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SUSTAINABILITY IN SHIPBUILDING
– OBSERVATIONS FROM PROJECT-ORIENTED SUPPLY NETWORK IN CRUISE SHIP CONSTRUCTION

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1. INTRODUCTION

1.1. Sustainability and Transparency in Shipbuilding Networks (SUSTIS) project

The Finnish maritime cluster (see Karvonen et al. 2016) was developed by integrating local needs for winter seafaring and connections to Europe into expertise for constructing ferries, icebreakers and related equipment. Soon Finnish shipyards also specialised in building cruise ships. Later, a broad supplier network for various marine equipment and interior supplies was created. Although the base demand came from domestic shipyards, many became global suppliers. With this background and strong relationship with the cruise industry's customers, the Finnish cluster has introduced innovative ship designs, enabling the building of the world's largest passenger ships and also system-specific novelties like azimuth thrusters. As environmental awareness increases, the cruise industry faces more pressure to advance its sustainability and transparency practices. In cruise ships energy efficiency improvements have been made but interest in a broader sustainability approach has also been identified.

In recent years, the shipping sector has received a critical eye regarding the sector's sustainability and its performance. Even as a highly efficient transport mode, the industry's emissions are sought to be minimised, leading to sulphur caps and other regulations. Compared to the vast cargo shipping sector, the cruise industry's share is very small. However, the market's passenger and tourism dimensions make the topic much more sensitive. For the Finnish maritime cluster, cruise ships' sustainability is interesting, since the ships can act as important testbeds for new greener technology and innovations. Also, cruise ship production methods are often more advanced than cargo ship production, which might provide better performance regarding efficiency and sustainability.

Against this background, initial discussions were begun in 2015 to assess sustainability in shipbuilding, how sustainability assessments in shipbuilding could be performed more holistically and how these assessments are related to cluster-level competitive advantage. As a result, the SUSTIS project's first phase was launched in 2016, focusing on sustainability-related indicators, data transfer, cross-industry benchmarking and employee perspective (see Heikkilä (2016) and Apostol (2016)).

In 2017, the second phase of the project was broadened into a company consortium. The consortium included Meyer Turku Oy, DNV GL Business Assurance Finland Oy, Evac Oy, NIT Naval Interior Team Oy, Paattimaakarit Oy, Piikkio Works Oy and Sininen Polku Oy. Additionally, Finnish Marine Industries, SSAB and Lautex became supporting members. Each consortium company had its development projects supported by a joint research project, carried out by the University of Turku and VTT. The second phase dealt with cruise ship-related sustainability data, data illustration pilots (Future Technologies/University of Turku) and environmental footprint evaluation (VTT). Also, the social and economic aspects of sustainability were explored broadly for the supplier network; the main results are summarised in this report. The report covers project topics researched by the Centre for Collaborative Research and Finland Future Research Centre of Turku School of Economics, University of Turku.

A major trend in cruise ship construction has been the gradual increase of outsourcing, up to 80% of a ship project's total value. This increase implies that research on shipbuilding must consider shipbuilders' supply networks, which is also one of the goals of this study. This report aims to form an overview of sustainability practices with shipbuilding suppliers in the Finnish maritime cluster, from the perspective of

production methods, project management, buyer-supplier relationships and perceptions on clusters' future competitiveness. These practices influence the actualisation of all three forms of sustainability: environmental, social and economic. The report mainly emphasises social and economic sustainability in the supply network. The focus was selected because typical sustainability research in shipbuilding has an environmental perspective or a single company's social perspective (occupational health and safety). However, the Finnish maritime cluster's practice to utilise broad supply network, dividing a ship into areas is a global and rare complex production system. This study is an explorative attempt to identify elements and factors relevant to sustainability in complex project-based supply networks that do not necessarily come from a single company or employee-level studies. This overview report aims to offer insights into the following research questions:

- What has been researched regarding the sustainability of shipbuilding's construction phase so far, and what findings have been made?
- What changes and trends in shipbuilding production and supply chain management practices affect shipbuilding clusters' sustainability?
- How does shipbuilding's project-based operational environment affect the practices and perceptions of sustainability in the supply network?
- How are the future of the cruise industry and related shipbuilding seen, and what kind of weight sustainability is perceived to have in the future?

1.2. Cruise ship construction and sustainability

The literature offers multiple definitions of sustainability. For example, Dahlsrud (2008) and Sarkar and Searcy (2016) reviewed the previous definitions and found similar aspects in the different definitions. Dahlsrud (2008) defines sustainability as including five aspects (economic, environmental, social, voluntariness and stakeholder dimension), whereas Sarkar and Searcy (2016) highlight six aspects (economic, ethical, social, stakeholders, sustainability and discretionary). However, in this paper, we follow Aguinis's (2011) proposed definition as 'context-specific organisational actions and policies that take into account stakeholders' expectations and the triple bottom line of economic, social, and environmental performance' since, in our view, this definition better suits our setting.

Feasible frameworks for examining shipbuilding come from project management literature: for example, the project business view (Artto & Wikström, 2005) of the one-off, long-term nature of the industry. A project's life-cycle is typically divided into i) pre-construction, ii) construction iii) operations and iv) end-of-life stages (Elo & Saurama, 2013). Finnish maritime sector activities focus mainly on the pre-construction and construction stages. Shipbuilding supply networks are a nexus of business-to-business -relationships between integrators (buyers) and suppliers (sellers). According to Davies (2004), system integrators are specialists in the design and integration of activities along the value chain. Suppliers are specialists for mass production of key tasks, components or materials. In shipbuilding, the shipyard is usually at the top of the supply network hierarchy and is principally responsible for the project and interaction with the customer (shipowner). First-tier suppliers (major system providers and turnkey interior outfitters) act as both integrators and suppliers. Second-tier suppliers provide ready-to-install products, semi-finished products or installation work.

Concerning sustainability in this context, Larsson and Larsson (2018) indicate that in project-based industries, where one-off solutions are provided by fragmented business-to-business supply networks, the focus is usually on customer-driven business projects. Only incremental innovations tend to fit in such

projects. Wide-scale development focused on explorative and systemic innovation is left out of the core activities. The reason is that such innovation activities are difficult to implement across multiple parties, and sustainability improvements fall into this category.

The impacts of shipping operations and their influence on climate change are well studied. Recurring research objects include emissions and their reduction through technology, and operations like slow steaming and regulation (see, e.g. Capaldo et al., 1999; Corbett et al., 2009 and Balcombe et al., 2019). At shipping industry conferences, environmental issues and the need for industry-level changes have gradually expanded. Operational focus is present also in research of shipping's safety issues (see, e.g. Hetherington et al., 2006), addressing social elements like crew welfare. Regarding the cruise industry as a special case of shipping sectors and tourism industry, the research on sustainability focuses on an operational level that impacts the cruise destination's biodiversity or economy, waste management and staff working conditions (see, e.g. Johnson, 2002; Klein, 2011; Bonilla-Priego et al., 2014). Jones and colleagues (2016) believe cruise lines only follow a weak approach to sustainability to maintain their existing business models and the current rate of the industry's growth. Pakbeen (2018) noted that major cruise lines mostly report energy efficiency, water and wastewater treatment, waste management and conservation of ecosystem activities. Overall, operation phase is seen to have the largest sustainability impacts in previous studies. The shipbuilding phase is often left unaddressed in detail.

Probably due to the project business nature and the tendency for customer-driven development, the sustainability of the shipbuilding industry is a relatively less-researched topic. However, some examples can be identified. Pulli and colleagues (2013) compiled a report of environmental indicators from the shipbuilding perspective. Kytölä (2017) developed a model for innovative sustainability drivers in in the context of Chinese and South Korean shipyards. The coexistence of top management commitment and strategy, together with long-term pursuit of competitiveness and external pressure from customers and legislation, were seen as supporting sustainability initiatives. A curious detail in the study was that some Chinese shipyards had difficulties describing their practices regarding the social perspective of sustainability, showing that the holistic approach to sustainability is not yet industry-wide. Rahman and Karim (2015) explored green production technologies, but the role of the systems integration was not addressed.

Caniëls et al. (2016) adopted a supply network view of Dutch shipyard suppliers and found that suppliers with adequate capabilities, a sense of sustainability-oriented competitive advantage and efficiency gains are more likely to use green supply chain practices. This approach is relevant for cruise shipbuilding since the supply networks are significantly larger. Ruuska et al. (2013) specifically explored shipbuilding suppliers' capabilities and found that shipbuilding buyers prioritise technical, operational and business capabilities over relational and developmental capabilities. Control and coordination mechanisms, as well as learning from previous experience to get the job done, are seen as more important than, for example, R&D or increasing strategic relationship qualities. This result is in line with Larsson and Larsson's (2018) ideas of project-based industries where all resources tend to be put into completing ongoing projects, and long-term development across projects is rare.

