanced services are more and more aimed at offering total pipeline/supply chain visibility to customers in terms of reliability performance through advanced tracking and tracing, environmental impact measurement (e.g. carbon footprint calculator), security risks and related event management.

Figure 1.15. The evolving service demand in ocean freight logistics



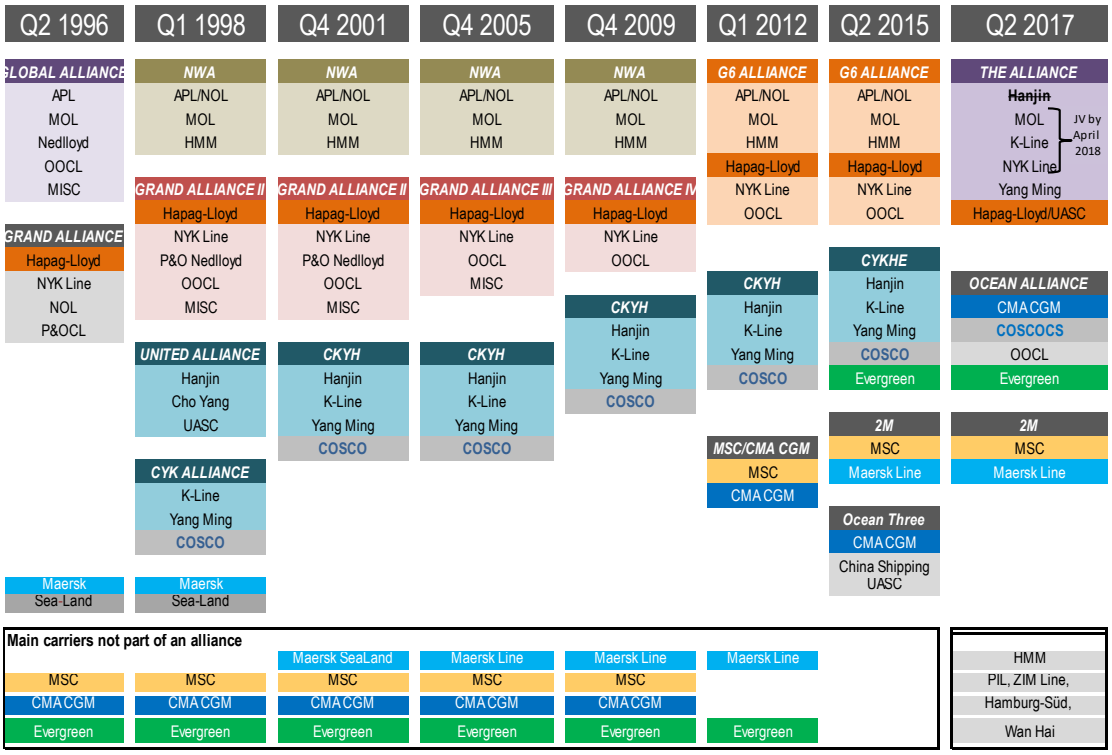
Note: OFR = ocean freight, FCL = full container load, LCL = less than container load

Source: based on DHL (2010)

1.5.4. Scale increases in vessel size, consolidation and integration in liner shipping

Shipping lines are viewing market mass as one of the most effective ways in coping with a trade environment that is characterized by intense pricing pressure. Operational co-operation between container shipping companies comes in many forms ranging from slot-chartering and vessel-sharing agreements to strategic alliances. The first strategic alliances among shipping lines date back to the mid-1990s. The main incentives for shipping lines to engage in strategic alliances relate to the need for critical mass in the scale of operation and to spread the risks associated with investments in large post-Panamax vessels. The alliance partnerships evolved as a result of mergers and acquisitions and the market entry and exit of liner shipping companies. Alliance members increasingly opt for dedicated terminal facilities or berths in those ports were volumes are sufficient to do so. In the past few years, a new generation of super-alliances is reshuffling the market (figure 1.16). A smaller number of customers creates volatility, uncertainty and higher risks for port authorities and port terminal operators. The pressure for faster vessel handling is growing.

Figure 1.16. Evolution in alliances among container lines



Source: Notteboom (2016) compiled from BRS Alphaliner, ASX Alphaliner and Containerisation International.

Figure 1.17. Slot capacities of top 30 container lines (based on TEU) – status on 15 December 2016

Rnk	Operator	Teu	Share
1	APM-Maersk	3,277,701	15.8%
2	Mediterranean Shg Co	2,822,172	13.6%
3	CMA CGM Group	2,123,840	10.3%
4	COSCO Container Lines	1,596,824	7.7%
5	Evergreen Line	992,905	4.8%
6	Hapag-Lloyd	972,645	4.7%
7	Hamburg Süd Group	600,730	2.9%
8	OOCL	575,560	2.8%
9	Yang Ming Marine Transport Corp.	565,766	2.7%
10	UASC	525,008	2.5%
11	NYK Line	518,897	2.5%
12	MOL	494,209	2.4%
13	Hyundai M.M.	455,859	2.2%
14	PIL (Pacific Int. Line)	364,600	1.8%
15	K Line	349,677	1.7%
16	Zim	302,090	1.5%
17	Wan Hai Lines	219,988	1.1%
18	X-Press Feeders Group	155,304	0.8%
19	KMTC	126,351	0.6%
20	IRISL Group	99,867	0.5%
21	SITC	96,188	0.5%
22	TS Lines	84,861	0.4%
23	Arkas Line / EMES	72,547	0.4%
24	Simatech	60,020	0.3%
25	Transworld Group	54,058	0.3%
26	Quanzhou An Sheng Shg Co	53,888	0.3%
27	Hanjin Shipping	52,907	0.3%
28	RCL (Regional Container L.)	51,224	0.2%
29	Sinokor	50,822	0.2%
30	Emirates Shipping Line	49,916	0.2%

Source: Alphaliner

The container shipping industry has also been marked by several waves of mergers and acquisitions. The main M&A events include the merger between P&O Container Line and Nedlloyd in 1997, the merger between CMA and CGM in 1999 and the take-over by Maersk of Sea-Land in 1999 and P&O Nedlloyd in 2005. In more recent years, a new consolidation wave has hit the market with the take-over of APL by CMA CGM, UASC by Hapag-Lloyd, the merger between COSCO and China Shipping, the acquisition talks between Maersk and Hamburg-Sued and the bankruptcy of Hanjin. Shipping lines opt for mergers and acquisitions to obtain a larger size, to secure growth and to benefit from scale advantages. Other motives for mergers and acquisitions in liner shipping relate to gaining instant access to markets and distribution networks, obtaining access to new technologies or diversifying the asset base. The liner shipping industry has witnessed a concentration trend in slot capacity control, mainly as a result of M&A activity (figure 1.17). The top twenty carriers controlled about 86% of the world's container vessel capacity in early 2016 compared to only 56% in 1990 and 26% in 1980. The top three lines (i.e. Maersk Line, MSC and CMA-CGM) alone supplied about 40% of the global fleet capacity.

Shipping lines have always attached great attention to cost and asset management. Since the 1990s a great deal of attention is devoted to larger, more fuel-efficient vessels. The size of a typical container vessel deployed on the Far East - Europe trade increased from 4,500-5,500 TEU in 2000 to over 13,000 TEU in 2016. Units of close to 20,000 TEU are already calling at Belgian ports. The number and size of the mega container vessels of the last generation has considerable consequences for the ports and the port operators. The impact of the growing cargo throughput on port handling facilities and port area locations, as well as on logistics and transport infrastructure capacities, mobility aspects and other strategic challenges is huge.

Simultaneous handling of these large container vessels causes greater peaks in the container terminal operations and needs storage and handling facilities and capacity large enough to handle big container volumes at the same time. As a consequence, the terminal opening hours have to extend and the waiting time at the terminal and the traffic jams on the roads increase considerably. Ensuring easy access to and from the port is a major challenge for all parties involved. The coordination of the individual modes of transportation and the synchromodality as well as the hinterland connectivity have to be optimised, making sure that the best option is chosen in every specific situation. This means that the transparency in the transport market has to be optimal. Moreover, the services of feeder ships for goods in transit as well as the hub-and-spoke transhipments have to increase, empty transports have to be reduced and maritime and continental flows of goods need to be combined. Terminal operators have to anticipate on ship calls, efficient cargo handling and traffic management strategies whilst maximizing terminal capacity and evaluate alternative solutions.

Another way for shipping lines to control costs is to opt for slow steaming or the reduction in the sailing speed of maritime vessels. This has become an increasingly common practice in container liner shipping since 2008 (Notteboom and Vernimmen, 2009). Slow steaming helped to absorb vessel overcapacity during the crisis (more vessels required to maintain the same service frequency), to save on fuel costs, to restore liner shipping company profitability and to reduce environmental emissions by ships at sea.

The focus of container carriers on alliances, consolidation, larger vessel sizes and slow steaming did not lead to a more stable market environment. Unpredictable business cycles and the seasonality on some of the major trade lanes have more than once resulted in unstable cargo guarantees to shipping lines. In June 2011, Maersk Line started the

discussion on a new mission for container shipping based on three pillars: (1) on time performance / reliability; (2) ease of business (i.e. avoid complexity, increase transparency) and (3) environmental performance. These three aspects should be considered in a supply chain perspective. More recently, it is clear that particularly the larger shipping lines are increasingly focusing their attention on logistics integration (sea-land) and IT implementation (see later in this report).

As a reaction to the carrier alliances, the *container terminal operating industry* has witnessed an internationalisation process during the last decades, leading to the emergence of terminal operators offering globe-spanning services. The top ten global container terminal operators control an increasing share of the world's total container handlings (table 1.1). Global port operators will continue to create worldwide terminal networks that can offer consistent levels of services and modes of operation. Port terminal operators will also forge alliances in order to promote economies of scale and use of global capacity.

Evidence underlines that the consolidation process that has rapidly taken place in recent years may have reached limits. Global terminal operators are now increasingly hedging the risks by setting up dedicated terminal joint ventures in co-operation with shipping lines and strategic alliances. Quite a few of the top terminal operators have invested in container operations in Belgian ports often in partnership with shipping lines and other companies. This has resulted in very complex ownership structures with many operators present in more than one port. The same applies to bulk trades where terminal groups are expanding the scope over more than one port.

Table 1.1. The top container terminal operators in 2013 and 2014

Ranking		Operator	2014		*Influence'* *	2013			
2014	*2013*		Million teu	% share	*Million teu*	Million teu	% share	Growth/ decline (million teu)	Growth/ decline (%)
1	*1*	Hutchison Port Holdings	80.2	11.8%		76.1	11.8%	4.0	5.3%
2	*2*	APM Terminals	71.7	10.6%	*74.4*	68.0	10.6%	3.7	5.5%
3	*3*	PSA International	65.2	9.6%	*145.3*	61.7	9.6%	3.5	5.6%
4	*4*	Cosco Group	64.3	9.5%		59.9	9.3%	4.4	7.4%
5	*5*	DP World	58.6	8.6%		53.7	8.4%	4.9	9.1%
6	*6*	Terminal Investment Limited (TIL)	32.9	4.9%		29.9	4.6%	3.0	10.1%
7	*7*	CMHI	25.6	3.8%	*88.5*	23.5	3.7%	2.0	8.5%
8	*8*	China Shipping Terminal Development	20.9	3.1%		20.3	3.2%	0.6	2.9%
9	*9*	Hanjin	14.5	2.1%		14.4	2.2%	0.1	0.7%
10	*10*	Eurogate	14.4	2.1%		14.0	2.2%	0.5	3.3%
11	*11*	CMA CGM	11.4	1.7%		9.9	1.5%	1.5	15.0%
12	*12*	SSA Marine / Carrix	10.1	1.5%		9.8	1.5%	0.3	3.0%
13	*13*	Evergreen	10.0	1.5%		9.5	1.5%	0.5	5.3%
14	*14*	NYK	7.8	1.2%		7.6	1.2%	0.3	3.5%
15	*18*	ICTSI	7.4	1.1%		6.3	1.0%	1.1	17.9%
16	*16*	OOCL	7.1	1.0%		6.5	1.0%	0.5	8.0%
17	*19*	APL/NOL	6.6	1.0%		6.3	1.0%	0.3	4.8%
18	*17*	Yang Ming	6.5	1.0%		6.5	1.0%	0.0	0.1%
19	*20*	K Line	5.4	0.8%		5.8	0.9%	-0.4	-6.3%
20	*21*	MOL	4.5	0.7%		4.1	0.6%	0.4	9.4%
21	*22*	Hyundai	4.0	0.6%		4.0	0.6%	0.0	1.3%
22	*23*	Bollore	3.7	0.5%		3.9	0.6%	-0.2	-4.8%
23	*24*	Grup TCB	2.5	0.4%		2.4	0.4%	0.1	2.7%
Global/international operators total			**535.3**	**79.0%**		**504.1**	**78.5%**	**31.2**	**6.2%**

* 'Indirect influence' throughput figure includes the total teu (excluding individual terminals with stake of 10% or less) of any other GTO/ITO or non-GTO/ITO operators in which a stake is held. Results in some double counting.

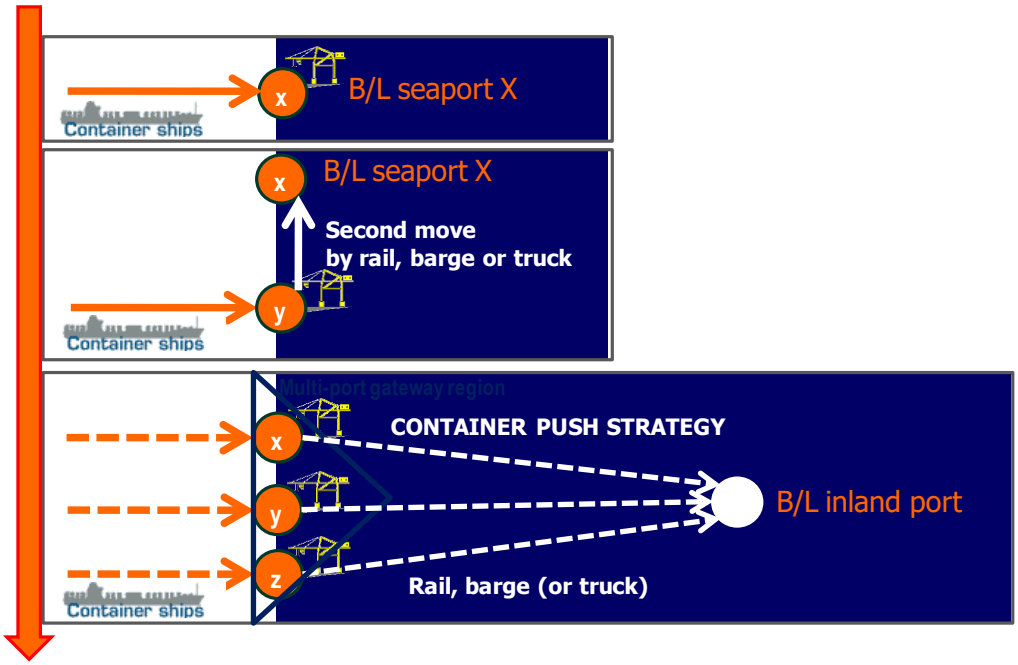
Source: Drewry Shipping Consultants (2015)

1.5.5. Supply chain integration and hinterland focus of market players

Many market players have come to understand that landside operations are key to a successful integration along the supply chain. As a result, competition between ports and across the logistics sector looks set to intensify. As ports and logistics firms battle to protect and gain market share, the race to find cost savings and efficiency gains will become even more pronounced.

Shipping lines are keen on developing carrier haulage volumes. The deployment of larger vessels, the formation of strategic alliances and the waves of M&A have resulted in lower costs at sea, shifting the cost burden of shipping lines to the landside. Therefore, a number of shipping lines extend their scope beyond terminal operations to include inland transport and logistics. In order to streamline the inland distribution system, shipping lines and alliances between them seek to increase the percentage of carrier haulage on the European continent. Contrary to the Rotterdam-Antwerp inter-port market where barge container transport is 'dominated' by the deep sea shipping lines in the framework of second moves (carrier haulage – see Figure 1.18), the inland market is still dominated by large shippers (merchant haulage). The crisis has made merchant haulage even stronger as some shipping lines and terminal operators have reduced their commitments in inland transport by focusing more on their core activity (i.e. maritime transport when considering shipping lines).

Figure 1.18. Evolving role of shipping lines in the hinterland: towards a 'push' strategy



Source: Notteboom (2013)

Still, a number of larger shipping lines such as Maersk Line and MSC are developing hub-concepts in the hinterland of the key ports in their networks. Inland terminals and rail and barge services are combined to push import containers from the ocean terminal to an inland location, from where final delivery to the receiver will be initiated at a later stage. This "push" strategy (see Figure 1.18) is initiated by the shipping line, yet prioritized based on the

required delivery date. Export containers are pushed from an inland location to the ocean terminal, initiated by the shipping line, yet prioritized based on available inland transport capacity and the estimated time of arrival (ETA) of the mother vessel.

In September 2016, A.P. Møller-Mærsk announced a major restructuring initiative that will lead to it focusing exclusively on its container line, terminals and forwarding businesses as an integrated transport and logistics company. The company wants to focus on new product offerings, digitalised services and individualised customer solutions. Transport & Logistics will consist of Maersk Line, APM Terminals, Damco, Svitzer and Maersk Container Industry. The goal is to enable and facilitate global supply chains through a lean transparent global conglomerate with each business unit operating on arm's-length principles. This clearly points to a stronger focus on logistics integration by better combining and coordinating the activities of its various sister companies.

Some *terminal operators* in Europe are also increasing their influence throughout supply chains by engaging into inland transport. They seem to do so mainly by incorporating inland terminals as 'extended gates' to seaport terminals (see Box 1.1) and by introducing an integrated terminal operator haulage concept for the customers. The advantages of the extended gate system are substantial: customers can have their containers available in close proximity to their customer base, while the deep sea terminal operator faces less pressure on the deep-sea terminals due to shorter dwell times and can guarantee a better planning and utilization of the rail and barge shuttles. However, the success of both extended gates and terminal operator haulage largely depends on the transparency of the goods and information flows. Unfortunately, terminal operators often lack information on the onward inland transport segment for containers that are discharged at the terminal. A close coordination with shipping lines, forwarders and shippers is needed to maximize the possibilities for the development of integrated bundling concepts to the hinterland.

Box 1.1. About 'extended gates' and 'terminal operator haulage'

Inland terminals can be incorporated as 'extended gates' to seaport terminals and as such can help to reduce container dwell times on seaport terminals. Container terminal operator ECT in Rotterdam (part of HPH) follows an active strategy of acquiring key inland terminals acting as extended gates to its deep sea terminals. Through 'European Gateway Services', ECT offers shipping lines, forwarders, transport companies and shippers a variety of services to facilitate the optimal flow of containers between the deep-sea terminals in Rotterdam and the direct European hinterland. ECT bundles cargo, which allows for highly frequent inland barge and rail connections to various logistics hotspots in the European hinterland. The inland network includes a.o. the TCT Venlo rail and barge terminals (the Netherlands), DeCeTe terminal in Duisburg (Germany), TCT Belgium in Willebroek (Belgium), ACT in Amsterdam, MCT in Moerdijk, AVCT in Avelgem (Belgium) and LCT in Liège (Belgium).

ECT is not the only deep sea terminal operator developing an active extended gate policy. The door-to-door philosophy of other companies such as APM Terminals, DP world and Eurogate has transformed these terminal operators into logistics organisations and or organizers/operators of inland services.

