Maritime National Single Window — A Prerequisite for Sustainable Seaport Business

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Review

Maritime National Single Window—A Prerequisite for Sustainable Seaport Business

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Abstract: This paper presents a comprehensive review of National Single Window concept and its impact on sustainability in maritime transport and seaports. The theoretical frameworks of sustainability, maritime transport, seaports, the National Single Window and the Maritime National Single Window is provided. The importance of stakeholder connectivity in maritime transport and seaports in improving sustainability is demonstrated, as well as the advantages of smoother data exchange through global analysis of National Single Window examples, the majority of which present national and regional best practices and initiatives. Empirical data has been provided in order to demonstrate the impact of National Single Windows and Maritime National Single Windows on seaport sustainability (economic, environmental, and social).

Keywords: maritime national single window; seaport business; sustainability

1. Introduction

The Single Window concept, which enables all stakeholders involved in the business process to input the data and information used by other stakeholders only once (by using a single point of data entry and storage) has significantly changed the process of information exchange between transport stakeholders, particularly in maritime transport and seaport business. Implementation of a National Single Window as a single-entry point has the potential to harmonize and standardize the information exchange between commercial and administrative stakeholders and to provide fast, reliable, paperless, and efficient transactions. Interestingly, the first Single Window implementations did not necessarily involve information and communication technologies (ICT), instead, they were envisaged as one-stop-shop trade facilitation services at national cargo entry points. With the development of technology and networking, digitalization became a staple concept around which Single Window implementations are developed and implemented. The most commonly accepted definition of a Single Window is the one provided by the United Nations Economic Commission for Europe (UNECE) Recommendation number 33: "A facility that allows parties involved in trade and transport to lodge standardized information and documents with a single-entry point to fulfil all import, export, and transit-related regulatory requirements" [1]. The first electronic Single Windows were set up at the beginning of 2000s in early, adopting countries such as Ghana, Singapore and Senegal [2].

On a global level, the largest percentage of cargo is transported by sea, and it accounts for 80% or cargo by volume and 70% by value [3]. According to the United Nations Conference on Trade and Development (UNCTAD), world seaborne trade continues to grow and sustainability becomes vital for seaport business [4]. Economic, environmental and social aspects of seaport sustainability can be further strengthened by applying the (Maritime) National Single Window (MNSW). Thus, the implementation of (Maritime) National Single Window is getting the prominent and decisive role in seaport business sustainability. This unique maritime interface will align and improve interoperability

between the various systems, which will in turn facilitate the exchange and reuse of data. Furthermore, the (Maritime) National Single Window provides the possibility to upgrade from the micro-national to macro-regional system to contribute even more to sustainable seaport business. Considering the number of various involved stakeholders, it is a general consensus that the implementation of a (Maritime) National Single Window systems in maritime transport, on national, regional, and supranational levels is of great importance for the facilitation and enhancement of cargo flow, increase of security, and compliance with legislative requirements.

This paper researches the concept of National Single Window and its applications, with special emphasis on maritime transport and seaports (Maritime National Single Window), and its impact on sustainability. The research problem stems from the increased costs and the lost time due to the archaic or inadequate execution and monitoring of business processes. The goal of the paper is to research National Single Windows and Maritime National Single Windows from economic, environmental and social aspects of sustainability. This paper presents a comprehensive review of research papers dealing with this topic, providing a better understanding of NSW and MNSW implementation and its impact on sustainability in maritime transport and seaports.

2. Research Methodology, Data and Scope

In this section, the methodology, review scope and selection of researched papers are presented. The search for papers was conducted according to the time limitations (2010–2019) although most of the papers were published in 2018, due to the recent popularity of the topic in academia and business. To ensure that possible useful findings from various fields are not excluded, the authors did not limit the queries to a specific field or index. Non-English journal papers were excluded. Table 1 (created according to Shi et al. [5]) shows journals, books and conference papers taken into consideration. In total, several hundred literature units were studied. Thirty-six papers were selected from 12 journals and six papers from six conferences, as shown in Table 1. Two books relevant to this topic were also included.

Furthermore, the importance of (Maritime) National Single Window in seaport sustainability was demonstrated through the analysis of various global applications and experiences. For this purpose, the authors have studied several hundred other sources, out of which 55 official web pages (e.g., Deloitte, UNESCAP, Doing Business etc.) and other relevant sources related to MNSW implementation and its impact on sustainable business in seaports were included. The relevant findings have been summarized, demonstrating how MNSWs affect the sustainability of business processes and overall sustainability. Ultimately, authors have summarized the findings and categorized them according to appropriate aspects of sustainability (economic, environmental and social).

Table 1. Journals, books and conferences related to sustainability and (Maritime) National Single Window ((M)NSW) research from 2010 to 2019.

No.	Journals	2010–2017	2018	2019	2012–2019
1	MDPI Sustainability	5	14	6	25
2	MDPI Logistics	0	1	0	1
3	Logistics & Transport	1	0	0	1
4	Journal of Cleaner Production	0	1	0	1
5	Transportation Research Part D: Transport and Environment	1	0	0	1
6	Transactions on Maritime Science	0	1	0	1
7	Ocean & Coastal Management	0	1	0	1
8	Soft Computing	0	1	0	1
9	Journal of Korea Port Economic Association	1	0	0	1
10	Transportation Research Record: Journal of the Transportation Research Board	1	0	0	1
11	Asian Journal of Shipping and Logistics	1	0	0	1
12	Transportation Research Procedia	1	0	0	1

Table 1. *Cont.*

No.	Journals	2010–2017	2018	2019	2012–2019
	Books				
1	Springer International Publishing, Sustainable Shipping. Springer Nature Switzerland AG	0	0	1	1
2	M. Janić, The Sustainability of Air Transportation: A Quantitative Analysis and Assessment. Netherlands, Routledge: Ashgate Publishing, Ltd.	1	0	0	1
	Conferences				
1	5th International Maritime-Port Technology and Development Conference, MTEC 2017	1	0	0	1
2	Bled eConference eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future	1	0	0	1
3	CITEM Conference on International Trade, Education and Marketing 2012.	1	0	0	1
4	31st Bled eConference - Digital Transformation: Meeting the Challenges Conference Proceedings	0	1	0	1
5	International Conference on Science, Management, and Engineering 2018	0	1	0	1
6	MIPRO 2019, 42nd international convention on information and communication technology, electronics and microelectronics	0	0	1	0

3. Theoretical Framework

In this chapter, the authors provide a detailed review of relevant literature and previous research regarding the subject. In this respect, it is important to define the term "Sustainable development," which will be a basis for this research. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It consists of three main components: economic, environmental, and social sustainability, known as the "triple bottom line" [6]. Economic sustainability is created by producing various goods and services in a responsible manner. The dimension of economic sustainability is comprised of the elements that include technology and innovation [7]. Environmental sustainability means the ability to maintain the quality and the reproducibility of the natural resources [8]. Social sustainability is vital for businesses, as it contributes not only to business goals, but also to greater well-being, stability, and success of the surrounding society [7].

Transportation is a very dynamic activity that causes harmful emissions which are affecting the sustainable development. Almasi, Sadollah, Kang et al. [9] define transportation as a multimodal, multi-problem and multi-spectral system, as it involves different categories and activities, such as policy-making, planning, designing, infrastructure construction, and development. Furthermore, the authors consider the transport as one of the main contributing factors of economic growth and quality of life, but also as one of the main causes of environmental pollution [10]. In the transport context, there has often been a strong focus on economic outcomes, with less consideration given to social and environmental aspects [11]. The energy consumption related to transportation amounts to one-third of global energy consumption, making the transportation sector the second largest energy consumer after industry [12]. The transportation industry is facing new challenges related to the sustainability of the business models from the economic, environmental, and social points of view [13].

Transport sustainability has become an important factor of sustainable development strategy, due to the strong correlation between transport, economic, and social development, and particularly

because of its significant impact on the environment [14]. Bamwesigye and Hlavackova [15] have identified three core values of sustainable transport. First, sustainable transport should provide safe and consistent access to individual and societal basic needs, while securing both human and ecosystem health to ensure stability for future generations. Second, sustainable transport must have value for money through efficiency in operation and affordability, while offering various alternative transports means. Finally, the emissions control and global waste management should be the core goals of sustainable transport.

The overall goal of sustainable transport based on three core values should be providing mobility that safeguards regional economic development while at the same time ensuring a long-lasting future for natural resources [15]. Sustainable transport and logistics is proclaimed as a key area in which sustainable intervention can have the greatest impact in terms of enabling more sustainable trajectories [16]. To achieve and maintain efficient and sustainable transport systems, collaboration and co-operation between freight carriers is both critical and crucial issue. Effective collaboration between stakeholders across the supply chain results in reduction in inventories and costs and improvement in speed, service levels, and customer satisfaction [17].

As mentioned before, maritime transport is the main mode of transport in global trade and one of the cornerstones of globalization [18]. Thus, the integration of sustainability principles becomes crucial for all maritime transport stakeholders. Maritime transport sustainability is the ability to provide transport infrastructure and services that are: safe, socially inclusive, accessible, reliable, affordable, fuel-efficient, environmentally friendly, have a low carbon footprint, and resilient to shocks and disruptions, including those caused by climate change and other natural causes. To achieve complete sustainability goals in maritime transport, all three dimensions should be equally considered and improved [19]. Economic parameters to be evaluated include market access, connectivity, infrastructure capacity, trade competitiveness and transport costs. The environmental issues may include: Air emissions (pollutants and greenhouse gases), waste control, spills and pollution (e.g., oil and other substances), climate change impacts, biodiversity loss, and resource and energy depletion [19]. The social dimension may include safety, health, security, employment, and working conditions.

