Smart Shipping on Inland Waterways

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Abstract. Inland shipping has been struggling with a shortage of skippers for several years. This means, among other things, that smaller vessels disappear and the smaller waterways are no longer used. In addition, it is also difficult for inland shipping to compete with road transport. In time, this will cause a reverse modal shift: cargo will be brought back from the waterway to the road. However, the road is already dealing with a lot of congestion while the potential of the waterway is being used less and less. This will lead to major mobility problems.

Over the years, an international consensus has grown that the automation of vessels can be a mean to solve a large part of the above problems and to revive transport via the waterways. In this way, the great pressure on our roads will also be reduced.

In order to gain a better insight in the possibilities of Smart Shipping, the PIANC WG 210 was established in 2019. The PIANC INCOM WG 210 Report on Smart Shipping on Inland Waterways has been published in March 2022. This report researches the impact of Smart Shipping developments on the physical and digital infrastructure and on traffic management, with focus on inland waterways. Smart shipping developments were viewed from the perspective of infrastructure providers and traffic managers of inland waterways to stimulate and maximize the deployment of Smart Shipping.

The report includes an analysis of the current (until 2019) Smart Shipping developments, what is currently lacking to stimulate Smart Shipping developments, as well as recommendations for the future that can be picked up in other PIANC working groups or research groups. This paper will highlight the findings of the WG and will zoom in on some more concrete examples of Smart Shipping in Belgium, where de Vlaamse Waterweg nv is monitoring a test area in which several 100s of test have taken place since 2019. Recent international legal initiatives will also be described.

Keywords: Smart Shipping · Automation · Automated inland vessels · Projects · Regulation

1 Introduction

Inland shipping has been struggling with a shortage of skippers for several years. This means, among other things, that smaller inland waterway vessels disappear and the smaller waterways are no longer used. In addition, it is also difficult for inland shipping

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to compete with road transport. In time, this will cause a reverse modal shift: cargo will be brought back from the waterway to the road. However, the road is already dealing with a lot of congestion while the potential of the waterway is being used less and less. This will lead to major mobility problems.

Over the years, an international consensus has grown that the automation of inland waterway vessels can be a mean to solve a large part of the above problems and to revive transport via the waterways. In this way, the great pressure on our roads will also be reduced.

In order to gain a better insight in the possibilities of Smart Shipping, this paper will go through the highlights of the PIANC INCOM WG 210 report on Smart Shipping on Inland Waterways. The PIANC WG 210 was established in 2019 and published its report in March 2022. In this paper an overview of the current regulations concerning automated shipping will be presented. Next to that some ongoing projects in Belgium will be discussed.

2 Pianc Findings on Smart Shipping

As digitalization broadens the possibilities for new business developments, Smart Shipping solutions are finding their way into the market, ranging from the development of inland waterway vessel trains, remote controlled ships to small(er) drone-like platforms for transportation of goods and people.

The new PIANC report focused on the interactions between autonomous vessels and the infrastructure, the role of the authorities and regulations with regard to Smart Shipping. Smart Shipping developments were viewed from the perspective of infrastructure providers and traffic managers of inland waterways to stimulate and maximize the deployment of Smart Shipping. An overview of recent Smart Shipping developments and use cases were analyzed in order to define the gaps that are prohibiting the further deployment of Smart Shipping developments. Possible solutions to cope with these gaps and recommendations for the future were described. These can be picked up and analyzed further in other PIANC working groups or research groups.

The biggest challenge as defined by PIANC WG 210 is the switch from human to machine, as many tasks, performed by humans on vessels as we know them today, might be executed by machines on automated vessels. Standards in communication today are human centered, but in the future they should also be machine-optimized, so that both human and machine can work with them. Therefore, collaboration with knowledge institutions and standardization organizations is necessary.

Next to that, more test areas should be created in order to create a safe space to test different technologies on their maturity. Collaboration between governments and private partners is necessary as the former can create the overall framework to make smart shipping possible but only the latter can develop specific technology and have in-depth expertise on specific topics. Collaboration is needed so that the overall framework answers the needs of the sector and the technology can be tested in a safe environment.

The inland waterway sector is not fully aware yet of all possibilities that Smart Shipping can offer. It is therefore important to raise awareness about the positive change Smart Shipping can bring and the problems it can solve. More awareness will

increase the amount of R&D. Also learning from other sectors that work on automation is something that could be done more.

