Environmental and Climate Technologies
2023, vol. 27, no. 1, pp. 476–488
https://doi.org/10.2478/rtuect-2023-0035
https://content.sciendo.com

Small and Medium-Sized Port Greening Initiatives as Trigger for a Servitisation Port Ecosystem

Christopher MEYER[1*], Laima GERLITZ[2], Gunnar PRAUSE[3]

[1–3]*Hochschule Wismar, University of Applied Sciences: Technology, Business and Design, Philipp-Müller-Str.14, 23966 Wismar, Germany*

[1,3]*Tallinn University of Technology – TalTech, Ehitajate tee 5, Tallinn, 19086, Estonia*

Received 27.03.2023; accepted 31.07.2023

***Abstract* – Despite the highest competition among the big EU seaports – gateways and hubs, such as Rotterdam, Antwerp, Hamburg or Valencia, etc. which stand for the Core Ports in the European Union (EU) Trans-European Transport Network (TEN-T) Core and Comprehensive Network, the present paper addresses challenges and raises potentials immanent in Small and Medium-Sized Ports (SMSPs) in the EU. Environmental responsibility and digital efficiency – Europe's twin to a green and digital economy paves the way for SMSPs to improve innovation capacity, upgrade demanded future skills and competencies, accelerate EU policies compliant operational, environmental, digital, social and market performance. The paper deploys a multi-case study approach. Using an ecosystem approach, the paper reveals potentials and pinpoints to key short- and long-term challenges pursuant to SMSPs in the three different EU macro-regions – Baltic Sea Region, Adriatic-Ionian Sea Region and Mediterranean Sea Region along the three TEN-T Core Network Corridors Orient-East Med, North Sea-Baltic and Scandinavian-Mediterranean. Departing from the role model – Baltic Sea Region – ports of Kaunas, Klaipeda & Wismar are connected via TEN-T corridors with ports of Bari and Corfu. In this vein, knowledge, skills and best practices are transferred from the North Europe to the South and vice versa using the concepts of co-creation and servitisation. Illustrated case studies reveal how all SMSPs are capable to kick-start environmental and digital transition through co-creation and servitisation mindset in a SMSP ecosystem conceptualisation.**

***Keywords* – Blue economy; green transition; maritime transition; port sector.**

1. INTRODUCTION

Applicable innovation and growth policies are key to achieve innovation. In the EU, innovation is highly policy driven. New EU Industrial Policy based on circular economy principles and the European Green Deal (EGD) as the New EU Growth Strategy serve as key roadmaps. Future business will need to focus on transformation by twinning environmental and digital goals. By doing this, it is believed here, a sustainable socio-economic growth can be grounding, simultaneously benefiting business and society, i.e. providing growth opportunities for businesses and meeting needs and expectations of more environmentally conscious society. EGD calls for 90 % reduction in transport emissions by 2050; a clear boost for multimodal transport with substantial increase of freight (75 %) transported on inland waterways and short-sea-shipping and smart traffic management systems [1]. In the

* Corresponding author.
E-mail address: christopher.meyer@hs-wismar.de

©2023 Author(s). This is an open access article licensed under the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0).

Communication of the Commission [2] on 'Sustainable and Smart Mobility Strategy', there is a need to create zero-emission ports by 2050, enhancement of Emission Control Areas in all EU waters, in particular, Mediterranean and Black Seas; increase of inland waterways transport with 25 % by 2030 and with 50 % by 2050 as compared to 2015.

There are around 225 Comprehensive and only 104 Core seaports in the TEN-T framework, and the majority of them are SMSPs. Harsh environmental, competitive, and operational pressures are expected in SMSPs that partly build up the so-called comprehensive TEN-T Network. According to the International Transport Forum Forecast (2015), waterborne transport will grow with 327 % by 2050, thus producing 238 % more CO_2 emissions. In Europe, freight volumes will increase by 2050 by 216 % with 174 % CO_2 emissions. There will be enormous shift in commodity transportation. 66 % of all Baltic Sea Region (BSR) ports are small and medium sized ports [3]. SMSPs, especially in the BSR, suffer from less freight volumes, missing smart specialisation, outdated infrastructure, investments and new business models contributing to blue and green growth. They are not able to secure financing. As noted also by the BPO, due to their full commitments to primary tasks – port operations – staff in SMSPS have limited chances to engage in projects and thus have less knowledge and capacity.

SMSPs are essential for regional economy, innovation, and specialisation. In fact, there are noted both research and practical lacunas. Very little is known how small ports shape local economy [4]. Potentials of such ports can be increased, once opportunities are recognised and challenges accepted [5]. It is essential to provide ports with capacity and tools to build up their future decision-making based on environmental and digital transition. Those decision-making are insufficiently provided by current literatures [6], also only few literature records (e.g. [7], [8]) are incorporating servitisation and / or co-creation concepts to the port sector, however, they do not consider ports as ecosystems [9], which clearly frames the research gap of this study, which asks how to position co-created port initiatives based on servitisation into a SMSP ecosystem framework. Hence, this paper provides a multi-case study approach connecting port ecosystems of the macro regions Baltic Sea, Adriatic-Ionian Sea and Mediterranean Sea under the umbrella of co-creation and servitisation to illustrate potentials for SMSPs to enhance their greening processes using case studies on innovation application in ports. Multi-cases covering environmental and digital transition pilot initiatives planned or partly developed by included ports are analysed and embedded into SMSP ecosystems. Here, co-creation and servitisation concepts are integrated to upscale the individually planned actions and showcase environmental and digital transformation potentials. In this, the research paper is utilising on an already existing ecosystem transformation framework for digital servitisation [10] and is putting it into the particular context of SMSP ecosystems and their transition through co-creation and servitisation. Hence, the main research objective of the conducted research is to synthesise and identify main trigger for SMSP ecosystem establishment using existing port ecosystem framework [9] with its transformation through servitisation [10] to contribute to digital and environmental transition. In this, the conducted research is position itself in the nexus of SMSP ecosystem research, which is a quite new stream within the maritime and port research field, as well as servitisation and business trigger for such, which is also an underdeveloped area especially in the SMSP research context. Hence, the research claims to be novel in its nature by contributing to the underdeveloped knowledge on SMSP ecosystem potentials and exploitation.