The maritime industry, including ports, shipping and logistics, has begun to embrace environmental guidelines and regulations to reduce environmental impacts and carbon emissions [20]. The Swedish Environmental Protection Agency has set up the national targets for shipping in the reduction of carbon dioxide (CO_2) in Sweden. Until 2050, the amount of CO_2 from shipping should be reduced by 20% [21]. Although the maritime industry is technologically advanced, innovations in the maritime sector have been primarily related to ship construction, oil and gas exploration, seabed exploitation technologies, and so on. Insufficient attention has been given to sustainability improvements. [22]. One of the most promising areas of maritime innovation is related to digitalization, including the development of smart ships, smart fleet, and smart global logistics [23], so the digitalization can serve as the basis for sustainable maritime transport.

A seaport is the main node of maritime transport, a link in the sea–land transport chain [24]. Seaports play a substantial role as a cluster of loading, unloading, and transshipment activities, and brokerage, warehousing, and storage services [25]. Seaports are essential for the support of economic activities in the surrounding areas [26]. Seaport business causes environmental pollution, noise, and congestion [24]. According to Di Vaio and Varriale [27] the environmental issue is primarily and usually associated with vessel and cargo handling operations, industrial activities in ports, port planning and expansion initiatives, and hinterland accessibility. According to Notteboom and Lam [28] terminal activities are the primary source of environmental impact of seaports, which can be summarized into the following categories: air emissions of ships at berth and terminal handling equipment (such as cranes and yard equipment); noise associated with cargo handling operations; and the environmental effects and potential congestion associated with landside operations of barges, rail, and trucks.

In the Delloite's "Study on Global trends to 2030: Impact on Ports Industry," sustainability is identified as one of the key issues for the future of seaports [29]. Slinger et al. consider the sustainability

as a fundamental requirement in seaport business [30]. Seaports are in a unique embedded position in the supply chain, which enables them to provide incentives to industry stakeholders in their efforts to improve the industry's sustainability. Sustainable business is inevitable for seaports also, due to the customers requiring sustainable and green supply chains initiatives that strengthen to the ports' sustainability [31].

Seaports are being pressured to respond to problems related to negative impact resulting from activities in the entire logistics chain [24]. Thus, more attention urgently needs to be paid to the environmental protection to ensure ports' sustainability while facilitating the development of port logistics in the coming decades [32]. The sustainable seaport business is the appropriate planning and management of seaports, balancing environmental, social, and economic interests through mediation and open dialogue. Furthermore, managing the different stakeholders and interactions among them is of the crucial importance in improving sustainable seaport business [33].

The concept of sustainability for seaports is focused to the integration of the environmentally friendly methods in the seaport business. Sustainable seaport business causes the minimum possible impacts, contributing to improving measures and controls for the quality of the air, water, noise, and waste [34]. Therefore, the concept of sustainable seaport business becomes a standard business practice. This model implies business strategies and activities that meet the current and future needs of the port and multimodal transport chain stakeholders, while protecting and sustaining natural resources and environment. Considering the three pillars of sustainability, Oh, Lee, and Seo [35] identified key management criteria for sustainable seaport business. An environmental management criterion includes environmental policy, reduction of environmental risks and collaboration between all stakeholders to develop a green supply chain. Economic management criteria include cost saving by using cleaner technologies, while social management criteria include the improvement of the welfare and working conditions, continuous training, and education, as well as supporting the social and economic activities of the seaport.

The efficiency of port sustainability addresses the comparative relationship between the input in terms of port resources and the actual effective outputs (including the economic, environmental, and social output) as a synthesized measure of the operational status and sustainable development potential of the port [36]. Sustainable seaport business contributes to strategic goals of seaports through increased revenue and market share; reduced cost of operations; reduced environmental and financial risk; more efficient use of financial, human, and natural resources; enhanced brand image; enhanced access to capital; increasing employee productivity; easier hiring and retention of best talent; improved relationship with key stakeholders; more efficient approval of regulatory permits, and an enhanced ability to maintain a license to operate and grow [30]. Seaports must secure the 'license to operate' and the 'license to grow' by operating and undertaking investments in a sustainable manner, preferably following the guidelines of international port-related organizations. As such, the American Association of Port Authorities is developing and regularly updating guidelines and codes of practice for green (sustainable) port development) [30].

Integrating the sustainability principles into all seaport activities is the aim of sustainable practices in seaport operations. Organizations and industries related to seaport business have progressively started to make sustainability issues central focusses in management activities towards efficiency and competitiveness [37]. Coordinated action between seaports and communities is vital for success in sustainable port businesses and operations [38]. The higher the level of coordination and integration among the stakeholders of port and supply chain, the higher the sustainability of the entire supply chain and of the port. From an economical and societal dimension, a port's sustainable operation is associated with the close coordination with logistics actors outside the port perimeter and an integrated approach to port infrastructure and resource planning. Government, customers, and various stakeholders are considered as the main actors that motivate firms to incorporate sustainability factors into their supply chain management schemes [39].

Seaports involve numerous cargo manipulation procedures, involved stakeholders and data that need to be exchanged.

Seaports have to improve their operations continuously, both commercial and administrative, in order not only to optimize their business but also to achieve sustainable growth in cargo volumes [40]. Information systems used to improve seaport operations can be divided into different types: Port community systems, vessel traffic services, gate appointment systems, automated gate systems, etc. [41]. The usage of ICT as a tool for conducting electronic business (with special emphasis on the electronic exchange of data and messages within the seaport systems) ensures efficient connection of different segments of business processes that take place among the various stakeholders of seaport operations [40]. The advantage of ICT is that they allow information to be processed and disseminated simultaneously and in real time [42]. The Ericsson sustainability report shows that ICT could help reduce global greenhouse gas (GHG) emissions by up to 15% [43]. There is clear evidence that ICT may positively influence enterprise competitiveness, but also social and environmental issues [44].

However, ship operators, masters, and agents are still burdened with having to fill in paper documents, which include repetitive information, and to distribute them to different government authorities, including port, maritime, safety, security, Customs, border control, and health authorities [45]. Modern transport and logistics environments, therefore, call for investments in an integral ICT solution implementation which will connect the (primarily administrative) seaport stakeholders—the National Single Window.

The Single Window concept permits the trader or transporter to submit all the data needed for determining admissibility of the goods in a standardized format only once to the authorities involved in border controls and using a single portal. It places the onus on the authorities to manage the Single Window and to ensure that the participating authorities or agencies are either given access to the information or are actually given the information by the managing authority. Further to this, it eliminates the need for the trader or transporter to submit the same data to several different border authorities or agencies [46]. Single Window may be considered as a trade facilitator. For UNECE and its UN Centre for Trade Facilitation and Electronic Business (UN/CEFACT), trade facilitation is "the simplification, standardization and harmonization of procedures and associated information flows required to move goods from seller to buyer and to make payment" [47]. Such a definition implies that not only the physical movement of goods is important in a supply chain, but also the associated information flows. It also encompasses all governmental agencies that intervene in the transit of goods, and the various commercial entities that conduct business and move the goods. This is in line with discussions on trade facilitation currently ongoing at the World Trade Organization [47]. Trade facilitation involves a wide and diverse range of public and private stakeholders seeking to establish a transparent, consistent and predictable environment for border transactions based on simple, and standardised procedures and practices [48]. In this respect, many countries and international organisations have recognized the numerous benefits of electronic trade facilitation, promoting the development and implementation of trade portals that allow business operators and governments to process trade information submitted in electronic formats, typically in one place, to all the concerned parties [49].

The Single Window concept, as mentioned before, enables all stakeholders involved in the business process to input the data and information used by other stakeholders only once. This is accomplished by using a single point of data entry, which is basically a unified, networked and interconnected ICT system. Such a system enables the interchange of information between various stakeholders by using a central data repository and by applying the agreed business procedures. The Single Window concept is especially useful in the international trade and transport procedures, which take place in seaport clusters [50]. "The Single Window is a national or regional facility mainly built around an IT platform, initiated by a government or ad hoc authority to facilitate import, export, and transit formalities, by offering a single point for the submission of standardized information and documents, in order to meet all official demands and facilitate logistics" [51].

The National Single Window system enables a single submission of electronic documents by the trader, such as a single data preparation and submission of a Customs declaration and duty payment for Customs release and clearance [52]. The NSW is also a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single-entry point to fulfil all import, export, and transit-related regulatory requirements [53]. The NSW refers to the implementation of a national system that will act as a single point of contact for the electronic submission and exchange of information between public and private stakeholders from different transport modes [54]. It is important to note that Single Window has evolved from the Customs automation era to trade information exchanges, from limited Single Windows connecting traders with a single regulation (e.g., Customs, port, etc.) to nationwide NSWs that allow all parties to submit standardized information only once to fulfil all regulatory requirements [55].

Maritime National Single Window also known as Maritime Single Window (MSW) (the name varies from country to country) is similarly defined as a National Single Window: A place where all information is entered only once and becomes available to various stakeholders [56], but related to the maritime environment. Its focus lies on data related to vessels, and not information about cargo and trading.