A last recommendation is to use more sailing simulators in order to train the crew for new ways of navigating an automated ship[1].

3 Regulation on Smart Shipping

The area of law surrounding Smart Shipping is both emerging and relatively untested. That is, the development of emerging Smart Shipping technologies is challenging current applications of legal regimes governing Smart Shipping operations. This, in turn, spurs significant debate in the domestic and international legal communities. Technology has outpaced the relevant regulations. Consequently, stakeholders and scholars continue to assess the use of Smart Shipping operations under the existing regulations, laws, treaties, and conventions and they have yet to reach universal consensus. Therefore, the PIANC report gives a general overview of the main international inland water transport legislation that could be relevant to Smart Shipping and that might require adaptation in the future, as the first step towards an international regulatory basis for the commercial use of automated inland navigation vessels (Smart Shipping).

The regulatory framework relevant to Smart Shipping for Europe, China and the U. S. has been reviewed based on the following nine policy areas: definitions; competences and crew qualifications; technical requirements for inland navigation vessels; presence of the boatmaster and crew members on board; responsibility and liability; communication between a vessel and a competent authority, and vessel to vessel communication; emergency situations; cybersecurity and inland waterway infrastructure. Those policy areas were chosen as they cover the main, most relevant aspects of Smart Shipping.

The analysis conducted in the report shows that there are important differences in the organisation of the regulatory and institutional framework between Europe, the U.S. and China. In Europe, there is a clear and strict separation between inland and maritime navigation regulations. Not only does Europe have a separate regulatory framework for inland and maritime navigation, there is also a strict separation between the competent institutions. Within Europe, several international institutions each have their own authority over inland navigation, such as the European Union, the United Nations Economic Commission for Europe, the Central Commission for the Navigation of the Rhine, the Danube Commission, the Moselle Commission, …At the national level, national/regional waterway authorities are responsible for managing inland waterways and drawing up inland navigation regulations. As a result, each member state has some kind of national inland navigation strategy. When looking at the way inland navigation is regulated in the U.S. and China, we find that there is no clear separation between inland and maritime navigation in terms of the competent institutions and the regulations themselves. Unlike in Europe, regulations are of a more hybrid nature, with

[1] PIANC INCOM Working Group 210, Report on Smart Shipping on Inland Waterways (2022), 41–48.

certain regulations applying to both inland and maritime navigation. The analyses also showed that the U.S. and China do not really have a clear structure of governmental institutions with exclusive responsibility for inland navigation. In the U.S. inland navigation is managed by a collection of federal, regional (states) and local agencies, each of which is partially responsible for inland navigation and partially for maritime navigation. As a result, the US doesn't really have a national inland navigation strategy. In China the roadmap is to gradually build up a guidance, standards, and rules in different levels for inland and maritime navigation particularly. In the meantime, the systems and platforms for testing and measurement of intelligent ships should be established with detailed steps and protocols. Without functional testing regulations, practical applications are hard to be issued by administration. All in all, China would like to establish the ability of testing in short term and a series of standards in the long term.

Owing to the difference in governance structure and the way inland navigation is regulated in Europe, China and the U.S he concept of automated navigation is also handled differently from a legal/regulatory point of view. When considering the situation in Europe, we find that it is first of all necessary to adapt existing inland navigation regulations and to subsequently consider the potential development of new regulations for automated inland navigation. In China, the China Classification Society (CCS) leads the regulations for ship building while the Maritime Safety Administration (MSA) leads the rules and regulations for crew-related training and management. Due to the differences between inland vessels and seagoing ships, some items of the existing rules and guidance may not be applicable for inland vessels.

In conclusion we can say that the analysis conducted in the report shows that there are important differences in the organisation of the regulatory and institutional framework between the three regions studied. This does not mean, however, that synergies regarding standardisation work should not be undertaken. For instance, in the field of River information services (RIS), similar technology blocks and associated standards (with sometimes regional adaptations) can be used. For Smart Shipping, it remains very relevant to continue the monitoring of the evolution of the regulatory frameworks in the three regions, because rules/standards developed in one of the regions could usefully inspire the others and then facilitate and speed up the development of Smart Shipping.[2]

4 Projects Findings on Smart Shipping

In Belgium several projects on Smart Shipping are already ongoing and some of them are finished. This Chapter gives an overview of the most important projects and their findings. Furthermore, attention is also drawn to an international project that will test in Belgian waters, the Horizon 2020 AUTOSHIP project.