Conclusively, the paper is structured as follows: after this introduction, the background is given for key topics covered, namely SMSPs, co-creation and servitisation. Afterwards, the research methodology as well as the multi-cases are described which are the theoretical

justification of developed results. Lastly, developed results will be put into discussion with other research outcomes in this research field leading to concluding remarks by the authors.

2. BACKGROUND

SMSPs can be defined by a total cargo turnover less than 2 million tonnes / year. There is, however, no unified definition of what an SMSP is [11]. Yet, three main functionalities can be deviated for SMSPs: a) enhancing Blue Economy competitiveness; b) actors in regionalisation processes and c) key capacity to set up multiport gateway regions [12], [13]. In addition, SMSPs also are defined by their limited competitive position in their port cluster regions [12] and their role in a port hierarchy as the lowest based on cost and efficiency [14]. Finally, SMSPs have not only low trade volume and disproportioned freight turnover, but also geographic, economic, and environmental disadvantages [15], [16]. Yet, at the end ports cannot be narrowed down simply to the geographical notion of a delimitated spatial area [17].

Using the same categorisation used for the BSR ports for the Adriatic, Ionian and Liguria Sea, the number of SMSPs within and along the Adriatic, Ionian and Liguria (Mediterranean area) are 93. The Adriatic Sea has 67 ports in five (5) countries, of which nine (9) are categorised as big ports while the rest (58) are SMSPs. The Ionian Sea has 34 ports in two countries with 31 of the ports falling within the SMSP category. Out of the six ports around the Liguria Sea, four (4) are SMSPs. Note that many of these ports are considered as ordinary harbours and very small ports. Unlike what is noticeable among the SMSPs in the BSR, there is a huge gap in spatial interlinkages between critical energy and transport infrastructures (for clean fuels as well their technologies) highlighting the need for intricate harmonisation at both policy and technical level for these ports. Connections and interfaces to the ports are hindered by mountains. Many SMSPs are far from inland urban areas. There is a disconnection between many SMSPs home country and international markets, making cooperation and standardisation of environmental action plan among the ports difficult. Further, because these ports are isolated, they often are exempted during developmental plan unlike what is obtainable with many SMSPs in the BSR, where there are interfaces and connectivity between the ports and international markets and other major ports. The Adriatic and Ionian Region especially are deeply affected by a long-term decline in the competitiveness of the regions' main industries. Therefore, for these ports, most efforts geared toward the preservation of existing conditions and economies rather than on environmental sustainability. In the face of growing international pressure on environmental regulations and policies, only increasing obsolete infrastructures are noticed, whereas innovation exploration and self-discovery remains scant. This is also implicating a research problem to identify potentials and methods to equip SMSPs with necessary innovation capacities to respond to the existing and upcoming challenges born from environmental regulations.

Nevertheless, maritime innovation and research in the 21st century both are increasingly becoming international endeavours and most innovations originate from multiple sources, with many drawings in components or technologies developed in multiple locations [18]. Potential evolutionary pathway of those innovations for ports is dependent on inherent structures and existing dynamics that have to do with the adaptation of radical transformation [19]. Whereas in early discourses innovations were regarded as those emerging only in firms, networks and clusters as well as multi-level and multi-cultural communities became sources in innovation process and enabled to combine internal and external knowledge bases [20]–[23], approach actors at various spatial scales [24], [25], maintain different types of interactions and transfers and focus on locally available capacities

and capabilities [26], [27]. As a result of differentiating socio-economic setting in Europe and especially on the transnational level, in order to accelerate innovative capacity and overcome socio-economic obstacles there emerged a stronger need to address local and regional challenges [28]–[30].

Co-creation is linked with innovation, at is a continuous process that requires a systematic and integrative approach, an intensive implementation roadmap that leads to a success and shared value creation [31], [32]. It also refers to collaborative innovation, where both a supplier and receiver of the innovation itself work together, integrate their needs and taking aspects of social-cultural circumstances into account [31]. In addition, co-creation process offers actors and their networks involved significant opportunities for innovation, as each actor offers access to new resources through a process of resource integration [32]. In this, co-creation is a strategic approach, as it enables to generate and develop resources and capabilities that are valuable, rare, imperfectly imitable, and non-substitutable. Finally, co-creation process is essential in the digital transformation and business modelling, as digital transition is taking placed based on shared and collaborative interactions within systems and communities [33]. Co-creation goes hand in hand with innovation processes.

When it comes to servitisation or product-as-a-service concept, it promotes to change the view from selling products rather than to sell integrated packages of products and services with focus on customer value creation [34], [35]. Moreover, it enables institutions, or here SMSP ecosystems, to better react to an increasingly volatile business environment and, in this, has potentials to contribute to more resilient positioning as well. Thus, servitisation concept is applicable for SMSPs too, especially in line with digital and environmental transition, when referring to [12], since servitisation can be a driving force in an organisational change [36] and has close interactions to digital changes in port ecosystems [37], [38].

