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A Service Blueprint Approach in Shipbuilding Activity Mapping

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ABSTRACT

In the evolving landscape of shipbuilding, the confluence of innovative methodologies and advanced technologies is reshaping paradigms in ship design and production. The industry's quest for multidisciplinary methods that elaborate representing diverse ship building activities and boost efficiency in managing these activities has unveiled the potential of the service blueprint, a tool used in service design, which addresses design of activities and determining who does what activities when in collaboration with whom.

Our proposition centres on the structured activity mapping representation, a novel activity map that utilizes service blueprint with detailed description of activities with rich and structured representation of context. The framework offers a comprehensive perspective, illuminating intricate processes such as concept design, detailed design and production stages as well as service and operation stages. This mapping would ensure alignment of each activity with overarching project objectives, encapsulating values, interactions, collaborations. This paper illustrates the approach of service blueprint in representing ship building activities with discussion on improvement potential of current activity mapping through the service blueprint approach as being conducted in the SEUS EU Horizon project.

Key Words

Shipbuilding Process Methodology, Human-Centricity, Activity Mapping, Service Blueprint

Introduction

The European shipbuilding industry is currently navigating a complex landscape with challenges, including intensified competition from thriving Asian counterparts, economic volatility, and a growing demand for environmentally sustainable and technically advanced vessels (Seppälä et al., 2023). This paper examines these challenges as the industry stands at the intersection of addressing current impediments, redefining its competitive strategies for the future, and embracing the shift into a more human-centric paradigm. This paper is based on research conducted within the Smart European Shipbuilding (SEUS) project.

One of the primary challenges faced by European shipyards is the rising competition from Asian nations such as South Korea, China, India, and Vietnam. These competitors have progressively expanded their market share, driven by factors like robust economic growth, substantial government support, reduced production costs, and technological advancements (ECORYS, 2009). To ensure a sustainable competitive advantage, European shipyards may make a prudent decision by placing greater emphasis on the concept design phase. It is asserted that a substantial 80% of the total life-cycle costs of a product are determined during the design and planning stages. Therefore, the concept design holds a crucial role in the overall process of product development (Ohtomi, 2005). A typical commercial ship takes about two to three years to build (Payne & Chokshi,

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2020). A well-conceived concept design, characterized by a comprehensive integration of emerging technologies, business prospects, and human ingenuity, would bring a competitive advantage (Agis, 2020). In this context, the question arises: How can we foster innovation by adopting more comprehensive and advanced perspectives?

In shipbuilding industry, needs, functions and structures of typical design issues are applied in the concept design phase of shipbuilding to enhance resilience by considering latent capabilities (Pettersen, 2018). It emerges that value considerations should be articulated early in the design process to enhance the concept design phase. This will empower designers to make informed decisions and integrate values into technological innovations, leading to responsible and accountable design outcomes (Van Den Hoven et al., 2015). Thus, the value issues should be addressed in the concept design phase because it helps to empower the design process by ensuring that the project aligns with the organization's diverse values and goals. By considering the value perspective, the design team can ensure that the project is not only technically feasible and efficient but also aligns with the organization's mission, vision, and culture. Shipbuilding activities vary across different shipyards due to different contexts (Strandhagen et al., 2020). Various shipyards may prioritize distinct values, such as a commitment to environmental sustainability, and may emphasize the transition towards advanced technologies (Oloruntobi et al., 2023). Furthermore, it is important to acknowledge that there are additional values that could be considered in the decision-making process.

Now the research issue is to develop a methodology with a proper tool to enable considerations of diverse value perspectives in an integrated manner to encompass the overall shipbuilding process including concept design, detail design, production, and operation and use stages at a high-level so that value issues of diverse stakeholders are reflected. This paper presents an approach to address this research issue as being developed at the SEUS project. Specifically, this is done with overall shipbuilding planning and management with human-centric representation and management of shipbuilding activities and interaction and collaboration of various shipbuilding actors including ship owners, operators, and service providers as well as users and passengers.