The Life Cycle Assessment (LCA) is a distinct branch of research that takes an environmental perspective of the construction, operation and disposal phases for a vessel. It seems that detailed information on shipbuilding's environmental factors is more commonly found in overarching studies, rather than research dealing only with shipbuilding. LCA studies (for example, Fet, 1998; Kameyama et al., 2007; and Favi et al., 2018) mention that the construction phase's environmental impacts appear mostly as smog formation, usually originating from steel production and refining. Alternative designs are compared through LCA calculations, with a focus on energy consumption and emissions. Walnum (2011) also comments that

data from the cruise ship construction phase has so far been unavailable. Generally, the studies on shipbuilding show that it is rare for information on, e.g. companies' management and personnel practices, supply network, relationships with stakeholders or development goals, to be included. The literature review for this report did not identify any longitudinal studies of shipbuilding's' sustainability performance across several projects.

1.3. Frameworks for sustainability-related changes and innovations

The complexity and interaction between nature, society and technology have been formulated as a research area for sustainability science (Kates et al., 2001). Due to the topic's significance, much research has recently emerged regarding how changes towards sustainability can be made. Popular contexts for researching these changes have included the energy, food and transport sectors. The sustainability transition is one of the most-used theoretical frameworks (see overview in Markard, 2012).

Kemp et al. (1998) noted that new technologies, which should have more sustainable performance, might not be adopted because they do not fit well with existing technological systems, regulations, psychological perceptions, user preferences, investment plans or infrastructure. In their article strategic niche management is offered as the intentional creation and managing of protected spaces for experimenting with new technologies to facilitate regime shifts. Geels (2002, 2010, 2011) has expanded the original framework of sociotechnical transitions to sustainability transitions with a multi-level (MLP) perspective. MLP adopts the idea of niches as special applications that are developed to be adopted or rejected by the established sociotechnical regime, influenced by the macro-factor landscape. Möller (2010) adds industrial marketing network theories to the framework and introduces sense-making and agenda construction as key cognitive processes shaping networks for new radical innovations.

From a company perspective, sustainability-oriented innovation (SOI) is a useful concept. Jaye et al. (2015) describe SOI as new goods or services that also create positive social or environmental effects. These effects are divided into three categories:

- Sustainability-driven innovations are purpose-designed and built innovations for solving a particular public problem, by either a new product or a new process.
- Sustainability-informed innovation is the most common category. Here, innovation made for an existing need utilises information regarding sustainability factors, which are communicated to its users.
- Sustainability-relevant innovations are innovations with hidden sustainability benefits. They are not fully discovered or utilised in the original value development process. Factors related to sustainability might recognise a delay when the innovation is in use.

Hansen et al. (2009) present the sustainability innovation cube as a tool to evaluate different sustainability areas. The cube positions methods, such as quality management systems or different reporting methods for different sustainability use cases. Adams et al. (2016) further define SOI as outcomes of intention for the organisation's values and operations to create social and environmental value as well as economic returns. For sustainable business, the company should first shift focus from technical features to the perceived value; second, aim for systemic linkages to a broader ecosystem than a single company; and third, integrate sustainability into companies' core activities rather than as a separate add-on element. SOIs benefit from linkages within the firm's business units and external stakeholders, utilise wide-range

environmental strategies also aiming for competitiveness and reshape business models. Three stages for sustainability-oriented innovation are identified:

1. Operational optimisation: The company makes incremental improvements to an existing business to reduce existing harms or gaps in its sustainability.
2. Organisational transformation: The company makes a fundamental shift in the firm's purpose to offer social or environmental value to the market. Novel products or services are developed and commercialised.
3. Systems building: company extends its influence beyond the firm boundaries to drive systemic institutional change. The company engages in initiatives that are impossible to solve alone because they require changes in whole ecosystems.

From a supply chain perspective, Griffiths & Petrick (2001) claim that companies should have processes that integrate ecological information and employees' insight into strategic-decision-making. Gong et al. (2018) specify further strategies to promote sustainability, all involving collaboration, coordination or information exchange with buyers and suppliers. Setting joint project-level goals and practices, selection of partners with sustainability capabilities and their early involvement is emphasised.

Regarding sustainability-oriented innovation, Klewitz and Hansen (2014) categorise companies' strategic sustainability behaviour and how they pursue radical and systemic sustainability change:

1. Resistant companies: They ignore any environmental or social issues that are not obliged by law. They are reluctant to commit to any changes.
2. Reactive companies: When facing external pressures from customers or other stakeholders, they react to outside expectations. Reactions are more likely if efficiency improvements are also involved.
3. Anticipatory companies: They utilise second-mover advantage to follow general trends and their stakeholders on what drivers and pressures might be emerging. They do not want to take risks themselves, so they observe and follow pioneers and learn from them. Only the most feasible innovations are adopted selectively, and integration is missing.
4. Innovation-based companies: They perform a proactive search for new solutions that have a positive impact on environmental or social issues. They seek for first-mover advantage by taking risks but also aim to establish early positions in markets.
5. Sustainability-rooted companies: They have completely redesigned their business models to include sustainability goals. They aim for high interaction with external partners and seek to launch ecosystem-level systemic changes.

Pettit and colleagues (2018) frame the idea of sustainability transition in cargo shipping, and do not see technological innovations for ships forming easily protected niche markets that would incubate sustainability transitions. Pettit and colleagues argue that the global shipping sector's complex and global world-trade is embedded in governance and long asset life-cycles. More likely, they see the pressure for change coming from the landscape level, requiring major critical events or shifts in the world economy's production and consumption equilibria. No existing studies on the cruise industry's sustainability transition were specifically recognised, but Williams and Ponsford (2009) note that in the tourism industry, joint long-term visions and plans with tourism destination stakeholders should be formed.

1.4. Data and methodology

Theme interviews were used for data collection since they were seen as more useful for explorative research design around social and economic dimensions of sustainability in shipbuildings' supply networks. The purpose of the interviews was not only to focus on key themes but also to let interviewees talk freely about key events, values and practices in their own company and, more generally, in the industry.

A total of 26 interviews were conducted in seven members of SUSTIS project and in ten companies outside the project. Companies were selected based on their value chain position in shipbuilding, including first- and second-tier suppliers. First-tier suppliers were providers of specific systems or ship interior areas, acting as a designer and integrator of materials and their installation. Second-tier suppliers were mostly producers of materials or semi-finished products for systems or interior areas. While the SUSTIS project's first phase focused on interviews with shipyard personnel, the second phase focused on the shipyard's (or, in some cases, ship-owner's) first- and second-tier suppliers.

The total number of interviewees was 32. Most were project managers, but CEOs and blue-collar employees were also interviewed. Two of the interviews were group interviews with three interviewees. Also, in four companies, more than one in-terview was completed. Interview durations varied from 21 to 94 minutes, with an average of about one hour. One interview was held by phone; the rest of the interviews were conducted at the inter-viewee'sworkplace. Finnish was spoken in all of the interviews, and all but two interviews were recorded and transcribed. Interviews were held between November 2017 and August 2018. Companies and inter-viewees were anonymised in this report.

The core interview themes included the following:

- Interviewee's company's offerings, position in the value chain and typical project description
- Perceptions of successful and unsuccessful projects
- Relevance of sustainability for interviewee's company and work
- Interviewee's company's sustainability practices
- Finnish maritime cluster's production and supply chain management practices compared globally to other actors
- Perceptions of the cruise industry's future and related shipbuilding and the significance of sustainability in the industry's future

In addition to the main interviews, additional free-formed background discussion was held with a representative of a shipowner regarding overall project execution practices in shipbuilding, project stages and overall sustainability innovation opportunities. This background information helped to build an overall understanding of the operational environment of the suppliers. This information is partly utilised in structuring and analyses of the not as distinctly reported as the main interviews.

Supportive information was gathered from company websites and industry media regarding the project. Also, observations of maritime system providers and supplier marketing were gathered from one of the maritime sector's largest industry fairs (SMM Hamburg 2018). The focus was the exhibitors' use of sustainability information in their marketing. Detailed analysis of this data is in the making and not ready for this report, but some observations are utilised.

2. RESULTS

2.1. Shipbuilding project stages and supplier-led sustainability innovations

To illustrate the project-based practices within shipbuilding, interviewees' perceptions of roles and actions are roughly structured regarding different project stages. Although the perceptions are not necessarily particular to the sustainability aspect, they highlight important industry structures that influence the adoption of sustainability innovation and thought.

Pre-construction and sales stage

The ordering of a new passenger vessel typically starts when the shipowner approaches the shipyards with a call for bids. The call for bids includes a rough outline of the ship's main characteristics, such as size, construction time and intended service for a new vessel. Within the cruise industry, shipowners typically use several brands. A trigger for a new order and its outline typically originates from commercial functions that deal with the actual passenger operations and business. Next, more detailed negotiations are begun to formulate the actual ship's specifications with shipyards that are interested and most feasible for the task.