3. METHODOLOGY AND MULTI-CASE DESCRIPTION

3.1. Research Methodology

Taking identified research problem and gap into account, the research is driven by qualitative methodological approach to explain and analyse a conceptual phenomenon of interest [39]. Qualitative approaches enable an emerging research design of conducted research which allows researchers to be responsive in their method implementation depending on yielded results during the process [40]. In this, the research also claims to be explanatory as it is connecting different concepts and put them into new context to identify and create knowledge within an underdeveloped topic [41] with qualitative nature [42], [43].

Moreover, the research is utilising on multi-case studies. Building up on Yinian proposition, the application of single cases is not sufficient to approach complex research discourses. This is because researchers are analysing real life entities (SMSPs), their boundaries (environmental and digital transition) and context (SMSP ecosystems) which is not in the control of researchers at all [44], [45]. In this frame, creating knowledge is the driving impetus of the research's reality. Here, it can be created objectively by applying methodological actor's approach. In this particular approach, knowledge and reality is constructed independently from the actors involved. This is especially applicable for this research as ports are understood as ecosystems / social constructs which are independent from individuals, but constructed as such by a certain number of meanings share by a large or small number of actors [46]. Here, the present research is offering a strength of considering ports as kind-of social constructs which are forming the actual ecosystem. First, the actor's approach is

offering an advantage allowing ports to address multiple disciplines and domains, which corresponds to their practical role in being logistics, economic, social, environmental, political, and innovative constructs [47], [48]. Second, taking up previous argument, consequently the research is also positioned between different research disciplines, such as business and management, environmental engineering, social sciences, regional and spatial planning as well as political studies [6]. Nevertheless, this research does not aim at being defined or associated within a specific research discipline but contributes to construct valuable knowledge towards environmental and digital transition potentials to capitalise on for SMSPs. Third, the research is addressing organisational aspects for port governance as well, which is addressing learning and capacity absorption as well. In this, the present research is circulated around organisational concepts, models and approaches which are utilised on for result examination.

The research methodology is born in constructivism and interpretivism perspectives of the researchers. Constructivism is proposing the utilisation of theoretical constructions [49] and multiple realities to investigate, whereas researchers themselves are also integrated within the objects being analysed [50]. Thus, knowledge is created by the researcher rather than simply taken which correspond with the actor's approach paradigm as introduced previously. Interpretivism is giving a certain meaning and foundation to actions and processes [51] which allows the positioning of port inputs given by multi-cases into the overall concept of digital and environmental transition of SMSP ecosystems.

Lastly, the multi-case analysis in the presented philosophical stance of the research has been supplemented by literature analysis of scientific research items covering the topics as of SMSPs, co-creation for innovation processes and servitisation towards digital and environmental improvements. Fig. 1 summarises the research path for this study.

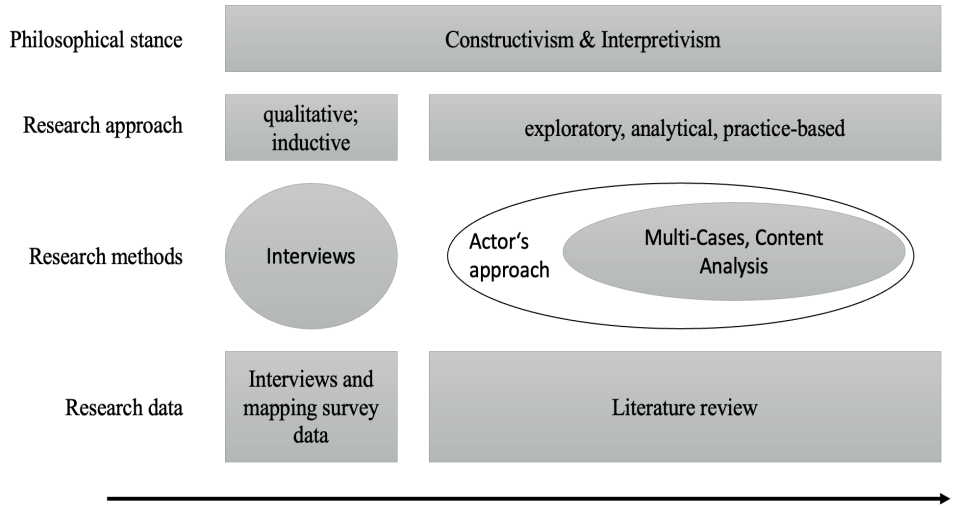


Fig. 1. Methodological Pathway (Conducted by authors).

3.2. Multi-Case Description

The multi-cases have been analysed in the scope of a Horizon project proposal on improving the environmental capacities of European SMSPs. The pilot actions have been co-created involving port representatives from different SMSPs, academics and entrepreneurs with

moderation of Creative Broker. Here, bilateral meetings, port representative interviews and mapping surveys have been conducted as main research methods to gather primary data from ports on their piloting actions to have significant impact on their environmental performances. In this, the present research claimed to be inductive, using the analysed cases to develop and create common knowledge being applicable and adaptable to other SMSPs and research as well. Table 1 below is providing a short comparison of the included cases.