Source: ECT, Rodrigue and Notteboom (2009) and Notteboom (2009)

The increasing involvement of large 3PL companies and shipping lines in the streamlining of supply chains and the advances in data analytics and visibility, put an increasing pressure on

traditional freight forwarders. New technology can make traditional freight forwarders largely obsolete as forwarding can rapidly go digital in its transactional form, with online sales, instant orders and automated processes. This is particularly the case for the spot business and basic port-to-port transport which are easier entry points for e-forwarding. At the same time, shippers will get better information using Big Data solutions and e-marketplaces. This will result in a higher rate transparency and a better visibility of liner service schedules, shipment service attributes, overall performances and equipment availability. Intermediary forwarding agents are most at threat from new technology providers or business models unless they adapt to or embrace change by, for example, offering easy visibility across the whole market. Differentiation and cost optimisation can be achieved through improved online customer experience and automation. Major freight forwarding and third-party logistics providers thus have the responsibility to develop innovative new booking and logistics platforms in order to see off a potential threat from "disruptors" coming from within or outside the logistics sector. New technology-driven companies, particularly those within the e-commerce space such as Google, Alibaba or Amazon, or as yet unidentified players, are likely to enter or have already entered the transport and logistics arena to give them a competitive edge or seeing a competitive opportunity to bring new models to the market. A good example is Cainiao, the logistics arm of Alibaba which controls a vast e-commerce delivery network in China. Forwarders are challenged to opt for collaborative technology driven networks. In order to face the challenge freight forwarders would also need to recruit new talent from outside of the traditional freight forwarding and logistics sector, including coming from IT-driven potential disruptors. Persuading the right people from innovative technology companies to join the freight forwarding and logistics sector is quite a task given the lack of a strong public image and brand image of the logistics sector. Moreover, integrating new business approaches and models in the relatively conservative freight forwarding businesses will require an open mind towards change.

Drewry (2016) points out that the small and mid-size shipper, spot shipment and LCL segment will move online extensively through complete web based forwarding services (from instant quote, booking, up to payment) as well as online sales platforms which dynamically push public and customer-specific rates. These platforms may only target and penetrate specific markets where a certain degree of automation can be achieved. Customer profiling and market segmentation will be at the core of the business model of these online sales channels. Large shippers will have access to more procurement options, benchmarking and insight capabilities. Large exporters and importers will continue to tender their sea-freight (port-to-port or port-to-rail ramp) and land transport, directly with their core carriers and with their forwarders for some part of their volumes. This practice will be available to many at a lower transactional cost with more flexibility using tailored e-tools. E-forwarding and spot procurement will complement traditional contract-based procurement channels.

1.6. Disruptive key ICT innovations for ports and logistics firms

Competition across the logistics sector looks set to intensify. However, firms also face an opportunity offered by rapidly evolving innovations in ICT. The ports and logistics sector has already embraced technology to a certain extent. For instance, the operations of many ports have changed dramatically over the past few decades. Today, scanning technologies can monitor for harmful or illicit substances, and importers can visit a “one-stop-shop” website to arrange an order directly from their smartphone. However, over the next decade the sector will witness more substantial changes as automation becomes more widespread and operations are increasingly directed and optimised in real time by sensors and intelligent software.

Five innovations are particularly relevant and will affect almost all aspects of the trade process (Economist Intelligence Unit, November 2015). These are further discussed in the next sections. Some of these innovations relate to disruptive technology or applications thereof. A disruptive innovation can be defined as an innovation that creates a new market and value network and eventually disrupts an already existing market and value network, displacing established market leaders and alliances.

1.6.1. Robotics and automation

Ever since the introduction of automated stacking cranes at the European Container Terminal in Rotterdam in 1990, automation in ports has firmly progressed. Automation has developed into almost all terminal functions ranging from water to land side; from ship-to-shore activities straight across the terminal into and including the handling activities on or from the land connected modes.

The extent of automation ranges from remote controlled operations under safe and efficient conditions to fully autonomous terminal operations.

Also in the field of safety there is continuous progress with research projects such a SaLsa that aim to safely test autonomous transport vehicles in yards that link into the Internet of Things world. Sensors installed in the yard infrastructure enable vehicles to detect other objects and their position which allows the combined operation of automated vehicles, forklifts, and people in an efficient and safe manner.

Software is also used to monitor and optimise the flow of goods through the port, which provides savings in time, fuel and personnel and optimisation of capacity and space.

The drivers of automation are cost of labour, land cost and the need for efficient handling of larger sized ships.

The trend in ever larger ships enabled further by such events as the expansion of the Panama Canal, as well as those of the increasing costs of labour and ever more efficient and low cost of technology, will further push the need and desire for automation.

Automation can also play a key role in the transformation of logistics service provision. For example, technological advances make it increasingly possible in real time to dynamically integrate pricing, schedules, bookings, shipment visibility with customers, carriers and marketplaces. Rate automation and shipment visibility technology facilitates online sales.

This can create new opportunities for (larger) forwarders, as the use of these decision tools enable a deeper integration with carriers which will further facilitate shipment and allocation optimization.

1.6.2. Autonomous vehicles for port operations

The most advanced and also the most "visible" types of "robot" being developed in all forms are autonomous vehicles, from small last mile solutions to full sized autonomous sea-going vessels. Next to the already described terminal dedicated autonomous vehicles such as autonomous straddle carriers, the type of vehicles being developed will undoubtedly have an impact on the way operations will have to be organised. The development and implementation of these "robots" in the relative short term will entail its own threats and opportunities.

Autonomous trucks and cars

The development of driverless trucks is in full swing and vehicles like Daimler's 18-wheeler Freightliner, unveiled in May 2015, already have been licensed for road tests. It operates on autopilot on highways but switches to a human driver for lane changes and parking. It uses radar sensors, cameras, and servomotors to detect objects around it, and then takes over actions from the driver such as steering and braking.

Box 1.2. What does "autonomous driving" really mean?

In 2013, the US Department of Transportation's National Highway Traffic Safety Administration (NHTSA) defined five different levels of autonomous driving. The levels of autonomy describe the system, not the vehicle:

- Level 0: The driver (human) controls it all: steering, brakes, throttle, power.
- Level 1: Most functions are still controlled by the driver, but specific functions can be done automatically by the car (like steering or accelerating).
- Level 2: At least one driver assistance system of "both steering and acceleration/deceleration using information about the driving environment" is automated, like cruise control and lane centering assist. It means that the "driver is disengaged from physically operating the vehicle by having his or her hands off the steering wheel and foot off pedal at the same time," according to the SAE. The driver must still always be ready to take control of the vehicle.
- Level 3: Drivers are needed, but are able to completely shift "safety-critical functions" to the vehicle, under certain traffic or environmental conditions. It means that the driver is still present and will intervene if necessary, but is not required to monitor the situation in the same way as for the previous levels.
- Level 4: "Fully autonomous". These vehicles are "designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip". However, it is important to note that this is limited to the "operational design domain (ODD)" of the vehicle meaning it does not cover every driving scenario.
- Level 5: This refers to a fully-autonomous system that expects the vehicle's performance to equal that of a human driver, in every driving scenario, including extreme environments like dirt roads that are unlikely to be navigated by driverless vehicles in the near future.

In October 2016, the NHTSA updated their policy to reflect that they have officially adopted the levels of autonomy outlined in the SAE International's J3016 document.

Source: based on http://www.sae.org/misc/pdfs/automated_driving.pdf

Considering the continued investments in the field, it is only a matter of time that in the future fully automated driverless trucks and delivery vans will be used by logistics firms. The main purpose and expected impact of autonomous trucks is increased efficiency and greater safety. For some, a key motivation effectively is to reduce the liability firms face when a human driver makes an error. In this way of thinking, once the technology has a solid track record and a clear safety record, implementation of such vehicles will become self-evident. It is clear that contrarily to what is stated by some proponents, for others it effectively raises awkward liability questions. Does liability lie with the logistics firm or with the truck manufacturer in case of incidents?

Increased implementation of autonomous trucks and vans will effectively reduce transportation costs and result in faster transit times. Considering the expertise and reliance on data driven models to control such vehicles this might change the type of companies running such solutions. Effectively, companies like Uber or Amazon already have plans to expand into the logistics sector.

Considering the fact that autonomous trucks will still be required to carry “drivers” for the foreseeable future and levels 4 and 5 of autonomous driving are still some time away, the immediate impact on port operations will most likely exist of increased efficiency because of assisted manoeuvring, improved planning and synchronized timing, allowing for increased terminal and truck operator efficiency.

Drone planes

Drones are already being used for security surveillance in some ports (such as Abu Dhabi’s Khalifa Port), and could also have a role in monitoring port operations and detecting problems requiring maintenance in both port equipment and ships. The main barriers for the use of drones in the ports and port terminals are regulatory, but it may be expected that this will only be a short term obstacle. Still, international harmonization is needed.

Technology is developing fast, especially in the field of autonomous flight. These represent the business cases for industry and there is a lot of interest from the logistics sector, but mainly in supporting a range of monitoring and inventorying activities as well as deployment in restricted and secure areas.

Implementation in the public domain such as last mile logistics or public access areas in ports, are highly questionable considering the complexity of implementation in relation to the risks involved. Despite boastful declarations of several service providers’ real life proof of concept testing by companies such as DHL clearly highlighted this complexity which somewhat reduces the outlook of intense use of flying drones in the public domain.
Also others such as UPS are focusing on understanding how flying drones can be applied.

Considering that most acclaimed applications seem to be developed for use within restricted areas, warehouses, for humanitarian aid and medical supplies to remote areas, inspection activities, and the fact that wide-spread implementations in the public domain seem a long way off, direct impact on port logistics operations where inter-connection with other supply chain actors is involved, is not to be envisaged in the near future.

Drone ships

Drone ships are the least "visible" type of robot being developed and as such hold a large "unlikeliness" factor to them.

The main challenges are regulatory considering international maritime conventions have clear specifications on minimum crew requirements. Another challenge is the concern about safety, especially where it concerns the aspects of weather, obstacles and in-trip repair requirements and the uncertainty how such autonomous or remotely operated ships would cope.

The main advantages regard a significant reduction in fuel consumption, and therefore emissions, by up to 20% as well as increased cargo capacity and massively (about 40%) reduced operating expenses, all according to Rolls-Royce.

And even though safety is currently considered a concern, overcoming the challenges effectively would mean that maritime safety potentially could be improved, as the majority of shipping accidents are the result of human error, often related to fatigue.

Even though the first serious initiative was only unveiled in 2014 by Rolls-Royce, and even though there are significant challenges to be met, the possible advantages are a strong driver for fast and furious development.

In December 2016, Rolls Royce and VTT Technical Research Centre of Finland Ltd have announced a strategic partnership to design, test and validate the first generation of remote and autonomous ships. The new partnership will combine and integrate the two company's unique expertise to make such vessels a commercial reality. In a statement Rolls Royce stated to believe a remote controlled ship will be in commercial use by the end of the decade. The company is applying technology, skills and experience from across its businesses to this development. The VTT Technical Research Centre of Finland will build on its deep knowledge of ship simulation and extensive expertise in the development and management of safety-critical and complex systems in demanding environments such as nuclear safety.

On the other hand, more prudent maritime organisations such as the International Chamber of Shipping, predict that the use of drone ships will not be realised for another two to three decades

The debate between believers and non-believers focuses mainly on the projected costs; reduced operational costs where the absence of a crew can be seen as a liability in case of need for repairs or problem solving and the operational costs this induces, and reduced construction costs where the need for increased quality for unmanned ships is to be taken into the equation.
There seems to be some agreement on the possibility to increase cargo capacity that may offset the minor savings in crew costs and questionable savings in construction costs (Roar Adland, 2017).

1.6.3. The Internet of Things (IoT) and big data analytics

The ever more rapid development of cheap sensors has resulted in ever more "items" being equipped with such sensors. This effectively means all such items can be tracked and that any activity such item is engaged in, or any circumstances it is exposed to, can be "measured". Thus, the item "senses" an activity, event or an environmental factor. Such item is also capable of receiving information from other "sense-like" items. A network of such communicating items can be labelled as an Internet of Things.

Effectively, the IoT refers to a wide and increasingly large range of physical objects ("things"), that are connected to a system and that are able to send and receive data.

The IoT is a development that is rapidly taking place across all industries and throughout society. It is obvious that such a network of communicating "things" opens up a large array of possibilities for logistics.

These "sensorized" items will allow all things, including autonomous and robotized vehicles and equipment as described earlier, port equipment, infrastructure as well as the goods themselves to become connected.

This will result in massive amounts of data being produced and being available. It is not hard to imagine this offers an almost infinite array of possibilities for logistics and port operators and stakeholders to optimize and automate processes, and to gather an ever more precise and real-time insight.

In order to effectively and successfully implement applications that build on the IoT possibilities, robust communications systems need to be in place. Ports, with containers and equipment interfering with signals, and warehouses with attenuated and scattered signals, are notoriously difficult environments. Even though many ports and warehouses have network infrastructure available, many of it is about a decade old and is often not suited to the new IoT applications' requirements of high bandwidth and secure protocols.

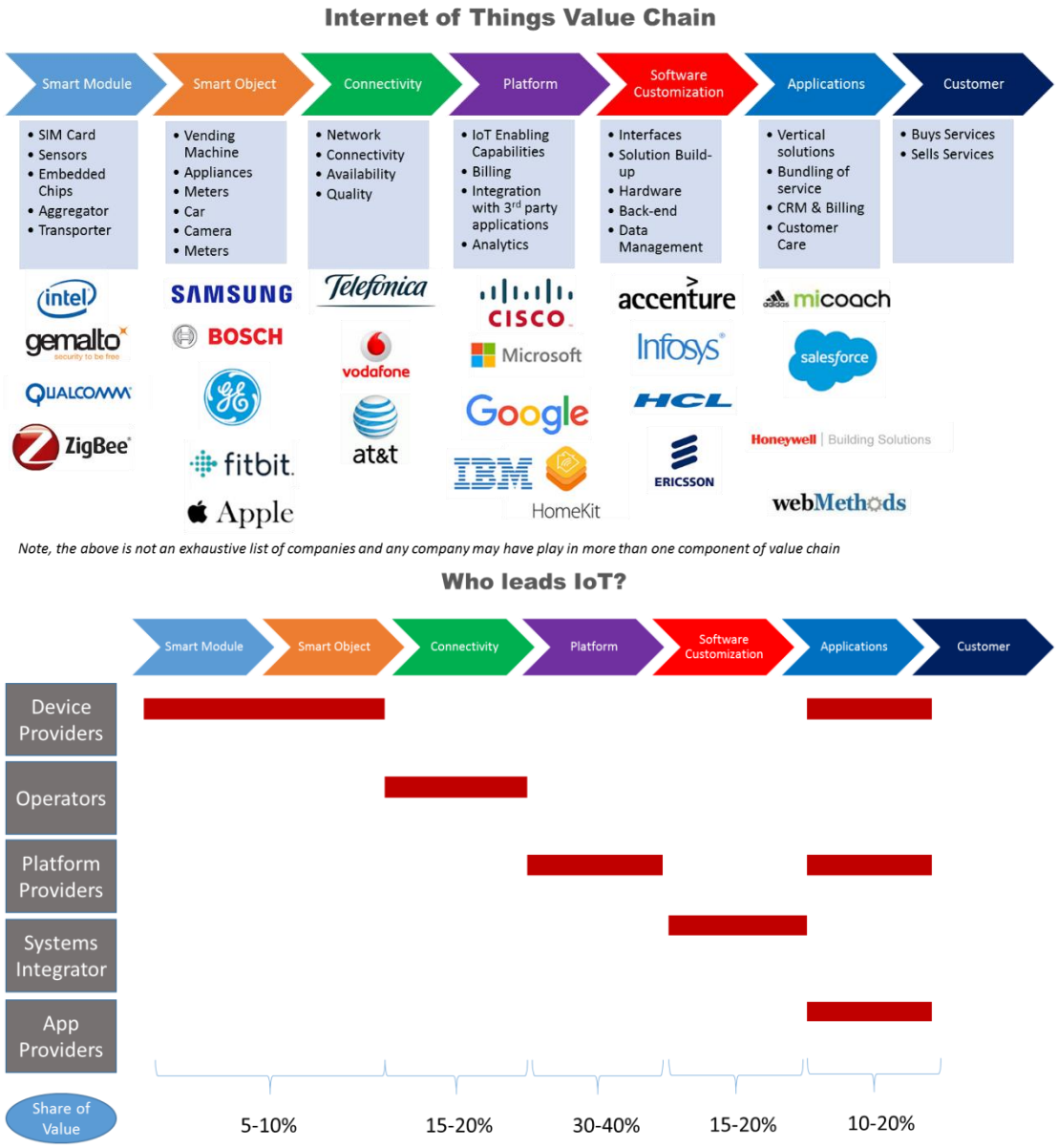
New cloud computing solutions will make data instantly and simultaneously accessible in many locations and across many devices. This massive amount of data requires the collection, curation, analysis and storage of large and complex datasets. This is often defined as the use of big data.

Having discussed the "sensing" of data and the collection and storage of it, the true challenge lies in the use of this data. The data will thus "actuate" new processes or decision making. It can be used in port operations such as preventive maintenance schedules of either infrastructure or equipment, create intelligent inspections systems, sensor track data on speed, direction and driving performance of large numbers of vehicles (UPS) in order to optimise future routes, or support resilience management tools (DHL) in order to adjust routing of supply chains in real time.

The possibilities are almost endless and consequently, the evolution of IoT and the use of big data creates the prospect of logistics becoming a data-centric industry where information takes precedence in logistics services' value propositions over the actual ability to move cargo.

The growing interest and developments in the area of IoT and big data analytics gives rise to new business models and partnerships and questions on who is best positioned to lead these partnerships. IoT and big data analytics have an impact on a large number of processes, which implies many stakeholders have to work together to make it work. Figure 1.19 breaks down the value chain and links it to a list of indicative (non-port related) players.

Figure 1.19. The value chain in IoT



Source: Agrawal (2017)

There are five key groups of players: device providers, operators, platform providers, systems integrator and application providers (Agarwal, 2017). None of these players can deliver integrated IoT solutions, so partnerships are crucial. Device providers are basically vendors who might capture more value in the chain if they succeed to develop a service model. The operators are very critical stakeholders as they provide the connectivity.

However, they need a partner to go to market and are unlikely to play a leading role in any partnership/alliance. The platform providers bring together the hardware, the connectivity, the service providers and the vertical applications to provide industry with specific solutions. Most of the serious players are eyeing to become platform providers. System integrators make the individual components of IoT to work together in the most optimal way for the customer. They typically are niche players and enter into partnerships with large platform players. The application providers are often small and might be integrated in larger IoT players.

1.6.4. Simulation and virtual reality

The availability of big data applications will lead to possibilities for port operators and logistics service providers to fully exploit the advantages of simulation software. Port operations can be modelled in order to analyse operational flows, pinpoint possible barriers as well as define enhancements, and simulate and assess various scenarios of design and throughput. This can be done for existing or newly planned port layouts as well as for terminals. An additional benefit is that such simulation software can also be used to train staff.

Already, current proprietary or service based resilience predictive tools are becoming far more powerful and efficient, and such simulation tools are a valuable asset in emergency and mitigation planning.

Considering the previously described automation and robotization of various types of vehicles and equipment, simulation will be important in understanding the impact of these developments as well as how to adjust terminal processes in order to optimally integrate these developments into every day operations.

Virtual reality (VR), defined as the expansion of physical reality by adding layers of computer-generated information to the real environment, will further support such simulations. This is a technology in full development that will become part of everyday life. In a port related environment one can envisage enhanced feeds from infrastructure, port equipment, automated vehicles and various types of drones.

It is to be envisaged that VR will have a wide field of applications ranging from operational support of how to execute certain processes to active safety or security interventions.

Other applications could regard more complex VR applications in extending value added service offerings in warehouses, assisting the service providers with product assembly, refurbishment or repair activities.

1.7. Structuring the challenges for port logistics

The above described trends are already happening on a global scale and it is clear they will impact the future working of ports. Consolidation and ever larger vessel size, increasing time constraints and security issues, more pressing societal end economic pressure, changing industrial and macro-economic realities, ever more disruptive ICT innovations that will impact the role of the various logistics stakeholders, the need for collaboration, etc. All

these developments are expected to have impacts on several dimensions and development factors of modern seaports.

