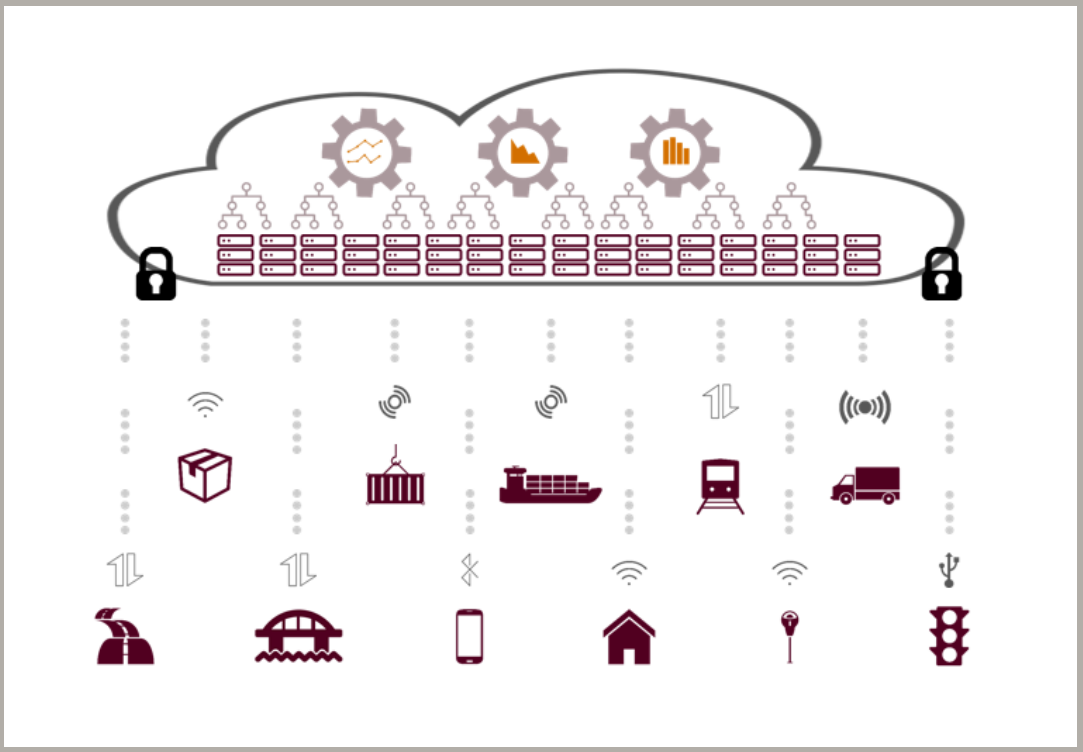
siapartners

INSIGHT

OCTOBER 2016

THE INTERNET OF THINGS IN TRANSPORTATION

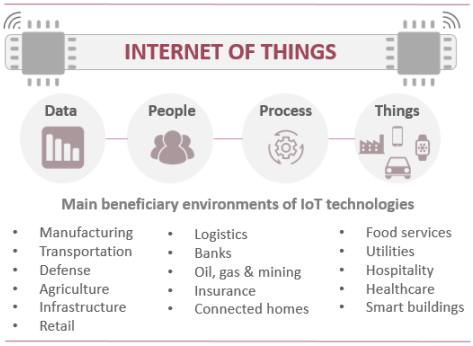
PORT OF HAMBURG CASE STUDY



The rise of the internet since the early 1990s has completely revolutionized modern society and has had profound changes on the way we live and the way we work. Scientists and leaders of industry agree that we are now at the dawning of a new technological revolution: the Internet of Things (IoT).

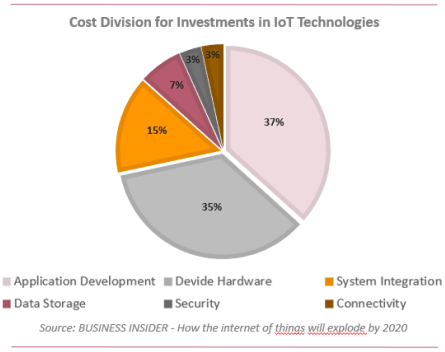
IoT basically consists of adding sensing and communication capabilities to a wide range of physical objects and connecting these objects to each other over the internet so that they can monitor their environment, report their status, receive instructions, and even take action based on the information they receive. Thus, any object can theoretically be turned into a source of information about that object. Using big analytics then reveals new meaningful information and insights on how these physical objects work and interact, which in turn allows us to improve their functioning. Furthermore, machine to machine (M2M) communication between devices combined with cross-platform data analytics allows these devices to interact with each other, much like humans have been interacting over the internet during the past decade.