TABLE 1. MULTI-CASE COMPARISON

	Kaunas	**Klaipeda**	**Wismar**	**Bari**	**Corfu**
Country	Lithuania	Lithuania	Germany	Italy	Greece
Type	Inland Port	Seaport	Seaport	Seaport	Seaport
Handling	Container, Multipurpose	Passenger, Break Bulk, Bunkering, Container, Dry Bulk, Dry Dock, Liquid, Multipurpose, Ro-Ro, Shipyard	Break Bulk, Dry Bulk, Liquid	Passenger, Break Bulk, Container, Liquid, Dry Bulk, Multipurpose, Ro-Ro	Passenger, Dry Bulk, Liquid
TEN-T access	Core North Sea Baltic	Core North Sea Baltic	Comprehensive North Sea Baltic; Comprehensive Scandinavian – Mediterranean	Comprehensive Orient / East-Med	Core Scandinavian–Mediterranean
Research methods applied	Interview & Mapping Survey	Interview & Mapping Survey	Interview & Mapping Survey	Interview & Mapping Survey	Interview & Mapping Survey
Servitisation Pilot	Electric Tugboat	Blockchain-based process integration	Automated ship loader and cargo plant	IT based marine energy production based on tides	Electric watercraft & hinterland connection

In the following, the cases and their environmental pilots are shortly presented. Here, it is important to know that those pilots are mainly in development stage and not yet realised. However, for a theoretical conceptualisation, this research is capitalising on these pilot initiatives to frame a sufficient SMSP ecosystem conceptualisation on digital and environmental transition.

3.2.1. Port of Kaunas, Lithuania – Inland Port

In order to ensure smooth transport of goods and fully achieve zero CO_2 emissions, it is necessary to incorporate (build) a new shallow water electric tugboat adapted for inland waters and shallow rivers. Currently, there are no such vessels on the market, because even conventional tugboats existing in the market and used in Europe and in the world are oriented towards a greater draft than is the case in Lithuanian inland waterways. Therefore, a low-draft electric tugboat would be a project based on innovative solutions. Furthermore, it is necessary to implement a new electric mobile harbour crane in Kaunas port. Currently, mobile telescopic cranes (auto cranes) are used in Kaunas port. Mobile telescopic cranes (auto cranes) are powered by diesel engines. Kaunas port is located near Kaunas city centre and Kaunas old town. Therefore, a lot of attention is paid to CO_2 emissions. Zero CO_2 emission can be achieved by using electric crane.

At the moment we prepared a 'Feasibility Study for the Design of a Battery-Powered Electric Locomotive' (hereinafter – Study), the essence of which is the conversion of a powerful shunting diesel locomotive TGM6A (or analogue) into an electric battery-powered locomotive. This type of locomotive would be more than three times powerful than the plug-in locomotives that are using BEGA at the moment. New locomotives would work on longer railway sections and ensure the pushing/pulling of larger segments of railway trains. This is necessary not only for the wagon unloading/loading stations where the plug-in locomotives work, but also for the use of green technologies in the wagon supply chain. This would have an even greater effect on reducing of burned fuels emissions and would create a green logistics chain in which only renewable electricity would be carried out for all BEGA's railway work.

3.2.2. Port of Klaipeda, Lithuania – Seaport

The goal of this pilot project is to develop, on top of an automated blockchain-based logistics document flow solution, a seamless accounting layer for emissions, which will empower actors in the system with real-time decision-making tools to select the most environment-friendly logistics options in their supply chain processes. Overtime, while participating nodes draw efficiency benefits from the automation of logistics-related documentation, distributed and verified via automated smart contract algorithms, they will also benefit from the collection of data on environmental performance from all different logistic nodes. This environmental monitoring function will establish footprint tracking services, navigation towards environmentally friendly logistic chains solution, emission planning and other services. The platform will provide a breakthrough for a green port standard and best implementation practices.

3.2.3. Port of Wismar, Germany – Seaport

In recent years, Seaport of Wismar has already made several changes for the benefit of the environment and particularly for the reduction of its Carbon footprint. Basically, the envisaged pilot on green and energy self-sufficient fully automated bulk cargo plant builds upon the implementation of the following four sub-systems: Fully automated ship loader with the onshore wind power station. First steps are made for the automation by integrating and setting up 5G technology in the port area. The implementation of the needed wind power station represents an innovative endeavour, since our conducted feasibility study revealed that currently there is no suitable system of required size (i.e. maximum height of 50 m with 150 kW nominal power and an annual output of 500 000 kWh on the market. The only system that would have fit for our envisaged requirements, the 'bventus machine', was withdrawn from the market due to technical problems and excessive noise emissions. Furthermore, the rotor was simply too big for a system with a total height of 50 m. Hence, neither the manufacturers of small nor of the large systems currently offer a suitable system for the German market of required size.

3.2.4. Port of Bari, Italy – Seaport

This pilot will include an audit of a specific area of the port and a freight pollution forecasting service in conjunction with energy efficiency strategies for buildings using IoT. Moreover, the port energy assets will be forecasted using Artificial Intelligence (AI) solutions. The VEGA monitoring system will be enhanced with smart and innovative tools and will be integrated in the architecture of the Port Community System GAIA. Moreover, a passenger electric van and station will be incorporated, in order to see the environmental

benefits from its usage. Marine renewable energy – in particular electricity generated by waves and tides – is now coming out of the research and development phase and is steadily entering the operational, pre-commercial phase, as full-scale prototypes are already being built – in real environment. Although the availability of marine energy resources in Europe is highest along the Atlantic coast, it has been recognized that the Mediterranean Sea offers significant opportunities both for its significant energy production capacity and for technological development.