1.7.1. Challenges linked to a changing economic geography

Belgium's logistics performance is a necessary condition for the performance of its open economy. Seaports, as important pillars in the nation's logistics infrastructure, remain key enablers to the performance and competitiveness of the Belgian economy. The Belgian port system together with the whole economic and logistics structure in Belgium and neighbouring countries are continuously challenged to remain competitive.

Port choice in the future might be influenced by ability of logistics/industry clusters to adapt to Industry 4.0 and newly developed services in this field by the logistics sector.

The economic geography of Industry 4.0 also plays an essential role. At the foreland side, Asia and other emerging economies become more important in the cargo flows. At the hinterland side, growth in the Belgian ports will increasingly have to come from regions outside the traditional 'blue banana', as the traditional hinterland is comprised of mostly rather mature economies. The contemporary European ports' environment looks very different when compared to a few decades ago and this has impacted port competition. The number of Member States of the European Union increased from 15 in the mid-1990s to 28 at present. Economic centres in East and Central Europe, the Nordic triangle and the Iberian Peninsula have taken up a more important position next to the traditional economic heartland of Europe. The increased participation of these regions on the European economic scene opened possibilities for new seaports and inland transport corridors to emerge. Seaports located far away from each other are now to some extent competing, as more and more port regions are in a good position to reach the economic and industrial heartland of Europe. Trends to nearshoring and the creation of land-based corridors in Europe and in the context of One Belt One Road (OBOR) further support a future of intensified competition between ports across Europe.

Still, the local hinterland will remain the backbone of the cargo volumes in Belgian ports. Synchromodal solutions, even on these shorter distances, should be further developed. The rise of economic centres in Eastern and Central Europe creates opportunities to develop shortsea shipping services and water- and land-based hub-feeder networks to these areas. The Belgian port system, where possible in combination with Dutch ports, have opportunities to increase the inland penetration of its intermodal offer so as to increase its capture area. They should therefore consider broadening their hinterland reach without disregarding the needs and continued importance of their core hinterland regions. The existing dense network of direct shuttles to nearby destinations can then be complemented by inland services to more distant destinations built around one or more inland hubs. Containers for the more distant hinterland benefit from the strong local cargo base as local containers often provide the critical mass for allowing frequent deep sea liner services. The limitation in the number of ports of call per loop enhances a concentration on trunk lines.

The expanding European market challenges the strong reliance of Belgium on EDCs and re-exporting activities. Any major changes in the design of distribution networks, e.g. through a move of EDCs to other regions, a network redesign towards a system of RDCs (Regional Distribution Centres) or more DC bypass operations will have an impact on the distribution of container flows among European ports, with potentially a traffic effect on the container ports in the Delta.

1.7.2. Challenges linked to the dynamics among logistics market players

Belgian ports increasingly have to deal with large port clients who possess a strong bargaining power vis-à-vis terminal operations and inland transport operations, and who are increasing aiming for better supply chain integration. Against this background, it has become increasingly difficult for port managers to identify the port customers who really exert power in the supply chain or who are driving port selection. The integration strategies of the market players will create an environment in which ports are increasingly competing not as individual places that handle ships but within transport networks or supply chains. The port loyalty of customers cannot be taken for granted.

In line with the above, instead of port competition between clearly-defined port areas with spatial boundaries (nodes), competitive forces are shifted to groups of spatially-dispersed but functionally-integrated terminals in different ports (networks). This leads to an increased functional interdependency between ports. The network focus is further supported by the 'push' strategies of shipping lines and terminal operators towards the hinterland: cargo will be channelled through the system not only based on individual port qualities but primarily by network-related considerations regarding asset deployment (ships, barges, rail, etc..), schedule optimisation at sea and on land and transit times.

The further digitalization in all aspects of the supply chain will result in ever faster decisions later in the supply chain (in some applications even in real time) based on securely shared/latest/best quality data. In essence, the supply chain will move from sequential (chain links) thinking (often up front and/or delayed) towards a full supply chain visibility/awareness. In this new reality of shared data, a new breed of service providers will develop that will be able to connect physical logistics with data logistics. 'Smart' forwarders will develop services based on linking these realities to knowledge and information about the supply chain that is vastly richer than the information shippers are able to extract from their existing rigid ERP systems. Next to somewhat more traditional forwarding services they will be able to valorise their knowledge by being able to link into the new reality of horizontally and vertically integrated supply chains using their skills to adapt to and work with the available sets of data. This will make them supply chain orchestrators, going from the analogue version that kept all the information to themselves to the digital version that knows how to securely manage the new realm of the above.

The quality of the services to information flows is rapidly becoming as important as the services to the physical flows. This implies that ports have to make sure the right infrastructure, software and human skills are in place to respond to the ever higher market requirements for the accommodation of global information flows. A seaport should not tackle this challenge in isolation as one singly node, given the network focus of market players.

To be successful, Belgian ports will have to think even more along with the customer, try to figure out what his needs are, not only in the port but throughout the supply chains and networks. Success is more and more determined by the ability of the port community to fully exploit synergies and coordination with other transport nodes and other players within the logistics networks of which they are part. These developments call for closer co-ordination, co-operation and integration with logistics actors and nodes in and outside the port perimeter and a more integrated and broader spatial approach to port infrastructure use and planning.

1.7.3. Challenges linked to the search for (economies of) scale and terminal automation

Last generation container ships keep getting ever larger. This has an immediate effect on the types of ports that can handle such vessels. It effectively means that these ships need bigger ports. Moreover, there is an ongoing process of carrier alliances consolidating into super-alliances. Fewer carriers thus leads to fewer but bigger ports. As a reaction to these super-alliances, global port operators will continue creating worldwide terminal networks.

Increasingly large container ships will sail between major transhipment hubs where they will interconnect with smaller vessels that service more local networks. This can further complicate global supply chains, but as long as the advantages of building such larger ships supersede the change in operating costs, an increase in size of these ships will continue. It also means an additional risk for the port authorities and terminal operators, as super-alliances mean fewer customers which in turn means higher market volatility.

While ships are slow steaming, the pressure on achieving a short port turnaround time is increasing. Carriers are attracted to fast and speedy ports for obvious reasons. Automation and robotized equipment will leverage desired speed as well as ultimate port and terminal capacities.

Even though further robotization is to be expected, this automation will require all port services and logistics service providers to follow suit and to participate in a 24/7 economy. Notwithstanding the fact that far-reaching automation might have a negative effect on nominal employment in the port and on the terminals, it might rescind this negative effect by drastically increasing the ports attractiveness by optimizing the inter-connectivity with local industry or industry clusters in the hinterland.

1.7.4. Challenges linked to space requirements and land management in seaports

The facilitation and accommodation of future port logistics will require new approaches to space, capacity and land management in seaports, and therefore also affect the port planning process.

First, the increasing size of carriers has a tremendous impact on the physical constraints within ports. Draught and the related cost of guaranteeing it, ensuing pressure on local infrastructure, especially near cities, are just a few of the immediate consequences of these mega-sized container vessels. This also increases societal and economic pressure and will increase the call for alternative transport modes and possibly the call for a 24/7 economy. The latter in itself will further increase societal backlash. These super-sized carriers will be confined to a limited number of routes, and possibly even pushed outside cities because of the physical constraints, but possibly also because of a societal counter current. Port economics however are in contradiction with this move as it is unlikely that such remote ports are nearly as well inter-connected to the hinterland. Such move might also disturb the inter-connectivity between ports and industry clusters.

Second, the increasing role of logistics clusters and industrial eco-systems in seaports is another element affecting future spatial needs and land management in seaports.

Third, the uncertainty and volatility in the market and changing customer needs and expectation drive the need for new port land management and port planning approaches. When it comes to land management by port authorities, the system of rigid volume guarantees and associated penalties seems no longer suitable in an increasingly volatile buyers' market. Terminal operators are getting more reluctant to commit to specific volumes to be generated on a terminal, while port authorities are facing a problem in determining volume guarantees that are acceptable and legally binding to terminal operators. These observations are an incentive to search for more 'flexible' approaches to terminal throughput guarantees that help to attain an efficient usage of terminal areas while at the same time incorporating the existing volatility in the container market.

When it comes to port planning, current approaches to port planning, design, and evaluation do not always fully take uncertainty into account and result in plans and designs for port infrastructures that prove inadequate under changing requirements. Consequently, the infrastructure has a shortened economic lifetime, which makes payback on the investments risky. Accounting for uncertainty within the planning process should become inherent to all port related investments. The Adaptive Port Planning (AAP) framework based on the work of Taneja (2013) tackles the problem of uncertainty from a new angle. Instead of creating a static port plan this approach allows for changes, learning and adapting to the constantly shifting environment. The method combines two frameworks, namely Assumption Based Planning and Adaptive Policy Making. The strength of combining these two methods is that uncertainty is not depicted as a description of possible futures and their respective probability of occurring, but rather the formulation of strategies and actions aimed at minimizing the chance of a catastrophic plan failure. To a certain extent this can be compared to one of the core project management principles that this framework tries to provide: continuous business justification even if external actors try to destabilize the preferred outcome.

Table 1.3. Differences between traditional and adaptive master planning

	Traditional approach to Masterplanning	Adaptive Planning approach
Treatment of the future	Assumes it is useful and possible to predict the future	Assumes that the future cannot be predicted, or it is dangerous to try to do so
Treatment of uncertainties	Uncertainty is included in the scenarios, but planning is eventually based on single point forecasts	Imagines Black Swans and prepares for them
Planning process	Static or at most periodic	Continuous
Embedded options	Single option	Multiple embedded options make the plan dynamic
Focus	On demand forecasts	On vulnerabilities and opportunities
Approach	Target oriented	Performance oriented (thus, flexible and integrated)
Reactivity	Ad-hoc reaction to strong signals	Monitors and reacts to predefined triggers (mostly performance indicators)
Decision-making	Decisions are based on available information	Decisions are based on acquiring new information and evaluating new developments
Solution space	Limited to physical and operational space	Looks further, to shape the external environment by altering the industry structure, creating associations, and restructuring relationships

Source: Based on Taneja (2013)

1.7.5. Challenges linked to sustainability

The Belgian port system is highly dependent on bulk commodities linked to energy production and the oil-based chemical industry. The shift away from fossil fuels to non-fossil fuels is considered as a major challenge and opportunity. The port region should adopt a leading role in this transition to remain competitive as one of the most important energy and chemical clusters in the world.

Circular economy concepts and cradle-to-cradle are gaining acclaim, both in production processes as in the extended supply chain. This will mean that waste and residues from one process will serve as raw material for another. This will require a harmonization between production and logistics processes. Volume is an important aspect in successfully implementing such concepts. Considering the presence of local industrial clusters and the proximity to the hinterland, it is only logical there are opportunities abound for ports to play an important role in this harmonization. Moreover, the multimodal capacity of ports could be an additional asset in this harmonization providing critical volumes can be guaranteed.

Ports should develop as green hubs to become part of new green/sustainable grids/networks between which new green corridors will develop. In order to meet expectations, ports will have to take on a more enterprising role. Environmental issues are having an ever-larger impact on port development and port operations: dredging and dredge disposal, wetlands preservation, emissions into the air (both from ships and from port facilities), water pollution, congestion, light and noise externalities and potential conflicts with commercial fishing and recreational uses of area waters. Port authorities and port companies must demonstrate a high level of environmental performance in order to ensure community support. However, environmental aspects also play an increasing role in attracting trading partners and potential investors. A port with a strong environmental record and a high level of community support is likely to be favoured by market players.

1.7.6. Challenges linked to the development of smart(er) ports

Ports will have to make the most of the available space, time and resources available whilst creating the lowest conceivable pressure on the environment. To this extent the disruptive ICT innovations discussed earlier; robotics and automation, autonomous vehicles for port operations, big data analytics and the Internet of Things and simulation and virtual reality possibilities, are all important enablers. Ports should play an active role in supporting the accomplishment of a physical, digital and operational interconnectivity. Port authorities and governments are challenged to invest in smart infrastructure to support business and turn ports and infrastructure in general into “smart” infrastructure that is able to “sense” whatever is required from it by the supply chain processes.

The current climate of disruptive ICT innovation being introduced in the world of logistics is an exciting one. Even though it will require a specific approach for each individual company, a few distinct principles can be distinguished.

Investment requirements

Following up on disruptive ICT innovations requires significant investment. It is important to be leading when automating, especially in fiercely competitive markets. Otherwise it might be wiser to monitor the evolution of capital cost, especially if certain technologies become more widespread. However, it is important to distinguish fads from trends in order to make the correct decisions and to gain approval in an environment of slowing down trade flows and increased competition. Another aspect is to safeguard interoperability with other stakeholders throughout the supply chain processes wherever applicable.

Policy and regulation

The way governments go about in dealing with certain disruptive technologies can widely vary. Legislation and policy in the UK is such that government actively supports large scale testing of certain innovations. At the same legislation in some countries finds itself in a

conundrum between regional and federal authorities, slowing down testing opportunities of such innovations (e.g. autonomous vehicles or platooning with driver assisted trucks). There is however a lot of interest from governments to increase the competitiveness of their economies at the same time as the sustainability of their society. This offers opportunities for innovators to leverage government support. Focus is largely on urban developments in this field but especially for port applications government support is crucial, especially considering the extensive upfront costs required for large-scale testing.

Cybersecurity

Cybersecurity within a port or logistics environment has long been an underestimated problem. The number and impact of active attacks has quietly risen although have gone largely unreported or uncovered. Also robustness of certain systems when entering into more and more collaboration throughout the supply chain stakeholders is a potential threat. Considering the type of innovations that are entering the world of port logistics as well as the importance of ports within the economy and to everyday life, ports are likely to become increasingly possible targets for attacks. Port operators unlikely are able to tackle these challenges on their own and therefore more coordinated efforts with both governmental as private organisations is critical.

Hence, ICT capabilities become ever more important for ports and logistics operators. To date a certain reluctance from port and logistics stakeholders alike has been a major part of the attitude towards disruptive innovation in the field of increased digitalisation of port or logistics processes, especially where it involves sharing data and collaborating with other supply chain stakeholders. It will be paramount to demonstrate the robustness and security of these systems when looking for approval from authorities, regulators and supply chain partners and shipping customers alike.

Thus it is clear that one of the major barriers preventing stakeholders to enter in automated data exchange in B2B and B2Platforms interaction concerns data confidentiality and unauthorized intrusion and usage. The challenge is in itself to ensure the 'trusted' and 'seamless' access for supply chain stakeholders. Focus on ensuring data exchange and access in a secure, controllable and trusted way is therefore pivotal without losing sight of providing easy connectivity facilitating generic data exchange. Supply chain data and information should be visible and standardised on an international scale.

Blockchain

A technology often cited as the silver bullet to solve the insecurities and risks of intense supply chain collaboration is the notorious "blockchain" technology. Most typical of this technology is probably the poor understanding about the technology within the corporate world.

The Council of Supply Chain Management Professionals (CSCMP) therefore has issued a white paper undergirding the technologies building blocks (E. Camerinelli, 2016).

The blockchain comprises an enormous database running across a global network of independent computers that are collaboratively maintained by distributed participants.

The big difference with current data exchange methods is that instead of each unit in the supply chain creating "islands of data" that are mostly only available to the immediate upstream and downstream supply chain partners, the implementation of blockchain technology, based on its decentralized and distributed nature, would continuously validate each and every single transaction between all parties and sequentially record those in public "blocks". Reference coding would allow every node in the network to access those transactions they are authorized to consult.

Thanks to the specific nature of the way the databases are updated and the fact that the data blocks are rendered unchangeable through complex cryptography, all such "blocks" are **notarized**, i.e. all related items to the data (e.g. bill of lading) are connected to a particular date and time, and are **irrevocable/immutable**, i.e. all records are permanent. These two main characteristics render hacking or fraud useless.

It is easy to understand why such technology is considered to be the silver bullet, however it is not very clear how exactly this technology creates business opportunities for all stakeholders involved. Therefore first focus should be on potential use cases that will test and ascertain the potential of the use of this technology in a supply chain environment.

Connecting networks

Concepts such as true synchromodality or the Physical Internet require a maximal postponement of decisions to support the ideal scenario in which the best decision is taken based on as much information available as possible including the largest set of data covering capacity, mode, operational realities, risk, and many more, to optimize the journey of physical entities throughout the supply chain.

This means that responsibilities for the "final" decision to physically allocate the merchandise to a mode, transport unit or caretaker, should be transferred to the relevant, and most likely, local networks. Taking into consideration the many platforms being developed ranging from port networks to booking platforms or various forms of horizontal collaboration, and this in various ports or industries, a clear need emerges for implementable network solutions that transcend the individual platforms.

In other words, the reality of a multitude of network platforms will need to be operationally viable and therefore there is a need to connect the various networks of connected networks. The chances of there one day being a superordinate solution, some form of super network encompassing all the data, physical and operational aspects of the PI, are very small indeed.
How exactly technologies such as blockchain are to support this, remains to be seen and is subject to intense research.

New skills

The level of disruptive ICT innovation is such that a new set of skills is required to operate within the sector. Some traditional skill sets will become obsolete whereas others will thrive. Creatives and problem solvers will find their way into this new reality, but definite hard skills such as applied mathematics, statistics, data analytics, software engineering, and cybersecurity will be required. Considering these fields are already being drained at the source, the logistics sector will have to engage with universities, government and knowledge institutions in order to reshape the available university and other educational program to ensure high quality influx into the logistics sector. It is clear that two worlds collide; the fast, creative and disruptive environment of digital innovations start-ups on the one hand and the operationally standardized, process driven and risk averting environment of port and maritime operators on the other. One of the true challenges will be to reconcile disruptive technology with the real-world environment of day to day port operations.

2 SET-UP OF THE SURVEY ON THE FUTURE OF PORT LOGISTICS

2.1 Aim of the survey

The general objective of the study consists of the research of the future of port logistics and how to meet the demand for supply chain integration. The key question is how ports and port companies can deal with the increasing requirements and challenges of chain optimization, integration and coordination.

The objective of the survey consists of mapping the expectations of port logistics of the future and the corresponding innovations business models, more specifically how progressive and innovative the port logistics companies in Flanders think about the future in general and more specific in their sector.

The survey specifically analyses the expectations of the port community in Flanders, Belgium.

2.2 Survey structure

In part 1, the study analysed the trends and outlooks for port logistics. New business models, disruptive technologies and applications in data collection and processing, the changing roles for the various actors, changing economic realities were all studied. Various initiatives and projects were identified and evaluated after which we proceeded to a qualitative analysis of the impact of these trends on the existing models of the port logistics companies.

This resulted in a categorization of the developments in five sub-themes:

- Global demand and economic development
- A changing landscape for the global economic system
- Connecting the world: corridors and synchromodality
- Supply chains and logistics networks of the future
- Disruptive key ICT innovations for ports and logistics firms

This same categorization was used for the questionnaire, and all questions and statements were edited accordingly. The specific challenges of supply chain integration previously analysed in the first part of the study were taken into account, including the role of ports. Within the five sub-themes a total of 15 topics were addressed. Each of the topics included two up to 14 statements or data fields.

Specific survey software was used to process the answers and have a first analysis. Subsequently, more detailed listings were drawn, allowing for more refined analysis and interpretation of the results and answers from the various groups of respondents.