Shipowners often have technical departments with the expertise to evaluate, e.g. production and safety related details which are needed to finalise the ship specifications, together with the shipyard. A reference ship or level might be given. The shipyard, or possibly a ship design office, presents multiple designs. Through negotiation, a feasible balance of features is pursued. Ship specifications usually include a maker's list where certain manufacturers are listed as the shipowner's preferred manufacturers for significant systems or equipment. The shipyard is obligated to use suppliers from these lists. If no suppliers are named for a certain system, then the shipyard can select the supplier itself. When the specifications are ready and a suitable price has been determined, the actual contract can be formulated and signed. The contract specifies both the builder's and buyer's obligations, risk and finance perspectives and remedies.

Basic design stage and selection of first-tier suppliers

After signing the shipbuilding contract, the basic design work starts. This work is done largely by the shipyard, but the process requires interaction with the shipowner's project managers, architects and also classification society to ensure compatibility with the ship's class rules. The shipowner usually establishes its own project site at the shipyard to ensure the project's execution complies with the intended outcome. As soon as the design work has progressed sufficiently, calls for bids for the first-tier suppliers are opened. Before the call, preliminary information might be exchanged. Successful bidding often requires preparations, such as reserving critical materials and hiring personnel:

"The turnkey supplier might, for example, visit named reference ships to see what level of interior is used, what are the materials: for example, a percentage of stone materials required." (II-tier supplier)

Not just any supplier can place bids. The passing of audits is required. A new supplier starts with smaller projects, and only those with plenty of previous references are included for the most demanding tasks. Turnkey delivery refers to a certain area's construction responsibility, which is given to a single company whose task it is to refine steel surfaces into finalised, ready-to-use operational space. A first-tier supplier (turnkey supplier) calls for bids or asks their partner second-tier suppliers to provide different roles. For example, one company provides materials and another one installs them:

"The area is made ready from bare steel, turnkey-ready. That means we take care of insulation, plumbing, electrical work, HVAC work, surfaces and installation of furniture, building corridors, installing carpets and everything." (I-tier supplier)

Detail design stage and selection of second-tier suppliers

In the detail design stage, the first-tier suppliers design their own area's detailed plans, including scheduling and logistics. The second-tier suppliers are more involved with the project execution and details.

Designs are approved after examination of the mock-ups of intended structures and materials. A mock-up can range from a full-scale working model of a cabin to samples of different materials presented in a meeting. It is normal that different alternatives are discussed and pondered. Architects representing the buyer try to accomplish the overall vision, but technical, regulatory or cost factors may deviate from the vision. In the end, a feasible compromise for all is sought and confirmed.

"When we receive an order, we might not know why certain things are in the plans as they are. But when we do the mock-ups and meet the shipowner's people, different things reveal why the design has been made like this and that." (II-tier supplier)

The first-tier supplier is responsible for their project and, in a sense, there is a principal-agent problem between first-tier and second-tier suppliers. The principal buying the material from a specialised manufacturer does not necessarily have the skills to evaluate whether the quality of the provided material is good enough. Control mechanisms are required for both the supplier's operations and products. In practice, e.g. audits, document requirements and inspections are used.

Construction, outfitting and modifications

Actual shipbuilding activities begin with the construction of the ship's hull. At first, blocks are manufactured, outfitted and assembled. After that, the ship is launched and the outfitting stage follows, which includes most supplier activities. The repetition of modified designs, their approvals and inspections has caused many companies operating in the sector to specialise in modification management. The modifications are needed from both directions. The shipowner might have changed preferences in the functions the ship will carry, or define the market that is intended. The suppliers might try to find alternative production methods or materials to finish their project.

Modifications are often part of a broader search for balance between specified requirements and project progress. Decision-makers try to find the optimal combination of time, cost and weight of the ship. As cruise ship size and total material weight have grown, even interior details are more important, since everything ultimately affects the fuel consumption of the vessel.

"If an architect, for example, wants more stone surfaces than in a reference ship, then it needs to be negotiated. It can be that stone surfaces are taken away from toilet areas and increased in a certain lobby area. So it's kind of a game around additional costs and others." (II-tier supplier)

The progress of outfitting is, in some situations, interdependent on other parties. Some planned tasks cannot go forward before, for example, certain tasks in other areas are completed or certain material arrives at the site. Careful project scheduling, logistics, management of modifications and resilient negotiation and problem-solving skills are key factors for successful suppliers. When the ship is finished, the shipowners often use their own start-up crews to test the ship's functions. After completion, guarantee-related agreements might be addressed by the suppliers when the ship is in daily use. Later, when the vessel is planned for an upgrade, some suppliers might also be involved in retrofitting projects (see Chapter 2.6.).

The project business nature of the shipbuilding also requires early involvement for sustainability

The preceding overview of cruise ship project stages highlights interdependencies within the shipbuilding supply network, which was mentioned in nearly all of the interviews. Therefore, the set-up is different than in 'series production'-oriented industries that, at least in principle, can introduce incremental improvements more easily. This approach can also be used for sustainability, since the entire production is usually controlled by one company. However, in a project business world, requirements may vary greatly between customers and even between the same customer's different projects. Decision-making and sustainability innovations are more complex and need a longer period.

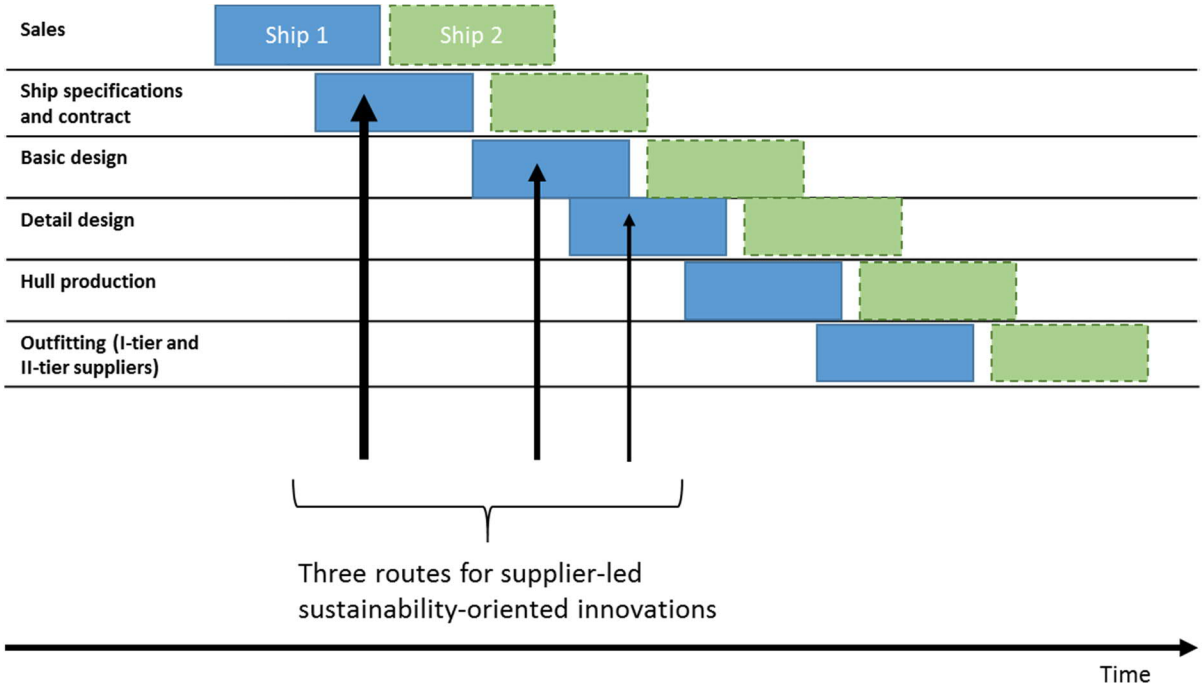

***Figure 1**. Routes for supplier-drive SOI in ship project construction*

Three routes for SOI can be identified from the interviewee's comments related to the project stages: i) ship specifications in the pre-construction stage, ii) basic design modifications and iii) detail design modifications. The main observation is that any sustainability innovation should be determined before any

building takes place, whether in the design or the sales stages. The ship specifications level is the most impactful, as it dictates the goals and requirements of the whole project. Major interior changes can have a cumulative impact on the architecture and overall design of the ship, and therefore must be defined in the ship specifications. It is often a challenge for suppliers to get novel concepts into the awareness of the people involved in ship sales negotiations. Several different units in different organisations should understand the new idea; it is especially important to have support from the shipowner. Determined long-term efforts and a credible reputation would be required from the supplier, at least.

The basic design stage is a second route for sustainability-related changes. For good reasons, specific sections of the ship can be opened for alterations. However, at this stage, both the shipowner and the shipyard are already building the project, and any changes need to be approved by several parties already working with the original plans. If a major change affects the overall design too much, the concept will probably be rejected.