The paper first reviews of service design and a method with a tool used in service design so that activities of diverse stakeholders are designed and represented. Service design results are typically represented as service blueprints. Shipbuilding activity mapping is briefly reviewed. Then a service blueprint approach of activity mapping is sketched as this would allow planning and management shipbuilding activities with emphasis on human-centric perspectives. The next section summarizes findings on current practices of activity mapping in two shipyards including their unmet needs and expectations. In the following section, a structured activity mapping framework is proposed with detailed explanations including a sketchy utility of the proposed framework in enabling comprehensive integration of shipbuilding process including concept design, detail design, production, and operation and use stages for the next-generation shipbuilding competitiveness. The paper is concluded with discussions on novel characteristics of the proposed activity mapping framework as well as future work.

Service Blueprint Approach in Activity Mapping

Service Design and Service Blueprint

A service blueprint has been used in designing services (Shostack, 1982), and is a visual representation of the process involved in delivering a service, specifying the linkages between different activities and the roles of different actors involved in service delivery (Patrício et al., 2011). The service blueprint prioritizes roles and activities of actors over individual tasks. Utilizing service blueprints, the process of shipbuilding activity mapping can place a greater emphasis on human-centered perspectives.

Service design and service blueprint are receiving greater attention because they play critical roles in creating new forms of values co-created with customers, organizations, and experts, and service innovation involves a new process or service offering that creates value for one or more actors in a service network through a human-centred and holistic thinking approach (Patrício et al., 2018). In simpler terms, service blueprints prioritize human-centric issues such as customers, service providers and other stakeholders within the entire system of value chain. The real virtue of service design has been verified with cases in various industries, particularly in the context of experience-centric services (Zomerdijk & Voss, 2010). Moreover, the emphasis on human-centricity in manufacturing-oriented industries through service integration has been in a growing trend in Product-Service System (PSS) development (Goedkoop et al., 1999; Costa et al., 2018). Note that a PSS is a system of products, services, supporting networks and infrastructure that is designed to satisfy customer needs and to generate values (Goedkoop et al., 1999; Tukker, 2015). Note that, in recent view of human-centered PSS design perspective, values are elucidated by activities and experiences that human stakeholders make using product artefacts in collaboration with other stakeholders of the ecosystem, rather than directly from artefacts (Kim, 2023).

In essence, service design is the process of designing human activities of service provider and service receivers. A service blueprint is a visual representation of all activities in the entire system, which helps to identify which stakeholder is engaged in which activities, in relation to which other stakeholders and in interaction with which other stakeholders. That is, a service

blueprint, a tool used in service design, addresses design of activities and determining *who does what activities when in collaboration with whom.*