[2] PIANC INCOM Working Group 210, Report on Smart Shipping on Inland Waterways (2022), 16–26.

Overall, no big incidents happened during testing. The companies also discuss needs for improvement regularly with the waterway authority. Thanks to the fact that communication is very transparent during testing, all tests have been successful so far.

4.1 Seafar

Seafar is a company that provides services to help operate unmanned and crew-reduced vessels. They support and control automated ships via their Control Centre in Antwerp. Seafar has already received several approvals for testing in the Flemish region of Belgium.

4.1.1 Testing Unmanned Ships

Since October 2019, tests have been carried out in the Westhoek region on the river Yzer and the Plassendale-Nieuwpoort canal with Watertruck X, a CEMT class II bulk carrier on behalf of company Decloedt. The project went through different stages of automation. The first few weeks were sailed with a full crew (phase 1). When the captain had sufficient contact with the ship, the captain was moved to the Remote Control Center (RCC) (phase 2). A second captain remained on board, along with the rest of the crew. The waterways were monitored from the RCC and more and more was controlled from the RCC itself. The captain on board had ultimate responsibility and intervened when necessary. In a third phase (phase 3a) the captain was removed from the ship and only a technical superintendent remained on the ship. This person could only intervene if the captain in the RCC gave him the command to intervene. The last phase (phase 3b) consists of complete control from the RCC with nobody on board of the ship anymore. The modalities for all phases were laid down in an experimental agreement in 2019. From 2019 until now (2021), 5 changes were made to this experimental agreement via addenda:

1. Since April 2020, additional permission has been given to deploy two additional Watertrucks on the same route: Watertruck VII and Watertruck VIII. In phase 2 there was a separate skipper on the SCC for each vessel.
2. Since July 2020, permission has been given to switch to the first part of phase 3, where there is no crew. In phase 3a, testing is carried out with the permanent presence of a technical superintendent on the ship. The responsibilities of the technical superintendent, as well as those of the skipper in the SCC were laid down in the addendum to the experimentation agreement. For example, the skipper always had ultimate responsibility and the technical superintendent was not allowed to sail longer sections and only bring the ship to safety on the instructions of the skipper.
3. After Seafar completed a full year of testing in October 2020, they were granted an extension to test for an additional year.
4. Since March 2021, Seafar has received additional permission to operate at night and move to phase 3b: testing without crew on board, but with full control from the SCC. Seafar has developed safety procedures for this and they have tested them during the phase with crew on board so that the ship can continue to sail safely once it sails unmanned.

5. On October 18, 2021, the test was extended for another year.

Seafar and the Vlaamse Waterweg nv are in regular contact and each addendum was prepared via a project change application, an updated risk analysis, gap analysis and ConOps and various evaluation meetings. Since April 2020, Seafar also received permission to sail with a (different) Watertruck on the Leuven-Dijle Canal (on behalf of Celis). The actual tests only started at the end of October/November 2021. The phases that will be followed here are the same as for the tests in the Westhoek. The Watertruck vessels are self-propelled barges, certified under Flemish regulations, in accordance with Article 24, second paragraph, of EU Directive 2016/1629 with regard to exemptions for vessels that travel limited routes of local importance or in port areas.

4.1.2 Testing with the Aim of Crew Reduction

Since June 2020, Seafar has also been testing the vessel Gamma, a CEMT class I bulk carrier, owned by Gitra BVBA, on the Bocholt-Herentals canal and the Brussels-Scheldt Sea Canal. This ship is manned: the captain is always on board. The ship therefore sails according to current laws and regulations. However, the ship is controlled from Seafar's RCC. The responsibility lies with the skipper on board. This project was completed at the end of 2021.

Since March 2021, the inland vessel Tercofin II (CEMT class Va - dry bulk/container) has been sailing between the Port of Antwerp and Liège, via the Albert Canal. There will always be crew on board, but control is with the RCC. The efficiency of the ship will be increased by supporting the ship's crew. This makes it possible to sail for longer with the same number of crew members on board, without exceeding the sailing and rest times. Work was also carried out in two phases. In phase 1, the crew on board will consist of 1 captain and 1 sailor instead of 2 captains and 2 sailors. The rest of the crew is located in the Seafar Remote Control Center. A team of 3 captains and 2 traffic controllers in the Remote Control Center will be in control of the ship. A Captain and Traffic Controller in the Remote Control Center work in 8 h shifts. The addendum to the experimental agreement allows the transition to phase 2 from March 2021. The ship is currently sailing with 1 mate and 2 sailors on board and 1 captain is present in the SCC, who is responsible for the ship. In March 2022 Seafar was granted an extension to test for an additional year.