3.2.5. Port of Corfu, Greece – Seaport

In-port electric charging station in the port of Corfu is the primary objective of this pilot. The station will be installed in order to power supply the electric watercrafts that are moored in the port. The aim is to utilize electricity as the main power source of the moored watercrafts. This pilot comprises the employment of electric watercrafts, which are making headlines in the last years as an alternative option for zero emission operations, mostly in short sea shipping, in light of a wave of stringent environmental regulations. The electrification of watercrafts for green transformation requires onboard electrical energy storage as well as an energy supply network in the port area. The electrification shall be connected to the hinterland passenger transportation. Ports accommodating cruise ships are often facing problems with the satisfactory service of the people that disembark to go sightseeing or to spend some time in the city of the port.

4. RESULTS

To place the multi cases into ecosystem framework setting for SMSPs, the present research is utilising on the Functional Port Service Ecosystem framework, which has been developed for SMSPs and is already considering servitisation aspects and transformation in the port sector [9]. However, this framework is analysing and describing the architecture of an established SMSP ecosystem. To further analysis environmental and digital transition potentials in such ecosystems, the conducted research is adding the perspective on how to trigger the establishment of such an ecosystem as well as the potential effects of it by using an ecosystem transformation framework [10] and adapt it to the port sector research.

The key building blocks identified for a SMSP ecosystem are institutional, technological, socio-environmental and market (place-based) architecture, whereas ports shall build up close relationships towards their customers (servitisation) as well as collaborative actors (co-creation) alongside all four areas. As indicated in the framework, each of these building blocks is not only crucial in an ecosystem setup, but are also important driver for sustainable development, covering digital and environmental potentials. It emphasises institutional stability being crucial for exploiting and grasping potentials from a governing perspective, thus, the SMSP ecosystem framework is connecting to policy level, e.g. European Green Deal and Fit for 55. Thus, SMSP ecosystems as proposed might be an approach to overcome the challenge to achieve the aspired target set for port sector and maritime industry. Furthermore, solid technology architecture and listed determinants are principal enablers for digital and service-led development, whereas socio-environmental architecture affects sustainability of ports through the cultural, mental, and historical attributes of actors. Lastly, a SMSP ecosystem needs to address and react on external forces on the markets, funding resources and port-related competitiveness through the servitisation logic, i.e., moving from the sole product-based solutions towards service-driven innovation solutions in ports and SMSP ecosystems.

The analysed cases, based on co-created pilot actions being developed, are place in the nexus of digital and environmental transition. Here, digital transformation is seen as a method or tool for ports to support environmental transition rather than an individual aim by itself. Or, in other words, digital transition is a holistic approach being involved in nearly all transformation processes within a SMSP ecosystems. Digital transition can't be regarded as independent and individual area anymore as it is embedded in a SMSP ecosystem across all levels and section. Thus, for the conducted research, digital transition is intertwined with environmental transition in its nature and reflected in all four building blocks of the SMSP ecosystem framework.

During the co-created pilot action development of covered cases, additional enabler for an ecosystem in port sectors were identified. However, as those are out of the research scope of the research even though slight synergies to co-creation and servitisation may be identified, they shall only be shortly mentioned to provide a comprehensive overview of potential SMSP ecosystem establishment. Also, other research items are already covering these specific areas in port related literature towards digital and / or environmental transition. Here, sufficient business modelling [52], Entrepreneurial Culture [53], [54] and Capacity Building [55] are emphasised as additional enabler for SMSP ecosystem setup.

Fig. 2 illustrates the introduced framework including the positioning of identified trigger to initiate a SMSPs ecosystem. Moreover, after case and ecosystem analysis, the effects of an ecosystem establishment for ports can be emphasised and classified into three key areas as of strategic, management and technology improvements.

In terms of Strategic Improvements, the case analysis revealed an improved awareness of involved port representatives towards regulations such as the European Green Deal and Fit for 55 through the co-created pilot actions. This is still a burden in port sector as already existing regulations especially on environmental impact in shipping and port industry will strongly affect daily business for SMSPs as well. However, as the research has shown, through the development of covered pilot actions, involved SMSPs also grappled with their readiness for environmental targets set from policy level. Here, additional steps have been made to develop or improve environmental strategies and plans to push the environmental transition within the SMSP ecosystems.

Management Improvements were identified on two key topics. First, collaboration among ports as well as ecosystem stakeholder involvement can be improved towards digital and environmental transition when setting up SMSP ecosystems. Here, the approach of co-creation is highly useful to initiate learning and self-discovery affects for port representatives being involved in such processes. Second, energy circularity awareness on management level was pinpointed as crucial aspect for port development especially regarding environmental transition. So far, individual attempts and plans have been developed, e.g. the application of photovoltaic in port areas. However, through co-creation for SMSP ecosystems, a shift in mindset can be achieved towards energy circularity and symbioses enabling a more comprehensive perspective on energy management for a SMSP ecosystem.

Lastly, technology improvements can be identified as effect of the multi case analysis and framework application under co-creation and servitisation aspects. Here, the co-created pilot action plans are all covering technological improvements through different integration approaches of new infrastructure as described in the cases.