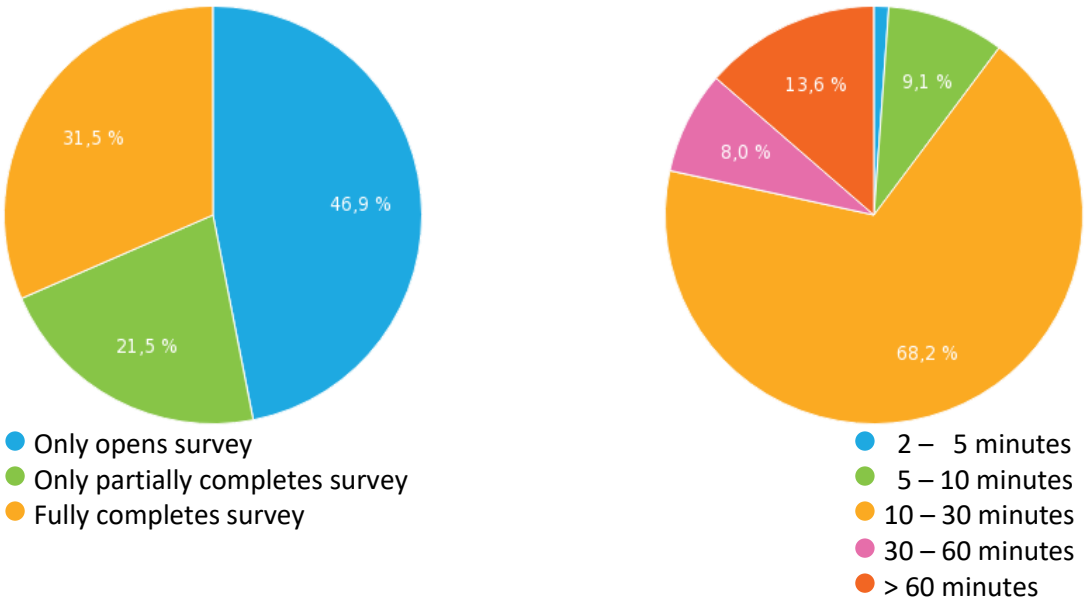
2.3 Target groups and representativeness of respondent groups

The target group of the survey was composed of a wide range of companies including terminal operators, shipping companies, logistics service providers, port authorities, port industry companies, shippers, shipping agencies, etc. A total number of 550 companies was invited to participate in the survey. The list of companies was compiled based on a selection of the membership list of VIL, inputs obtained from the port authorities of Antwerp, Ghent and Zeebrugge, and the ING customer database.

A total of 82 respondents completed the survey. These respondents were divided into six sub-categories of respondents:

- Shipping companies and nautical services: this group includes shipping companies, short sea shipping operators, inland navigation companies, shipping agencies and a number of nautical service providers;
- Maritime transhipment: this group includes 'pure' terminal operators active in terminal activities in the container, breakbulk, bulk and RoRo markets;
- Port logistics service providers: this category includes 2PL, 3PL and 4PL companies which have a strong waterfront linkage. These companies are entirely or largely focused on port-related logistics with all or a significant part of their warehousing and distribution activities located in port areas;
- (General) Logistics service providers: this group includes 2PL, 3PL and 4PL companies with main logistics activities in the hinterland. It often involves larger global players.
- Freight forwarders & customs agencies
- Shippers and industry: this category includes manufacturers, importers/exporters and other cargo owners.

Figure 2.1. Survey statistics: visits of online survey and time spent to complete the survey

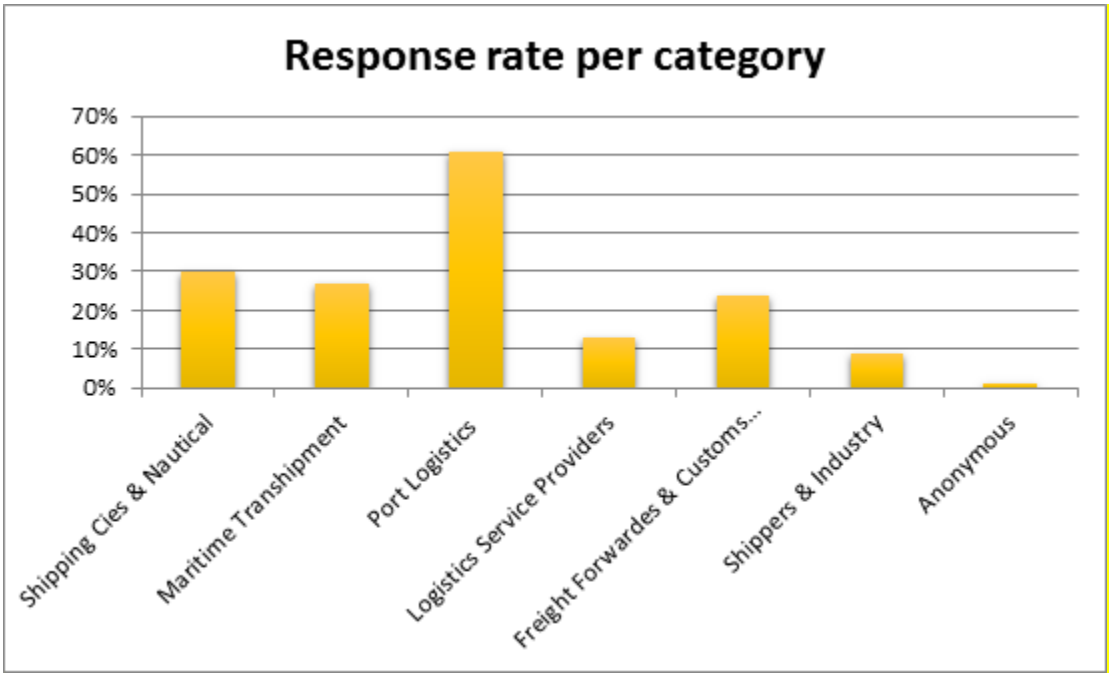


The survey was made available to respondents via a web-based survey application and supported by an invitation letter. The number of visits to the web-based survey pages amounted to 266 or 52% of the total number of invitations. Figure 2.1 provides more details on the behavior of the people who visited the online survey. In the end, 82 company representatives completed the survey or 31.5% of the number of visits to the web-based survey application. The net response rate of the survey reached 15% of total participants invited. About two thirds of the respondents spent between 10 and 360 minutes to complete the survey. This is in line with the time the research team members needed to fill out the survey in a test phase (about 15 min).

The survey was sent mainly to C-level (CEO, CFO, etc..) or senior management positions. This was reflected in the answers. About 54% of respondents were of C-level (or owner), 24% consisted of senior management or VP level and the remaining 22% was composed of people working at managerial level.

Figure 2.2 represents the response rate per type of respondent. Especially the response rate of companies effectively active within the direct environment of seaports are high. The catchment rates for both (general) logistics service providers as well as for shippers (manufactures, importers, exporters) are significantly lower. This can be attributed by the size of the respective groups (abt. 200 each) and less close direct involvement of these categories in seaports. Still, having answers from these categories has value in view of also gauging for reactions from participants deeper in the supply chain.

Figure 2.2. Survey statistics: response rate per category



3 I THE FUTURE OF PORT LOGISTICS: ANALYSIS OF SURVEY RESULTS

3.1 Introduction

The third part of the study focuses on the detailed and refined analysis of the answers provided by the survey's respondents. The results were drawn over the full group of respondents and subsequently separate reports were drawn for each of the six individual sub-categories of respondents. This allowed for a more refined analysis and interpretation of the results. The final analysis of the survey was performed with attention for possible linkages between the answers and differences in the answer patterns among respondent sub-groups

Whenever substantial trend differences were noted, this was mentioned in the respective explanation of the respective survey themes and statements. Whenever relevant separate graphs were drawn and elaborated upon.

All analytics were performed against the background of the key question of how ports and port companies can deal with the increasing requirements and challenges of chain optimization, integration and coordination.

The survey specifically analyses the expectations of the port community in Flanders, Belgium.

3.2 Theme 1: Global demand and economic development

For the first theme of "global demand and economic development" two topics were surveyed. The first topic probed the view of respondents on the economic developments in Central and Eastern Europe.

Figure 3.1. Statements on the economic development of Central and Eastern Europe

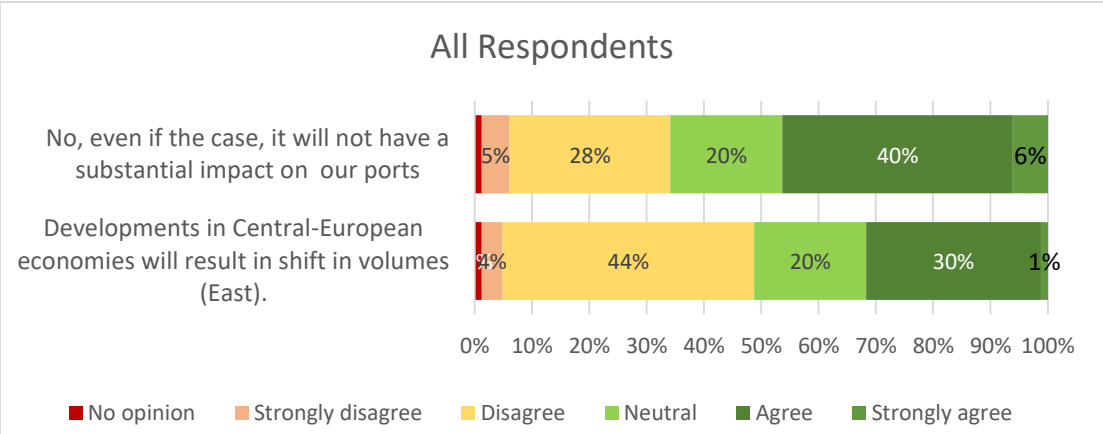


Figure 3.1. presents the view of the respondents on the economic development of Central and Eastern Europe. Almost 48% of the respondents do not agree with the statement that new maritime and continental connections (as a result of the development of the One Belt One Road initiative (OBOR), with its new logistics stakeholders and logistics concepts will

result in a substantial shift of volumes towards the East. About 32% agrees with this statement. Considering another 20% to be undecided the response is undecided altogether. Additionally, when suggested that even if this would be the case, such shift would hardly impact the development and role of our own ports, the response is equally ambiguous. Considering the push in other branches such as real estate, one can wonder whether or not the port community is sufficiently aware of the opportunities presented by these evolutions.

Figure 3.2. Statements on the relation between trade barriers and economic activities in ports

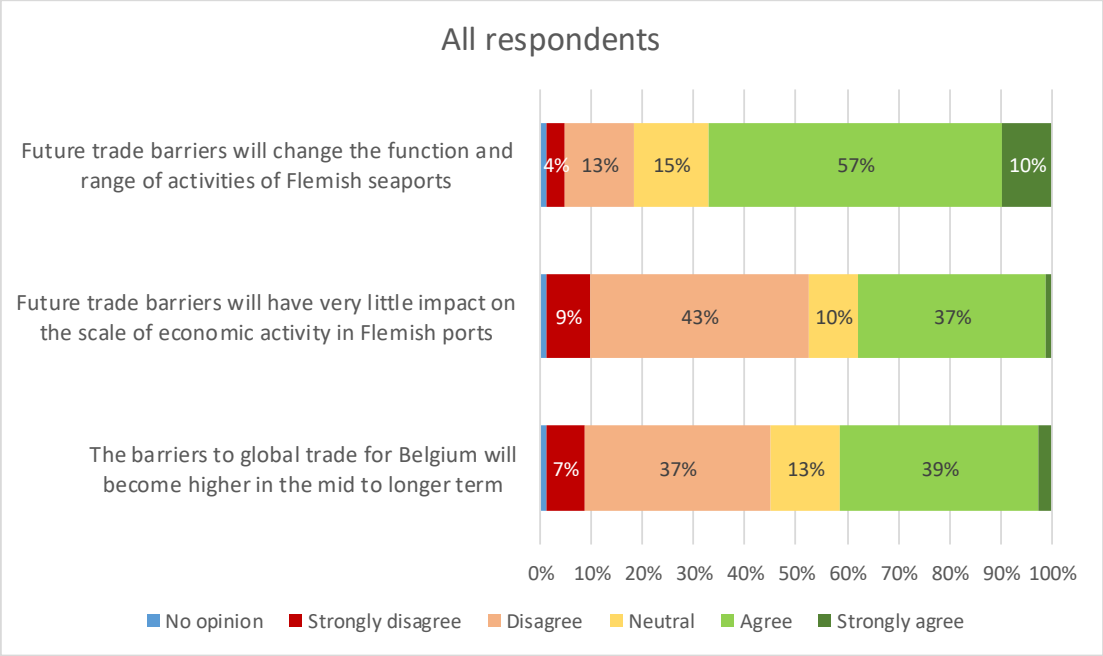


Figure 3.2 presents the survey results on the sub-theme 'relation between trade barriers and economic activities in ports'. About two-thirds of the respondents agree or strongly agree with the statement that trade barriers change the function and range of activities in Belgian seaports. However, there is no agreement on the impact of such trade barriers on the scale of port activities: slightly less than half of the respondents argues that future trade barriers will only have little impact on the scale of economic activity in the Flemish seaports. Also, the third statement does not lead to a univocal conclusion. Around 42% of the survey respondents believes that the barriers for Belgium to global trade will become higher in the mid to long term, while the remaining group disagree or strongly disagrees with this view.

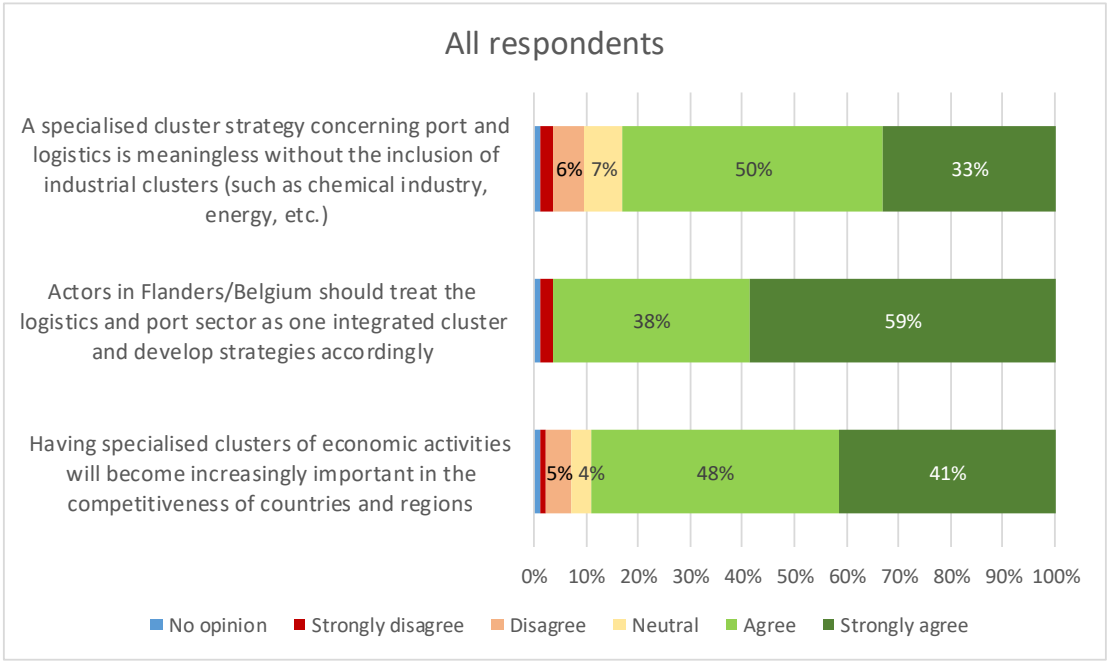
When combining the views on the three posted statements, we conclude that there is a lot of uncertainty on the future outlook of trade barriers in the wake of ongoing trade-related issues such as (a) US economic policy currently being rolled out by president Donald Trump, (b) the announced Brexit, (c) the political uncertainty on the outcome for the EU of the 2017 general elections in the Netherlands and France (which had not taken place yet at the time of the survey process) and (d) supranational policies such as the One Belt One Road (OBOR) initiative. A two-third majority of respondents believes that future trade barriers will have an impact on the function and range of activities in the Belgian ports, but the answers are quite divergent when it comes to the impact on the scale of these activities. In other words, while most respondents expect that trade barriers will change the function and type of activities in seaports, this does not necessarily result in a different scale of port activities (bigger or smaller).

3.3 Theme 2: A changing landscape for the global economic system

Three statements were presented to the respondents in relation to theme 2 of the study. The three statements all relate to the role of clusters in the (global) economic system. As indicated in section 1.3.1., we see an increasing tendency for companies to regroup and relocate forming clusters in the process. Seaports can be regarded as clusters since ports typically consist of geographically concentrated and mutually related business units centred around transport, trade and industrial production.

Figure 3.3 demonstrates that some 89% of the respondents agree or strongly agree with the idea that clusters will become increasingly important for the competitiveness of countries and regions. Almost all respondents argue that the logistics and port sector in Flanders/Belgium should be treated as one integrated cluster. This also implies that an integrated cluster policy and strategy should be developed for logistics and ports. A vast majority (i.e. 83%) argues such a port and logistics cluster strategy should also include industrial and energy clusters. In other words, clusters are considered key to the competitiveness of Flanders/Belgium and port and logistics activities should be approached as one integrated cluster with inclusion of the industrial sub-clusters in ports.

Figure 3.3. Statements on cluster strategy



3.4 Theme 3: Connecting the world: corridors and synchromodality

Synchromodality is the optimal, flexible and sustainable use of various means of transport in a network under the direction of a logistics service provider, offering the shipper or forwarder an integrate "hinterland" solution. When supported by reliable technological developments, it will fundamentally change the selection of the transport modes to be used.

Figure 3.4. Statements on the impact of "Synchromodality"

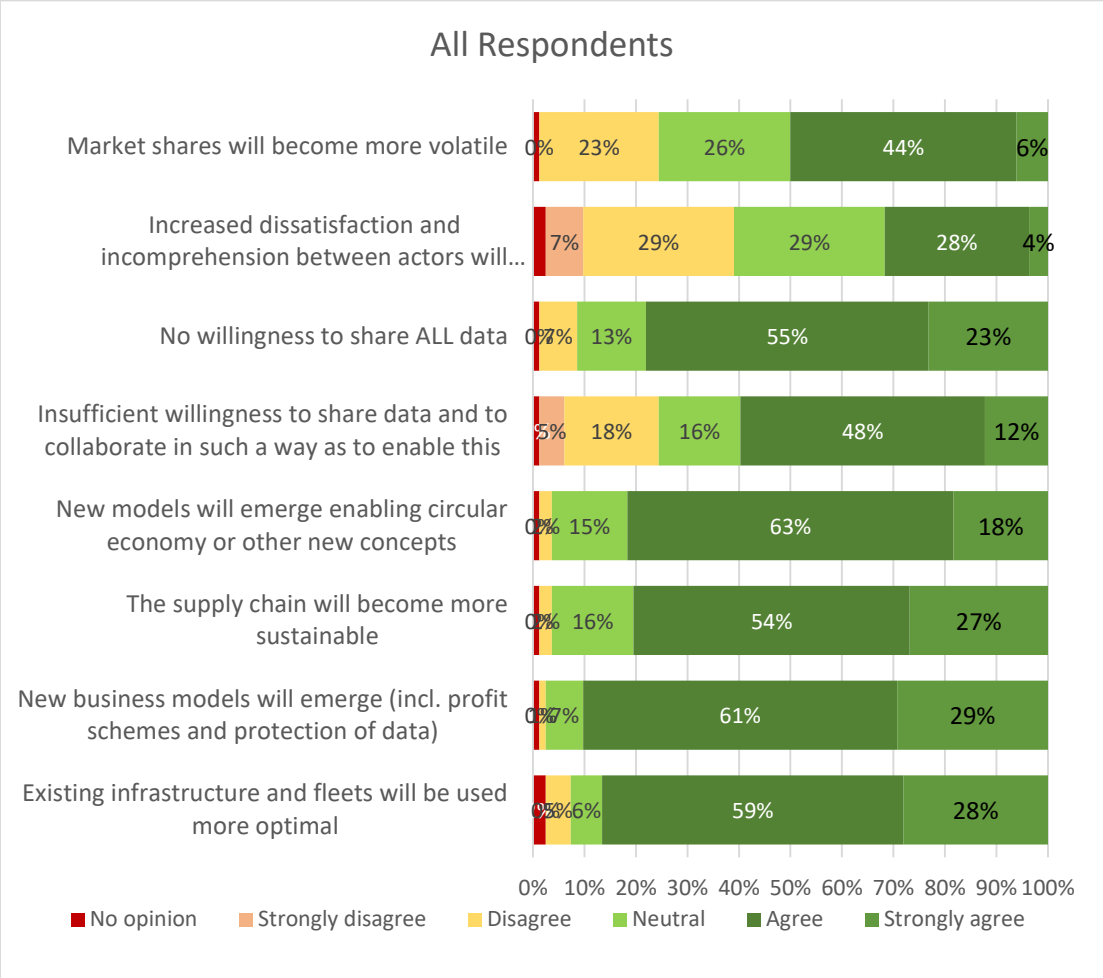


Figure 3.4 presents the respondents' view on the theme of synchromodality for which they were presented with eight individual statements. The large majority of respondents considers synchromodality a lever for concepts such as the circular economy (81%), supply chain sustainability (81%) and a more optimal use of existing infrastructure and fleets 87%).