In the detail design and mock-up stages, only small details can be changed. The change of surface material in a certain area might be a minor change but at that point, budgets and schedules are already fixed, so changes can be made only within agreed boundaries. The changes should not include extra costs or schedule delays.

When comparing the first- and second-tier suppliers' interviews, a difference was recognised related to the relationship between the suppliers and the shipowner as an end customer. The first-tier suppliers who carry out larger subprojects or provide specific systems commented that they have enough contact with the shipowner's representatives and architects. These meetings facilitate the exchange of information, transmit reasoning for decisions and allow opportunities to offer alternative solutions or new ideas. However, some second-tier suppliers said they have less interaction and narrower communication channels with the customer, which might limit the transmission of values, emphases or needs for sustainability from the customer. Suppliers cannot always understand why certain decisions are made and how decision-making takes place. Personal-level networks formed during Finnish shipbuilding's long history with the cruise lines are, in principle, helpful in promoting SOIs.

2.2. What is associated with sustainability in shipbuilding?

One of the interview themes was the perceived expressions and significance of sustainability in the interviewee's company and its business environment or interviewee's own work. Most of the interviewees reflected sustainability through previous project experience, customer requirements or typical industry practices. In general, attitudes towards improving sustainability were positive and associated with a response to climate change, but also with a sense of professionalism and responsibility for employees through supply chains. However, sustainability was not perceived to a high priority in the industry. Increasing trends towards change in priorities were recognised but were still considered to move slowly. Two of the interviewed suppliers had taken steps towards product innovation emphasising their better environmental attributes. In other companies, no clear sustainability-related focus was visible in products or strategies.

Many interviewees noted that in their work, sustainability requirements were dictated either from the project realisation when ordering customer-required materials or the shipyard's operational rules. Although cruise companies, as the suppliers' final customers, have increased activity and reporting related to sustainability in decision-making within the shipbuilding processes, the project realisation was still seldom recognised.

“Well, when speaking honestly – how would I say this; (in the cruise companies) they are waking up to sustainability issues, but that has not so far influencedthe decision-making really that much. But it's clearly a trend that is rising, and admittedly, we also (as a supplier) must take it into account.” (I-tier supplier).

Nevertheless, general trends were felt to enforce sustainability and that sustainability cannot, in any case, be totally neglected. Reputation risks would be too high if a crisis event occurred. Shipbuilding cannot afford to be different from other industries. Many suppliers are also engaged in other markets, and transfer practices from that context to shipbuilding.

The actual cruise ship project realisation is an outcome from both the customer and shipyard sides. The Finnish maritime cluster has had decades of joint history with major cruise lines. This history has formulated project-by-project, practical-level rules and norms. Simultaneously, there is a considerable lock-in in this past track, since many decisions are compared those from previous projects. OHS is often mentioned as an area that has been under strict regulation in Finland. Several Finnish suppliers have activities also abroad, and companies tend to spread the domestic standards for OHS if possible.

“Most of the work we do is carried out at the shipyard. We follow the rules that are enforced in the shipyard in question. We cannot do much related to environmental issues. We don't have permission to intervene that much. What is still the most important though is safety. And it's our foremost interest also in a shipyard where we don’t know beforehand to get everyone to comprehend that all installation employees and others need to have a safe working environment. That is the furthest where we can influence. How the shipyard, for example, handles their waste, we as a supplier do not have anything to say for that.” (I-tier supplier)

Physical materials onboard a ship were mainly linked in two ways to sustainability: the weight of the structures correlating with the vessel’s fuel consumption, and safety-related rules for the selection of materials, e.g. to prevent fires. The weight has become more important as cruise ship sizes have grown. In ship specifications, limits for cabin and public area materials per square metre are given. Safety requirements come from maritime regulations and classification societies, indirectly reflecting lessons from accidents and research.

From the cruise line’s perspective, every area related to hotel function, such as cabins and public areas, is revenue-generating because the ship’s function is mainly to create costs. One interviewee stated that the cruise companies’ motivation is to maximise revenue generation on a ship at the expense of any other functions, if no obligations otherwise exist. The ship function has many obligations to international maritime regulation and authorities who enforce vessel safety. Therefore, ship function-related suppliers seem to associate sustainability with safety. Classification societies were seen to have a mediating role in guiding application of the rules.

One interviewee recalled that cruise companies started to express interest in energy efficiency of all the cruise ship systems, including the hotel function, when oil prices were high. As the cruise industry has become more mature and competitive, more functions are tweaked for competitiveness and operational expenses. Cost-competitiveness is the primary goal and the environmental energy or resource-saving is a byproduct. Previously, in new buildings, more weight might have been provided for capital expenses, but today's life-cycle view of total costs has taken root.

On the employee level, one interesting sustainability topic is the sense of professionalism and personal liability on work quality. These observations were already present in the project's first-phase interviews (Heikkilä, 2016). Experienced employees in the sector have witnessed project business characteristics by

winning tenders through previous references. Also, employees have seen a cyclical shipbuilding market where, from time to time, the whole cluster's survival has been questioned, and new orders have been limited. In that setting, employees seem to have absorbed the idea that delivering high quality within the schedule is critical to ensure the company's business continuity. The concept of knowing one's personal responsibility for details assigned to oneself often supports high-quality behaviour and outcomes:

"Classification society made it very clear for me what liability means. It is not like that you can just sign up anything and say ok good bye. If something would happen, there are rather nasty consequences on those who are liable. So let's think of a situation that the component should have been fire safe, but then, in reality, it wasn't. Then if a fire would happen on that ship, and then when the accident would have been investigated they found out that the fire happened because of this component. Then they would contact classification society and the producer's quality managers, and they look into it further. If there is a quality management system, then everything should be traceable." (I-tier supplier)

One measure for the significance of sustainability is the visibility of related topics in companies' communication and marketing. As described in the methodology section, supportive observations were collected from a major maritime sector's industry fair (SMM Hamburg 2018) on the sustainability perspective's utilisation in companies' upfront communication and marketing. The top discovery was that where maritime equipment and system providers frequently mentioned sustainability, the interior supplier's equivalent communication was extremely rare in the sample provided at the fair. Equipment and system providers either offered sustainability reports and fact sheets, or at least used words like 'green', 'SO_2' or other emissions in their communication. This reflects the topicality of sulphur regulation in shipping in general. Many interior suppliers lacked this dimension in their communication. Intention is not to say that there would be no arguments, or utilisation at all, in more detailed material and communication with customers but just what kind of image and first impression is given outside.

2.3. Control and co-operation in buyer-supplier relationships

Control mechanisms in supplier selection

For typical shipbuilding projects, a project-based organisation is formed by selecting a shipyard, and then the shipyard selects the set of suppliers it will use in that project. When selecting suppliers, buyers usually do a status check and examination for a company not previously known to them:

"We look at the company's three last years, what kind of profit and equity ratio have they made, all those, and what reference projects they have done earlier. If we see that there are two companies bidding, one is offering a few percent cheaper but the other one has good previous reference cases. Again, the first one is high on debts, the second one not. In critical tasks, I take the more expensive one. Then you can rely on that job getting done." (I-tier supplier).

The second approach is to form long-time partner relationships with suitable companies. A common first-tier supplier strategy is to include some key tasks in the supplier's own core competence. More routine tasks might, however, open for bids to balance cost levels. Critical, but specialised, tasks may be given to key partners.

One characteristic of a specialised network is that different actors have high proximity: not only geographically but also in the relationships of customers and suppliers. For example, employees change workplaces between different companies or travel to industry fairs. Some interviewees noted that this approach creates transparency that also acts as a control mechanism for suppliers:

"Our supplier needs to commit that it will not take other overlapping projects that would interfere with our project. That would bring sanctions, and if needed we could then break off the deal. But that hasn't really happened. These circles here are so small that it doesn't pay off to act so." (I-tier supplier)

Often, before a supplier is selected for a major project, audits are performed and a visit to the supplier may occur. In some cases, people from all buyer-parties (shipowner, shipyard and I-tier supplier) might attend these visits.

Some interviews implied a legacy where supplier relationships had used a 'take it or leave it' type of one-sided relationships with bigger parties using their power against smaller suppliers. However, the interviewees commented that behaviour has gradually changed:

"Yes, it has changed from enslaving into partnerships. I have seen it how it was in the 1990s. In those days with the buyers, there were situations that there were two meeting rooms with both having a supplier who was auctioning on the same deal. The buyer went between these rooms and told one after another that the other supplier offered this price, how much you can go under it. It was beyond all reason. But it then started to change as projects and networks became larger. It became more like guidance." (II-tier supplier).