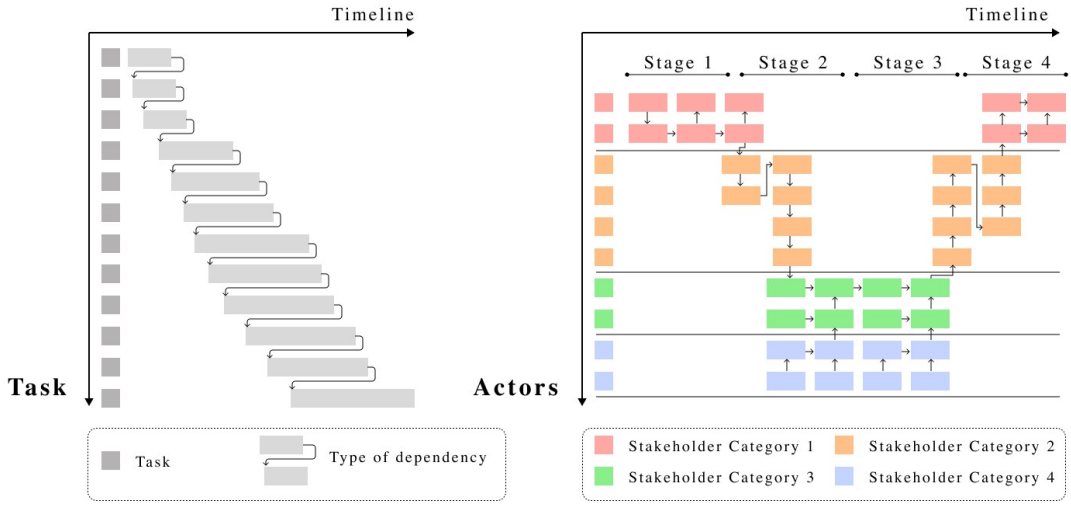
Shipbuilding Activity Mapping

Bruce (2021) explains what shipbuilding activity mapping in detail as follows. Shipbuilding activity mapping refers to the process of creating an overview of ship production, outlining the stages of a ship project and the major functions within a shipyard. Shipbuilding activity addresses a set of tasks, processes, or events related to a particular project. Shipbuilding activity can include financial planning, schedule planning, design work planning, design team organization, reporting, staff meetings, action items, master calendars, security classification and document marking. According to our interviews with two shipyards participating in the SEUS project, as summarized in the third section, current shipbuilding activity mapping practices concentrate on tasks and schedules. This current approach supports in planning, tracking, and monitoring all ongoing tasks and resources, ensuring timely delivery to ship owners.

Toward Human-Centric Shipbuilding Activity Mapping

There are extensive and diverse range of stakeholders and subcontractors involved in shipbuilding activities. They may include ship owners, government agency representatives, port engineers, ship supervisors and risk insurers; designers, naval architects, inspectors, marine engineers, and estimators; shipyard personnel, major vendors, major subcontractors, consultants, contract preparers; project managers, project planners, superintendents, maintenance supervisors (Bruce, 2021). It is important to recognize that these individuals are active actors with intent, motivation, expertise and relationships with other actors. Human-centricity issues are significant as reflected in Industry 5.0 (Xu et al., 2021).

Conventional shipbuilding activity mapping primarily centers on tasks. That is, activity mapping addresses how tasks are assigned considering resources and when tasks are done. Tasks are shown vertically with timeline progresses as in Figure 1 (a). By incorporating the service blueprint approach, actor-centered considerations including relationships among actors can be addressed with primary focus. In this approach, on the other hand, actors are shown vertically with horizontal timeline as in Figure 1 (b). Moreover, diverse values can be specifically associated with activities by utilizing the context-based activity modeling (CBAM) method. Please note that the CBAM method has been devised to represent activities in service design field with a formal and rich representation together with context elements (Kim et al., 2020) as briefly reviewed in a later section.



(a) Task-focused Approach (b) Service Blueprint Approach

Figure 1: Shipbuilding Activity Mapping Approaches

Emerging Demands in Activity Mapping Practices: Cases of Two Shipyards

The current practices of two shipyards, Shipyard A in Spain and Shipyard B in Norway, in their activity mapping have been investigated through semi-structured interviews. Three kinds of questions were made on how their activity mapping practices are done currently, on their unmet needs and expectations, and on their visions on the next-generation activity mapping. Key contents of the interviews have been summarized in Table 1. Their approaches to planning and managing shipbuilding projects have been understood and some insights were obtained.

Activity Mapping	*Shipyard A*	*Shipyard B*
How shipyard maps the activity nowadays	Microsoft Project serves as the primary software for activity mapping. The primary emphasis lies in scheduling functions, encompassing coordination of tasks and monitoring project progress.	Microsoft Project is employed currently. There is a lack of dedicated software for facilitating communication with suppliers. No software exists to help manage resources and retain their knowledge and experience.
Needs and expectations	A strong interest and need in the integration and analysis of data to derive actionable insights, generate reports, and establish benchmarks.	A desire for collaborative tools to engage with ship owners and to boost collaboration among supervisors and team members. The expectation of data integration across design, production, sourcing, and engineering.
Vision of next generation activity mapping	A high level planning of high of task, resource, allocation, schedule, and team. The detailed activity information about "who does what activities when in collaboration with whom"	The emphasis is on thorough planning, covering major milestones, dependencies, and confirmations. Extension to detailed activity information, specifying task ownership, collaboration with others and understanding the relationships between different activities.