In this Insight Paper Sia Partners explores the role of IoT in the sector of transportation and logistics, which is one of the early adopters of the technology. More specifically, the benefits, challenges, and lessons of IoT implementation in the industry are detailed in a case study on IoT in the Port of Hamburg.



The Rise of IoT

The sector has enjoyed a strong market demand for innovative digital solutions, aided by an ever increasing technologic adaptiveness of modern society, high availability of resources and falling tech costs. This has led to rapid technological advancement in the form of more diverse and efficient technologies: increased sensor quality means extended sensing capabilities in ever smaller sensors; better connectivity allows for fast transfer of large quantities of data; centralized cloud storing and data analytics lower the threshold to big data management, and extended battery life allows more physical objects to be connected. No wonder enterprise IoT deployments have grown by more than 400% since 2012[i], with businesses in the likes of Cisco, GE, IBM, Samsung, Google, Intel, Oracle making IoT investment a priority through R&D and the acquisitions of IoT start-ups. Continuous innovation is further being driven by the democratization of R&D financing through models such as Kickstarter and Indiegogo, and peer-to-peer learning through open source electronic prototyping (such as Arduino). So far, we are only at the beginning of the IoT revolution. The number of smart devices connected to the internet is expected to rise exponentially to anywhere between 24 and 50 billion in 2020, with computers, smartphones and tablets representing only 17 per cent of this figure (and the rest being all other physical objects like clothing, furniture, automobiles, home utilities, etc.).[ii] [iii]



Transport sector leading the way

Of the estimated €16,8 trillion value at stake in IoT over the next decade, roughly one tenth of that value is attributed to IoT in transportation and logistics.[iv] The sector is currently at the forefront of implementing IoT technologies, and has been quick to adopt it. This because innovation is a necessity to stay ahead, to increase bottom-line, and maintain to customer loyalty in this typically low-margin fragmented industry. IoT is perfect for meeting the need of increased supply chain transparency and rapid decision making in widely distributed networks.

IoT in transportation started with track-and-trace GPS technology to track shipments, and was further advanced with the introduction of RFID. Nowadays, IoT technologies can be seen across the entire logistics value chain including warehousing, freight transportation, and last mile delivery.

IoT in the Port of Hamburg

One institution in transportation leading the way in incorporating IoT is the Port of Hamburg. As one of the busiest ports in Europe (along with Rotterdam and Antwerp), modernizing through technological innovation is vital to the Hamburg port to maintain business growth and its international competitiveness while minimizing the port's externalities on the city's inhabitants. The port is a major economic driver for the region and the country. It comprises about one-tenth of the total area of Hamburg city, has over 260 thousand jobs dependent on it in Germany, and generates over €750 million in yearly tax revenue for the city of Hamburg.[v] The port handles the usual product mix of containers and bulk cargo (dry and liquid), both of which see a continuously steady increase in volume. Containers passing through it are expected to rise from 8 million in 2010 to 25 million in 2025, and total cargo handled from 121 million tons in 2010 to 296 million tons in 2025.[vi] The port is also an important node for the tourism industry as per year around 500 thousand cruise passengers arrive and leave from there.[vii]

The expected rise in traffic means that annual handling capacity must be upgraded, but space limitation due to the location of the port in the heart of Hamburg city means that this capacity increase must be derived mostly from a volume-adequate increase of productivity. At the same time, the negative externalities (e.g. traffic congestion, pollution, and road safety) caused by the seaport's activities on the lives of local citizens must be minimized, as well as the environmental impact of the port. In summary, the goal is to create a more efficient, safe, and low-cost port environment.

The strategic and operational plan detailing all ongoing and future projects aimed at achieving this goal are specified in the 2025 Port Development Plan issued in 2012 by the Hamburg Port Authority (i.e. the entity in charge of strategic planning, management, and governance of the seaport; henceforth "HPA"). The report contains a detailing of many non IT-related schemes that will aim to modernize and upgrade port infrastructure, and introduce green practices (e.g. renewable energy) in the port. Further, it also details the planned evolution towards a smart port, on which work started in 2011. This smart port consists mainly of three smart logistics pillars: Smart port infrastructure, intelligent traffic flows and intelligent trade flows.[viii]

Smart Port Logistics

Smart Port Infrastructure

As an investment in smart port infrastructure, the HPA is embedding sensors and communicative capacities in the port's main tangible assets. This includes smart lighting, which illuminates only those areas necessary, based on motion detection, which saves energy costs. Even further, lighting could in the future automatically be adjusted so that extra emphasis is placed on specific objects or locations that require attention during an activity, fed by an intelligent system which knows exactly what type of activity is taking place.