Documentation requirements and quality management

Being selected as a supplier depends on the supplier's capability to fulfil various documentation requirements, so there is a need for risk assessment. If certain certificates are in place, the buyer does not need to examine the supplier in a detailed manner. The quality and depth of the design, and the utilisation of the drawings, affect the whole project's performance. Therefore, it is natural that more documentation and information exchange is demanded from the supply network. The purpose is to verify in advance that the actual production and installation stages will match the designs. Documentation requirements have evolved from both supply chain management and quality management perspectives.

First, core processes, such as the exchange of project-related design drawings, product information and such are needed for the actual buyer-seller integration. Second, some material may be related to documentation requirements and, more often, product-level requirements. These requirements may be classification-related rules like fire safety, or production management instructions for the project. An additional layer to materials and products would be sustainability-related information, such as the carbon footprint of the material. Third, there are requirements for company-level operations. These requirements include quality management systems for a supplier's overall plan to ensure quality in outputs. In each buyer-seller relationship, some balance between different levels has evolved. For example, having a product-level certificate might satisfy the need for additional material-level information.

Based on the interviews, suppliers with their own specialised manufacturing tend to follow the product-level approach. Companies that are larger and involved in multiple activities, such as design, production, purchasing and installation, also develop more complex products and are more likely to adopt quality management systems. As operations processes require significant complexity, quality management systems

are a type of self-evaluation and self-regulation verified by a certifying party. Companies that mainly provide installation work note that there is no lengthy tradition that requires extensive documentation. As one interviewee described:

"There might be a hundred different suppliers in our scope, and if you think about ISO systems, these installation firms hardly have them. The documentation generation is easier for companies that deliver products or goods. Regarding installation, these [quality systems] are still underdeveloped. Of course, shipyard rules need to be followed in any case." (I-tier supplier).

However, interviewees point out some frustration when observing that what happens in the field does not match the formal requirements:

"These fire safety demands, it is confusing them. We have these high requirements. We need to test and get a certificate. But when you go to an actual site, you might see that the guys are installing the actual products, they might use them however they happen [incorrectly]. The installation is not controlled like we are." (II-tier supplier)

Mass-customisation

The design-driven documentation requirements enable more standardised multi-actor processes, ultimately providing efficiency, traceability and predictability for the whole supply network. In other words, it helps to introduce mass-customised production, which has been a major change in the industry since the 1990s. Mass-customisation is illustrated in the following statements:

"A cruise ship has hundreds of different kind of cabins. [Products] manufactured by us are different design types, easily hundreds as well. In a ship, in reality, you might have different shapes and pipes and other that you need to take into account in dimensions and such. Every design type is individually drawn by a designer in 3D with the product's information. For each component, its designed drawing, welding and installation instruction and production layouts are made. With [that design effort] we can combine several hundred designs in a week into real series production. Without all the planning, it would be impossible. Some customers have a false view that we have our product almost ready and then when necessary we customise it when it's installed. The customer might want something at the end stage with different colour or shape or so. But no, that's the wrong way to think about it. Everything must be designed and planned in detail from the start." (II-tier supplier)

The shift into mass-customisation has had a positive impact on shipyards in reducing work phases or the need for in-site installations. Also, masscustomisation deepens manufacturer specialisation and stimulates innovation in their own product or component and production line. Shipyards or other systems integrators might not be able to reach such detailed knowledge of the product what is required from mass-customising suppliers.

Control mechanisms in project execution

When actual operations are underway, the control mechanism over suppliers involves, for example, close communication, possible further audits and risk assessments. Realised supplier risk may harm a project through delays or added costs. One interviewee described risks in the following way:

"We need to follow the risks. The worst is that we won't even notice it. Our supplier goes bankrupt or makes poor quality. Repairing that costs greatly. If we save 10 percent in the contract, that's nothing compared to losing 20-30 percent on repairing the risks. Plus all the arguing if there's a conflict. Project manager time is lost there, when the focus should be on the operations. It messes up normal daily routines." (I-tier supplier)

Control includes constant comparison of actual project progress with the designs and work plans. Many interviewees involved in the integration aspect of several actors emphasised the significance of precise scheduling.

High outsourcing rates and the large supply network create challenges, such as opportunistic or dominating behaviour in buyer-seller relationships. Signs of these issues were claimed to be present when the doctrine changes were introduced in the 1990s. However, the industry's outsourcing-apparatus has become feasible and is something most of the actors can get by with. One-sided relationships have become scarce. Buyers negotiating with a supplier are still seen as rather demanding, but also dialogic and counselling. From an economic and social perspective, this can be seen fostering continuity, the cluster's resilience and adaptiveness. Some interviewees saw the control and documentation requirements as frustrating bureaucracy. However, many comments reveal that industry already has a massive, on-going information management system. The system demands work but, in theory, additional sustainability-related requirements could be integrated if needed.

Co-operation

In buyer-supplier relationships, the transactional nature requires control mechanisms described above to ensure deliveries for the project. Strategic relationships and partnerships are important and present in the industry. Also, value is created for a project through communication and trust to achieve new ideas and solutions. In the interviews, signs of strategic relationships are most often described when the interviewee's company has key partners with years of joint history.

These partnerships are usually described as remarks on a close person-level communication and shared mindsets. Related to that concept, two levels were identified: daily task-related problem-solving in the multi-actor environment, and long-term business development. The former aspect emphasises solving and avoiding visible problems with several characteristics:

- High expectation for a commitment to work towards a joint project's progress
- Direct, easy communication and structures that unify the exchange of information
- Joint person-level history that enables tacit understanding and predictability of business partners' behaviour in different situations

Proactiveness and constant adaptation to the external environment.This issue is further highlighted in the following interview:

"A good impression is made by suppliers that are proactive and show initiative themselves. And those are easy to communicate with, and you know that people there take care of their employees." (I-tier supplier)

However, what is mentioned much more rarely is the long-term business development cooperation regarding first- and second-tier suppliers. The ship projects are massive, with fixed schedules and modifications that are difficult to implement. Only during the new project's sales negotiations, or after project completion in quieter periods, can entirely new collaborative initiatives be pursued. However, systemic

long-term development work happening alongside daily project execution activity is rarely mentioned in interior outfitting. This lack is a challenge for introducing systemic change, such as sustainability improvements.

The rising share of outsourcing and planning-driven productions are common factors joining many of the previously introduced aspects. Since the 1990s, these changes have had lasting effects and have created and fostered the supply network. It is also notable that attitude and mindset have shifted from seeing suppliers simply as a cost-cutting, transaction-focused one-off game, but rather as an adaptive quality-focused solution-selection game. Design and planning-focused-doctrine has formulated many management practices as well as information and documentation exchange. These changes have enabled an increase in efficiency as ever larger cruise ships have been produced in ever more shorter schedules.

Also, horizontal relationships are very rarely mentioned. Because bidding for projects has tight margins and schedules, many suppliers are competitors. Even though the crises (Wärtsilä shipyard company's bankruptcy, or the STX era of financial difficulties) have brought suppliers together, the suppliers tend to focus on their own business. Alliance-type models of several first-tier suppliers who collaborate for joint goals towards joint goals together were imagined in some interviews but, in practice, such initiatives have not really existed. Also, self-made entrepreneurship as a characteristic of Finnish business leaders was recognised to favour a company-specific growth focus rather than the network level.

2.4. Employee perspective: work safety, work-related stress and the role of project managers

The project business nature of shipbuilding brings its own characteristics from the employee perspective. Within projects, workloads tend to be unevenly distributed with a high peak at the end. Across projects, shipbuilding demands tend to be cyclical, with booms and downturns making long-time business continuity somewhat uncertain. Many supplier companies are also engaged in international markets, which require intensive mobility on the part of the employees. Shipyard sites are hectic environments with heavy machinery and objects, making safety procedures vital.

As production methods have developed into a more design-driven and network-relying environment, core processes have also been synchronised. From the employee's perspective, this outcome is probably the most visible of requirements related to occupational health and safety (OHS). In supplier audits, for example, working conditions, equipment, safety training and cleanliness are typically checked. Nearly all interviewees commented that work safety is among their top priorities in personnel practices. In the industry, there exists a rather joint standard understanding on what is required for OHS. Many interviewees in managerial positions held themselves responsible for checking and ensuring the work site's safety for both employees and suppliers. This safety emphasis could be characterised as the backbone of the shipbuilding industry's social sustainability. Many interviewees also mentioned that their own company takes extra actions towards wellbeing-at-work besides safety-related practices.

Safety promotion partly originates from the oil and gas sector, where requirements, e.g. component specifications, documentation and supply chain management, are tighter. Suppliers that have engaged that market have adopted new practices, which have also been transferred later to the shipbuilding market.