At the same time 60% believes that the unwillingness to share data and to collaborate within the spirit of the concept of synchromodality will slow the introduction of this concept. The fact that 78% fears that stakeholders will not be willing to share ALL required data clearly shows the suspicion amongst them. Fear seems to be an important factor as 50% (with 26% undecided) expect market shares to become more volatile. Only 23% disagree. Clearly only a minority sees the concept of synchromodality as an opportunity to become more involved in transparent and integrated supply chains.

Therefore it is even more surprising that 90% of the respondents believe new business models will emerge that will solve such delicate issues as profit sharing and protection of data.

Another sub-theme included in the survey under main theme 3 relates to the identification of key issues in port-hinterland connections in the coming ten years. In part 1 of this study, we underlined the importance of port-hinterland connections for the efficient organization of global supply chains and the future competitiveness of seaports. Eight themes were identified and presented to the survey panel (see figure 3.5).

The results show that concepts to connect ports and logistics platforms in the hinterland are considered the most important theme for the coming ten years with no less than 94% of all respondents ticking the boxes 'large importance' or 'crucial for future of port'. For shippers and industrial companies, this share even reached 100% with 56% of this group seeing this theme as crucial for the future of ports. Also the respondent group 'shipping companies and nautical service providers' attaches a higher than average importance to this theme (i.e. 66% for 'large importance' and 34% for 'crucial for future of port').

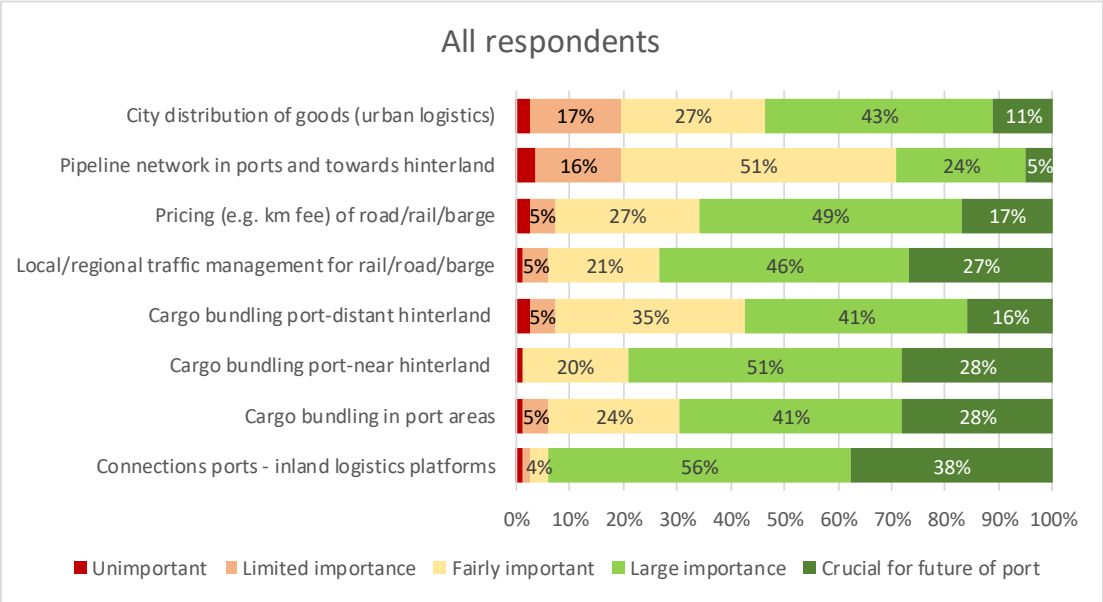
The results further demonstrate the importance of developing concepts to bundle cargo in port areas and to the near/immediate hinterland. Overall, the respondents assign a slightly higher importance to cargo bundling to the near hinterland (defined in the survey as Benelux, Northern France, western part of Germany and UK) than the more distant hinterland (i.e. rest of Europe and including rail links to Central Asia and China). This outcome suggests that the core hinterland of the Belgian/Flemish ports remains very high on the agenda of the respondents. Continued efforts and initiatives are thus required to further optimize the cargo flows between the Belgian/Flemish seaports and this core hinterland. The importance assigned to the connections with the more distant hinterland is in line with the growing role of long-distance multimodal/synchromodal connections and the increasing competition with more distance seaports located in the Mediterranean and East and Central Europe. Despite the clear importance of port-hinterland connections, many respondents also underline the role of cargo bundling solutions in port areas (mainly via barge or rail). In fact, 99% of the respondents see this issue as fairly to extremely important for the future of ports.

The pricing of inland transport modes is considered very important or even a crucial issue by 66% of the respondents. For the sub-group 'general logistics service providers' this figure even reaches 73%.

The pipeline network received the lowest priority of all listed themes. However, large differences can be observed when analysing the results for individual respondent groups. For example, about half of the group 'shippers and industrial companies' see the pipeline network as an important or crucial theme for the future of ports compared to 29% for the entire survey population.

Also the theme 'urban logistics' received wide-ranging answers. While 54% of all respondents attribute a large or crucial importance to city distribution, this figure amounts to 69% for the group 'shippers/industry' and 44% for the group 'forwarders'.

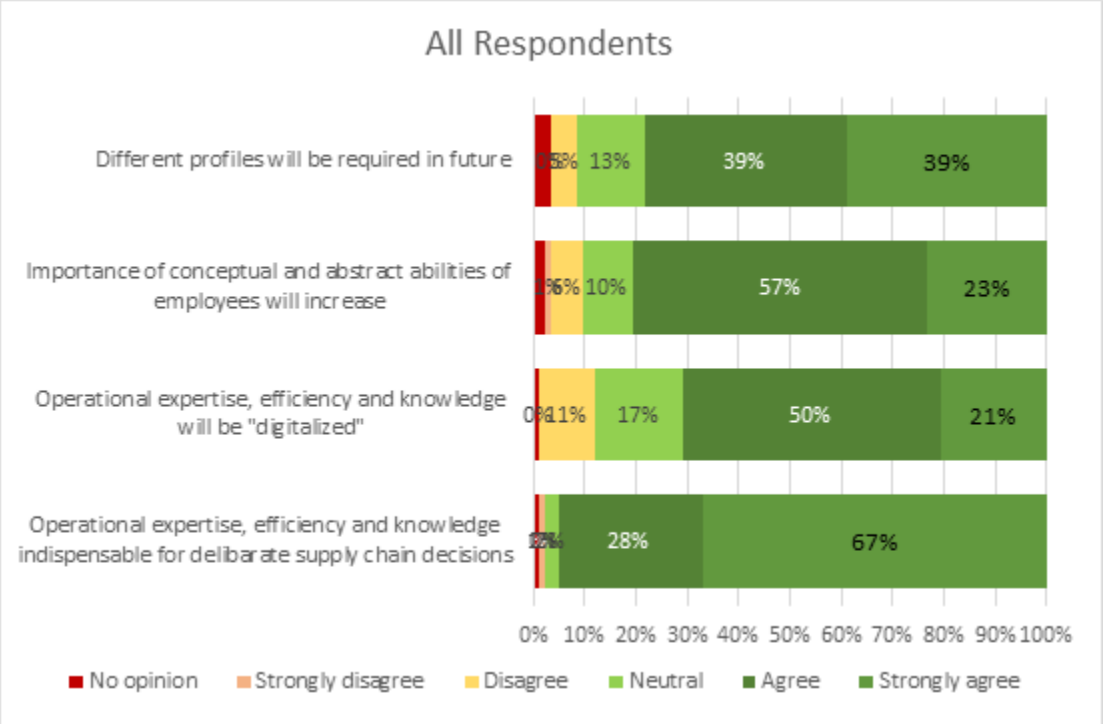
Figure 3.5. Which of the following themes do you consider key themes in port-hinterland connections in the coming ten years?



3.5 Theme 4: Supply chains and logistics networks of the future

Theme 4 focuses on the developments and innovations, and subsequent expectations, of the supply chains and logistics networks of the future. This theme explores the general logistics trends as well as the new dynamics in logistics networks throughout Europe, with particular attention to supply chain integration and its impact.

Figure 3.6. Statements on staff characteristics



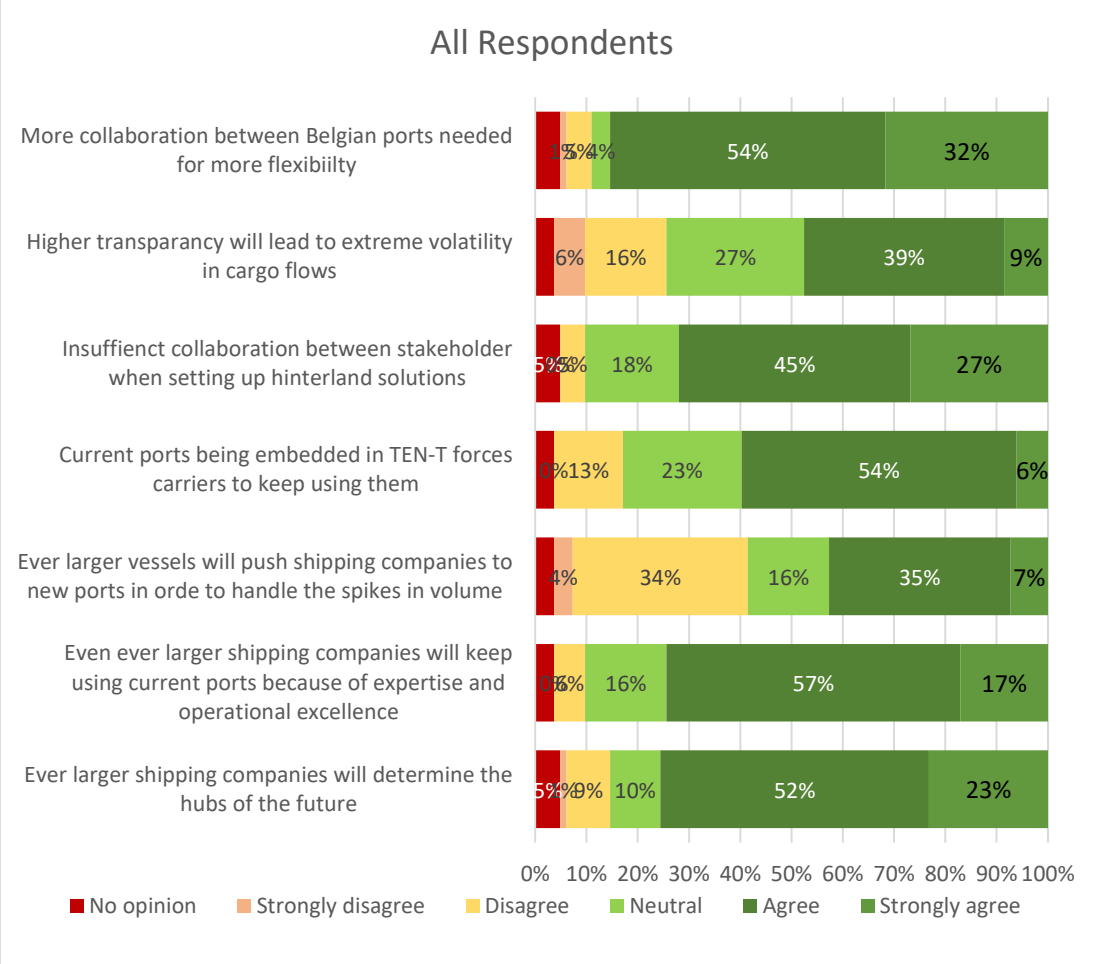
A first topic in the survey concerns the benefits of operational expertise, efficiency and knowledge of employees against the need for creativity, conceptual and abstract abilities of employees. Where it concerns human capital, respondents in general were in agreement with the statements presented, as clearly represented in figure 3.6.

Some 95% of the respondents agreed that operational expertise, efficiency and knowledge of employees will remain indispensable for companies to be successful. When considering the future, only forwarders and maritime terminals believe less in the "digitalization" of these core competences. Only 54% of them subscribe to this statement whereas 85% of shipping companies and logistics service providers see this happening in their sectors.

Even so, 80% of all respondents agree that the importance of conceptual and abstract abilities of employees will increase in a further digitalizing world and the same number (78%) acknowledges the fact that different profiles will be required in future.

In conclusion, it can be stated that the importance of human capital is clearly recognized, as witnessed by the overwhelming degree of confirmative answers to the various statements. Port logistics clearly remains to be seen as a people's business, even in a digital reality.

Figure 3.7. Statements on the trend to consolidation



The trend towards consolidation and larger vessels, mega-carriers and mega-hubs is everywhere. Therefore , participants were confronted with seven statements regarding this topic. Figure 3.7. presents the results of the survey on the sub-theme of consolidation in the maritime world.

About 75% of the survey's participants agree with the statement that ever-larger shipping companies will determine what the hubs of the future will be and that it is their expertise and operational excellence (74%) that will be the determining factor when it comes to making such crucial decisions. Even so, 42% of the respondents do subscribe to the statement that ever-larger vessels will push shipping companies to new ports in order to handle the spikes in volume. Although this is a minority in absolute terms, it is also important to note that 16% remains undecided and that only 38% disagree to some extent.

When embarking on the statements concerning collaboration within a maritime environment of consolidation, larger vessels, mega-carriers and mega-hubs, a large majority (72%) states that there is insufficient collaboration between stakeholders when setting up hinterland connections with an even larger number (86%) stating that more collaboration between Belgian ports is needed to deal with the trend towards consolidation in the industry.

However, again, fear creeps in with 48% conceding that the higher transparency because of the consolidation trend will lead to extreme volatility in cargo flows. This concurs with the demand for more collaboration.

The survey contains several questions on supply chain co-ordination and co-operation. A first key question sheds light on respondents' views on the drivers of and barriers to effective supply chain co-ordination and co-operation. The identification of drivers and barriers is based on extant literature on the theme. For example, Van der Horst & De Langen (2008) identified a set of factors which explain why coordination and integration problems exist. In a port context, these include:

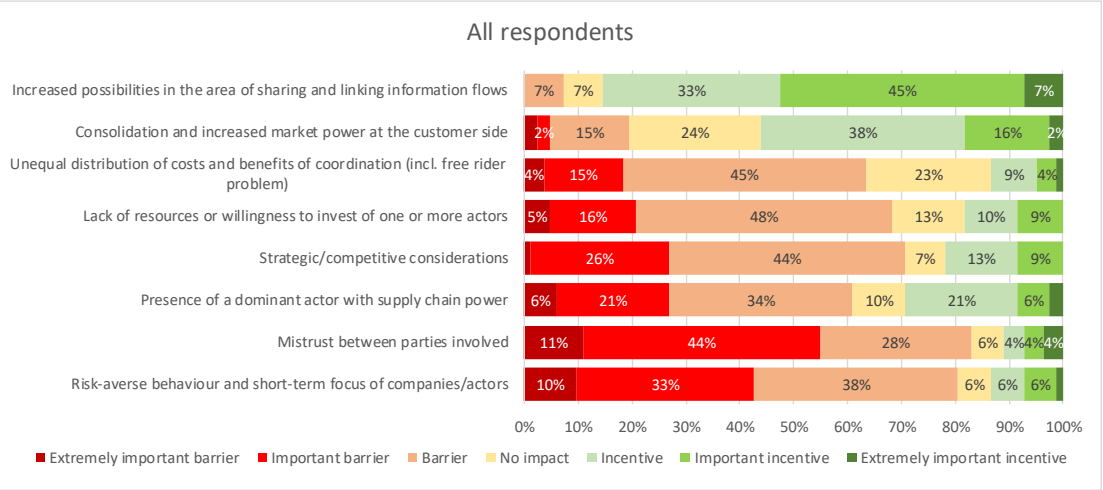
- Risk-averse behaviour and short-term focus of companies/actors;
- Lack of a dominant actor with supply chain power;
- Strategic/competitive considerations;
- Lack of resources or willingness to invest of one or more actors;
- Unequal distribution of costs and benefits of coordination (incl. free rider problem)

In the survey, we have added a few more factors and reformulated some of the above factors. This resulted in a list of eight factors potentially enhancing or limiting co-operation and co-ordination among actors in port-related supply chains (figure 3.8).

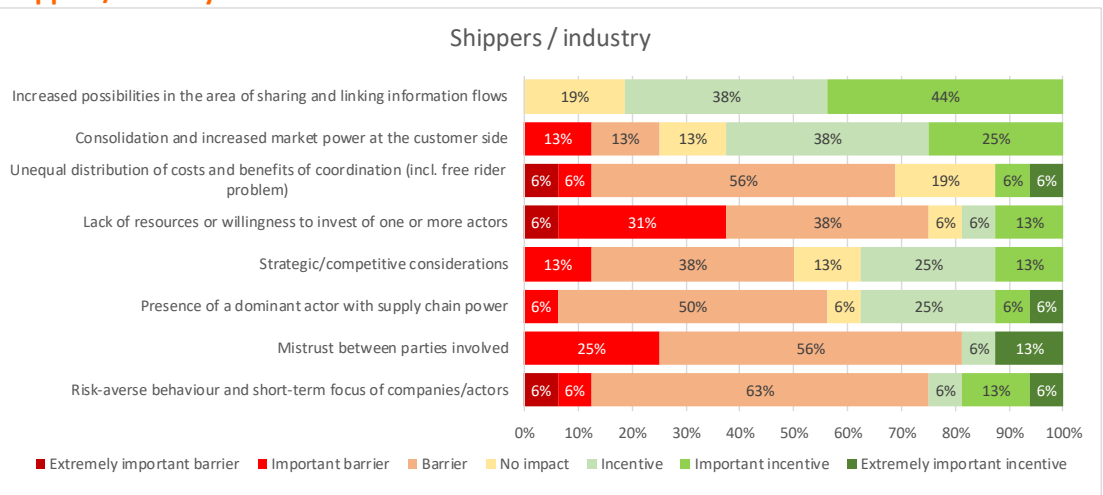
The results for all respondents (top part of figure 3.8) show that mistrust between parties and risk-averse behaviour are regarded as the two most important barriers to co-ordination and co-operation in port-related supply chains. In both cases, less than 20% of the respondents see these factors are having no impact or a positive impact on co-ordination and co-operation among actors.

Figure 3.8. Which are - based on your experience - the main factors affecting co-ordination and co-operation among actors in port-related supply chains?

ALL respondents



Shippers/industry



About two-thirds of the respondents view the unequal distribution of costs and benefits of coordination (incl. free rider problem) as a barrier to co-operation and co-ordination. This seems to point to the need for establishing systems that can assist in achieving a balanced and fair distribution of costs and benefits among the co-operating partners. This issue will be addressed later in this survey.

The presence of a dominant actor can act as a barrier (61% of answers) but also as an incentive (37%). For 56% of the respondents the increased market power of customers is a clear incentive for co-operation/co-ordination, while about 20% considers this factor as a barrier. About 85% of the respondents see IT as a key incentive / enabler of co-ordination/co-operation. In other words, IT is seen by the respondents as the strongest enabler of co-operation and co-ordination among all listed factors.