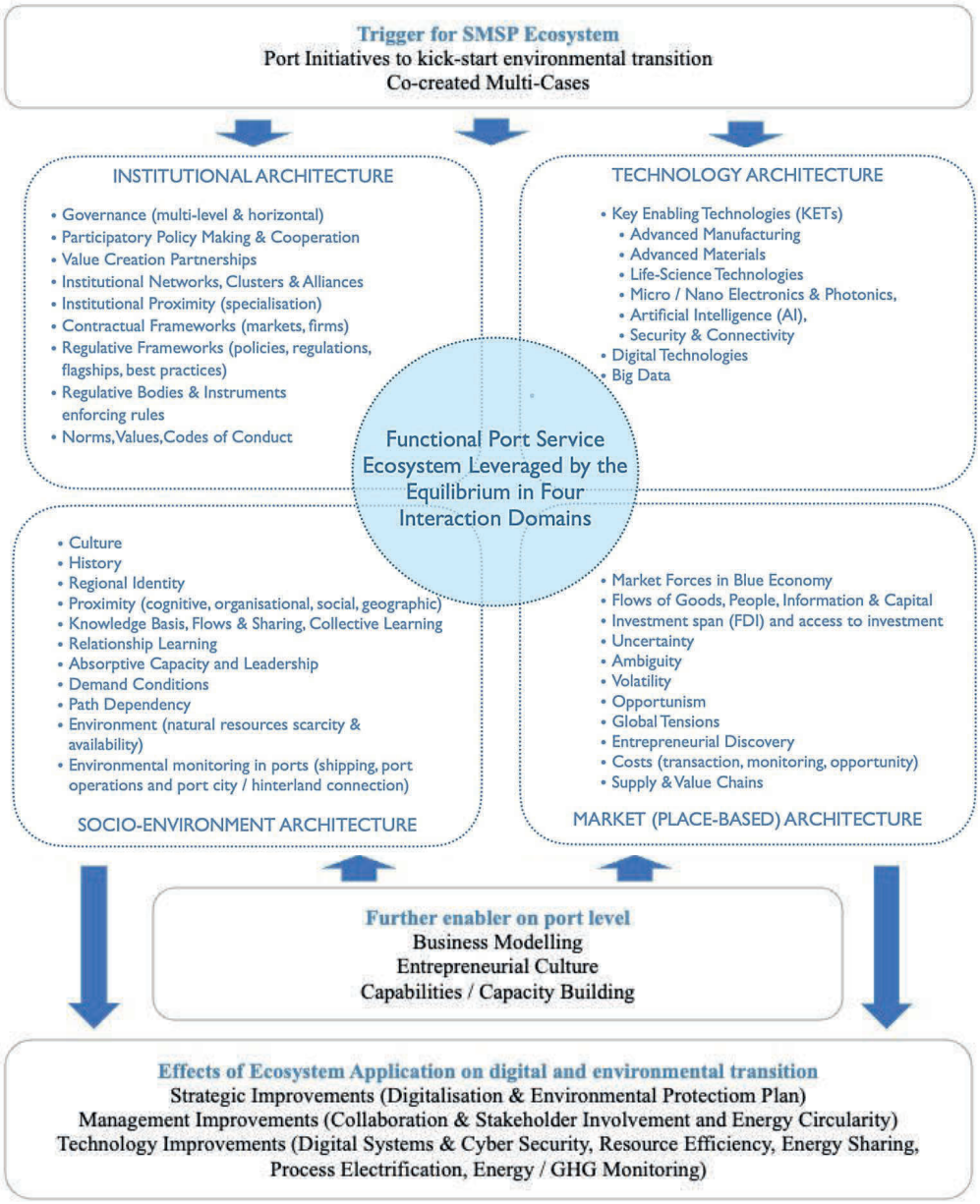


Fig. 2. Servitisation SMSP Ecosystem framework (Compiled by authors, adapted from [9], [10]).

5. DISCUSSION & CONCLUDING REMARKS

The digital and environmental transition of European SMSPs remains a pivotal issue in Europe's Blue Economy considering the targets being set by European Green Deal and Fit for 55 regulations. Moreover, additional International Maritime Organisation (IMO) regulations or ReFuelEU aviation are already published which increase the pressure in the port sector to act now. Here, port managers are in a position to kickstart and improve operational capacities by addressing different port areas involved such as

- Shipping and waterborne activities including port reception facilities (e.g., mooring, towage, bunkering, ballast water treatment, nautical technical assistance);
- Daily port operations including port services (e.g., cargo handling, consignment of ships, passenger transport, stowing, dredging);
- Hinterland connection (intermodal access, passenger accessibility, tourism services, safety and security).

Here, utilising on ecosystem approach is sufficient to analyse and design the greening of European SMSPs as well as to exploit further potentials through collaboration, stakeholder involvement and spill overs to other sectors. In this, the ecosystem approach is also referring to the regional importance of SMSPs being actors with economic, environmental, social, and political importance.

In the same vein, the ecosystem approach is essential for environmental transition. Greening initiatives should achieve environmental, technological, legal, economic and governance (social) feasibility and value creation. This is the logical link between SMSPs ecosystems and environmental transition, whereas digital transformation is rather a comprehensive element or method to achieve such. Here, the research has shown the positioning of pilot actions as trigger for SMSPs ecosystem establishment. Here, the research has analysed several cases being co-created with focus on servitisation in participating ports. Thus, the present research is stepping into the scant literature landscape of SMSP research. Despite the low amount of research targeted to SMSPs, the present research is underlining the link of SMSPs towards digital and environmental transformation [9], [56] and policy setting [57].

In the analysis, the research is dealing with limitations. The cases of participating ports cover pilot initiatives, which are developed on theoretical basis and have not yet proven their feasibility to be practically applicable. Moreover, the ecosystem is a theoretical construct which needs to be further elaborated and transferred into practice. Nevertheless, the conducted research is rather a starting point for future research avenues dealing with SMSPs and their role in European sectors.

REFERENCES

[1] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal. Brussels: EC, 2019.

[2] European Commission. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee of the Regions. Sustainable and Smart Mobility Strategy – putting European transport on track for the future. Brussels: EC, 2020.