Sensors monitoring the use of assets (e.g. trucks, cranes, carriers, roads, etc.) and infrastructure (e.g. roads, parking lots, warehouse storage rooms, etc.) identify recurring underused capacity and allow for making adaptations to optimize utilization by e.g. relocating assets or rerouting goods flows. Smart storage systems with temperature, humidity, ventilation, and barometric pressure sensing ability in warehouses or containers can detect the needs of the cargo they contain and adjust these factors to increase product quality and decrease cargo damage. Cameras, opening sensors, and heat detection sensors along with alarm systems on the other prevent theft, and provide solid input for planning security improvements.

The life-cycles of port assets and infrastructure are extended, and the likelihood of defects that influence normal port activity is drastically reduced due to smart maintenance systems. Smart maintenance systems track the usage and wear-and-tear of fixed assets, and can pre-emptively detect damages and malfunctions, saving tremendous costs on reparation, replacements, and mitigation in case of a breakdown. They also extend the life-cycles of port assets and infrastructure, and reduce the likelihood of defects that would disturb the normal flow of activity in the port.

Finally, smart energy management is also a priority in moving towards a greener port, with Hamburg port accounting for over 40% of Hamburg's total energy consumption. As part of this plan, certain key infrastructure is equipped with smart meters that can monitor and control energy use by adjusting factors like temperature, pressure, electric drivers, etc. Smart energy efficiency systems should allow the port to save a yearly amount of 12 thousand tons CO2.[ix]

Traffic Management System

Over 40,000 truck trips strongly impact Hamburg port and city daily.[x] Managing this flow of traffic is an important task to keep the port attractive for business and the city attractive for its inhabitants. Starting in 2011 the Hamburg port authority placed 300 sensors on roads and bridges to track and manage the roadway traffic in the port. These provide the Port Road Management Center continuous updates on the status of bridges (i.e. open/closed) and traffic throughout the port. This data allows the traffic management system to make efficient decisions on directing traffic flows to optimize routs, and therefore minimize congestion and transit time for all customers. Traffic lights can be adapted accordingly and digital road signs currently communicate proposed directions, and currently HPA is working on directly suppling this information to the drivers' smartphones or on-board computers. Similarly, parking recommendations, which are made based on continuous parking space monitoring, allow all port visitors to find parking with ease. Automatic radar identification of ships and speed detection even imply that the traffic management can be done using not only the as-is status of bridges, but also the to-be status, which optimizes traffic even further in accordance with predicted delays. Thus, bridges can be planned to open and close just in time, and open only as much as needed for the ship to pass, and this same information is used for the routing of traffic. Mining of aggregated data over a longer time period then allows the Port Road Management Center to improve journey time predictions, and plan future traffic infrastructure investments or modifications to further optimize traffic flow. The Nautical Control Center on the other hand is the entity charged with the management of water traffic. Sensor-collected information on the conditions of the River Elbe, and the vessel traffic on port waters is continuously fed to the center, which can in turn share this information with all vessels to assure smooth sailing on its waters. Lastly, the Rail Supervision Headquarters similarly manage the rail transport.

Initially, road, rail and water IoT traffic systems were developed and implemented separately. Currently, HPA is moving towards an intermodal traffic center by integrating these systems and allowing for data interchange and feedback loops between them, as the different transport modes obviously interact with each other and cannot be seen as stand-alone.

Trade flows management

Thanks to automatic radar identification and RFID, port authorities know at all times what is moving around in the port, what the origin and destination are of goods, what the expected delivery times are, and what port services need to be deployed for proper handling (i.e. how to load and unload cargo). Data mining allows for the optimization of not only cargo routing, but also material handling schedules to minimize handling time. This information is shared with all parties involved in the movement of the goods through an integrated cargo information platform. Status sensors on cranes, pallet loaders, etc. help determining optimal asset use. Thanks to GPS and geo-referencing, pick-up services or warehouses can automatically be alerted of delays to readjust delivery or inbound schedules, and adapt handling requirements (e.g. for sensitive or perishable goods); and status sensors on cranes, pallet loaders, etc. The same technologies along with intelligent visual inspection also aid in reducing the amount of physical checks needed at custom control points, which in turn reduces labor costs and time at customs.