The responses vary somewhat depending on the respondent group under consideration. The respondent category 'Shippers/industry' (bottom part of figure 3.8) sees the lack of resources or willingness to invest as the main barrier to co-operation/co-ordination. Shippers/industry have a less extreme view on the potential role of mistrust, risk-averse behaviour and the presence of a dominant actor as barriers to co-operation and co-ordination.

Figure 3.9. Which actions are most suited in view of obtaining more co-ordination and co-operation between actors in port-related supply chains?

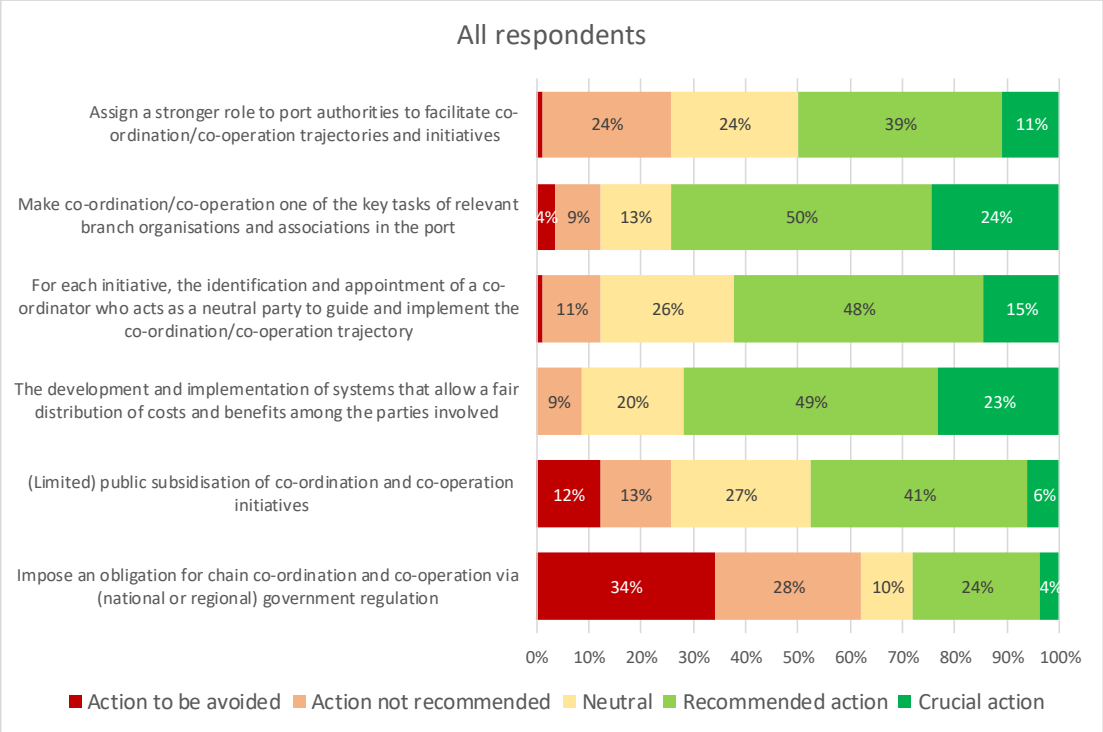


Figure 3.9 elaborates on a set of actions in view of obtaining more co-ordination and co-operation between actors in port-related supply chains. Based on literature and insights from the research team, six possible actions were presented to the respondents. Two of these actions deal with public policy initiatives to stimulate co-operation and co-ordination:

- Impose an obligation for chain co-ordination and co-operation via (national or regional) government regulation
- (Limited) public subsidisation of co-ordination and co-operation initiatives

Two of the six listed actions refer to initiatives that might result in a fair and balanced governance setting and organisation of co-ordination and co-operation schemes:

- The development and implementation of systems that allow a fair distribution of costs and benefits among the parties involved
- For each initiative, the identification and appointment of a co-ordinator who acts as a neutral party to guide and implement the co-ordination/co-operation trajectory

The last two actions relate to the role of specific actors in enhancing or facilitating co-ordination or co-operation:

- Make co-ordination/co-operation one of the key tasks of relevant branch organisations and associations in the port

- Assign a stronger role to port authorities to facilitate co-ordination/co-operation trajectories and initiatives

Many landlord port authorities across Europe have adopted a more active role either as facilitator or entrepreneurial port authority (Verhoeven, 2010). In the Belgian context, the survey results show mixed views on assigning a stronger role to port authorities in view of supply chain co-ordination and co-operation: 50% of the respondents see room for a stronger role of port authorities while 26% of the respondents argue that this is not recommended or should even be avoided. It is difficult to judge whether the latter group of respondents thinks port authorities of Belgian/Flemish seaports have already adopted a sufficiently strong role to facilitate supply chain co-ordination and co-operation or, alternatively, argue that port authorities should not adopt a strong role in facilitating co-ordination or co-operation.

Branch organisations and associations seem to have a key role to play in facilitating co-ordination/co-operation: about three quarters of the respondents recommend or strongly recommend that co-ordination/co-operation becomes one of the key tasks of relevant branch organisations and associations in the port.

Approximately 47% of the respondents see (some) room for public subsidisation of co-ordination initiatives. 12% is strongly against and 13% does not recommend this type of intervention. Overall, there is only limited support (28%) for imposing co-ordination through government regulation. One third of the respondents even considers this as an action that should be avoided. These outcomes show that the support for public policy initiatives to stimulate co-operation and co-ordination is much lower than for the other four possible actions listed in figure 3.9.

The two actions that received the lowest number of negative evaluations (i.e. action to be avoided or not recommended) relate to the establishment of fair and balanced governance and organisation of co-ordination and co-operation schemes. About 72% of the respondents point to systems for a fair distribution of costs and benefits as a recommended or crucial action. This supports earlier results which indicate that about two-thirds of the respondents view the unequal distribution of costs and benefits of coordination (incl. free rider problem) as a barrier to co-operation and co-ordination (see earlier figure 3.8). The identification and appointment of a co-ordinator who acts as a neutral party to guide and implement the co-ordination/co-operation trajectory is seen as a recommended or even crucial action by nearly two thirds of the respondents.

The survey also contains questions on the expected changes in the power relations between market players active in port-related supply chains. For this purpose, we distinguished seven market player groups:

- Small and medium-sized forwarding companies (including customs agents);
- Large third-party logistics service providers (3PL) such as DHL, Kuhne & Nagel, Geodis, etc..;
- Port logistics companies which includes logistics companies with a strong focus on and origins in seaports (e.g. Stukwerkers, Zuidnatie, Molenbergnatie, Tabaknatie, etc..)
- Shipping companies active in international and intra-European tramp and liner shipping activities;
- Wholesalers, import/export companies and retailers;
- Industrial companies and cargo owners/shippers;

- IT-driven actors such (e.g. Amazon, Google, Alibaba, software development companies, etc..) and information brokers

Figure 3.10. How will the power relations within the supply chains you are active change in the coming ten years?

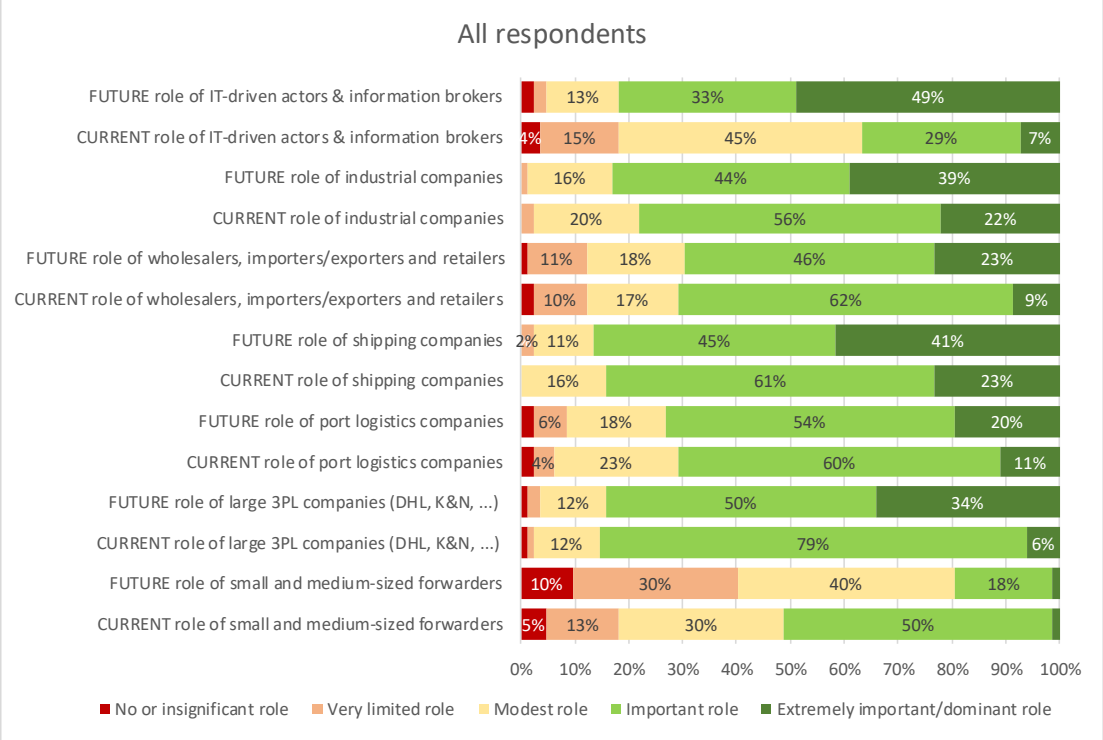


Figure 3.10 reveals that shipping companies, industrial companies and large 3PL companies and IT-driven actors are seen as the players with the strongest role in the supply chains in the FUTURE. The role of IT-driven actors is expected to increase the most. Many respondents see the role of 3PL companies grow from modest or important now to extremely important/ dominant in the future.

The role of small and medium-sized (traditional) forwarders is expected to decline sharply. About 40% of the respondents only sees a minor or even no role for forwarders in the coming ten years.

Except for the forwarder group, respondents expect that all other market players will increase their role in the future. This might indicate that the future will bring increased competition among market players. However, at the same time this observation might pave the way for balanced partnership arrangements among (strong) market players in view of achieving a higher level of supply chain integration. As indicated in part 1 of the study, such initiatives have already emerged in the form of vertical collaboration between different actors in the same chain or horizontal collaboration between similar actors (for example two shippers who jointly develop cargo bundle solutions).

Figure 3.11. Which actions are most suited in view of obtaining more co-ordination and co-operation between actors in port-related supply chains? (comparison all respondents vs. specific respondent groups)

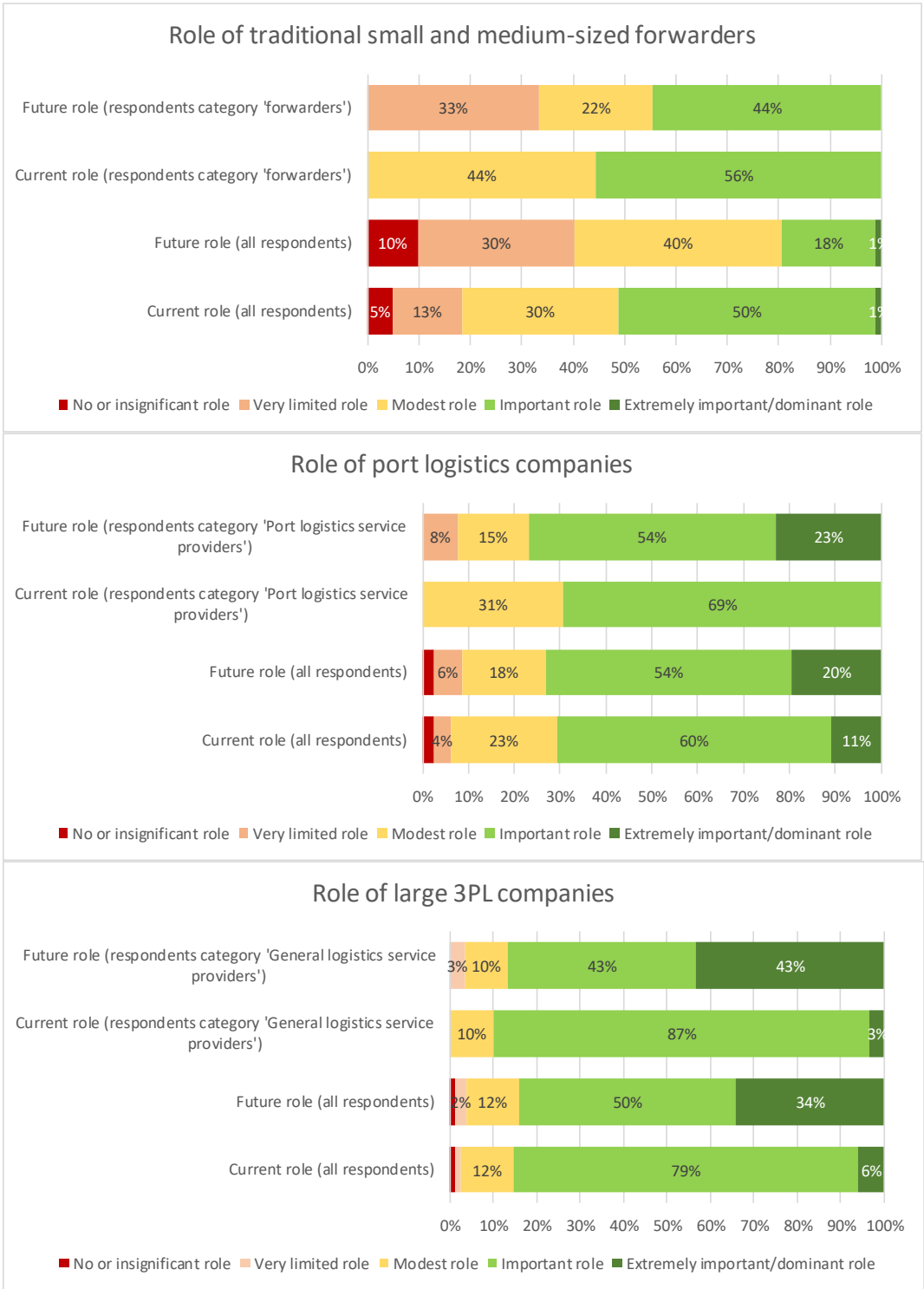


Figure 3.11 continued. Which actions are most suited in view of obtaining more co-ordination and co-operation between actors in port-related supply chains? (comparison all respondents vs. specific respondent groups)

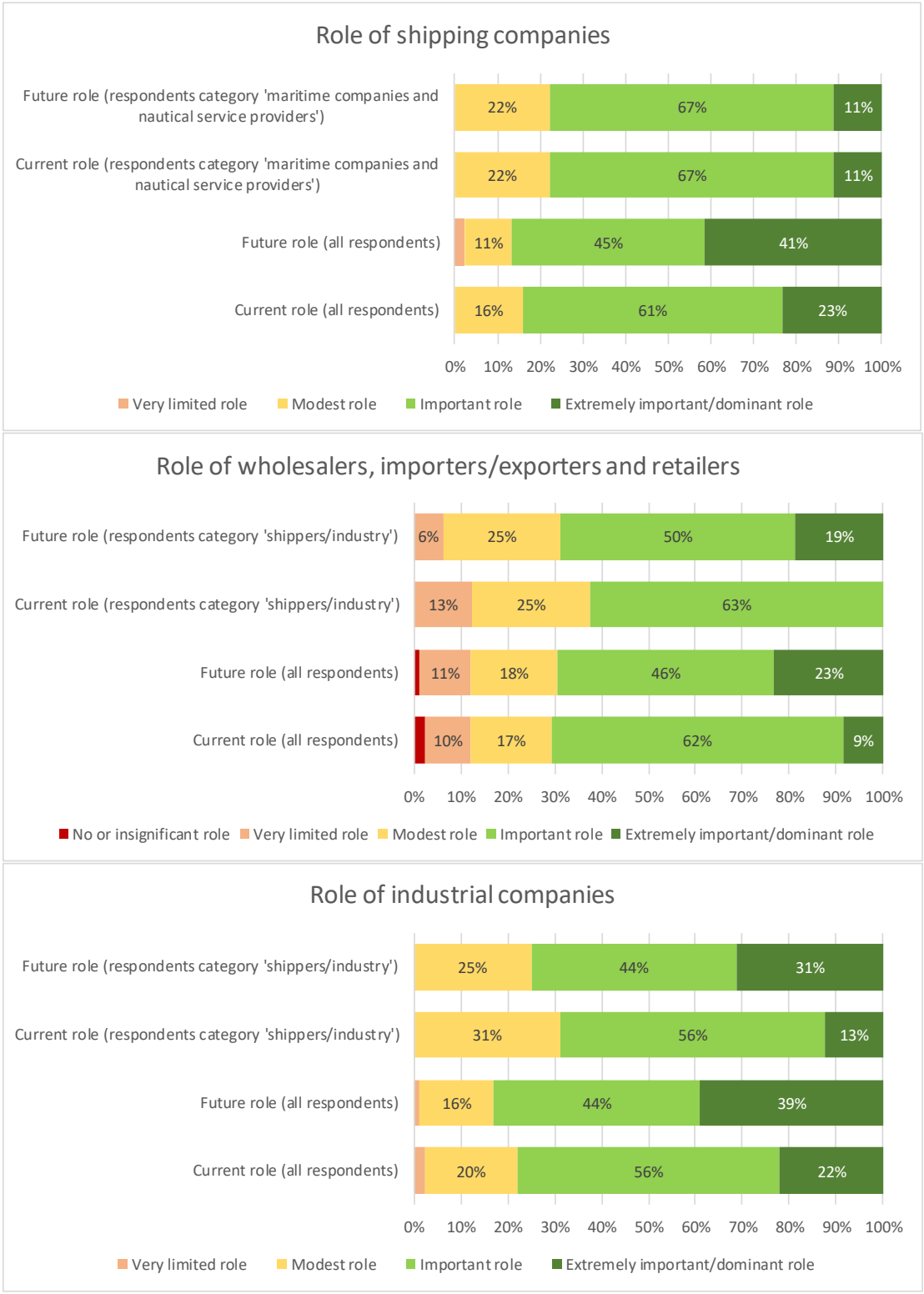
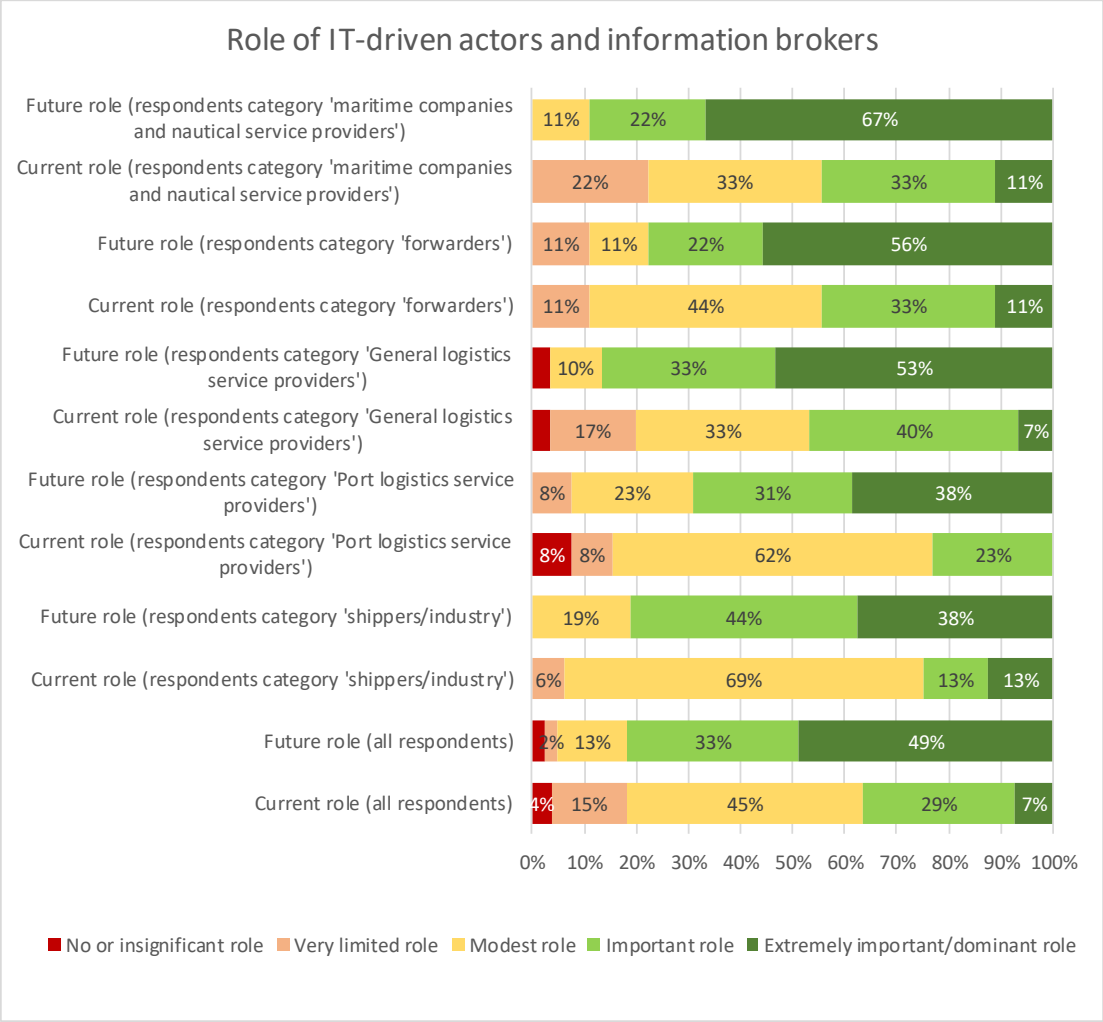


Figure 3.11 confronts the overall results based on all respondents with the view of the respondents in one specific sub-group. This leads to the following conclusions:

- Forwarders are slightly more optimistic about their future role than the entire respondent group, but they also see a decline of their role;
- The expectations of port logistics companies on their current and future roles in supply chains are fairly in line with the results for the entire respondent group
- 3PL companies are slightly more positive on their current and future role in supply chains compared to the entire respondent group.
- Shipping lines are somewhat modest about their current and future role compared to the entire group of respondents. More importantly, shipping lines do not expect a change in the relative 'weight' of their role in supply chains;
- The expectations of shippers/industry on the current and future roles of industrial companies, importers/exporters, wholesalers and retailers in supply chains are a bit lower than in case of the entire respondent group. In both cases, the role is expected to increase.