Apart from administrative stakeholders and procedures which fall under the scope of NSW, the commercial procedures also need to be performed in an efficient manner. In order to simplify the commercial procedures, a concept a port community system (PCS) was introduced. A PCS is a neutral and open electronic platform enabling intelligent and secure exchange of information between public and private stakeholders in order to improve the competitive position of the sea and air ports' communities. PCS optimises, manages and automates port and logistics processes through a single submission of data and connecting transport and logistics chains [57]. PCS helps the stakeholders of the port processes to reduce logistics costs through faster information flow, to deliver the cargo faster, to enable the flow of goods, and finally, to boost economic growth [56]. As a secondary consequence, it helps to reduce the externalities, such as pollution and harmful emissions [58].

4. Examples of (Maritime) National Single Window Implementation

In this part of the paper authors provide the review of NSW and MNSW examples which underline the impact and the potential benefits of NSW/MNSW on improving sustainable seaport business. Several general studies related to supply chain and shipping have been analyzed as background for this chapter. For example, in the OECD study "Contribution of trade facilitation measures to the operation of supply chains," the results have shown that harmonizing trade documents, streamlining trade procedures, making trade-related information available, and using automated processes could reduce total trade costs by 14.5% for low-income countries, 15.5% for lower-middle-income countries, and 13.2% for upper-middle-income countries. The study also states that the full implementation of Single Windows is one of the main facilitators in streamlining and simplification of procedures, affecting the economic aspect of sustainability [59].

Issues that occur (mostly due to inadequate data exchange) during the shipment process were reported by Maersk, one of the world's largest container shipping companies. Maersk analyzed the entire shipment process of avocado and roses from Kenya to Rotterdam in 2014. 30 different stakeholders were included in the shipment process and 200 communication issues were reported, with delivery time of around 34 days from farm to retailers, including 10 idle days for documentprocessing [60]. The entire shipment process was not sustainable because of increased man-hours, decreased employee productivity, inefficient use of human resources (social aspect of sustainability), increased costs due to unnecessary waiting (economic aspect of sustainability), etc.

Ferro, C., et al. [61] conducted a study about 12 selected trade facilitation mechanisms and determined that Single Windows generates one of the largest long-term cost savings, despite the highest setup costs and operating costs, and average implementation time of about four years. Their focus was on the economic aspect of sustainability. Furthermore, Wagner N. [16] analyzed several important sustainability topics in seaports based on sustainability reports and strategies of the largest

European seaports. Leading seaports, such as Port of Rotterdam and Port of Hamburg recognized the stakeholders' communication as one of the most important sustainability issues in seaports.

One of the most relevant examples of the evolution and implementation of National Single Window is the Port of Singapore. In 1989, the Port of Singapore implemented the first National Single Window "TradeNet" with the purpose of gathering various parties from the public and private sectors to exchange trade information electronically. The TradeNet is now used by approximately 2500 companies with 8000 users and providing nine-million transactions per year [62]. The implementation of TradeNet significantly reduced the processing time, which decreased from 2 to 7 days, to a 10 min maximum. Furthermore, document exchange has been transformed. Before TradeNet implementation, the number of documents in each transaction varied from four to 35. After the implementation of TradeNet, only one e-Form/e-Doc is necessary, with 24/7 submission instead of office open hours. The TradeNet is capable of handling more than 30,000 declarations a day; it processes 99% of permits in just 10 min and receives all monetary collections through interbank transactions [61]. Also, TradeNet implementation reduced the average fees charged, which decreased from \$6–\$13 to approximately \$2.10 (Singapore), affecting the economic aspect of sustainability. The faster data exchange includes the social aspect of sustainability as well, because accelerated data exchange enables improved communication and information exchange between stakeholders, decreased man-hours, increased employee productivity, etc.

A step further in Singapore's National Single Window evolution was the implementation of the TradeXchange system in 2007. The TradeXchange is a neutral and trusted integrated IT platform that enables the exchange of both business-to-business (B2B) and business-to-government (B2G) information, and seamless inter-connectivity among commercial and regulatory systems for the Singapore trade and logistics community to facilitate the flow of goods [63]. Trade permit application is often a manual and tedious process for many shippers, and retrieving copies of the approved permits from various logistics service providers (LSPs) adds to the time consumed. IBM Ireland Product Distribution Limited (IBM IPDL) in Singapore (with shipments that include strategic goods, which demand full accuracy in permit declarations) took the advantage of the functionalities of TradeXchange to integrate processes, reuse approved permit data, improve turnaround time, and increase efficiency. After submitting permit declarations through TradeXchange, IBM IPDL decreased the average man-hours from 578 to 102 monthly, achieving the savings of about 130,000 Singapore dollars annually [63], affecting primarily the economic (cost savings) and social aspects (decreased man-hours) of sustainability.

Being aware of the importance of the continuous improvement of NSW for the streamlineing of the trade and logistics processes of stakeholders, Port of Singapore has upgraded the NSW to a new level via the implementation of the National Trade Platform—NTP. The NTP is designed to be a trade and logistics IT ecosystem connecting businesses, community systems and platforms, and government systems. The NTP is a one-stop trade portal for business-to-government (B2G) and business-to-business (B2B) service and will completely replace TradeNet for trade-related applications and TradeXchange for connecting the trade and logistics community [64]. Specifically, it aims to be a [65]:

- One-stop trade information management system linked to other platforms;
- Next-generation platform offering a wide range of trade-related services;
- Open innovation platform allowing development of insights and new services with cross-industry data;
- Document hub for digitization at source that enables reuse of data to cut costs and streamline processes.

It is estimated that the NTP could potentially bring about up to 600 million Singapore dollars' worth of annual man-hour savings for businesses [66], including economic and social sustainable aspects of sustainability, as already mentioned above. The NTP encompasses the environmental aspect of sustainability as well (efficient use of natural resources, reduced number of trees cut down, and reduced environmental impact of travel—less fuel is used), by using paperless communication.

The main environmental advantage is the minimized need for paper documents (the reduction of CO2) as the demand for logging and deforestation is reduced.

Since 2017, all seaports in China have been included in Single Window Customs Clearance. The standard version covers all trade ports, with a total of 35,000 registered users and more than 100,000 daily declarations. The costs for involved companies could decrease by 10%, and companies could save 10% of time needed for clearance. A third of all clearance procedures will be cut, according to southwest China's Chongqing port. In the Port of Shanghai, cargo clearance efficiency has been increased by about 30% [67]. The average clearance time for imports and exports within the jurisdiction of Shanghai Customs was 21.67 h and 1.35 h, respectively.; for the first eight months of 2017, there was a 26% and 32% reduction in comparison to the same period of the previous year, allowing sustainable business (economic, social, and environmental aspects). The platform also enables authorities of 11 related agencies to share declaration data, logistics control information, and credit standings to create a better business environment. The aim of China is to extend Single Window processing of international trade and nationwide integration of Customs clearance procedures [67].

Integration of different ICT solutions is one of the challenges that exist when developing an IT infrastructure. Not only do ICT systems need to be integrated between each division within a port, but also externally with the other external parties, such as trucking companies, customers, etc. [68]. Indonesian container terminals are integrated via the Indonesia National Single Window (INSW), with the aim to reduce the administration time related to the import and export activity of Indonesia, taking into consideration that logistics cost in Indonesia contributes 24% of the GDP. Through the INSW system, the status of the dwell time and productivity per terminal can be monitored. This INSW is integrated with Customs, where the incoming ships will send planned arrival time of transport means, which will be forwarded to the Customs by the terminal. Therefore, the INSW integrates different ICT solutions in Indonesian seaports [68]. The INSW includes about 5400 registered business stakeholders, and processes around 12,000 documents daily. Average document processing time of INSW is 5 min. Until now, the 18 ministries have processed more than 3,902,800 permits via INSW [69]. Without INSW, sustainable business would be difficult, as INSW enables paperless business, reducing time and costs and responsible using of resources.

Thailand's National Single Window enables electronic data and information sharing and integration between government to government partnerships (G2G), government to business partnerships (G2B) and business to business partnerships (B2B) for import, export, and logistics. It also facilitates international cross-border data and information sharing between government and business sectors in Thailand and other countries. E.g., Thailand NSW includes the economic aspect of sustainability, because in the transport of goods like sugar, rice, rubber, and frozen products, it is possible to achieve up to a 54% time reduction of time necessary for delivery and to reduce the costs up to 9.5 million USD/year [70].

The implementation of National Single Window in the low-income countries and lower-middle income countries enables sustainable business as well, and shows significant benefits. For example, NSW in Azerbaijan has reduced border crossing time from 180 minutes to 20 minutes. In Senegal, NSW implementation has reduced document collecting time from 4 days to 1 day. Customs clearance procedures in Cameroon have been reduced from 6 days to 3 h. Total cargo turnover/dwell time has decreased from 39 days to 6 days In Benin, and from 4 days to 2 days in Malaysia [71]. Reduced document collecting time and accelerated Customs clearance procedures allow cost savings, CO2 reduction and increased employee productivity, encompassing all three aspects of sustainability.

To provide simpler procedures, since June 2015, ship arrivals at all German seaports have to be reported via the National Single Window [72]. It aims to provide sustainable business by minimizing multiple entries of the same data and by distributing the data automatically to the authorized recipients [73]. In addition, parts of this information are available to other EU Member States on request via SafeSeaNet (a Europe-wide system for the exchange of data in order to prevent accidents and pollution at sea, and to reduce the consequences of such events) [74].