Partnership Structure

For the development of the smart port, HPA has worked with a large variety of partners. A first important partner is the city of Hamburg. The smart port development runs parallel with the IoT development in the city of Hamburg, which is currently moving to the smart city model by implementing e.g. smart lighting, bridges, parking lots, etc. Since the port is in the middle of Hamburg city and outgoing as well as inbound traffic to some extent pass through the outer city streets, it makes sense for the city and port's traffic systems to be aligned and communicate. Besides direct involvement in the smart port, the city and state of Hamburg as well as the Federal Ministry of Transport, Building and Urban Development of course also play a pivotal role to the port's economic viability through the maintenance and expansion of inland transport infrastructure, and the expansion and modernization of industrial parks outside the port area.

Besides public partnerships, HPA has also formed a range of private partnerships with technology providers for the development of the smart port, to allow fully integrated customized solutions to be built. HPA's main IT solutions providers are Cisco, SAP, and Deutsche Telekom.

Smart Port Challenges

Below we list some of the main challenges HPA has had with the implementation of IoT in the port.

Heterogeneous technologies

Creating a smart network of things that interact with each other requires the integration of many different technologies proprietary to different business processes, different actors in the logistical chain, and even different parts of the world. The large disparities in data types, as well as the different types of equipment, operating systems, and technological standards pose a great challenge for centralized data management and interchange. In order to resolve this issue, HPA's IT providers need to continuously work on the development of a uniform central intelligence system, that is able to communicate with all connected devices in a common language. Key here is focusing on a modular approach and open technology standards, which enable the platform to continuously add new modules that can be integrated within the existing system. It is because of this that HPA's technologic partnership structure consists of a limited number of providers who provide multi-dimensional services over a long servicing period.

Fear for transparency

The IoT is a technology dependent on the free flow of data from smart devices to a central platform that coordinates the aggregation, analysis, and interchange of this data. However, many competing firms pass through Hamburg's port, and they are often very hesitant to share information with a central authority that will aggregate this information with that of competitors. Therefore, HPA has had to invest heavily in not only providing a secure data management system that only shares relevant data with the concerning parties through an encrypted approach, backed up by confidentiality agreements, but also communicating this clearly to these same companies.

Business process reengineering (BPR)

IoT requires not just the adoption of a new technology, but the rethinking and reengineering of entire business processes linked to it. This poses an obvious challenge, which requires much time and effort to get right, along with input and feedback from all stakeholders. Proper change management here is also critical to get the stakeholders to see the benefit of the change, and learn how to work within the new system. Prototype testing with small-technology integrations that can offer an insight into the functionality and benefits for example have proven to be an effective strategy to deal with this issue.

Best Practices

As well as alerting us to some of the challenges of IoT, Hamburg's smart port presents a useful case to extract a few important lessons for the industry. Firstly, key to developing a cohesive IoT system is an **inclusive stakeholder approach** that incorporates the requirements of all stakeholders affected by the business change (i.e. shippers; trucking, rail, and ocean carriers; customs authorities; terminals; contract warehouses; parking providers; port officials; city of Hamburg, industrial companies across the port; citizens; etc.). IoT projects are **typically long-term investments**, but this must be done right from the start with the reengineering of business processes. First step is identifying the main business need which the IoT system should adhere to, followed by a detailing of the to-be business process, and then an operational analysis for identification of the main technological requirements. **Cross-functional** teams are especially useful here to consider the full range of business requirements, IT-elements, and the regulatory environment, and provide an end-to-end view. As it is unlikely that a single vendor can supply all the elements necessary for a seamless IoT solution, a strong **partnership** structure must be developed with dedicated professionals, as well as with public institutions. Proper change management is also critical to gain the support of all stakeholders, alleviate transparency issues, and make sure all concerned actors properly adopt the new technologic adaptations. Finally, a flexible **modular** approach must be a priority to allow project oriented development of IoT to evolve into a fully **integrated system** with cross-platform operability, which encompasses all heterogeneous business processes (verticals and horizontals), parties, technologies, and modes of transport to the same network. This requires special attention to the early development of standards and protocols regarding the characteristics of the sensors, the format of the collected data, etc. The end goal should be to create a cross-functional extended supply chain view that begins with a shipment from another port and can extend to inbound truck drivers hundreds of kilometres outside of the port.