Since February 2021, the container ship DESEO has been sailing between Zeebrugge and Antwerp. For this application, advice was given by the Vlaamse Waterweg nv, but the license itself was granted by the GNA, the authority for the Sea-Scheldt, which exists out of different governmental agencies from Belgium and the Netherlands. The ship is currently supported from the RCC in Antwerp with a full crew on board. Since August permission from GNA to sail the entire trajectory in control from the RCC, but the full crew still remains on board. This project is also working towards crew reduction.

4.2 DEME

DEME has been testing the autonomous vessel Marine Litter Hunter (MLH) at the Scheldt bridges Temse-Bornem from October 2020 until October 2021. In the first

phase, testing was carried out with crew and since March 2021 a switch has been made to unmanned navigation. The MLH sailed autonomously and took certain mitigating actions itself in the event of problems. In case of unforeseen problems, a supervisor could help the MLH if necessary. Therefore, a responsible person always was designated as an "Autonomous Ship Supervisor", provided with a valid navigation license, to supervise the operations of the MLH from a distance.

The set-up consisted of a combination of a fixed installation that continuously removed "passive" floating waste from the water and a mobile system that "actively" collected larger floating debris, which can be harmful to shipping in the Scheldt. This mobile part was responsible for the part where shipping is allowed and focuses on larger floating debris (>200 mm) that can cause damage to shipping, such as ropes / mooring lines, fishing nets, wooden beams, pallets, and plastic items,…

The mobile system consisted of:

- a camera detection system by means of Artificial Intelligence (AI);
- the Marine Litter Hunter: The workboat that was fully electrically powered and equipped with an open push blade for actively catching floating debris and bringing it to the trap;
- a docking station, which was located at the Belgomine quay nearby the bridge.

Large floating waste and objects (such as tree trunks) were detected by smart cameras (AI) installed on the old Temse bridge at the height of the navigation channel. The waste was gathered in the collecting pontoon and was regularly transferred into a container by means of a crane equipped with a grab. The fixed crane was remotely controlled by an operator, using VR-3D vision technology. The container was placed on the workboat. When the container was full, the vessel autonomously took it to the docking station, where the container is unloaded by means of a transhipment crane on the Belgomine quay. The waste was transferred to a DVW waste container.

4.3 AUTOSHIP

AUTOSHIP is short for Autonomous Shipping Initiative for European waters. It is a project with several European partners and it is subsidized by the European Union under the Horizon 2020 program. The aim is to hold two demonstrations with ships equipped with Smart Shipping technology, with a focus on transport. One demonstration takes place in Norway and focuses on Short Sea shipping. Here there will be a limited crew on board of a fish feeder ship and the goal is crew reduction. The other demonstration takes place in Flanders and focuses on transport on inland waterways, with a ship from Zulu Associates. The route goes from the lock in Wintam to Willebroek and then back via the Rupel. During this demonstration there will be no crew on board and full control will therefore be at the shore control centre on shore.

The technology with which the boat will be converted is currently being developed by the Norwegian Partner Kongsberg. At the moment the shore control centre is being set up next to the lock in Wintam. Completion of the trajectory is planned for mid-2023 (this is still variable, depending on delays due to the corona crisis). The intention is to use the results from these 2 tests as optimally as possible. After all, they provide us with an enormous amount of information about legislation, security, socio-economic

factors and cybersecurity and this will be analyzed. Furthermore, the aim is to develop a roadmap, standards and methods that can be used by future developers and thus further the commercialization of automated sailing.

5 Conclusions

This paper highlighted the findings of the WG and zoomed in on some more concrete **examples of Smart Shipping in Belgium**, where de Vlaamse Waterweg nv is monitoring a test area in which several 100s of test have taken place since 2019. Recent international legal initiatives have also be described.

Reference

(2022) PIANC INCOM working group 210, report on smart shipping on inland waterways. 16–26:41–48