[3] Rozmarynowska M., Oldakowski B. Development perspectives for small and medium Baltic Sea ports. Diepoldsau: TransBaltic, Baltic Ports Organization, 2013

[4] Karimah I. D., Yudhistira M. H. Does small-scale port investment affect local economic activity? Evidence from small-port development in Indonesia. *Economics of Transportation* 2020:23:100180. https://doi.org/10.1016/j.ecotra.2020.100180

[5] Mańkowska M., Kotowska I., Pluciński M. Seaports as nodal points of circular supply chains: Opportunities and challenges for secondary ports. *Sustainability* 2020:12(9):3926. https://doi.org/10.3390/su12093926

[6] Bjerkan K. Y., Seter H. Reviewing tools and technologies for sustainable ports: Does research enable decision making in ports? *Transportation Research Part D: Transport and Environment* 2019:72:243–260. https://doi.org/10.1016/j.trd.2019.05.003.
[7] Danelec Marine. White Paper on Servitization in the Maritime Industry. Birkeroed: Danelec Marine A/S, 2016.
[8] Matzen D., McAloone T. C. From product to service orientation in the maritime equipment industry-a case study. *Manufacturing Systems and Technologies for the New Frontier* 2008:515–518. https://doi.org/10.1007/978-1-84800-267-8_106
[9] Gerlitz L., Meyer C. Small and Medium-Sized Ports in the TEN-T Network and Nexus of Europe's Twin Transition: The Way towards Sustainable and Digital Port Service Ecosystem. *Sustainability* 2021:13(8):4386. https://doi.org/10.3390/su13084386
[10] Kolagar M., Parida V., Sjödin D. Ecosystem transformation for digital servitization: A systematic review, integrative framework, and future research agenda. *Journal of Business Research* 2022:146:176–200. https://doi.org/10.1016/j.jbusres.2022.03.067
[11] PAC2. A cluster initiative: Small and Medium Sized Ports as Hubs for Smart Growth and Sustainable Connectivity. *2 Seas Magazine – Special Focus* 2014:6–15.
[12] Feng L., Notteboom T. Peripheral challenge by small and medium sized ports (SMPs) in multi-port gateway regions: the case study of northeast of China. *Polish Maritime Research* 2013:20:55–66. https://doi.org/10.2478/pomr-2013-0027
[13] Notteboom T. E. The peripheral port challenge in container port systems. International maritime transport: perspectives. Chapter 13. Oxfordshire, Routledge, 2005:173–188.
[14] Robinson R. Asian hub/feeder nets: the dynamics of restructuring. *Maritime Policy & Management* 1998:25(1):21–40. https://doi.org/10.1080/03088839800000043
[15] Lu W., *et al.* Network connection strategy for Small and Medium-sized Ports (SMPs). *The Asian Journal of Shipping and Logistics* 2018:34(1):19–26. https://doi.org/10.1016/j.ajsl.2018.03.003
[16] Unctad. 2014. Review of Maritime Transport 2014. New York, Geneva: UN, 2014.
[17] Notteboom T. E., Haralambides H. E. Port management and governance in a post-COVID-19 era: quo vadis? *Maritime Economics & Logistics* 2020:22:329–352. https://doi.org/10.1057/s41278-020-00162-7
[18] Hayek F.A. Competition as a Discovery Procedure. *The Quarterly Journal of Austrian Economics* 2002:5(3)9–23.
[19] Foray D. Smart Specialisation: The Concept. Presented at the Smart Specialisation Conference, Sofia, Bulgaria, 2012.
[20] Pavitt K. Sectoral patterns of technical change: towards a taxonomy and a theory. *Research Policy* 1984:13(6):343–373. https://doi.org/10.1016/0048-7333(84)90018-0
[21] Chesbrough H. Open Innovation: The New Imperative for Creating and Profiting from Technology. Boston: Harvard Business School Press, 2003.
[22] Asheim B., Gertler M. The geography of innovation: Regional Innovation Systems. Chapter 13. The Oxford handbook of Innovation. Oxford: Oxford University Press, 2005:291–317.
[23] Malerba, F. Sectoral systems of innovation: a framework for linking innovation to the knowledge base, structure and dynamics of sectors. *Economics of Innovation and New Technologies* 2005:14(1–2):63–83. https://doi.org/10.1080/1043859042000228688
[24] Smith K. Innovation as a systemic phenomenon: rethinking the role of policy. *Enterprise and Innovation Management Studies* 2000:1(1):73–102. https://doi.org/10.1080/146324400363536
[25] Tödtling F., Lehner P., Trippl M. Innovation in knowledge intensive industries: The nature and geography of knowledge links. *European Planning Studies* 2006:14(8):1035–1058. https://doi.org/10.1080/09654310600852365
[26] Gertler M. S., Levitte Y. M. Local nodes in global networks: the geography of knowledge flows in biotechnology innovation. *Industry and Innovation* 2005:12(4):487–507. https://doi.org/10.1080/13662710500361981
[27] Boschma R. A., Ter Wal A. L. J. Knowledge networks and innovative performance in an industrial district: The case of a footwear district in the South of Italy. *Industry and Innovation* 2007:14(2):177–199. https://doi.org/10.1080/13662710701253441
[28] Courchene T. J. Glocalisation: the regional/international interface. *Canadian Journal of Regional Science* 1995:18(1):1–20.
[29] Porter M. Location, Competition and Economic Development: Local Networks in a Global Economy. *Economic Development Quarterly* 2000:14(1):15–34. https://doi.org/10.1177/089124240001400105
[30] Wolfe D. Social Capital and Cluster Development in Learning Regions. Knowledge, Clusters and Regional Innovation: Economic Development in Canada, Montreal and Kingston. London: Ithaca – School of Policy Studies, Queens University, 2002:11–38.
[31] Payne A. F., Storbacka K., Frow P. Managing the co-creation of value. *Journal of the Academy of Marketing Science* 2008:36(1):83–96. https://doi.org/10.1007/s11747-007-0070-0
[32] Frow *et al.* Managing co-creation design: A strategic approach to innovation. *British Journal of Management* 2015:26(3):463–483. https://doi.org/10.1111/1467-8551.12087
[33] Chan H. C. Internet of things business models. *Journal of Service Science and Management* 2015:8(04):552. https://doi.org/10.4236/jssm.2015.84056