As work safety was considered to function appropriately, some doubts were raised concerning work-related stress. Stress was addressed many times, in the context of keeping schedules and that keeping the schedules is very important in the industry, and any deviations or delays to the plans are costly and

have far-reaching consequences. The general feeling was that the time required always became shorter and required improved efficiency. More detailed designs, careful work planning and selecting reliable suppliers are mentioned as ways to control tight schedules. One interviewee noted that smaller companies performing installation work have the fewest processes for monitoring and controlling workloads:

"The ship construction time has shortened. For us, it means that our [products] that used to be manufactured in nine months now need to be ready in six months. Same total number." (II-tier supplier)

High OHS requirements might be considered as mainly first of all blue-collar employees. However, for work-related stress, there are not as clear tools or support. Previous applies especially for project managers or white-collar employees. A project manager of the ship interior project, for example, has many responsibilities and interfaces which can create a high cognitive load. Towards the end of the project, working days are longer when things need to be completed. Some of the interior suppliers are also active in international markets when extensive travelling is added into the equation. As it might also consider blue-collar employees, still more often travelling is required from the project managers. The high travelling rate again raises questions about the balance between work and family life.

One observation from the interviews where the company's social and work well-being was discussed is that hardly any interviewee brought up leadership skills and culture. In a couple of occasions, it was noted that in the past, one-way bossing and shouting by superiors was common, but that has changed. Especially companies working abroad nowadays focus on building well-matching and performing teams.

In the long term, the cyclic nature of the market affects employees in the shipbuilding sector. On occasions, orders might be booming and at times no orders are on the horizon at all. For suppliers ensuring business continuity can, therefore, be a challenge in the long run. Thus for employees also changes of employers are normal in their careers. This fluctuation can though hinder the development of values and culture in organisations as only a limited number of supplier organisations reach long-term maturity.

Additionally, for balancing the cyclicity, agency-hired labour is commonly used. Previously, there was more employee mobility in Finland regarding shipbuilding but subsequently, during the 2000s, the Baltic and other Eastern European countries have become the source of labour. Due to temporary assignments of the project-by-project workers, the effect on such personnel continuity is poor. From that perspective, cyclicity is troublesome for economic sustainability. It is though worth remembering that shipbuilding supply network also has companies, which hold specialised employees and have succeeded in continuing their business through several downturns.

Successful suppliers have resilient practices that balance the project business cyclicity in the short term. A small supplier can be a flexible partner in the supply chain if its employees are flexible with the requirements and schedules of the project. Reciprocally, the company is flexible towards its employees at times when projects have ended allowing more free time. Combined with the employee's sense of professionalism and high trust among the established actors, supply network's flexibility can be an important asset.

"Our company has a custom that from time to time they tell that now is the moment to work overtime as much as you are able. Usually when the ship is becoming completed. It has been alright for me at least. I haven't stressed as you know when the ship gets ready then also the hurries end. In any case, it's in everyone's interest to get the job done and move to the next ones. After the project's completion, we then can hold all kinds of holidays and days off we have."

2.5. Finns working in the project environment and international comparisons

During the past 20 years, dynamism in the Finnish maritime cluster and its suppliers has continuously increased. Marine equipment and system providers have already served global markets, with some of the companies growing into global market leaders. However, during the 2000s, an increasing number of interior suppliers have engaged the international markets. Some of the suppliers actively seek new markets already early, and more suppliers internationalized then when Finnish shipyards had financial difficulties. New markets were gained through both retrofitting and new construction in international shipyards. Acknowledging that many suppliers have project managers with both international and domestic experience on shipbuilding such people can offer comparative insights on what elements affect successful project execution and sustainability as well.

Some words, such as like, *trustworthy*, *obedient*, *determined* and *easily approachable* tend to repeat in the interviews when describing Finnish companies' work and management approaches. One interviewee summarises:

"We on average make things reasonably, treat people quite well and we keep up with our words and promises and do not try to fool anyone." (I-tier supplier)

Of course, downsides can be recognised as well. Collaborating towards joint goals, communication and interaction towards stakeholders and promoting inspiration were at least developmental areas when reading between the lines.

Nevertheless, Finnish suppliers are well known in the cruise industry and have a long history in the industry. Recently, as cruise ship orders have boomed, new shipyards have engaged the cruise ship market for smaller cruise ships because the traditional cruise shipyards have full orderbooks. These new shipyards are told to appreciate guidance from Finnish suppliers who share knowledge of projects and supply chain management.

In the interviewees' comments regarding work practices and culture in projects, the experience of working in Asia is raised frequently. One of the perceived advantages in Finnish companies is that approaching senior directors can be done quite easily if necessary. However, in Asia hierarchies are much higher and more significant:

"Communication was through intermediaries if it was a [Asian] company. It was not possible to contact them directly. Here suppliers could very well agree to things on their own but not there [in Asia]." (I-tier supplier)

A similar type of issue is decision-making at work. Rules are strictly followed, and initiatives are rare. Many details are easily given to superiors to decide. The tendency to prioritise the respect of hierarchy can lead to long decision-making chains. Many tasks that in Europe would be carried out by single employee, might have several employees in Asia.

Regarding specific business activities, a weak spot that a couple of interviewees had detected was supply chain management and procurement. Especially during the new boom new shipyards entering the cruise market have been noted to make beginner's mistakes in planning and organising those activities:

"Their material procurement was in child's shoes. You thought no shipyard could do that, but still, we have seen such in Europe as well. … A major mistake was that they give the procurements just on a few suppliers. They did not know what they were doing…They did not anticipate what was needed and organise accordingly, like reserving capacity beforehand." (I-tier supplier)

In some European countries, personnel management is more strictly regulated and monitored than in Finland. Examples include controlling the workload of employees to stay under maximum limit per week or controlling salary levels used by the suppliers. Also, opinions on differences among European cruise shipyards were mentioned as one of the shipyards has more advanced utilising planning software.

2.6. Retrofitting market

The retrofitting market is a special niche for existing cruise ships in use. Some Finnish suppliers have specialised in these projects, and some do both retrofitting and newbuilding projects. Therefore, retrofit projects were also mentioned in some interviews. Because a cruise ship gets used for some years and then is relocated into a new market, some of the ship's interiors are retrofitted (refurbished). This means that during a docking, or sometimes aboard the ship in some public area or cabin area, old surfaces and furniture are removed and new ones are brought in. This is an important asset for the cruise lines to make the ships feel fresh for passengers and keep up revenues for the older ships as well.

There are significant differences between retrofitting and new building interior projects. The most crucial element is the schedule. Retrofit projects are decided very late, and time for the project's execution during docking is very short. During project execution, dozens of cabins are refurbished per day, and timing of tasks is very precise. The schedule is so tight that suppliers need to take risks even when nothing has been confirmed:

"In practice quite often we need to start preparing things already before the order is accepted which is, of course, principally horribly wrong thing to do, but it's the only way to survive in this business." (I-tier supplier)

The second difference is that dockings are usually made in the cruise ships' main operational areas: the Caribbean and Mediterranean, and in Asia. This also means that the supplier must handle the logistics of both material and people on the ship in a distant location. Also, transporting larger objects inside a ship is a specialised task of its own.

Due to the special requirements, retrofitting projects constantly process innovations, such as integrating lean thinking into their activities. Retrofitting projects can also generate a closer relationship between supplier and shipowner because interaction is more direct.

2.7. Perceptions of cruise market's growth, future and change drivers

A large majority of the interviewees were confident that the cruise industry could continue to exist in the near future. Interviewees noted the global growth of wealth and welfare, where more people will be able to travel, tourism cruising included. Even in wealthy countries, there are still potential passengers. The demand is explained by basic human curiosity:

“People will want [to travel] if they have an opportunity. When you are over the level that your money goes just into living expenses, then at some points, people want to see the world. We want to see the beaches, and the Far East and European cities. The Chinese want to see Lapland. It's a basic human interest to go and see something.” (I-tier supplier)

As negative scenarios for the cruise industry's demand, several interviewees listed incidents related to terrorism or war as the most significant threats. The impact would also extend into shipbuilding orders.

In future expectations for cruising, industry growth is associated with China’s economic growth. The Chinese demand for tourism is expected to grow as its middle class gets wealthier. This prospect is well known among the industry's managers:

“All is based in China and rest of Asia that they will get wealthier. 1,5 billion people and a growing middle class means they will start to have more money than here in Europe. They then need stores and vacations and also cruise ships. The curve is almost vertical in what I have seen in figures presented, starting from 2025 forward in passenger numbers.” (II-tier supplier)

This growth projection also generates anxiety that Chinese actors may try to capture much of that growth for themselves by entering both operations and shipbuilding markets for cruise ships. A common view is that cruise ships for the Chinese market will be different from ships built for U.S. or European markets. One interviewee identifies the Genting Hong Kong group as a new challenger by entering the shipbuilding market through acquiring the MV Werften shipyard in Germany and constructing new cruise ships for its own use. Some Finnish suppliers are active in these projects as well. Suppliers involvement with the new entrant has fed the debate over knowledge leaks to develop China-based cruise ship production, which could take over the market, or to participate in the growth as suppliers.