The MNSW has the potential to harmonize the seaport business processes and to become the base of sustainable maritime transport and seaport business. Information exchange between seaport stakeholders can be the bottleneck in the achievement of sustainability goals if it is provided through various different information systems. Joining the stakeholders via MNSW is the priority in providing sustainable seaport business, and will bring harmonisation and re-use of information, reducing the administrative burden. Consequently, it will contribute to seaport business sustainability [75].

The Republic of Korea Maritime Single Window "SP-IDC" (Shipping and Port Internet Data Centre)—apart from basic functions, such as port operation management, vessel operation management (vessel arrival/departure notice) etc.—provides non-stop service in spite of system malfunctioning; i.e., intelligent port operation services at disasters and calamities through marine-port distribution disaster recovery system operation [76]. It enables improving task efficiency through association and gathering the information; preparing a base that can be associated with foreign ports' shipping and port logistics information systems; improving distribution competency with cost cutting for information access and utilization; budget reduction, such as uniformed budget management and the prevention of redundant investment through system-integrated management; information access and processing the cost cutting of related subjects [76]. Although the advantages are mostly visible in the economic aspect of sustainability, reducing paper documents includes ecological and social aspects of sustainability as previously mentioned (CO_2 reduction, etc.).

The "MSW Reportal" is the Swedish Maritime Single Window portal for reporting government information linked to ship calls. The MSW Reportal is managed by the Swedish Maritime Administration and provides collaboration between the Coast Guard, the Customs, the Swedish Maritime Administration, and the Swedish Transport Agency. The environmental aspect of sustainability is improved by reducing paper documents, which also translates to reduced costs (economic aspect of sustainability), etc. When information is submitted to MSW Reportal, it is automatically forwarded to the relevant authorities and systems. Information integrated into MSW Reportal are [77]:

- Information on maritime security, crew and passenger lists, and health declarations—Coast Guard;
- Information related to ship reporting—Swedish Maritime Administration;
- Information related to delays—The Port of Gothenburg;
- Ship clearance information—Customs;
- Lot order and fairway declaration—Swedish Maritime Administration.

The Maritime Single Window in the Netherlands was initially developed for maritime information exchange. Because the Single Window is also intended for use by the aviation sector, the name has been changed to the Single Window for Maritime and Aviation. Regarding the data exchange from the "maritime perspective," the port authority ensures that received information is forwarded to National Competent Authority (NCA) SafeSeaNet [78]. NCA is the body designated by European Member States as being responsible for the management of the system at the national level [79]. The port systems of all the large ports in the Netherlands are connected to the Single Window for Maritime and Aviation for communications regarding the transport [78]. Larger seaports produce more harmful emissions, causing negative influence on the surrounding community. Furthermore, delays or other issues that are present during the data exchange among stakeholders in larger seaports may cause significant costs. In this respect, the Maritime Single Window, connecting all the large ports in Netherlands, may help the seaports to operate sustainably (paperless work, reduced costs, standardization, etc.). Furthermore, waiting for cargo loading or unloading in seaports due to ineffective and obsolete data exchange among stakeholders causes the increase of CO2 emissions. According to Ascencio et al. [80], unnecessarily long waiting time is the result of the existence of a large number of public and private stakeholders, requiring very large number of transactions and documentation processes, most of them based on paper documents. Development of electronic Transportation Management Systems such as (M)NSW could have a positive effect on fuel consumption and the reduction of CO2 emissions and other harmful emissions (environmental aspect of sustainability) [81].

The similar case of improving sustainability by implementing the MSW can be found in Spain. Dueport is the Spanish Maritime Single Window that includes all 70 seaports in Spain (commercial seaports, regional seaports, fishing ports) as well as nine national administrators. Through Dueport, 50,000 messages are exchanged daily. The advantages of the Spanish Maritime Single Window are the following: all formalities are reported electronically; harmonization of messages (EDIFACT standard); harmonization of spreadsheet (Pax and Crew list) etc. [82], affecting economic and environmental aspect of sustainability.

Portnet is a port information system maintained by the Finnish Transport and Communications Agency, and acts as the national Maritime Single Window system for Finland. The following information is supplied to the Portnet system for all vessel visits to Finnish ports: Preliminary Notice, Cargo Declaration, Dangerous Goods Declaration, etc. [83]. The notifications concerning vessel arrival and departure can be submitted electronically to Customs, as required by the authorities [84], affecting economic (decreased costs, waiting time etc.), ecological (lower use of paper), and social (increased employee productivity, efficient use of human resources etc.) aspects of sustainability.

During the analysis of Italian experiences in improving sustainability by implementing Single Window and closely related ICT systems, the importance of a port community system arose. In certain seaports, for example the Italian Port of Venice, port community system assumes the role of the Single Window. The Port of Venice uses LogIS—a web-based IT system for the stakeholders involved in the port community's shipping and logistics activities, including the Harbormaster's Office, Shipping Agents, Freight Forwarders, Pilots, and Terminal Operators. All the components of LogIS are integrated into a single platform. As a result, LogIS acts as the Port of Venice's Single Window [85]. Similar to MNSW, PCS enables decreased waiting time, decreased costs (economic aspect of sustainability), minimized use of paper documents (environmental aspect of sustainability), efficient use of human resources (social aspect of sustainability), etc.

The analysed examples point out the importance of implementation of MNSW for seaports business and confirm that MNSW possesses great potential for improving sustainable seaport business. Future seaports should be committed to being green, while building prosperity for current and future generations. For this purpose, the seaport sustainability will be the core of development strategies and plans; beyond "systems and policies." It could be the most important step for seaports towards becoming a more sustainable business, setting a foundation in which to evolve. Within the scope of sustainability, the future seaport approach can be achieved through sustainable planning of the crucial steps of smart seaport operations, preservation of the environment, the human element, and planning a bright future with seaport communities [34].

Although many successful cases of Single Window implementation can be found globally, several examples of less successful cases of MNSW implementation can be found, as stated below.

Singapore's aforementioned "TradeNet," which "handles almost all documents that are required for the Customs import and export procedures, such as declarations, various types of permits, certificates and licences, etc.), do not handle other transportation/cargo documents, such as air and sea manifests. For sea manifests (e.g., detailed lists of loaded cargo), the data are submitted and handled by another system, PortNet, which is operated by the port operator, while air transport-related cargo documentation is handled by yet another system, Cargo Community Network, which is operated by a subsidiary of Singapore Airlines [86]. When using multiple heterogenous systems, it is harder to improve the three aspects of sustainability mentioned earlier.

Another case of a less successful NSW implementation is the Croatian NSW. In the 2000s, the Croatian Ministry of the Sea, Transport and Infrastructure, recognized the importance and advantages of digitalization and stakeholder connectivity (such as forwarders, maritime agents etc.), in maritime transport [87]. As a result, three projects were launched that were supposed to solve the administrative problems faced by stakeholders in the logistics chain of freight transport, thereby facilitating data control. The first project refers to the establishment of a National Single Window, an information platform for data exchange and processing through the cooperation of the Ministry of the

Sea, Transport and Infrastructure, the Customs Administration of the Ministry of Finance, the Port Authority of Rijeka and the Port Authority of Ploče [88]. Two studies were produced in order to enable successful NSW implementation (the first study was produced in 2011 and the second one in 2017). Several issues have slowed down the implementation of Croatian NSW, such as less cooperative stakeholders who mostly own and operate separate ICT systems, insufficient governmental support, and financial issues. In the meantime, the Croatian Ministry of the Sea, Transport and Infrastructure (MMPI) has developed CIMIS system, the unique Maritime Single Window system that implements all national level processes related to the administrative aspect and aspect of navigation safety. In order for CIMIS to be able to exchange data with external systems, a new service CIMISNet has been established, which aims to improve data exchange, reduce administrative procedures among Ministries, all Port authorities, the Ministry of the Interior, the Customs administration, Coastal Shipping Agency, Croatian Bureau of Statistics, etc. Security in cross-border traffic will also be improved in accordance with Schengen rules [88]. Finally, in 2019, Croatia still does not have a functional NSW. CIMIS and CIMISNet can be considered as a MNSW, but with lacking functionalities. Because of that, obsolete methods of data exchange are still present, causing increased waiting time and unnecessary costs; therefore, decreasing the sustainability of Croatian seaports.

The final example of a less successful NSW implementation is the Italian NSW "UIRNet." According to Ferrari et al. [89], efficient administrative procedures, already present in several European ports (e.g., "pre-clearing" activity), cannot be easily implemented in Italian ports due to the co-existence of several authorities with their own administrative and information systems within the seaport. Due to this issue, it is difficult to improve sustainability/sustainable business because of increased costs, increased waiting time, etc. The issue may be solved through the unification of the control and information systems (so-called "one-stop-shop") of the different authorities and with the simplification of the administrative procedures improving the coordination of the several public bodies involved [90]. Furthermore, most Single Window and total logistics chain systems will have to be aligned in the future with significantly increased requirements of the proposal for a Regulation of the European Parliament and of the Council establishing a European Maritime Single Window environment and repealing Directive 2010/65/EU (COM (2018) 0278–C8-0193/2018–2018/0139 (COD)). If the above-mentioned issues were solved, every party involved (both commercial stakeholders and administrative authorities) could benefit from the implementation of a Single Window (reducing costs, reducing average processing times, increasing service predictability, etc.); therefore, increasing sustainability.