Table 1: Interview Results of Two Shipyards

As shown in table 1, regarding the current practices employed by both shipyards in mapping project activities, it is discerned that software tools are integral to their methodologies. Notably, Microsoft *Project* serves as the primary software for activity mapping in Shipyard A, with a predominant focus on scheduling functionalities. Shipyard B also uses *Project*. Shipyard B would want collaborative tools to engage with shipowners and to boost collaboration among project supervisors and team members. Shipyard A expressed interest in the integration and analysis of data to derive actionable insights, generate reports, and establish benchmarks. Similarly, Shipyard B would like data integration. Both shipyards desire hierarchical and structured activity representation tools which support high-level planning capability encompassing tasks, resource allocation, schedules, and team coordination, as well as a detailed activity information system specifying the who, what, when, and collaborative engagements involved in the shipbuilding process.

Proposed Structured Activity Mapping Representation Framework

A structured activity mapping representation is proposed in this section. In contrast to shipbuilding activity mapping currently used as in (Bruce, 2021), the stages addressed in activity mapping can be expanded to include maintenance, operation and use by reflecting PSS concept as shown in the activity mapping framework of Figure 2. Within this framework, activities conducted by various stakeholders in the shipbuilding process are organized across these stages so that activities of stakeholders are described horizontally in corresponding lanes of actors with stakeholders as used in service blueprints. Activity mapping can be represented with specific value dimensions highlighted in corresponding value layers as shown on the right part of Figure 2. A layer with values for human-centric issues, PSS, and knowledge management is shown on top. Layers with each of these three value viewpoints are shown below respectively. The incorporation of value layers can help quick and efficient identification and attention of relevant activities associated with specific values.

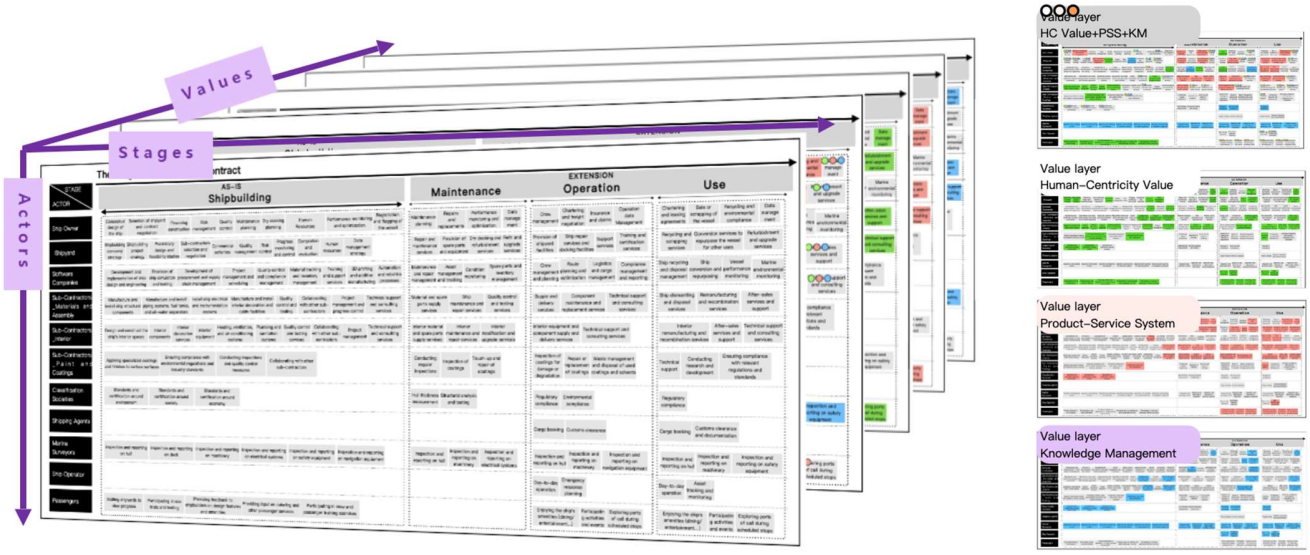


Figure 2: The Activity Mapping Representation Framework

Stages

Taking a cruise ship as an example, the duration required to construct such vessels may vary, typically ranging two to three years. For instance, the construction of the *Icon of the Seas*, the world's largest ship, spanned a period of about 29 months. In contrast, the operational lifespan of a cruise ship commonly exceeds 20 years. Comparing the 20-year operational span with the construction period of two to three years, it becomes evident that the operational and usage phases are significantly longer, implying ample opportunities for value creation and business development in the post-construction phases reflecting the PSS perspective. In Figure 3, we broaden the perspective beyond the current emphasis solely on the construction phase. We extend this perspective to include maintenance, operation, and usage phases.