[34] Melão N. Servitization. The SAGE Encyclopedia of Quality and the Service Economy. Thousand Oaks, USA: SAGE Publications, 2015:737–739.
[35] Kowalkowski *et al.* Servitization and deservitization: Overview, concepts, and definitions. *Industrial Marketing Management* 2017:60:4–10. https://doi.org/10.1016/j.indmarman.2016.12.007
[36] Vendrell-Herrero *et al.* Servitization as a driver for organizational change. *Strategic Change* 2014:23(5–6):279–285. https://doi.org/10.1002/jsc.1976
[37] Tronvoll B., *et al.* Transformational shifts through digital servitization. *Industrial Marketing Management* 2020:89:293–305. https://doi.org/10.1016/j.indmarman.2020.02.005
[38] Agatić A., Kolanović I. Improving the seaport service quality by implementing digital technologies. *Pomorstvo* 2020:34(1):93–101. https://doi.org/10.31217/p.34.1.11
[39] Creswell J. W. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. 4th ed. London: Sage Publications, 2014.
[40] Korstjens I., Moser A. Series: Practical guidance to qualitative research. Part 2: Context, research questions and designs. *European Journal of General Practice* 2017:23(1):274–279. https://doi.org/10.1080/13814788.2017.1375090.
[41] Shields P. M., Rangarajan N. A Playbook for Research Methods: Integrating Conceptual Frameworks and Project Management. Stillwater, USA: New Forums Press, 2013.
[42] Borrego M., Douglas E., Amelink C. Quantitative, qualitative, and mixed-research methods in engineering education. *Journal of Engineering Education* 2007:98:53–66. https://doi.org/10.1002/j.2168-9830.2009.tb01005.x
[43] Merriam S. B., Tisdell E. J. Qualitative Research: A Guide to Design and Implementation. Hoboken, USA: John Wiley & Sons, 2015.
[44] Yin R. K. Case Study Research and Applications. Thousand Oaks, USA: SAGE, 2018.
[45] Yazan B. Three approaches to case study methods in education: Yin, Merriam, and Stake. *The Qualitative Report* 2015:20:134–152. https://doi.org/10.46743/2160-3715/2015.2102
[46] Arbnor I., Bjerke B. Methodology for Creating Business Knowledge. Thousand Oaks, USA: SAGE, 2008.
[47] Audretsch D. B., *et al.* Entrepreneurial ecosystems: Economic, technological, and societal impacts. *Journal of Technology Transfer* 2019:44:313–325. https://doi.org/10.1007/s10961-018-9690-4
[48] Cantner U., *et al.* Entrepreneurial ecosystems: A dynamic lifecycle model. *Small Business Economics* 2020:1–17. https://doi.org/10.1007/s11187-020-00316-0
[49] Crotty M. The foundations of social science research: meaning and perspective in the research process. New South Wales: Allen and Uwin, 1998.
[50] Lincoln Y. S., Lynham S. A., Guba E. G. Paradigmatic controversies, contradictions, and emerging confluences revisited. The SAGE Handbook of Qualitative Research. Thousand Oaks, CA: Sage, 2011:97–128.
[51] King N., Horrocks C. Interviews in Qualitative Research. SAGE, 2011:6–24.
[52] Philipp R. Blockchain for LBG maritime energy contracting and value chain management: a green shipping business model for seaports. *Environmental and Climate Technologies* 2020:24(3):329–349. https://doi.org/10.2478/rtuect-2020-0107
[53] Okada T., *et al.* Green port structures and their ecosystem services in highly urbanized Japanese bays. *Coastal Engineering Journal* 2021:63(3):310–322. https://doi.org/10.1080/21664250.2021.1911194
[54] Witte P., *et al.* Facilitating start-ups in port-city innovation ecosystems: A case study of Montreal and Rotterdam. *Journal of Transport Geography* 2018:71:224–234. https://doi.org/10.1016/j.jtrangeo.2017.03.006
[55] Meyer C., Gerlitz L., Henesey L. Cross-border capacity-building for port ecosystems in small and medium-sized Baltic ports. *TalTech Journal of European Studies* 2021:11(1):113–132. https://doi.org/10.2478/bjes-2021-0008
[56] Philipp R., Gerlitz L., Moldabekova A. Small and medium-sized seaports on the digital track: Tracing digitalisation across the South Baltic Region by innovative auditing procedures. *Reliability and Statistics in Transportation and Communication* 2020:351–362. https://doi.org/10.1007/978-3-030-44610-9_35
[57] Meyer C. Integration of Baltic small and medium-sized ports in regional innovation strategies on smart specialisation (RIS3). *Journal of Open Innovation: Technology, Market, and Complexity* 2021:7(3):184. https://doi.org/10.3390/joitmc7030184