Conclusion

The Internet of Things is indeed the "next big thing" to take over the world of business in the next coming decades, as we will witness the rise of smart homes, smart factories, smart cities to what futurists call the "smart planet". Business IoT solutions will be widely adapted in manufacturing, agriculture, healthcare, infrastructure, mobility, warehousing, retail, energy, communications, transportation, and beyond.

On a personal, IoT can help us to save time, increase our health, comfort, convenience, safety, and knowledge, as well as raise our productivity and increase our customer experience for many services. It can support environmental sustainability by saving resources and energy, while decreasing waste. In business, it presents the opportunity to increased knowledge, which in turns leads to better and faster decision making, more efficient business processes, and the identification of new value sources. IoT is also the next step towards large scale automation, especially when combined with machine learning. It can bring forth significant cost savings by e.g. eliminating redundancies (e.g. empty miles) and waste, improving asset efficiency (e.g. platooning [xi]) and expanding life cycles, and maximizing asset utilization. It also allows businesses to better identify opportunities and anticipate threats, and completely reimagines the control they can exert over their assets. In transportation, IoT can help to fulfil orders right (i.e. right products, time, place, quantity, quality), can decrease lead times and generally makes supply chains more flexible and adaptable. It can help avoid stock-outs through improved real-time information on inventory levels in combination with automatic replenishment, and anticipatory shipping. It can also increase the safety of drivers (e.g. assisted driving or automated driving preventing collisions, signalization of fatigue, etc.) and workers (e.g. connected forklift to prevent collisions). Nevertheless, much of the potential of IoT is currently still beyond our imagination, and only time will tell how this technologic evolution will shape itself.

However large the benefits of IoT might be, the road to getting there is not without challenges. For one, there are many blind spots we do not yet see. Public policy around the topic is also lagging, which leads to uncertainties for many businesses. Technical issues are a major hurdle to be overcome (e.g. constraints on the number of available IP addresses for connected devices, inter-operability between heterogeneous technologies), and for IoT technologies to really take off, they will need to be highly functional: i.e. robust, and easy to install, configure and use (e.g. "plug-and-play"). Security and privacy are major issues, as connecting things to the internet opens possibilities to gain unauthorized access and control to those things, as well as valuable information theft. Thus, cybersecurity will be an integral part of every IoT project. Finally, despite falling tech-costs, one cannot underestimate the costs related to all the hardware, software, security, design, data¬ flows, supporting infrastructure (e.g. data storage, & analytics), business process reengineering, and change management.

The case study of the Hamburg smart port has proven that given the right approach, investing in IoT will yield results. Already, carriers and logistic providers are noticing a fall in their time spent in the port thanks to the increased operational efficiency. Finally, given the indispensable role that the internet has come to occupy in our personal lives and in business in its short existence, a future where things communicate and interact online just as we do now is not as far off as some might think.

Port of Antwerp's *NxtPort* Initiative [xii] [xiii]

The Port of Hamburg is obviously not the only global port with large-scale data management and IoT plans. Among others, Rotterdam started investing heavily in information exchange systems and a centralized data communications platform in 2009 through its *Portbase* initiative. Antwerp is also stepping up its game to increase the efficiency of nautical and hinterland port logistics through the recently announced creation of a digital data interchange platform, named *NxtPort*. Currently in project phase and driven by Flemish sector organization *Alfaport VOKA*, the aim is to create a financially self-sustaining data-commercialization company that will gather, centralize, store, analyze and exchange data from a wide variety of logistic actors in the port (i.e. shipping agents, freight agents, warehousing, customs, etc.), and thus create windfall profits through its data insights for each of these players. The project is currently being initiated with four applications that are meant to test and prove the added value of NxtPort: predicted ship arrival times, container weights signalization, digital transport instructions, and predicted container pick-up schedules.

YOUR CONTACTS

ROEL PEETERS

Senior Managers
+ 32 477 20 51 51
Roel.Peeters@sia-partners.com

SEBASTIAAN BAECK

Consultant
+ 32 2 213 82 85
Sebastiaan.Baeck@sia-partners.com

ABOUT SIA PARTNERS

Founded in 1999, Sia Partners is an independent global management consulting firm with over 700 consultants and an annual turnover of USD 125 million. The Group has 17 offices in 13 countries, including the U.S., its second biggest market. Sia Partners is renowned for its sharp expertise in the Energy, Banking, Insurance, Telecoms and Transportation sectors.