Figure 3.12. Which actions are most suited in view of obtaining more co-ordination and co-operation between actors in port-related supply chains?

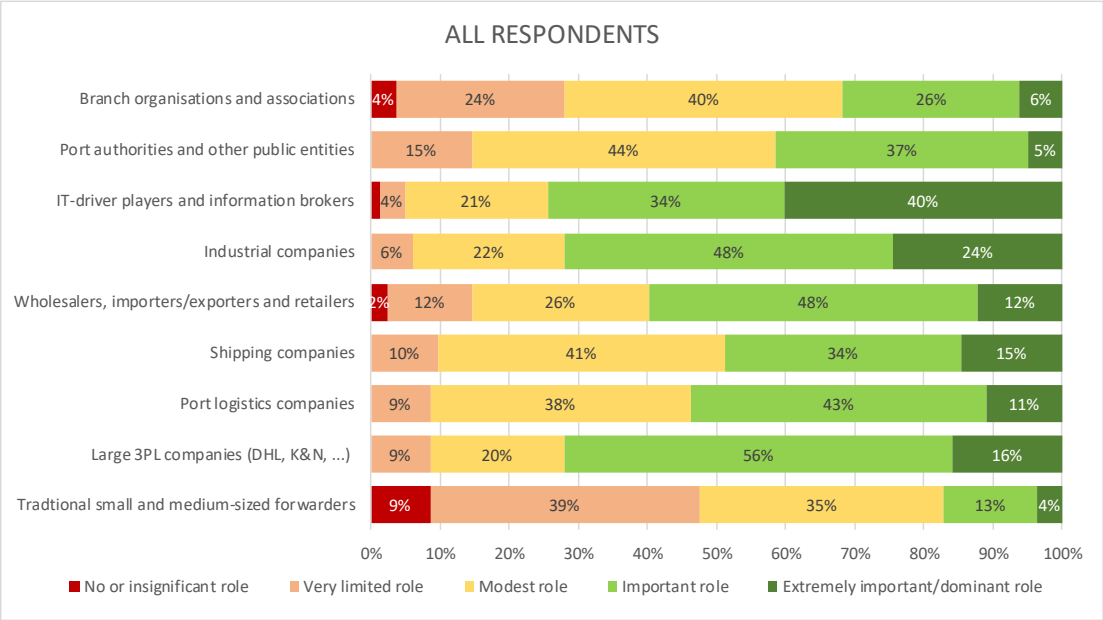


As indicated earlier, the role of IT-driven actors is expected to increase the most. It is interesting to analyse to what extent this conclusion is valid across the respondent groups. Figure 3.12 confirms all respondent groups expect a large increase in the role of IT-driven actors and information brokers. Shipping companies, forwarders and general logistics service providers expect a particularly strong or even dominant future role of these IT-driven actors and information brokers, despite the fact that the IT focus of these individual respondents is quite varied. The believe in the future strong role of IT-driven actors might explain why many of the other actors such as shipping companies, logistics service providers or industrial companies are heavily investing in the development of expertise and systems in the area of information technology, big data collection and analysis and IoT. The potential disruptive power of information technology giants is recognized by port communities. For example, in the press release at the occasion of the launch of the Nxtport initative in Antwerp (see nxtport.eu for more information), the initiators pointed out that the exploration and smart use of data in the port logistics sector is one of the main strategic opportunities for the Antwerp port community in the short and medium term. They further added that it would be a huge mistake if the Antwerp port community would sit and wait till technology giants redesign logistics and maritime business models using the untapped port-related data opportunities. Thus, the potential threat of large IT-actors extracting value from the wealth of data in port-related supply chains has been one of the main incentives for creating the Nxtport initiative.

The last question dealing with supply chain co-ordination and co-operation focuses on which parties will (in the coming 5 years) take the lead in aiming for co-ordination and co-operation in supply chains (figure 3.13). The results reveal that in the coming 5 years IT-driver players and information brokers, large 3PL companies and industrial companies are the most likely actors to take the lead in aiming for co-ordination and co-operation. Small and medium-sized forwarders are the least likely party to take the lead.

Most respondents see a modest to important role for port authorities (81% of respondents) and branch organizations (66% of respondents) to take the lead in co-ordination and co-operation. Only a small minority sees a dominant role for these actors (i.e. 5% to 6%), while quite a few respondents argue branch organisations and associations and port authorities have no or only a very limited role to play in leading such initiatives (i.e. 28% in case of branch organizations and 15% in case of port authorities).

Figure 3.13. Which parties will, in the coming 5 years, take the lead in aiming for co-ordination and co-operation within the supply chains you are active?



3.6 Theme 5: Disruptive key ICT innovations for ports and logistics firms

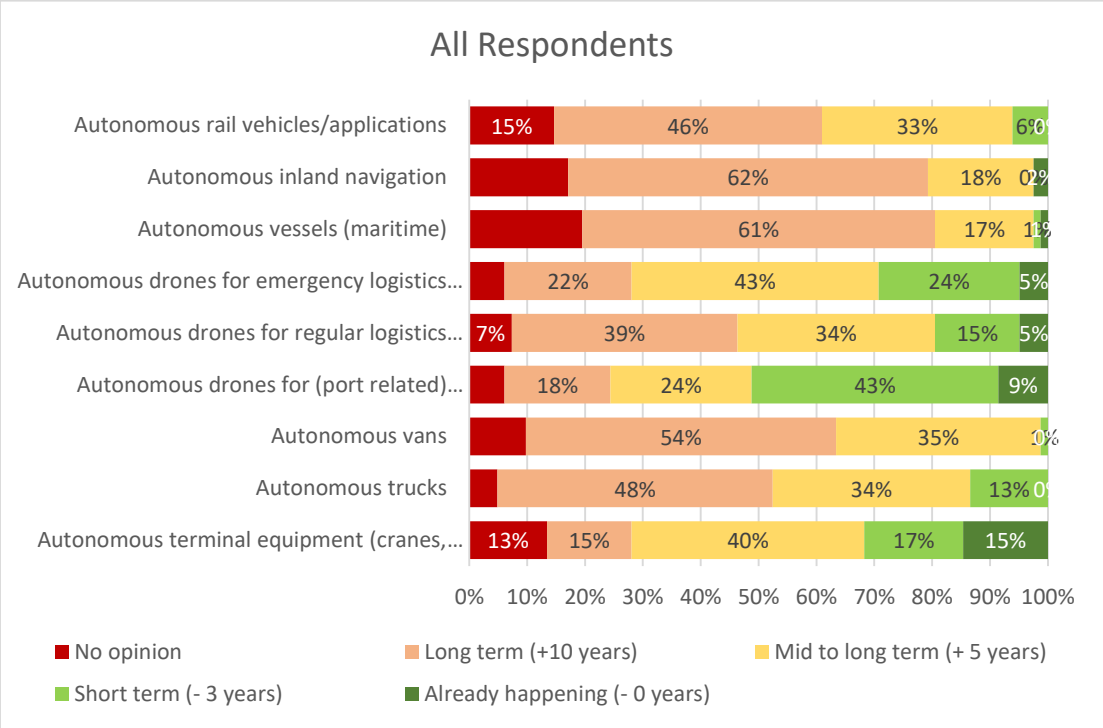
In the fifth and last theme, the respondents' views on disruptive key ICT innovations for ports and logistics are assessed. A first topic concerns the speed of robotization and the need for a regulatory framework. Opinions about the effective introduction in a port environment, and if so in what timeframe are largely divided.

A majority of 72% believe that the evolutions in the field of autonomous terminal equipment such as cranes, straddle carriers and autonomous trailers, effectively will be introduced within the next 10 years. 32% actually already sees this happening within the next three years. This supports the evidence and best practices found (1.6.1).

Where it concerns rolling equipment, the majority states that it will take more than 10 years before this robotization will take effect. The most ambiguous answer to this extent concerns autonomous trucks where about 48% believes this will happen within the next 10 years, whereas 47% of the respondents believes this will happen sooner. Some 13% even believe this will be a reality within the next three years. For rail applications, the trend is somewhat similar, be it with somewhat more moderate expectations; about 46% foresee a horizon of more than 10 years and the 39% see it happening sooner.

Even more reticence can be noted when water bound robotization is discussed. Regardless of the possibilities (1.6.2) roughly 60% does not see this happening within the next 10 years. Noteworthy is the correlation between the number of "no opinion" answers and the reticence towards a certain technology. The more people have no opinion about a certain technology, the higher the number of respondents who are reserved about its introduction.

Figure 3.14. Statements on the rate and speed of introduction of robotized and autonomous equipment and vehicles



The oddball reply concerns the introduction of autonomous flying drones. Here is a relatively high rate of acceptation where it concerns autonomous drones for port related inspections activities. 52% of the respondents see this happening in the next three years. This carries over to two more contentious applications of this technology with relative high acceptance for emergency logistics applications, with 29% seeing this happening within the next 3 years, and also 20% of respondents expecting this for regular logistics applications.

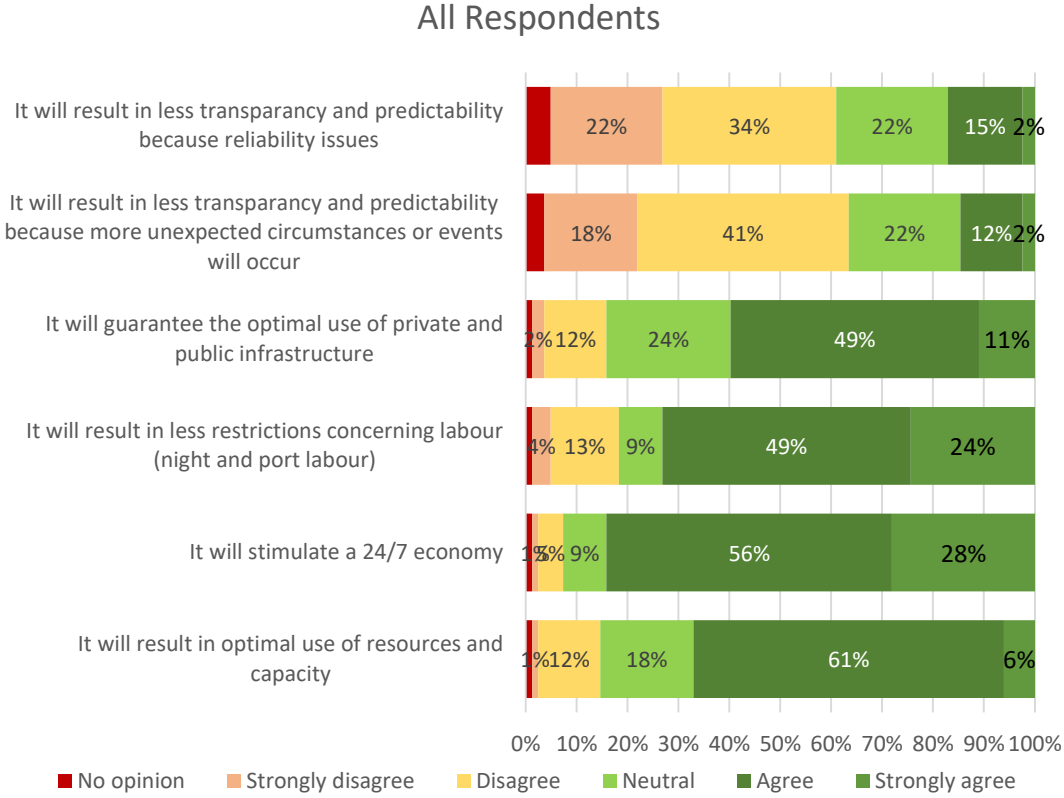
In our opinion this can partly be explained by the fact that flying drones are probably the most high profile and reported robotization technology. Considering the far more specialized innovation projects concerning rail and maritime applications, it is perhaps not that surprising that these technologies raise less expectations, regardless of real progress being made.

The following topic in the survey questions the operational impact of the robotization of ships, barges, road transport and terminal operations. A number of statements explore a range of possible impacts of these disruptive technologies within the port and port logistics community. Figure 3.15 presents the survey result on the sub-theme of the impact of disruptive technologies on port and port logistics operations

Generally stated, a large majority sees robotization as a catalyst for increased efficiency in all domains. 84% of respondents subscribe to the statement that it will stimulate a 24/7 economy and similar answers can be noted for optimal use of resources and capacity (67%) and resulting in less restrictions concerning labour such as night or port labour schemes (73%). Also where it concerns the optimal use of private and public infrastructure, respondents generally subscribe to the statement (60%).

Despite the general acceptance that robotization can be considered an efficiency driver, one should note that some fear creeps in where it concerns reliability and unexpected circumstances or events occurring. Even though there is still a majority that believes in the technology, respectively 34% (unexpected circumstance or events) and 37% (reliability issues) of the respondents expect less supply chain transparency and predictability.

Figure 3.15. Statements on the impact of disruptive technologies on port and port logistics operations

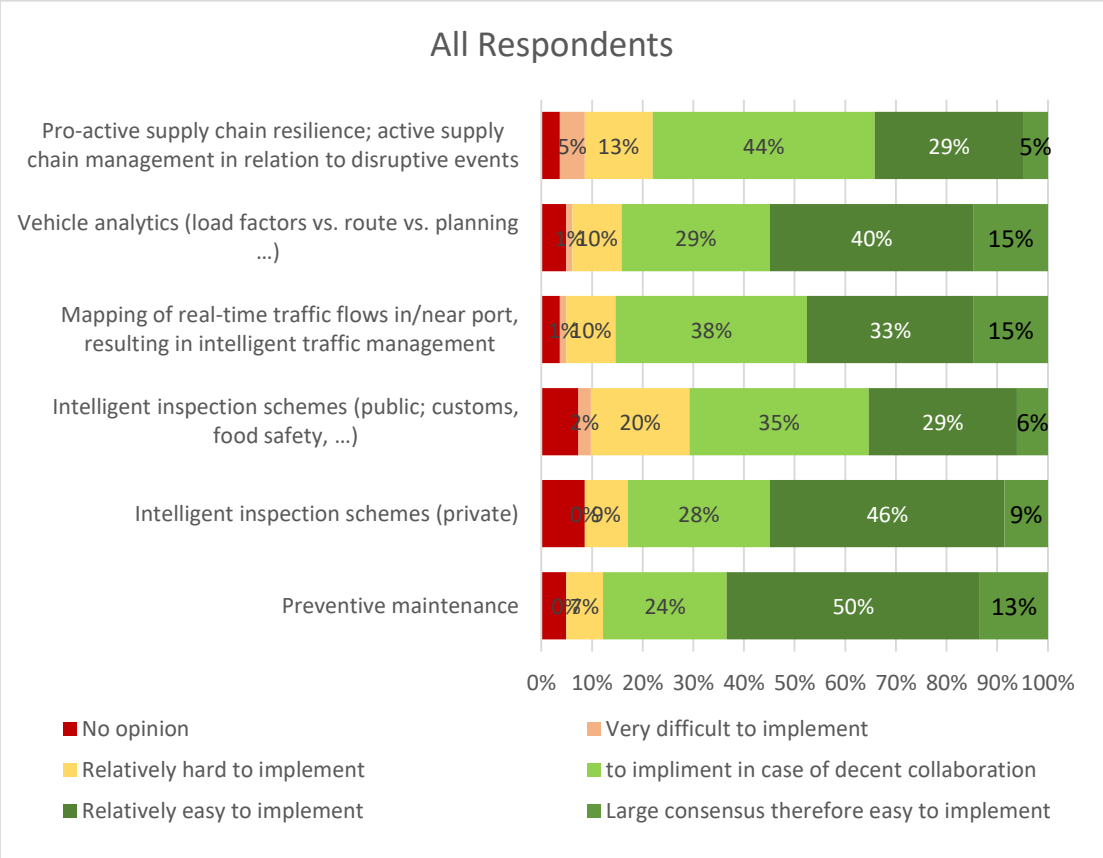


It is abundantly clear that the use of the Internet of Things (connected objects) will result in an enormous amount of data, and in an almost infinite number of applications, especially thanks to ever more precise and recent data. Figure 3.16 shows the expectations of the survey's participants about the introduction and availability of these large sets of data.

A large majority supports the statements that IoT will contribute to optimization of private maintenance (88%) and intelligent inspection schemes (83%). Even though slightly less pronounced there is also a lot of trust among respondents in future applications for public services (71%).

A second set of statements probing the expectations towards vehicle analytics (84%) and the mapping of real-time traffic flows in or near ports, resulting in intelligent traffic management (85%) provides the same high confidence in technology.

Figure 3.16. Statements on the expectations concerning the introduction of the Internet of Things



Only the application of IoT in pro-active supply chain resilience management, enabling a more pro-active supply chain management in case of disruptive events such as natural disasters, social disturbance or similar, seems slightly more abstract with still a large majority of 78% subscribing the statement.

These responses show a clear willingness to embrace the possibilities of digitalization and the availability of massive amounts of data. Some of the applications will be privately developed (maintenance, intelligent inspection or analytics at company level), whereas for others collaborative efforts will be required (e.g. public inspection, port traffic flow).

4 I CONCLUSIONS AND RECOMMENDATIONS

4.1 General conclusions

Port logistics will change in the future due to an interaction between changes in the global economic system, the global transport system (corridors and synchromodality), supply chains and logistics networks and disruptive key ICT innovations. Port choice in the future will be influenced by the ability of logistics/industry clusters to adapt to Industry 4.0 and newly developed services in this field by the logistics sector.