During the research process, significant effort was undertaken to research both the existing successful and challenged implementations of NSW globally. In all these cases, the research was focused to identify all major aspects of the sustainability principles, namely economic, environmental and social seaport sustainability enhancements directly derived and attributed to introduction of NSW, that would otherwise not be in effect. Furthermore, cross-component benefits of MNSW implementations were also identified, resulting in creation of the synergy effect and positive impact on the seaport business. Some of the identified effects are elaborated here:

1. Reduction or elimination of paper documents contributes not only to the economic seaport business sustainability in terms of reduced costs or time for providing operations, but also to the environmental sustainability through reduced demand for logging and deforestation, which is a typical example of synergy effect crossing individual stakeholder lanes.
2. The MNSW, as the "single entry point" system, reduces time-consuming activities in seaport business by enabling the reuse of already entered data which finally contributes to the economic sustainability of seaport business. Further benefits are achieved through reduction of the fee charges, increasing stakeholders' liquidity and financial position.
3. Decreased time affects the environmental sustainability aspect through the elimination of unnecessary movements, enabling the efficient use of natural resources and decreasing emissions.
4. Enforcement of the "single entry" principle via MNSW enables improved communication and information exchange between stakeholders and eliminates the differences between individual

systems and input errors during information and document exchange. MNSW also provides common regulations (legal framework) which simplifies communication and information exchange between stakeholders. The social sustainability aspect is improved via MNSW through decreased man-hours and increased employee productivity.

A comprehensive identification of all examples is provided in Figure 1. All identified benefits of MNSW implementation for sustainable seaport business are shown in a three-pillar form according to sustainability aspects—economic, environmental, and social seaport sustainability—along with all of their identified sub-categories and references to sources.

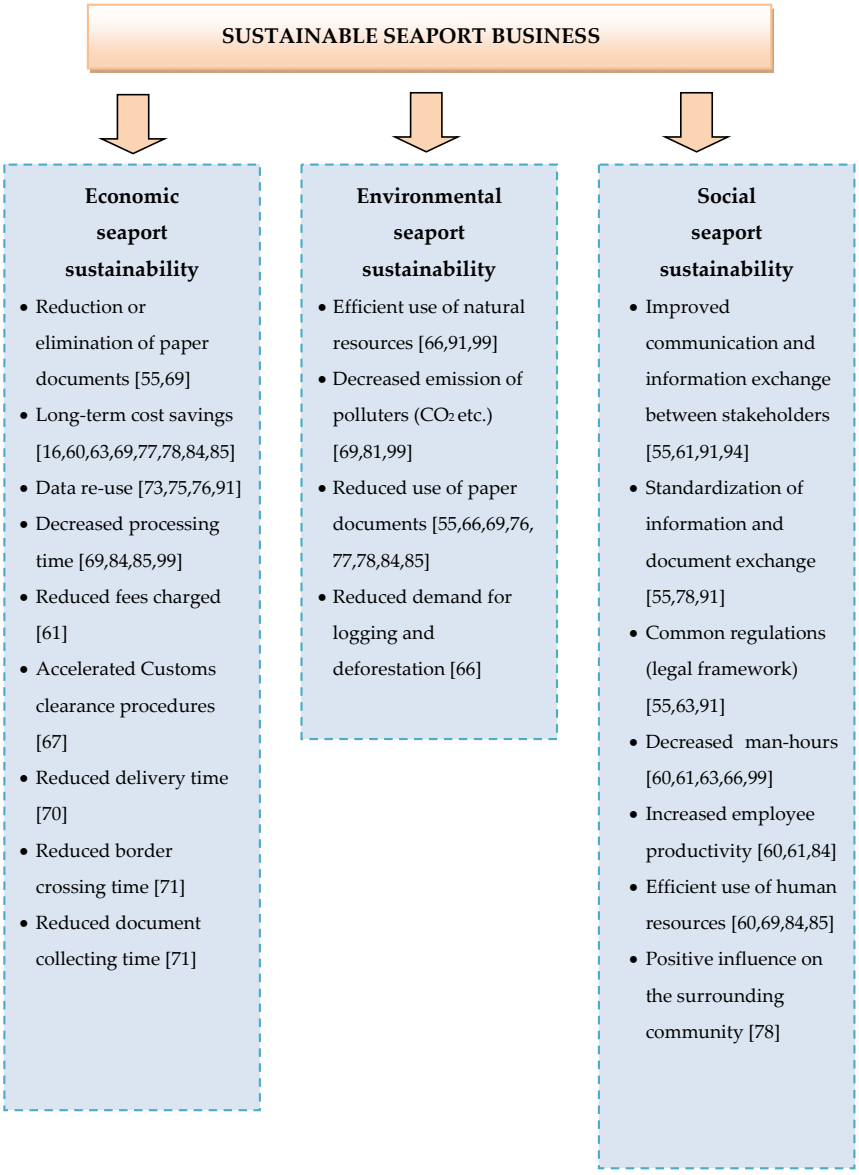

Figure 1. The three aspects of sustainable seaport business by implementing MNSW (authors).

5. Future Perspective of the Maritime National Single Window Concept

National Single Windows and Maritime National Single Windows are continuously evolving and transiting beyond national borders towards regional cooperation and implementation of the Regional Single Window concept and similar systems for collaboration of seaport business stakeholders. The reason is that economic groupings or countries from same territorial area recognize the benefits of NSW, and its possible impacts on the economic, environmental, and social aspects of sustainability.

In 2018, five southeast Asian countries: Indonesia, Malaysia, Singapore, Thailand, and Vietnam formed the initiative "ASEAN Single Window—ASW." The aim of ASW is to transform the Association of Southeast Asian Nations (ASEAN) into a single market and production base, enabling sustainable business. Trade facilitation measures—such as the ASW, the harmonization and integration of Customs' procedures, and the removal of tariffs and nontariff barriers—are key to the free flow of goods and services within ASEAN [91]. The ASW will provide economic sustainability (almost paperless clearance in ASEAN, more efficient and predictable supply chain management, data re-use, reduced costs of doing business improved risk and profile management), environmental sustainability (predictability, disaster management), and social sustainability (improved compliance, mutual recognition agreements, robust legal framework) for business and government stakeholders.

In 2017, the Monetary Authority of Singapore (MAS) signed a Memorandum of Understanding with its Hong Kong counterpart to jointly develop a cross-border distributed ledger technology (DLT) based utility infrastructure that will link up digital trade platforms and trade-related DLT platforms and communities around the world. This initiative is called the Global Trade Connectivity Network—GTCN. The GTCN aims to be an industry-neutral, service-agnostic, cross-border utility infrastructure that does not aim to control or dominate partner networks. In the beginning, GTCN will provide a common hub for trade finance applications between Singapore and Hong Kong. Further vision for the GTCN overcomes simple collaboration between Singapore and Hong Kong and extends beyond financial issues. The GTCN will integrate the digital platforms of Singapore and Hong Kong to provide digital solutions to address challenges prevalent in international trade, where different trade regulations and documentation standards are present. The end outcome is to enhance supply chain transparency, integrity, and security which contributes to goals of economic, environmental, and social sustainability: Simplified financial and other transactions, reduced paper administration, savings, the conservation of natural resources, a common communication platform for all stakeholders, equal regulations and standards for all stakeholders, a positive influence on society, etc. [55].

The process of digitalization and new technologies extend the range of possibilities and move the limits of Single Window concept in maritime industry and seaport business. The example of such an initiative is the Maritime Connectivity Platform (MPC), previously known as the Maritime Cloud. The mission of the Maritime Cloud was to enable an open vendor-neutral platform for the maritime sector that facilitates information exchange boundary-free and secured across various communication channels, such as internet, satellite, and cellular phone networks, and digital radio links [92]. The objective of the Maritime Cloud was to provide a secure platform to enable maritime stakeholders to securely access technical services to gain further information for decision-making onboard and ashore during a voyage from berth-to-berth. The Maritime Cloud shall not be considered as a product but as a common communication framework for maritime users to register, discover, and use the technical services, such as route optimization or weather forecast. Clients and Services communicated by standardized web service technologies supported by standard services to set up and facilitate the communication [92]. The new name, Maritime Connectivity Platform, "has been chosen to provide clarity and support e-Navigation going from testbed to real life implementation" [93]. MCP is a communication framework enabling efficient, secure, reliable and seamless electronic information exchange between all authorized maritime stakeholders across available communication systems [94], and thus, the MCP can contribute to the sustainable seaport business.

For the past several years, the EU has been working on the development of the European Maritime Single Window—EMSW, with the aim to fully harmonize interfaces available to ship operators in order to provide required information all across the EU [56]. The purpose of EMSW is to standardize information needed for port management so that the submitted data can be publicly available to all relevant stakeholders [95]. The harmonised EMSW environment for ships will build on the already existing framework (National Single Windows structure) [96]. The National Single Windows will continue to be mainly a coordination mechanism, serving primarily as a router (with technical converter between data formats where needed) to pass two-way information between the maritime transport

operators and the data recipients (e.g., port authorities, Customs interfaces and reporting systems, border control authorities, the SafeSeaNet, statistics authorities) with the aim to facilitate reporting for the maritime industry [96].

Due to the strategic importance of creating a common field for all modes of transport across Member States, the EMSW has been given a prominent position. In 2017, the EU Transport Ministers underlined in the 'Valetta Declaration,' the shortcomings of the Reporting Formalities Directive and invited the Commission to propose a follow-up to the evaluation of it (the RFD), which would include a harmonized EMSW environment [97].