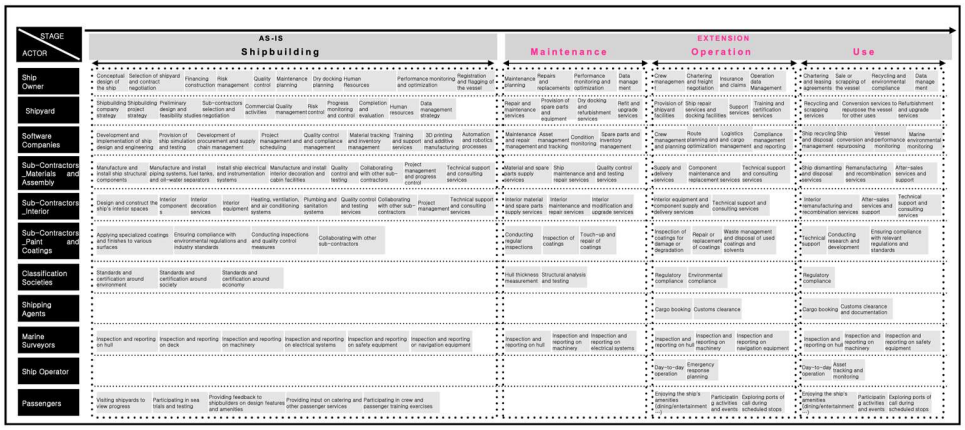


Figure 3: The Activity Mapping Representation Framework: Stages

Actors

There are extensive and diverse range of stakeholders and subcontractors involved in shipbuilding activities as Bruce (2021) highlighted. Stakeholders, also referred to as actors, play crucial roles. Service blueprint representation of activities of a project allows actor focused representation of the process of a project as shown in Figure 4. The service blueprint of Figure 4 illustrates how a PSS development project is represented so that how activities of different stakeholders interact and how stakeholders collaborate can be represented and interrogated in a structured manner (Kim and Lee, 2021). In this representation, stakeholders are presented vertically, emphasizing their central role, while arrows show the interrelations between different activities. Each individual box represents a high-level PSS development activity conducted by specific stakeholders. Three top lanes in blue

show activities of a company with different responsibilities. The PSS design team activities are shown with two lanes in light yellow. Activities of other relevant stakeholders are represented as well. The second column shows that the CEO of the company and the leader of PSS design team collaboratively determined the servitization strategy of PSS development. This is then followed by the activity of servitization direction decision collaboratively conducted by three stakeholders from three organizations as shown in the next progress step. In this way, the service blueprint representation of PSS development process shows *who does what activities when in collaboration with whom.* Our objective is to develop a comprehensive, human-centric representation and management framework for shipbuilding, fostering interaction and collaboration among diverse stakeholders, including shipowners, operators, service providers, users, and passengers. Central to our approach is the emphasis on stakeholders and their respective activities, facilitating clarity regarding roles, responsibilities, and collaborative dynamics.