Opinions vary in how likely it is that Chinese actors will develop a modern cruise ship production system. One interviewee thinks that Chinese learn everything fast and the construction of cruise ships will be no exception. In other interviewees’ experience, the Chinese would have trouble, especially in keeping up quality and managing supply networks. For example, cheating with documentation is mentioned as a possibility. One Finnish supplier commented that their company had considered starting production in China, but abandoned the thought due to the management risks involved. Another interviewee mentioned China’s significant problems with human rights, labour legislation, waste of materials and pollution. In that sense, it would be hard for a cruise line to emphasise a sustainability perspective if the line would simultaneously order a ship from China.

A few interviewees still considered Chinese cruise ship production to be possible if the shipyard would be heavily supported by European equipment providers, design offices and other suppliers. Because China, in general, invests heavily into becoming a global leader in shipbuilding, self-made cruise ships would bring prestige and value. One interviewee suggested that it is not necessarily in the interest of Western cruise companies but as an obligatory middle step towards the growing Chinese cruise market:

“I have a feeling that, for example, they declared [cruise company's] new buildings there [in China], they are more looking at the pace they have achieved. I would say they are more for the [cruise company] with this kind of political measure to get better status and position for their own business.” (I-tier supplier)

In some interviews, methods and ways to compete against Chinese production were pondered. Aiming for innovations, utilising the benefits of the network, constant development and improvements are according to those interviewees what has traditionally kept Finnish companies in the market. The same approach must also be kept in the future to stay a few steps ahead. Another interviewee emphasised that more political and regulative pressure should be used to ensure the same rules for everyone in the industry. Whether it is safety or sustainability, requirements should have real control and checks so all suppliers will carry out everything that is required. At present, that is not perceived to be realised at the fullest.

3. SUPPLY NETWORK AND AGENDA CONSTRUCTION FOR SUSTAINABILITY CHANGE

3.1. Overview of results

The Finnish maritime cluster and its cruise ship supply network's main focuses are high quality, on time delivery and the role of a trustworthy partner for its one main customer, the cruise industry. These attributes are represented in the results as many associations with a sense of responsibility for aligning its own actions, according to the project status. Also, several mechanisms for achieving first-grade output in a multi-actor environment are mentioned. It is worth noting that there is only limited information so far regarding sustainability in the maritime cluster. Also, at this time, sustainability reporting is mainly done by shipyards and major system providers. This study follows the approach that understanding sustainability advancement needs to happen in an industry context. Therefore, this study has explored current industry practices within the supply network to analyse factors affecting, for example, the adoption of SOI.

The suppliers and people managing cruise ship projects receive restricted operational space from the overall ship contract and its specifications. Therefore, the comments gathered in the interviews reflect what information or actions are requested in decision-making situations like the project tenders, selection of suppliers, approval of designs or modifications and others. According to the study's interviews, the current state is that sustainability information is not an overwhelming decision-making variable in the industry.

However, sustainability is recognised as a rising trend and might be more present in unofficial discussions, but the impacts are still only incremental. In a highly networked industry within a single company, many actions might be taken, but for the overall cluster, accumulated impact comes only if business relationships between companies are affected. In the study's results, for example, documentation exchange and control mechanisms in network management practices and their development in recent years are emphasised. Accumulated impact should be integrated into existing management practices to promote sustainability in the industry. Results also imply that the industry’s strong information management capabilities have evolved simultaneously with the growth of supply network utilisation. In theory, there seem to be no barriers to harnessing these capabilities for transferring sustainability information and controls.

Also, many supplier interviewees recognise that in principle and in interior projects, for example, more sustainable materials could be selected and more sustainability-related information could be collected about material origins or construction sustainability, but because the customer did not request it or is not willing to pay for it, those actions are not taken. This raises the question of how much the customers are aware of all suppliers' opportunities for sustainability-related value. In any case, cruise lines as customers tend to focus on operations, whereas e.g. environmental impacts are larger. The burden of proofing new ideas and opening new priorities shifts mostly to the suppliers themselves. However, long-term development across projects tends to be rare.

From the results of the interviews, 14 observations were compiled. The observations are shown in Table 1. The listed observations are not in any particular order, apart from partially following the report's structure. The right side column includes the authors' interpretation of what effect the observed matter has on the development and adoption of SOI. Both restricting and supporting factors were found. Because the

topics are multifaceted and their effect's analysis depends on the selected viewpoint, it is possible that other reasoning may lead to different interpretations.

Table 1. *Main observations detected from the interviews and interpretations by the authors.*

Observation	Interpreted effect on sustainability-oriented innovation
Project-based nature of the industry implies one-off project organisation set-ups, complex decision-making, path-dependent slowly changing regulation and design preferences dictate the supplier's operational environment.	Negative: it leaves only a narrow room for adopting innovations. Sustainability is no exception. Large project sizes fix the network to execution mode for the customer projects for several years, with room for only incremental changes. Afterwards, it is not possible to change project attributes and specifications that much even for innovations.
Sustainability is not perceived as a real decision criterion in customer requirements so far (except for weight). For example, material origins or environmental information from material production seldom affected decisions.	Negative: quality, costs and schedule have remained the main decision-making criteria in the industry. In some cases, those overlap with sustainability but customers still hardly prioritise sustainability in their requirements. Suppliers tend to focus on defined project attributes and contractual terms in their deliveries.
Some of the second-tier suppliers are uncertain how they could promote or introduce new ideas and how they could spread awareness of alternative solutions. Linkages between shipowners and suppliers are restricted (except for suppliers engaged in retrofitting).	Negative: does not support transferring information broadly enough as mutual consent would be required. Before, reaching one key decision-maker might have been enough, but today an innovation requires support from several directions, which can be a challenge for SMEs.
Long-term collaborative development over individual projects is not mentioned often. Some contradiction is noticeable as the industry is rather closed and its people know each other quite well and can anticipate the actions of others. However, that proximity does not seem to feed into new radical or systemic initiatives that often.	Negative: in results mostly within the company and within project improvements and problem-solving are reported. However, the literature on sustainability innovations emphasises integrative efforts between organisations and long-term strategic goals.
Supplier linkages and interactions are rarely mentioned to extend beyond direct business relationships into external stakeholders like media, research and public decision-making. Alternatively, then such activities are initiated by shipyard and suppliers are just supporting the activities.	Negative: restricted external linkages limit information flows to the suppliers. Changes in the operative environment might not be recognised. Suppliers might need more tools to form specific expertise-related sub-ecosystems and thus make the wider ecosystem more resilient towards unexpected events. Sustainability pressures might arise outside of the scope of usual business transactions and relationships.

Weight of materials is one of the clearest matter where ship interior has a sustainability impact by affecting the ship's design and its fuel consumption. A rise in oil price might add interest for them as well energy efficiency in general.	Positive: already, cruise ships have become larger and more light-weight structures and materials are used. There is an immediate, direct demand for such innovations, as the impact can be measured and monetised.
Sustainability information, reference cases and alternative concepts are only little utilised in the interior suppliers' public communication and marketing even such arguments might be used in customer-specific communication. The difference is striking against the ship function's system and component providers.	Negative: interior suppliers only narrowly open up dialogue in public. It may cause potential directions for sustainability in the construction phase to stay hidden. Differentiation values through sustainability are rarely exploited.
Companies' social practices usually addresses mainly employee-level prioritising safety. Even though the industry has constantly increasing amounts of information and data handled with tight schedules, few interviewees talk about, for example, leadership in their company or how workloads or work-related stress are managed.	1) Positive for safety: it supports, for example, employee turnover reduction. 2) Possibly negative for leadership and personnel practices, if lack of support can cause experienced experts to spend their energy only on project execution without room for development activities. Balanced and versatile work could foster continuity and innovation.
Finnish suppliers have useful values and practices that emphasise goal-oriented, equal and trustworthy business. Low hierarchy and sense of professionalism help in detecting problems and in learning. Some suppliers have resilient practices, with employees allowed to work overtime in peak times and spending time off when projects are completed. These attributes and experience enable complex supply network management to be effective.	Positive: mega-sized cruise ships built today require a vast variety of specialised inputs, which would be difficult to reach without an extensive supply network. Finnish suppliers are better positioned because of their resilient attributes, reputation and experience in introducing sustainability innovations than actors who have operated in a more hierarchical environment.
Currently, in everyday work in the industry lot of different documentation flows are in use. Documentation for work planning, material and product related information, supply chain management and quality management is exchanged.	Positive: sustainability information, at least in theory, can be an additional layer in the existing information flows and information management capabilities. For SMEs with more limited information systems, cost-benefit analysis needs to be clear.
Installation tasks are indicated to be not as strictly controlled as manufacturing outputs. A contradiction may happen if the manufacturer has many obligations for certificates and other validation, but then if in the installation phase the product gets installed in a wrong manner neglecting the obligations. These remarks create frustration and sense of bureaucracy.	Negative: good attention to sustainability strategies would get lost if their execution and realisation fell short of the plans in the last steps. Installation tasks are often done by smaller companies that do not necessarily have much information or quality management capabilities. However, sustainability-oriented businesses would require necessary control measures to avoid contradiction in the realisation.
Growingly detailed design work and related work planning have been a trend that has also shaped production methods. It has opened wider utilisation of mass-customised products, where suppliers	Positive: design-driven approach supports integrating sustainability-oriented goals and data, which in turn could be turned into additional value in customer relationships. Manufacturers' detail-