In the beginning of 2019, the European Commission signed the agreement with the European Parliament and Council on the implementation of EMSW, which is expected to enter into force in 2025. Although the agreement was well accepted by the maritime sector, including European seaports, the ports of Hamburg, Antwerp, and Rotterdam, have urged the European Transport Committee to vote against the EMSW when an amendment proposal sought to introduce an EU level access point interface, in addition to the new harmonized interface that would be developed at the European level for the NSW [98].

As the EMSW includes all EU countries, it will maximize the potential of improving economic, environmental, and social sustainability of seaports business across the EU. The economic sustainability could be improved via hours saved on reporting—22 to 25 million staff hours from 2020 to 2030, worth around €650 million for shipping operators. Furthermore, EMSW could improve the use and sharing of data, optimizing cargo flows and serving the whole logistics chain, while increasing the competitiveness of maritime transport. The environmental sustainability will be improved through optimized cargo flows which will reduce transport CO_2 emissions and the use of natural resources. [99].

6. Conclusions

Sustainable development is based on the consideration of present needs, without compromising the needs of future generations. It consists of the "triple bottom line" principle, or three aspects: Economic (producing goods or services efficiently), environmental (protection of natural resources), and social (well-being of surrounding society). Seaports, as the main nodes of maritime transport, should conduct their operations according to principles or aspects of sustainability as well: The economic principle (providing seaport services efficiently), the environmental principle (efficient use of natural resources, decreased emission of polluters and reduced use of paper documents), and the social principle (well-being of seaport employees and stakeholders).

Various stakeholders are still faced with a tedious task of producing and distributing paper documents to numerous administrative authorities. Multiple entry of the same data may result in increased errors and higher costs. Existence of these issues has encouraged the development of the Single Window concept, which allows stakeholders involved in the business processes to input the necessary data only once, and to reuse the data according to their scope of work and authorization.

The systematic literature review of numerous successful examples of NSW/MNSW globally has led to the conclusion that the implementation of NSW/MNSW has potential for improving sustainable seaport business. This potential arises from the advantages of a single-entry point for the administrative procedures among stakeholders involved in seaport business. Due to the complexity of seaport business, improved administrative processes via NSW/MNSW could have an important role, making seaport business more sustainable. Based on the researched examples, the main elements and potential benefits of NSW/MNSW in improving the economic, environmental, and social aspects of sustainability of seaport business have been identified, as follows:

The NSW/MNSW reduces or eliminates paper documents and enables data re-use, which improves economic seaport sustainability through savings (e.g., the once entered information or document in Swedish MSW Reportal is automatically forwarded to the relevant authorities and systems which reduces paper documents and obtains savings; via Thailand NSW costs reduce up to 9.5 million USD/year). Furthermore, NSW/MNSW could contribute to economic seaport sustainability by decreasing processing

time, accelerating Customs procedures and reducing document collecting time (e.g., via TradeNet document, processing time decreased from 2–7 days to 10 min the Port of Shanghai; cargo clearance efficiency improved by around 30%; and via Senegal's NSW, document collecting time has been reduced from 4 days to 1 day). Delivery time and border crossing time could also be reduced (e.g., by using NSW, total cargo turnover/dwell time has decreased from 39 days to 6 days in Benin, and from 4 days to 2 days in Malaysia; NSW in Azerbaijan has reduced border crossing time from 180 min to 20 min). The fees as an important element of economic seaport sustainability can be significantly reduced as well (e.g., via TradeNet, the average fees have decreased from $6–$13 to approximately $2.10).

The environmental seaport sustainability can also be improved by implementing NSW/MNSW. The Netherlands MSW, connecting all large seaports and airports, reduces waiting time for cargo loading and unloading, and thus provides efficient use of natural resources and decreased emission of CO_2 and other polluters via the elimination of unnecessary movements in cargo due to inefficient data exchange among stakeholders. The need for paper documents is minimized, therefore reducing the demand for logging and deforestation.

The NSW/MNSW can also improve social seaport sustainability of seaport operations, stakeholders, and community. With the help of NSW/MNSW, it is possible to use human resources more efficiently, to increase employee productivity, and to decrease the workload (e.g., IBM IPDL via TradeXchange decreased the average man-hours from 578 to 102 monthly). The NSW/MNSW improves communication and information exchange between stakeholders and standardization of business processes (e.g., via Spanish MSW Dueport, including all 70 seaports operating in Spain, which report all formalities electronically). Finally, the surrounding community may also benefit from NSW/MNSW through the elimination of harmful emissions, which is especially evident in larger seaports.

Although the majority of researched NSW/MNSW examples have been successful in recording improvement of the seaport sustainability, less successful cases such as Italian's UIRNet and Croatian NSW/MNSW also exist. They are not fully functional (or implemented yet) because of legal restrictions, administrative procedures, financial issues and less cooperative stakeholders who operate separate ICT systems.

The utilization of NSW/MNSW shows the potential well beyond the national level. Having awareness of the benefits obtained by using the NSW/MNSW, several countries or economic groupings have made a step forward and have started to establish the regional NSW/MNSW and similar initiatives, such as ASEAN NSW or EMSW-European Maritime Single Window. The integration of individual NSW's into the regional NSW/MNSW leads to further improvement of economic, environmental, and social aspects of seaport sustainability. For example, EMSW could have a positive impact on all three aspects of sustainability: The economic aspect (via hours saved on reporting—22 to 25 million staff hours from 2020 to 2030, worth around €650 million for shipping operators), the environmental aspect (through optimized cargo flows which will reduce transport CO2 emissions and the use of natural resources), and the social aspect (the efficient use of human resources, etc.).

In the future research, authors plan to analyze further development of Regional Single Windows and similar initiatives in order to gain a deeper understanding of NSW/MNSW implementation and impact on sustainable seaport business.

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References

1. The Single Window Concept. Available online: http://tfig.unece.org/contents/single-window-for-trade.htm (accessed on 28 February 2019).
2. The Evolution of the Concept. Available online: http://tfig.unece.org/contents/single-window-evolution.htm (accessed on 1 July 2019).
3. Khaslavskaya, A.; Roso, V. Outcome-Driven Supply Chain Perspectives on Dry Ports. *Sustainability* **2019**, *11*, 1492. [CrossRef]
4. Lam, J.S.L.; Yap, W.Y. A stakeholder perspective of port city sustainable development. *Sustainability* **2019**, *11*, 447. [CrossRef]
5. Shi, W.; Xiao, Y.; Chen, Z.; McLaughlin, H.; Li, K.X. Evolution of green shipping research: Themes and methods. *Marit. Policy Manag.* **2018**, *45*, 863–876. [CrossRef]
6. Zeng, D.; Fu, X.; Ouyang, T. Implementing Green IT transformation for sustainability: A case study in China. *Sustainability* **2018**, *10*, 2160. [CrossRef]
7. Masocha, R.; Fatoki, O. The role of mimicry isomorphism in sustainable development operationalisation by SMEs in South Africa. *Sustainability* **2018**, *10*, 1264. [CrossRef]
8. Barile, S.; Quattrociocchi, B.; Calabrese, M.; Iandolo, F. Sustainability and the viable systems approach: Opportunities and issues for the governance of the territory. *Sustainability* **2018**, *10*, 790. [CrossRef]
9. Almasi, M.H.; Sadollah, A.; Kang, S.; Karim, M.R. Optimization of an improved intermodal transit model equipped with feeder bus and railway systems using metaheuristics approaches. *Sustainability* **2016**, *8*, 537. [CrossRef]
10. Christodoulou, A.; Raza, Z.; Woxenius, J. The Integration of RoRo Shipping in Sustainable Intermodal Transport Chains: The Case of a North European RoRo Service. *Sustainability* **2019**, *11*, 2422. [CrossRef]
11. De Gruyter, C.; Currie, G.; Rose, G. Sustainability measures of urban public transport in cities: A world review and focus on the Asia/Middle East Region. *Sustainability* **2017**, *9*, 43. [CrossRef]
12. Liang, Y.; Niu, D.; Wang, H.; Li, Y. Factors affecting transportation sector CO_2 emissions growth in China: An LMDI decomposition analysis. *Sustainability* **2017**, *9*, 1730. [CrossRef]
13. Perboli, G.; Musso, S.; Rosano, M.; Tadei, R.; Godel, M. Synchro-modality and slow steaming: New business perspectives in freight transportation. *Sustainability* **2017**, *9*, 1843. [CrossRef]
14. Dimić, S.; Pamučar, D.; Ljubojević, S.; Đorović, B. Strategic transport management models—The case study of an oil industry. *Sustainability* **2016**, *8*, 954. [CrossRef]
15. Bamwesigye, D.; Hlavackova, P. Analysis of Sustainable Transport for Smart Cities. *Sustainability* **2019**, *11*, 2140. [CrossRef]
16. Wagner, N. Identification of the Most Important Sustainability Topics in Seaports. *Logist. Transp.* **2017**, *34*, 79–87.
17. Vargas, A.; Patel, S.; Patel, D. Towards a Business Model Framework to Increase Collaboration in the Freight Industry. *Logistics* **2018**, *2*, 22. [CrossRef]
18. Halim, R.A.; Kirstein, L.; Merk, O.; Martínez, L.M. Decarbonization Pathways for International Maritime Transport: A Model-Based Policy Impact Assessment. *Sustainability* **2018**, *10*, 2243. [CrossRef]
19. Springer International Publishing. *Sustainable Shipping: A Cross-Disciplinary View*; Springer Nature Switzerland AG: Basel, Switzerland, 2019; pp. 4–6.
20. Shin, S.-H.; Kwon, O.K.; Ruan, X.; Chhetri, P.; Lee, P.T.-W.; Shahparvari, S. Analyzing sustainability literature in maritime studies with text mining. *Sustainability* **2018**, *10*, 3522. [CrossRef]
21. Janić, M. *The Sustainability of Air Transportation: A Quantitative Analysis and Assessment*; Routledge: Abingdon, The Netherlands, 2016. Available online: https://www.taylorfrancis.com/books/9781315236889 (accessed on 6 June 2019).
22. Tijan, E.; Aksentijević, S.; Ivanić, K.; Jardas, M. Blockchain technology implementation in logistics. *Sustainability (Switzerland)* **2019**, *11*, 1185. [CrossRef]
23. Gausdal, A.H.; Czachorowski, K.V.; Solesvik, M.Z. Applying Blockchain Technology: Evidence from Norwegian Companies. *Sustainability* **2018**, *10*, 1985. [CrossRef]
24. Kotowska, I.; Mańkowska, M.; Pluciński, M. Inland shipping to serve the hinterland: The challenge for seaport authorities. *Sustainability* **2018**, *10*, 3468. [CrossRef]