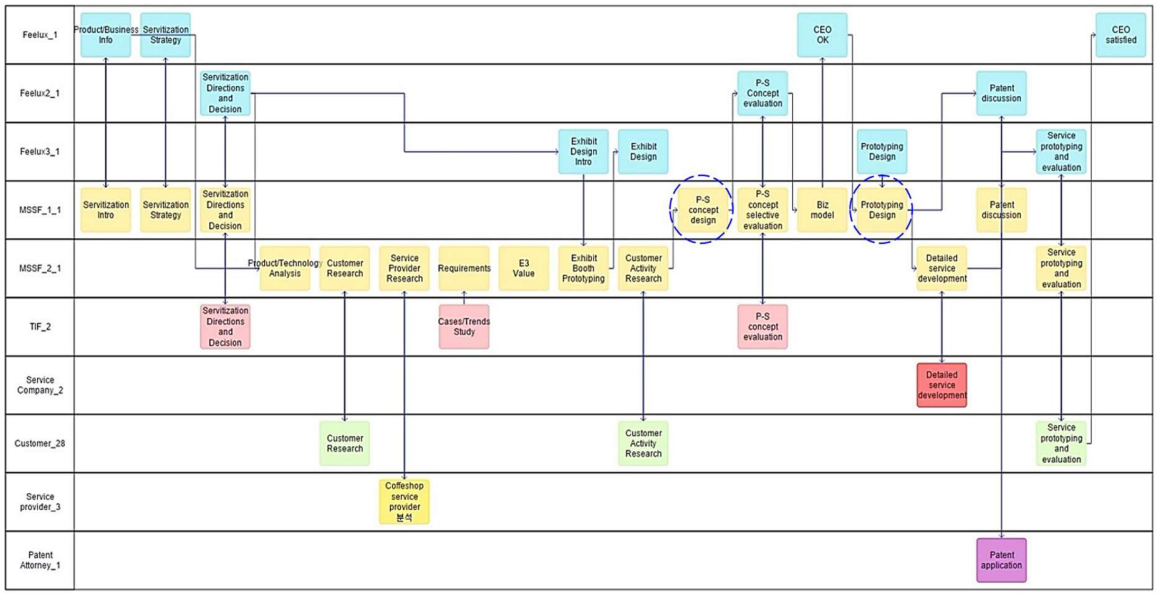


Figure 4: Service Blueprint Representation of a PSS Development Process (from (Kim and Lee, 2021))

Values

Different shipyards and shipowners may prioritize distinct values based on their individual contexts. As depicted in Figure 5, the integration of value layers enables the emphasis of activities associated with specific values. For instance, if the value of *human-centricity* is emphasized, corresponding activities will be highlighted in green. Similarly, activities linked to *PSS* or *knowledge management* will be highlighted in red or in blue respectively if those values are prioritized. In cases where multiple values are emphasized, all relevant activities will be highlighted accordingly.

Figure 5: The Activity Mapping Representation Framework: Values

Context-Based Activity Modeling

Human activities have been the object of designing services, and detailed representation of activities has been achieved through the CBAM method (Kim et al., 2020). Note that activities in a service blueprint would be represented by CBAM specifically. The CBAM method of modeling activities is illustrated in Figure 6. The activity description is centered around the action verb. The object of the action is specified as the *object* element of the activity. The *active actor* is the subject stakeholder of the activity who performs the action. In some cases, the *passive actor* and/or the *third-party actor* are specified as well. The *tool* of the activity is specified when a tool is used in the action. Another element of the activity in CBAM is the *context*, which is in turn described by the following 4 context elements: the *goal context*, the *relevant structures*, the *physical context*, and the *psychological context*.

Note that the goal context can be either other activities which the current activity supports or value themes derived by the current activity. The relevant structures are the entities associated with the object element in the action. Note that the relevant structure context represents various entities related to the object in this specific activity. This allows representation of relations of the object with various specific structure components. The physical contexts such as location and time are specified. The psychological context such as emotional states and motivation level can be associated. CBAM offers systematic and rich representation of context information of an activity. The psychological context includes sub-fields like social context, motivation context and emotional experiences, and can contain specific placeholders for specific value themes and their elucidated levels. In this way, CBAM enables specific association of various value items to activities.

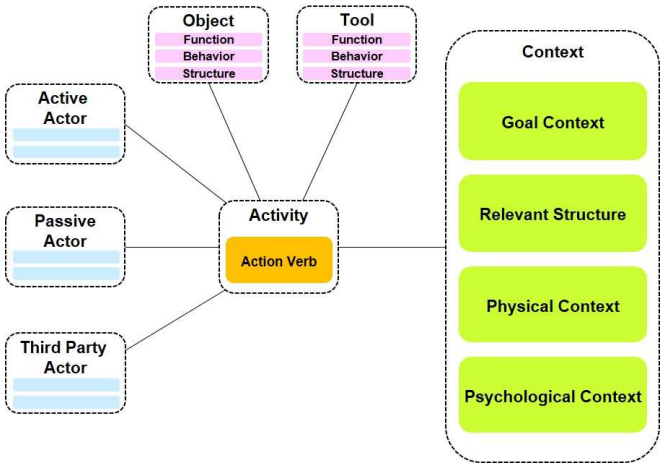


Figure 6: Context-Based Activity Modeling (from (Kim et al., 2020))