For more information visit: www.sia-partners.com . Follow us on Twitter @SiaPartners

Asia

Hong Kong
23/F, The Southland Building,
48 Connaught Road Central, Central,
Hong Kong
T.+852 2157 2717

Singapore
3 Pickering street
#02-38
048660 Singapore
T.+ 65 6635 3433

Tokyo
Level 20 Marunouchi Trust Tower-Main
1-8-3 Marunouchi, Chiyoda-ku
Tokyo 100-0005
Japan

Europe

Amsterdam
Barbara Strozzilaan 101
1083 HN Amsterdam - Netherlands
T. +31 20 240 22 05

Brussels
Av Henri Jasparlaan, 128
1060 Brussels - Belgium
+32 2 213 82 85

London
Princess House, 4th Floor, 27 Bush Lane,
London, EC4R 0AA – United Kingdom
T. +44 20 7933 9333

Lyon
Tour Oxygène, 10-12 bd Vivier Merle
69003 Lyon – France

Milan
Via Medici 15
20123 Milano - Italy
T. +39 02 89 09 39 45

Paris
18 bd Montmartre
75009 Paris - France
T.+33 1 42 77 76 17

Rome
Via Quattro Fontane 116
00184 Roma - Italy
T. +39 06 48 28 506

Middle East & Africa

Dubai, Riyadh, Abu Dhabi
PO Box 502665
Shatha Tower office 2115
Dubai Media City
Dubai, U.A.E.
T. +971 4 443 1613

Casablanca
14, avenue Mers Sultan
20500 Casablanca - Morocco
T. +212 522 49 24 80

North America

New York
115 Broadway 12th Floor
New York, NY10006 - USA
T. +1 646 496 0160

Charlotte
401 N. Tryon Street, 10th Floor
Charlotte, NC 28202

Montréal
2000 McGill College, Suite 600
Montréal QC H3A 3H3
T. (514) 926-2626

[i] Forrester Consulting, 2014, Internet-Of-Things Solution Deployment Gains Momentum Among Firms Globally, https://www.zebra.com/content/dam/zebra/press-releases/en-us/2014/zebra-tlp-final.pdf.
[ii] DHL & Cisco, 2015, Internet Of Things In Logistics, http://www.dhl.com/content/dam/Local_Images/g0/New_aboutus/innovation/DHLTrendReport_Internet_of_things.pdf.
[iii] Business Insider, 2016, *Here's how the internet of things will explode by 2020,* http://www.businessinsider.com/iot-ecosystem-internet-of-things-forecasts-and-business-opportunities-2016-2?IR=T
[iv] Cisco, 2013, Internet of Everything, http://internetofeverything.cisco.com/sites/default/files/docs/en/ioe_vas_public_sector_top_10%20insights_121313final.pdf.
[v] Hamburg Port Authority, 2012, The Port Development Plan to 2025, http://www.hamburg-port-authority.de/de/presse/broschueren-und-publikationen/Documents/port-development-plan2025.pdf.
[vi] Hamburg Port Authority, 2012, The Port Development Plan to 2025, http://www.hamburg-port-authority.de/de/presse/broschueren-und-publikationen/Documents/port-development-plan2025.pdf.
[vii] Marco Ferretti Francesco Schiavone , (2016),"Internet of Things and business processes redesign in seaports: The case of Hamburg", Business Process Management Journal, Vol. 22 Iss 2 pp. 271 – 284.
[viii] Marco Ferretti Francesco Schiavone , (2016),"Internet of Things and business processes redesign in seaports: The case of Hamburg", Business Process Management Journal, Vol. 22 Iss 2 pp. 271 – 284.
[ix] Hamburg Port Authority, 2015, Energieeffizienz und Smart Energy, http://www.hamburg-port-authority.de/de/smartport/energy/Energieeffizienz/Seiten/default(Standard).aspx.
[x] Forbes, 2016, The Hamburg Port Authority's Impressive IoT Project, http://www.forbes.com/sites/stevebanker/2016/04/01/the-hamburg-port-authoritys-impressive-iot-project/#5e02bd0d3d4c.
[xi] Sia Partners, 2016, Platooning toward sustainable road freight transport, http://transport.sia-partners.com/20160712/platooning-toward-sustainable-road-freight-transport.
[xii] Flows, 2016*, Privésector Antwerpse haven bundelt krachten in NxtPort*, http://www.flows.be/nl/trade/privesector-antwerpse-haven-bundelt-krachten-nxtport.
[xiii] Flows, 2016, *NxtPort-partners willen van Antwerpen maritieme Silicon Valley maken*, http://www.flows.be/nl/shipping/nxtport-partners-willen-van-antwerpen-maritieme-silicon-valley-maken