25. Li, K.X.; Park, T.-J.; Lee, P.T.-W.; McLaughlin, H.; Shi, W. Container transport network for sustainable development in South Korea. *Sustainability* **2018**, *10*, 3575. [CrossRef]
26. Gherghina, Ş.C.; Onofrei, M.; Vintilă, G.; Armeanu, D.Ş. Empirical evidence from EU-28 countries on resilient transport infrastructure systems and sustainable economic growth. *Sustainability* **2018**, *10*, 2900. [CrossRef]
27. Di Vaio, A.; Varriale, L. Management innovation for environmental sustainability in seaports: Managerial accounting instruments and training for competitive green ports beyond the regulations. *Sustainability* **2018**, *10*, 783. [CrossRef]
28. Notteboom, T.; Lam, J.S.L. The greening of terminal concessions in seaports. *Sustainability* **2018**, *10*, 3318. [CrossRef]
29. Deloitte. Global Trends to 2030: Impact on Ports Industry. 2017. Available online: https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/energy-resources/deloitte-cn-er-global-trends-to-2030-en-170104.pdf (accessed on 7 June 2019).
30. Slinger, J.; Taneja, P.; Vellinga, T.; Van Dorsser, C. Stakeholder inclusive design for Sustainable Port Development. In Proceedings of the 5th International Maritime-Port Technology and Development Conference, MTEC 2017, Singapore, 26–28 April 2017; Volume 26, p. 28. Available online: http://sustainableportsafrica.com/onewebmedia/SlingeretalStakeholderinclusivedesignforSustainablePortDevelopment2017.pdf (accessed on 21 August 2019).
31. Langenus, M.; Dooms, M. Creating an industry-level business model for sustainability: The case of the European ports industry. *J. Clean. Prod.* **2018**, *195*, 949–962. [CrossRef]
32. Wan, C.; Zhang, D.; Yan, X.P.; Yang, Z. A novel model for the quantitative evaluation of green port development—A case study of major ports in China. *Transp. Res. Part D Transp. Environ.* **2017**, *61*, 431–443. [CrossRef]
33. Ignaccolo, M.; Inturri, G.; Le Pira, M. Framing Stakeholder Involvement in Sustainable Port Planning. *Trans. Marit. Sci.* **2018**, *7*, 136–142. [CrossRef]
34. Docks The Future (DTF): Defining the Concept of the Future Sustainable Ports in Europe. Available online: https://www.docksthefuture.eu/docks-the-future-dtf-defining-the-concept-of-the-sustainable-future-ports/ (accessed on 6 June 2019).
35. Oh, H.; Lee, S.-W.; Seo, Y.-J. The evaluation of seaport sustainability: The case of South Korea. *Ocean Coast. Manag.* **2018**, *161*, 50–56. [CrossRef]
36. Jiang, B.; Li, Y.; Lio, W.; Li, J. Sustainability efficiency evaluation of seaports in China: An uncertain data envelopment analysis approach. *Soft Comput.* **2018**, 1–12. [CrossRef]
37. Kim, S.; Chiang, B. Sustainability practices to achieve sustainability in international port operations. *J. Korea Port Econ. Assoc.* **2014**, *30*, 15–37.
38. Cheon, S.; Deakin, E. Supply Chain Coordination for Port Sustainability-Lessons for New Institutional Designs. *Transp. Res. Rec. J. Transp. Res. Board* **2010**, *2166*, 10–19. [CrossRef]
39. Denktas-Sakar, G.; Karatas-Cetin, C. Port sustainability and stakeholder management in supply chains: A framework on resource dependence theory. *Asian J. Shipp. Logist.* **2012**, *28*, 301–319. [CrossRef]
40. Tijan, E. ICT Enablement of Administrative Processes in Croatian Seaports. In Proceedings of the Graduate Student Consortium–25th Bled e-Conference 2012, Maribor, Slovenia, 17–21 June 2012.
41. Hervás-Peralta, M.; Poveda-Reyes, S.; Molero, G.D.; Santarremigia, F.E.; Pastor-Ferrando, J.-P. Improving the performance of dry and maritime ports by increasing knowledge about the most relevant functionalities of the Terminal Operating System (TOS). *Sustainability* **2019**, *11*, 1648. [CrossRef]
42. Pérez-López, R.J.; Olguín-Tiznado, J.E.; García-Alcaraz, J.L.; Camargo-Wilson, C.; López-Barreras, J.A. The role of planning and implementation of ICT in operational benefits. *Sustainability* **2018**, *10*, 2261. [CrossRef]
43. Oyedeji, S.; Seffah, A.; Penzenstadler, B. A catalogue supporting software sustainability design. *Sustainability* **2018**, *10*, 2296. [CrossRef]
44. Madudova, E.; Čorejova, T.; Valica, M. Economic sustainability in a wider context: Case study of considerable ICT sector sub-divisions. *Sustainability* **2018**, *10*, 2511. [CrossRef]
45. European Maritime Safety Agency. National Single Window Prototype: An Electronic Solution for Simplifying Administrative Procedures. 2015. Available online: http://www.emsa.europa.eu/emsa-documents/latest/item/2317-national-single-window-prototype-an-electronic-solution-for-simplifying-administrative-procedures.html (accessed on 10 July 2019).

46. World Customs Organization. The Single Window Concept: The World Customs Organization's Perspective. Available online: http://www.wcoomd.org/~{}/media/wco/public/global/pdf/topics/facilitation/activities-and-programmes/tf-negociations/wco-docs/info-sheets-on-tf-measures/single-window-concept.pdf (accessed on 7 June 2019).
47. Trade Facilitation-Principles and Benefits. United Nations. Available online: http://tfig.unece.org/details.html (accessed on 10 June 2019).
48. UNCTAD | Different Types of National Trade Facilitation Bodies. Available online: https://unctad.org/en/DTL/TLB/Pages/TF/Committees/NTFB_background.aspx (accessed on 15 March 2019).
49. Nowak, J. The Evolution of Electronic Trade Facilitation: Towards a Global Single Window Trade Portal. Available online: https://www.researchgate.net/publication/228581401_The_Evolution_of_Electronic_Trade_Facilitation_Towards_a_Global_Single_Window_Trade_Portal (accessed on 20 June 2019).
50. Tijan, E.; Agatić, A.; Cisic, D. Single Window Concept In Croatian Seaport Clusters. In Proceedings of the CITEM Conference on International Trade, Education and Marketing 2012, Trebon, Czech Republic, 5–7 November 2012.
51. African Alliance for e-Commerce. Single Window as an Enabler for e-Commerce Development. 2017. Available online: https://unctad.org/meetings/en/Presentation/dtl_eWeek2017p61_AbdoullahiFaouzi_en.pdf (accessed on 7 June 2019).
52. The Progress of Thailand National Single Window. 2019. Available online: http://www.thainsw.net/INSW/index.jsp?nswLang=E (accessed on 24 June 2019).
53. General Department of Customs and Excise of Cambodia. National Single Window: Cambodia. 2019. Available online: http://www.customs.gov.kh/trade-facilitation/national-single-window/ (accessed on 22 May 2019).
54. Niculescu, M.C.; Minea, M. Developing a Single Window Integrated Platform for Multimodal Transport Management and Logistics. *Transp. Res. Procedia* **2016**, *14*, 1453–1462. [CrossRef]
55. World Customs Organization. Going Beyond the National Single Window. 2018. Available online: https://mag.wcoomd.org/magazine/wco-news-87/going-beyond-the-single-window/ (accessed on 24 June 2019).
56. Tijan, E.; Jardas, M.; Aksentijević, S.; Perić Hadžić, A. Integrating Maritime National Single Window with Port Community System—Case Study Croatia. In Proceedings of the 31st Bled eConference—Digital Transformation: Meeting the Challenges Conference Proceedings, University of Maribor Press, Bled, Slovenia, 17–20 June 2018; pp. 1–11.
57. PCS/Port Community Systems—IPCSA International. Available online: https://ipcsa.international/pcs (accessed on 22 May 2019).
58. International Port Community System Association. Port Community System. 2018. Available online: https://ipcsa.international/ (accessed on 23 May 2019).
59. Comcec. Single Window Systems in the OIC Member States. 2017. Available online: http://www.sbb.gov.tr/wp-content/uploads/2018/11/Single_Window_Systems_in_the_OIC_Member_States.pdf (accessed on 7 June 2019).
60. Singapore Customs. Building a New National Trade Platform: A Vision for the Future of Singapore Trade. 2018. Available online: https://www.sicexchile.cl/portal/documents/10180/13179/Intelligent_Integration_Workshop_Santiago_SingaporeCustoms.pdf/6d597124-05fb-476b-8b01-1305710afd55 (accessed on 7 June 2019).
61. Ferro, C.; Youbi, M.F.M.; Georgieva, D.P.; Saltane, V.; Múgica, I.Z. Trading Across Borders Technology gains in trade facilitation, Doing Business. 2017. Available online: http://www.doingbusiness.org/content/dam/doingBusiness/media/Annual-Reports/English/DB17-Chapters/DB17-CS-Trading-across-borders.pdf (accessed on 7 June 2019).
62. Koh, J. Singapore TradeNet Single Windows & Regional Interoperability—Trends and Considerations. 2017. Available online: http://www.unescap.org/sites/default/files/26Apr2017---SingaporeExperience.pdf (accessed on 7 June 2019).
63. World Customs Organization. Singapore's Approach to Streamlining Trade Documentation. 2014. Available online: http://www.wcoomd.org/-/media/wco/public/global/pdf/topics/wto-atf/dev/singapores_approach_to_streamlining_trade_documentation__wco_news_october_2014.pdf?la=en (accessed on 7 June 2019).