tune production lines for individual components instead of customising them in the installation phase. Mass-customisation creates less waste and errors and induces further supplier specialisation stimulating innovation.	level innovations can improve materials, components and products, which would be hard to envision from systems integrator positions.
Cruise ship markets in the shipbuilding industry are noted to have a very high cost focus compared to other sectors. Bidding culture for projects sometimes leads to bargaining on even the smallest price differences.	In principle, positive: if a new innovation's benefits can clearly be measured, then the cost focus can quickly direct support for the innovation. However, more uncertain innovations is probably negative for launching and financing R&D inputs. Sustainability-oriented innovation's business case should be illustrated in a straightforward way.
The cruise industry is widely believed to continue growing in the future. This is especially due to rising demand from China, where an increase wealth increases interest in tourism. Timing and shape of the growth and competition may still vary. Opinions are divided on what kind of position Chinese shipbuilders would have in the future and how it influences Finnish suppliers.	Probably positive: growth of the market creates continuity to develop innovations. Increased competition and peculiarity of the Chinese market might increase the value of sustainability as a differentiation factor. Regardless of where future cruise ships will be assembled, turnkey suppliers and design offices will have a key role. Cruise ships could also act as a test bed for new technologies for whole shipping.

The results could be summarised by saying that not many sustainability requirements have yet been enforced in industry practices, for example, concerning transmitting sustainability data through the supply network. On the other hand, suppliers have existing capabilities with the suppliers that can potentially support sustainability-oriented innovation. Some triggers may, in the future, add pressure towards sustainability in society and for customers who might shift into requirements for suppliers. Additionally, self-guided development regarding sustainability aspects by suppliers might bring in a shorter time span new SOIs to the industry.

These results can also be compared with Caniëls et al.'s (2016) study, in which they found that customer requirements did not influence shipbuilding suppliers' participation in green supply chain practices. The authors also pondered the result that deviated from other sectors. However, this report's qualitative study from the cruise ship focused on shipbuilding and its suppliers found that customer requirements had a major influence on shaping suppliers' practices. A possible explanation is that cruise ships are larger and detailed projects and cruise lines are more involved in designing and selecting many details compared to cargo shipowners.

3.2. System-level sustainability change

Finnish maritime cluster history is itself an interesting story of industrial evolution because it survived--in contrast to many competitors--and achieved a global market position with a small country's resources. On this path, there has already included evidence of the Finnish maritime cluster being capable of igniting systemic changes in their markets. Such examples include the reshaping of icebreaking methodology and winter seafaring, integration of cruise elements on car ferries or major leaps in ferry or cruise ship size. Getting such changes through for the customer has required persistence and turning heads recurrently in several organisations and business units.

A more recent, and still on-going, example can be found in the idea of autonomous shipping. The buzz around autonomous shipping is interesting because the thought and attention around the phenomenon was set off largely by media interest and recurring coverage (Saarni et al., 2018). System provider was successful in formulating an own strategic agenda for its own network. Möller (2010) calls this agenda-construction in industrial network management.

The idea of agenda construction could also be applied to the sustainability transition perspective for the cruise industry and its shipbuilding. The combination of communication and media visibility, ecosystem-building, research and development activities, individual public champions and customer-driven use cases could set off something similar: for example, a core sustainability-oriented innovation would be identified with a suitably interesting storyline. Also, the sustainability transition framework suggests that not all niches will succeed, so a portfolio of initiatives would be a better starting point.

SOIs emphasise that with a sustainability orientation, the focus should be put onto people and collaboration. Regarding the literature review and the study's results, a table showing system-level sustainability change is presented below:

Table 2. *Different levels of activities and systemic sustainability change orientation for supplier network.*

SUPPLIER NETWORK	CHANGE ORIENTATION: Reactive mode	Explorative mode	Systemic mode
ACTIVITIES: Development	Problem-solving inside business projects	Development actions acrossing several business projects	Integrated co-creation with customers (consumer insight)
Communication	Provide sustainability information according customer requirements	Agenda construction – setting visions and goals for own network	Active strategic and operative dialogue on the ecosystem level
Network	Supplier relationships within project-based organizations	Cross-disciplinary extended network (external architects, material providers, researchers, data illustrators etc.)	Extended shipbuilding network and the cruise industry together
Strategic focus	Process optimization	People & organizational change	Sustainability-driven business models

The studied interior suppliers tend to be tuned for optimised project execution and problem-solving in customer projects, which aligns with the findings of Larsson and Larsson (2018). Also in this study, most interior suppliers have lean organisations with few slack resources. Specific products or components or work processes are improved, but long-term systemic game-changers are not really pursued. Despite the close relations, not that much collaboration or exchange of ideas is mentioned apart from interaction related to the projects' execution. The outcome is a scarcity for long-term development across projects. That is understandable because traditionally, in the cyclic market, a few customer orders are known at a time. However, the current cruise vessel boom is exceptional since full orderbooks are known at least five years ahead. In such an exceptionally positive outlook, there is a rare opportunity to facilitate many more systemic changes, such as sustainability.

Suppliers interviewed in the study could also be placed into Klewitz and Hansen's (2014) division of five categories, according to sustainability's strategic position. Most interviewed companies could be characterised either as reactive or anticipatory, at most. Only two suppliers could be noted to have sustainability-related product innovations that might fall loosely into the innovation category. None of the companies could be categorised as transformed into a sustainability-driven business model.

Current worldwide high demand for cruise ship construction might also introduce gradual changes to industry structures, especially regarding first-tier interior suppliers. In shipyards, structural shifts have already happened. From old players Meyer Werft has acquired the Turku shipyard, and Fincantieri has become an owner of the St. Nazaire shipyard. New shipyards have also entered the cruise market. Because demand is high, capable first-tier suppliers also have many opportunities to do business outside their previous primary shipyards. It will be left to see whether one scenario might be that first-tier suppliers will see more consolidation. Then, there would be several major interior suppliers acting primarily in Europe, serving the cruise lines globally. If simultaneously more broader and versatile business ecosystems will be formed around such suppliers, they might be in a better position to influence the industry's global standards and requirements, even though the cruise industry is a niche segment for shipping as a whole. This is analogous with ship engine and other equipment manufacturers, which have developed by engaging shipowners on their own and setting development agendas for the whole sector. That type of activity has been missing from the interior scene but, if the growth of the cruise market lasts, suppliers might aim for a more integrative role. They might also differentiate against competition with sustainability.

3.3. Recommendations

Based on the literature review, observations during the SUSTIS project consortium meetings and the interview results, the following managerial recommendations support the research and development on SOI and their adoption in a sustainability transition:

- Shipbuilding clusters, involving its supplier network, could benefit by engaging supplier-led research and development projects aiming for SOI. This type of research and development suggests incorporation of the following elements:
    - Self-guided by supplier companies based on their capabilities and goals
    - Reserving slack resources within the company for development efforts
    - Opening up co-creative and versatile dialogue and several channels for their main customers,: especially shipyards and shipowners
    - Integrating cross-disciplinary, external partners to find new combinations of knowledge and application, for example, architects, experts on new materials and structures, consumer businesses engaged with sustainability practices, data illustration and transfer experts and communication specialists
- Ensure that social practices consider stress-related factors and allow room for creativity and feedback.
- Create information flows on employee practices, supply chain and material origins and other sources to be used in decision-making, marketing and other functions to use when needed to display sustainability arguments.
- Consider whether your company's supply chain documentation and criteria used for installation work meet the requirements of manufacturers and other related actors. Determine if there are troublesome or contradictory experiences where project planning and realisation have not matched, and learn reasons for these outcomes and fix them.
- Agree on network-level commitments that within the Finnish maritime cluster more sustainable alternatives would be included within the portfolios of each company's offerings and related marketing to promote cluster-level image and reputation
- Suitable individuals could act in sustainability champion roles to promote the company's related capabilities.
- Use sustainability data, arguments and visions more broadly in the company's communication and marketing. Build up reference cases and show the impact of the company's actions or plans. Benchmark such methods from other industries.
- Engage your company's stakeholders and construct goals and visions with them. Together formulate an ecosystem that is formidable enough that its opinions are heard for industry standards and practices.
- System providers and suppliers could be induced more to pilot and test novelties on cruise ships and later transfer them to the rest of the shipping sector. Such technology transfer could be integrated into the cruise industry's sustainability activities.

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