Port competition between clearly-defined port areas with spatial boundaries (nodes) is shifting to groups of spatially-dispersed but functionally-integrated terminals in different ports (networks). This leads to an increased functional interdependency between ports. Individual port qualities will continue to play a key role in cargo routing decisions. Still, cargo will be channelled through the system also taking into account network-related considerations.

Supply chain integration and port-hinterland connectivity have become key to market players. This focus increases competition among market players who get more and more vertically integrated, but at the same time demands more co-ordination and co-operation between market players in view of achieving efficient supply chains.

The first part of this report analysed trends and outlook for port logistics. Future trends and perception were analysed based on existing literature and notions. Various initiatives and projects were identified and evaluated after which was proceeded to a qualitative analysis of the impact of these trends on the existing models of the port logistics companies.

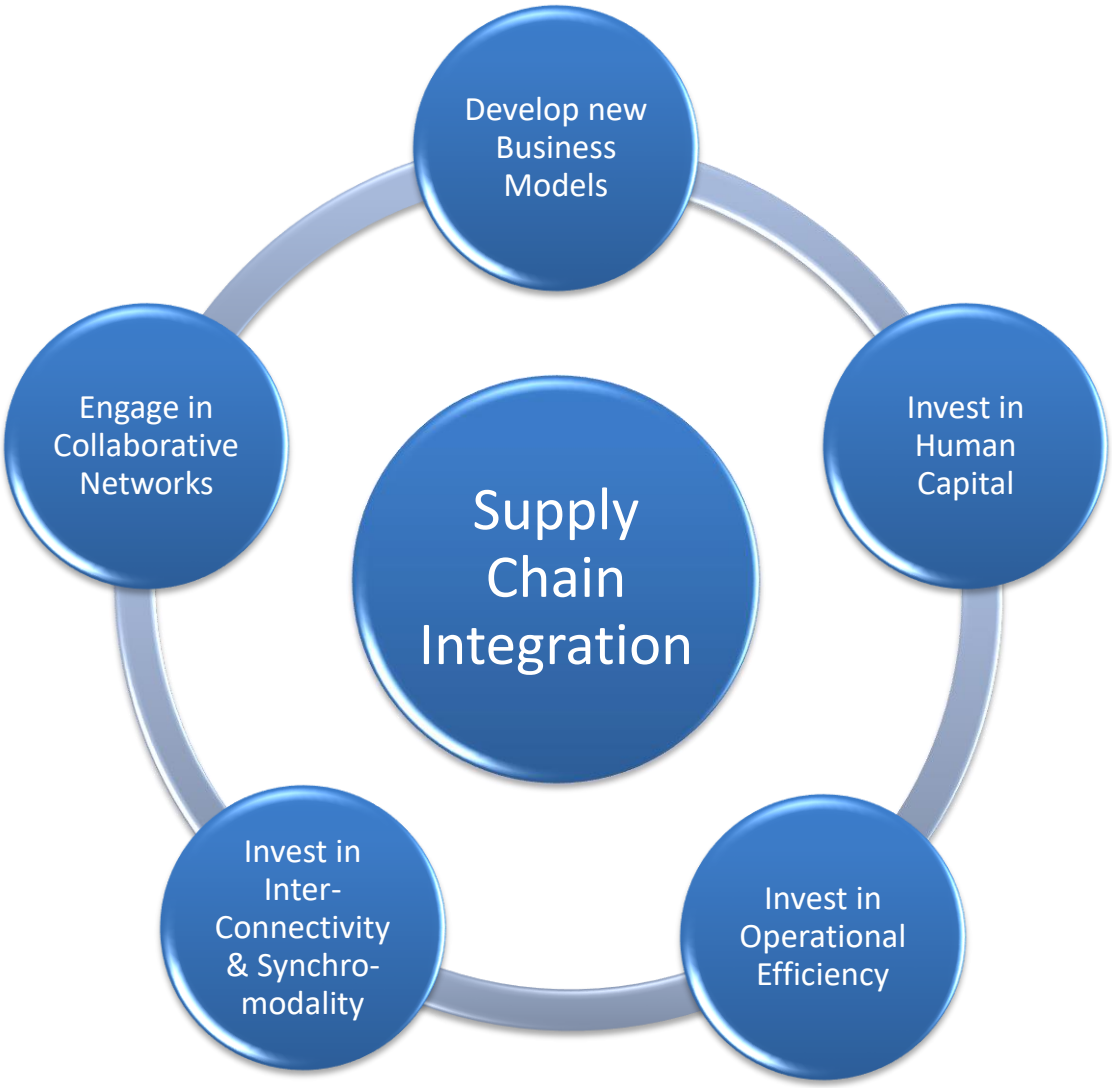
The second and third parts of this report contains the survey set-up and the analysis of its results. This survey probed the views and expectations in the wider port and supply chain industry and analysed in depth the five sub-themes that were identified in the first part of the report:

- Global demand and economic development
- A changing landscape for the global economic system
- Connecting the world: corridors and synchromodality
- Supply chains and logistics networks of the future
- Disruptive key ICT innovations for ports and logistics firms

Both parts individually contain the reflections on the respective subjects. Subsequently, a set of specific and concise set of recommendations for the Belgian/Flemish port community was defined.

4.2 Specific recommendations for the Belgian/Flemish port community

Figure 4.1. Recommendations by topic



Recommendations on Human Capital

Port Logistics is a service industry and human capital will remain pivotal in developing any and all innovation tracks to meet the challenges of supply chain integration.

While it is clear that the core competences such as operational expertise and general knowledge of the shipping industry remains imperative for port professionals, it is equally clear that an ever faster changing environment, also known as "Society 4.0" where

everything and everybody will be networked, will require the business to attract profiles that thrive in such surroundings.

In order for companies to fully engage with the need for increased collaboration they will have to include professionals with more conceptual and abstract abilities in project teams, willing to think out of the box in view of new opportunities and roles within these new realities.

Companies will also benefit from such profiles when exploring new methods and define specific projects for increased operational efficiency.

The further development of human capital requires a set of actions and initiatives such as:

- Port-related actors will need to recruit new talent from outside including coming from IT-driven potential disruptors. Persuading the right people from innovative technology companies to join the port logistics sector is quite a task given the lack of a strong public image and brand image of the port logistics sector;
- Continued and renewed interactions between learning centres (universities, schools of higher education and training centres) and the business community on the formulation and implementation of learning trajectories;
- Stimulating an environment for the sharing and mobility of knowledge and know-how. Such sharing and mobility are key to the performance of clusters, also in a seaport context;
- Lower the barriers to learning and competence development in the port community by creating low-entry platforms for exchange, discussion and sharing among people of all ages with diverse professional and educational backgrounds. Social media platforms and hackathon and other events are examples of how knowledge can be shared and innovation sparked. Port authorities and branch organizations and associations can facilitate this process. Enough room should be created for initiatives to emerge spontaneously. In any case, existing governance and organisational settings should avoid being a barrier to flexible adaptation in terms of competence development and learning.

Port authorities can play an important role by actively engaging in communication campaigns increasing the attractiveness of the sector and representing the interests of the entire port community . Attracting the right profiles should be supported by intense collaboration between port related actors and the educational system. For individual companies this is not an evident exercise. Again port authorities can fulfil a unique role by intensifying the contacts between business and academia, supporting academia with deeper insight on the latest evolutions thus enriching the operational expertise and knowledge programs whilst at the same time define, together with educators, ways to leverage such knowledge for the wave of new professionals with mainly conceptual abilities.

Recommendations on Operational Efficiency

Port logistics companies will have to continue to be leaders in operational excellence and expertise as more than anything else it is the deciding factor for ever larger shipping companies to select their hubs.

To this extent companies must further invest and focus on tackling the most pressing challenges of port infrastructure, such as spatial constraints and the pressure on productivity. Both technology (soft) and infrastructure (hard) components will build the smart port of the future whereby maximizing value is key, as well as maximizing and coping with the sheer volume of cargo flows.

To increase operational efficiency also collaborative efforts focusing on inter-operability will be key. Especially in view of the further automation and robotization of terminals, equipment and infrastructure, streamlining processes and a maximal standardization where it concerns automation in the operational field will leverage optimal, intelligent use and modularity of transport units, assets and infrastructure. This streamlining will lay the foundation for a seamless integration of modes and connection to hinterland ports and infrastructure.

It is clear that when it comes to operational efficiency port authorities can contribute greatly. Where port logistics companies focus on their own premises and concessions, the port authorities will have to continue to define port infrastructure and seamless integration projects that link into the hinterland connectivity requirements from a more holistic approach. Particularly port authorities, in association with academia and the logistics cluster, are the organisations that have the insights and overview to define and lead such projects that serve the whole port community. Setting up new rail or inland navigation connections, intermodal operational efficiency programs, cargo bundling, … all are examples of specific projects with both physical (infrastructural) and data-sharing components, that require such comprehensive approach.

Recommendations on Inter-Connectivity & Synchromodality

When meeting the challenge of supply chain integration port logistics companies will have to follow through on their efforts of operational excellence and inter-operability.

The development of concepts to connect ports and logistics platforms in the hinterland are considered the most important themes on port-hinterland connectivity for the coming ten years. Concepts to bundle cargo in port areas and to the near/immediate hinterland are particularly seen as key areas. This demonstrates that also in future the connectivity within the port areas and to the core hinterland areas of ports need to remain at the top of the agenda, with connections to more distant hinterland regions not far behind. Next to a further development of infrastructure facilities for synchromodal transport needs by the public and the private sectors, port logistics companies will have to engage in seamless integration projects within a “connected” hinterland network consisting of smart, efficient and intermodal terminals.

However, when setting up additional strategic alliances, the port logistics community should also anticipate on the new realities in Central, Eastern and Southern Europe. Understanding the true impact of initiatives such as the One Belt One Road (OBOR) initiative, and its impact on hinterland centres of gravity and connectivity, as well as new routes of serving the deeper hinterland, should be further researched.

It is here that there is also a unique role to be played by the port authorities. First there is the task of developing more knowledge about the complexities of the hinterland connections, especially where it concerns these deeper hinterland connections and new economic realities. Consolidating such knowledge and translating it into a proactive network strategy whereby port authorities engage in establishing port alliances should be the next.

Figure 4.2. Specific recommendations for port authorities

Recommendations related to collaborative networks

To be successful, Belgian/Flemish ports have to think even more along with the customer, try to figure out what his needs are, not only in the port but throughout the supply chains and networks. While individual port qualities continue to play a key role in port choice decision making, success is more and more determined by the ability of the port community to fully exploit synergies and coordination with other transport nodes and other players within the logistics networks of which they are part. These developments call for closer

coordination, co-operation and integration with logistics actors and nodes in and outside the port perimeter and a more integrated and broader spatial approach to port infrastructure use and planning. Such approaches can also help to further consolidate and develop industrial clusters in port areas and offers the opportunity for the creation of supply chain and industrial control towers in ports based on a collaborative network approach.

The aim of achieving supply chain integration hinges on co-operation. It is of pivotal importance that port logistics companies effectively keep investing and engaging in collaborative networks supported by powerful data collection and analysis platforms and IT systems. Port authorities can support this by actively participating in data sharing programs as well as investing in "sensory" infrastructure to support business processes and turn ports and infrastructure in general into "smart" infrastructure that is able to provide information as specific and suitable data to collaborative networks, thus enhancing and optimizing them.

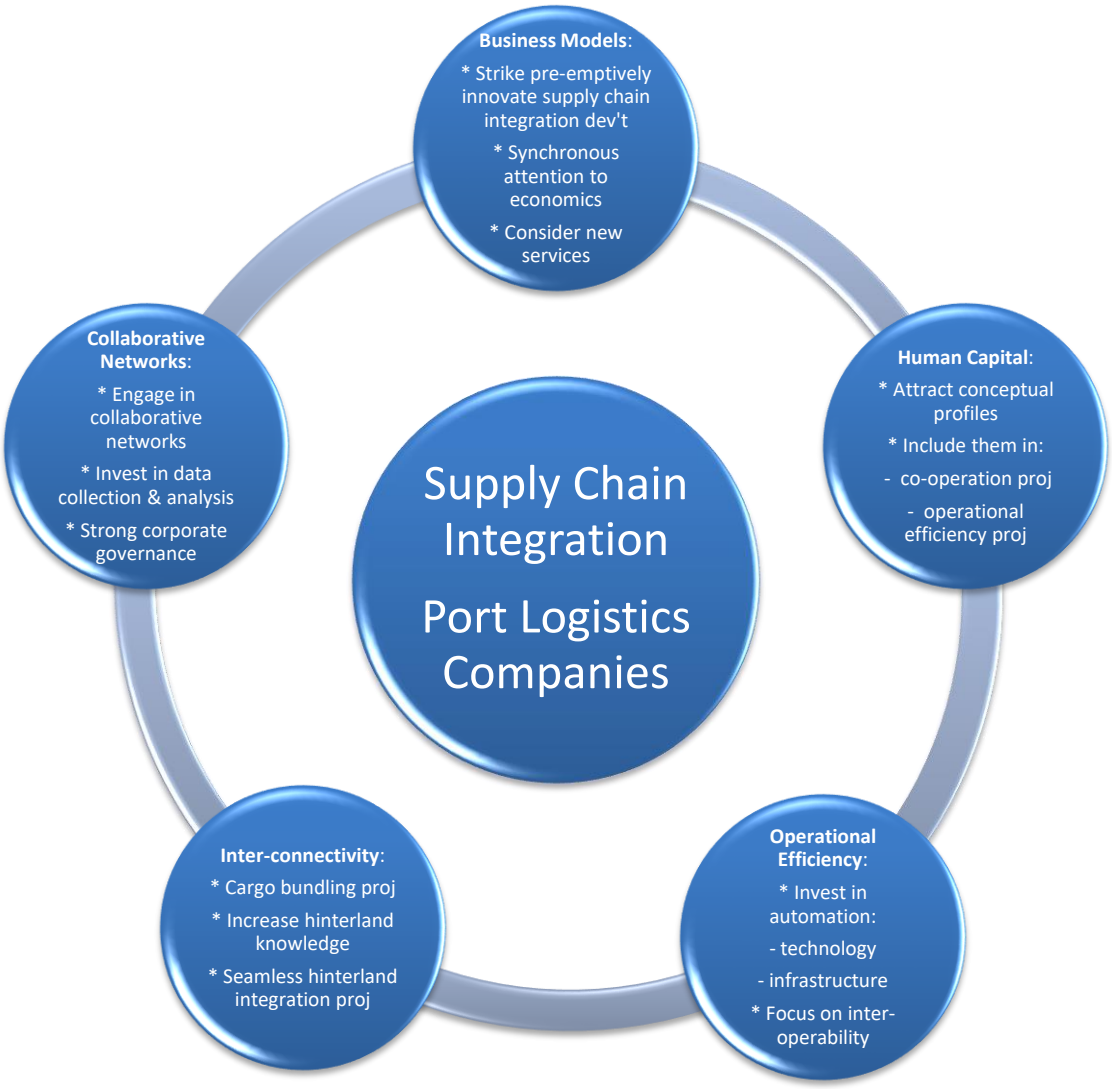
In the reality of the networked and automated society, ever larger volumes of data are available. This opens a window of opportunity for data experts to enter the world of logistics. In order to safeguard the position of port logistics companies and to make optimal use of (their) available data, a continued focus on co-operation between the respective supply chain stakeholders is needed.

This will undoubtedly put severe stress on data-integrity and therefore intense efforts to maximize cyber security efforts are critical. Effectively, the survey results demonstrated that lack of trust between parties and their risk-averse behaviour are seen as the most important barriers for increased co-ordination and co-operation.

The keys to successful coordination and co-operation are related to the creation of a trust regime and a more entrepreneurial and open mind-set towards coordination and co-operation. Thus, an environment of trust with a strong corporate governance should be created in order to boost entrepreneurial spirit in this context. Ideally, such trusted communities are to be initiated by the business itself, for example through a 'coalition of the willing' approach towards coordination and co-operation in port-related supply chains. The survey revealed port logistics companies and the industry see branch organizations and port authorities, specialised in community and inter-community development, as facilitators but not necessarily as leaders in port-related supply chain coordination and co-operation.
Existing and new initiatives will form the foundation layer for future proof gateways that integrate into transport systems that leverage smart collaboration with other gateways, including hinterland gates, leveraging smart modal shift concepts wherever possible.

Running such integrated transport systems means that responsibilities for the decision to physically allocate merchandise to a mode, transport unit or caretaker, will have to be rendered to the relevant, and most likely, local networks. Many platforms are being developed ranging from port networks to booking platforms or various forms of horizontal collaboration, across gateways and industries. Therefore, a clear need emerges for implementable network solutions that transcend the individual platforms.
Port logistics companies should be aware of this and, whenever possible, partake in the formation of such network of networks. One such concept could cover the regional initiatives in Flanders.

Figure 4.3. Specific recommendations for port logistics companies



Recommendations related to new business models

Port-logistics companies have an opportunity to (jointly) develop innovative supply chain integration solutions. Lack of action will result in the entry of "disruptors" coming from within or outside the logistics sector. New technology-driven companies, particularly those within the e-commerce space such as Google, Alibaba or Amazon, or as yet unidentified players, are likely to enter or have already entered the transport and logistics arena to give them a competitive edge or seeing a competitive opportunity to bring new models to the market.

As mentioned earlier, the main obstacles to achieve collaboration and therefore supply chain integration are the high levels of mistrust between partners and the risk-averse behaviour of companies. Generally new business models, including profit schemes and protection of data, are seen as the way to overcome this lack of trust. Integrating new business approaches and models will require an open mind towards change. IT serves as a key facilitator, while access to capital for such initiatives and systems to equally distribute costs and benefits among parties are also important in this respect.

When developing (the) other initiatives to further increase supply chain integration, there always should be a synchronous attention to weigh the impact of the innovation tracks on the future roles of the supply chain stakeholders and explore and define the business models that render these innovation tracks economically viable.
It is a project task often seen as a separate component, but it is absolutely paramount that business models are to be developed simultaneous to the other project parts of innovative collaboration tracks. Effective acceptance and implementation of new forms of collaboration will only be realised when it is clear what the possible roles, and therefore projected revenues, are within these new realities.
We believe that new business models in port-related supply chains supported by strong IT systems can generate new opportunities for attracting manufacturing industries, semi-industrial activities and VAL-related business to port areas and the economy at large. Transport, storage and transhipment of goods have always been considered as derived economic activities. If there is no extraction of raw materials, no production of intermediate and finished products or no consumption of these goods, there is no demand for cargo transportation, storage or handling. New business approaches in port logistics and supply chain integration could strengthen the role of the port logistics industry as a fully-fledged economic sector with its own dynamics, not just a derived activity. As such, a strong, forward-looking and competitive port logistics environment can be a catalyst for attracting new economic activities to port areas and the broader Belgian economy.

In this respect we would also like to refer to the opportunities of the integration of the synchromodality concept that could act as an enabler for a more sustainable supply chain and the introduction of circular economy or other innovative concepts.
Especially here, the role played by port authorities in leveraging more operational efficiency will reveal itself to be beneficial as efficient and effective logistics can make or break circular economy concepts. Considering their role as clusters, and as such they harbour mutually related businesses around transport, trade and also industrial productions, ports form a unique platform to attract material flows and develop a portfolio of recycling activities.
Port authorities therefore should develop a clear circular economy strategy.

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ABOUT THE PUBLICATION

This study analyses the changing supply chain environment in which Belgian/Flemish ports are operating. The central research question is 'how can ports and port-related companies deal with the rising requirements and challenges with respect to supply chain optimisation, integration and co-ordination?' To answer this question, we analyse the changing market environment of ports, changes in business models, the possible impact of disruptive technologies and the evolving role of market players. By doing so, the study provides insight in the drivers of future port logistics. A large-scale survey was conducted in the Belgian logistics and port industry. The survey outcomes are analysed in detail. The report concludes with a summary of the findings and a set of recommendations for the business communities in Belgian/Flemish ports.

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FURTHER INFORMATION

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