64. What Is Singapore's New 'National Trade Platform' | OpenGov Asia. 2017. Available online: https://www.opengovasia.com/what-is-singapores-new-national-trade-platform/ (accessed on 24 June 2019).
65. Singapore Customs. Networked Trade Platform. Available online: https://www.customs.gov.sg/about-us/national-single-window/networked-trade-platform (accessed on 7 June 2019).
66. Koh, J. Singapore's New National Trade Platform. In *Workshop on Advancing Interoperability of Single Windows*; United Nations ESCAP: Cholpon Ata, Kyrgyzstan, 2017. Available online: https://www.unescap.org/sites/default/files/Session2_4SingaporeNTP.pdf (accessed on 7 June 2019).
67. China's One-Stop Customs Clearance Facilitates International Trade. 2017. Available online: http://www.xinhuanet.com//english/2017-11/29/c_136788484.htm (accessed on 24 June 2019).
68. Wisesa, H.A.; Hui, F.; Wilson, S.; Wahyuni, S. Transforming Maritime Logistics with The Power of Information Technology. In Proceedings of the International Conference on Science, Management, and Engineering 2018, Jakarta, Indonesia, 22 October 2018; pp. 1–15.
69. Pengelola Portal: Indonesia National Single Window. 2019. Available online: https://www.insw.go.id/ (accessed on 24 June 2019).
70. Information and Communication Technology Bureau—Thai Customs Department. Thailand National Single Window & ASEAN Single Window: 'Welcome Government Officials from Asia-Pacific'. 2018. Available online: https://www.unescap.org/sites/default/files/S7-8_NSW-ASWpresentation%288Aug2018%29.pdf (accessed on 7 June 2019).
71. Single Window Systems Conceptual Framework and Global Trends and Practices OIC Study 2017 9th Meeting of the COMCEC Trade Working Group. 2017. Available online: http://www.comcec.org/en/wp-content/uploads/2017/03/9-TRD-PRE-2.pdf (accessed on 10 July 2019).
72. Port of Hamburg. "Digital Port," Port of Hamburg Magazine. Available online: https://www.hafen-hamburg.de/downloads/media/dokumente/Final_PoH-Magazine_1-16_Englisch.pdf (accessed on 7 June 2019).
73. NSW Konzept v1.4. Available online: http://www.emsa.europa.eu/ssn-main.html (accessed on 10 July 2019).
74. Informations Technik Zentrum Bund. National Single Window. Available online: https://www.itzbund.de/DE/ITLoesungen/NSW/NSW_node.html (accessed on 10 July 2019).
75. European Transport Workers' Federation. ETF and ECSA Welcome the Adoption of the Regulation Establishing a European Maritime Single Window Environment. 2019. Available online: https://www.etf-europe.org/etf-and-ecsa-welcome-the-adoption-of-the-regulation-establishing-a-european-maritime-single-window-environment/ (accessed on 24 June 2019).
76. Yes! U-Port. A Representative Brand for Enhancement of National Logistics Competitiveness. Available online: https://www.klnet.co.kr/resources/download/02.pdf (accessed on 7 June 2019).
77. MSW Reportal. The Swedish Maritime Single Window. 2019. Available online: http://www.sjofartsverket.se/sv/e-tjanster/Maritime-Single-Window/ (accessed on 24 June 2019).
78. Belastingdienst. Single Window for Maritime and Aviation. Available online: https://www.belastingdienst.nl/wps/wcm/connect/bldcontenten/belastingdienst/customs/reference_books_and_other_information/single-window/ (accessed on 7 June 2019).
79. European Maritime Safety Agency. National Competent Authority (NCA). Available online: http://www.emsa.europa.eu/ssn-main/ssn-management/ssn-users.html (accessed on 9 July 2019).
80. Ascencio, L.; González-Ramírez, R.; Bearzotti, L.; Smith, N.; Camacho-Vallejo, J. A collaborative supply chain management system for a maritime port logistics chain. *J. Appl. Res. Technol.* **2014**, *12*, 444–458. [CrossRef]
81. Shi, Y.; Arthanari, T.; Liu, X.; Yang, B. Sustainable transportation management: Integrated modeling and support. *J. Clean. Prod.* **2018**, *212*, 1381–1395. [CrossRef]
82. International Maritime Organization Facilitation Committee—Forty First Session. Dueport: The Spanish Maritime Single Window. 2017. Available online: http://www.puertos.es/es-es/BibliotecaV2/DUEPORT.pdf (accessed on 24 June 2019).
83. Finland. Available online: https://www.findaport.com/country/finland (accessed on 24 June 2019).
84. Port Traffic Declaration Service (Portnet). Available online: https://tulli.fi/en/e-services/services/port-traffic-declaration-service-portnet- (accessed on 7 August 2019).
85. Port of Venice. LogIS (Logistics Information System). Available online: https://www.port.venice.it/en/logis-logistics-information-system.html (accessed on 24 June 2019).

86. Single Window for Trade Facilitation: Regional Best Practices and Future Development. 2018. Available online: https://www.unescap.org/sites/default/files/RegionalBestPracticesofSingleWindows_updated.pdf (accessed on 4 February 2019).
87. Jovic, M.; Kavran, N.; Aksentijevic, S.; Tijan, E. The Transition of Croatian Seaports into Smart Ports. In Proceedings of the 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics, Opatija, Croatia, 20–24 May 2019; pp. 1618–1622.
88. The Ministry of the Sea, Transport and Infrastructure. 2018. Available online: http://www.mppi.hr/default.aspx?id=34251 (accessed on 24 January 2019).
89. Ferrari, C.; Tei, A.; Merk, O. The Governance and Regulation of Ports: The Case of Italy. Managing Sport Business. 2015. Available online: https://www.itf-oecd.org/sites/default/files/docs/dp201501.pdf (accessed on 2 August 2019).
90. Aksentijević Forensics and Consulting. *Cross-Border Action Plan for Enhancing Maritime and Multimodal Freight Transport, D.3.3.1, Best Practice Analysis, Promoting Maritime and Multimodal Freight Transport in the Adriatic Sea (Promares), Interreg Italy-Croatia Project*; unpublished; June 2019.
91. THE BUSINESS TIMES. Asean Single Window—A Digital Platform to Simplify Customs Clearance. 2018. Available online: https://www.businesstimes.com.sg/asean-business/asean-single-window-a-digital-platform-to-simplify-customs-clearance (accessed on 10 June 2019).
92. Group of Authors. Maritime Cloud Conceptual Model. Available online: https://maritimeconnectivity.net/docs/IALAInput-MaritimeCloudconceptualmodel.pdf (accessed on 7 June 2019).
93. EfficienSea2. The Maritime Cloud Becomes Maritime Connectivity Platform. 2017. Available online: https://efficiensea2.org/the-maritime-cloud-becomes-maritime-connectivity-platform/ (accessed on 7 June 2019).
94. Maritime Connectivity Platform. Available online: https://maritimeconnectivity.net/ (accessed on 10 June 2019).
95. European Maritime Safety Agency. Operational Projects—European Maritime Single Window (EMSW). Available online: http://www.emsa.europa.eu/related-projects/emsw.html (accessed on 23 May 2019).
96. EUR-Lex. Proposal for a Regulation of the European Parliament and of the Council Establishing a European Maritime Single Window Environment and Repealing Directive 2010/65/EU. 2018. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018PC0278 (accessed on 7 June 2019).
97. European Commission. European Maritime Single Window Environment. 2019. Available online: https://ec.europa.eu/transport/modes/maritime/digital-services/e-maritime_nl (accessed on 7 June 2019).
98. Safety at Sea. Era of Mandatory Digital Data Exchange Dawns on Global Ports. 2019. Available online: https://safetyatsea.net/news/2019/era-of-mandatory-digital-data-exchange-dawns-on-global-ports/ (accessed on 24 June 2019).
99. European Parliament. European Maritime Single Window: Harmonised Digital Reporting for Ships. 2019. Available online: http://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633179/EPRS_BRI(2019)633179_EN.pdf (accessed on 7 June 2019).