Toward the Next Generation Shipbuilding with Comprehensive Integration

With the proposed structured activity mapping framework, comprehensive integration of shipbuilding over stages and over a longer span of shipbuilding business can be envisioned with a smart PSS perspective supported by data-driven approaches. Considering cruise shipbuilding cases, as exemplified in Figure 7, the following three pivotal situations can be postulated: (1) the completion of building a cruise ship several years ago, (2) the ongoing building of a new cruise ship, and (3) the early planning of building of a later cruise ship. These situations correspond to distinct phases of *operation and use*, *building*, and *design*, respectively. The cruise ship built earlier, now in operation, presents abundant opportunities for gathering insights and addressing needs by comprehensively analyzing data from various stakeholders involved, including end users, shipowners, operators, service providers, and related communities. The building of a new cruise ship provides another avenue for identifying needs and insights, involving stakeholders such as ship builders, architects/engineers, construction contractors, subcontractors, regulatory authorities, and suppliers. Through data from an operating ship, production of a new ship can be improved. Furthermore, insights obtained from an operating ship and current ship production as well as various stakeholders can even improve designing of a future ship.

By integrating insights and opportunities across these three situations and engaging stakeholders in collaborative efforts, competitive advantages can be harnessed. With the proposed activity mapping framework and repository of activity maps of diverse ships and various shipyards, the next-generation shipbuilding can be postulated with data-driven ship design and building encompassing design data, production data and use data. Beyond utilizing design data in production planning and shipbuilding, shipbuilding activity information can support maintenance and operation. Moreover, various use and experience data from use, operation and service can support design of future ships.

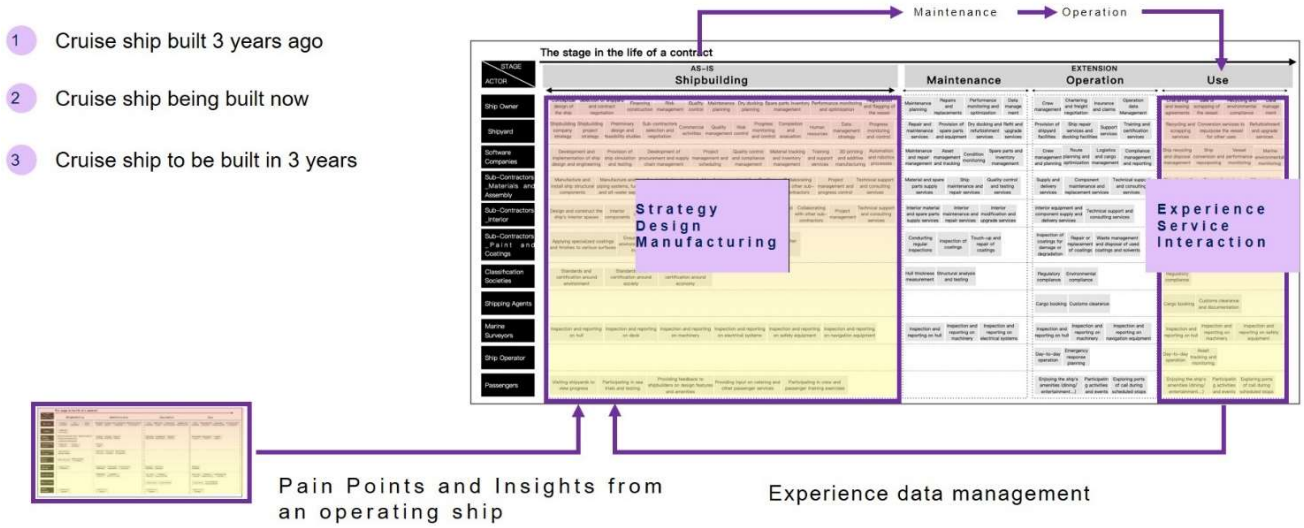


Figure 7: Integration of Design, Production, Service, Operation and Use Stages

Discussions and Conclusion

The objective of the SEUS project is to create a framework for European shipyards by architecting and developing an integrated platform for data-driven shipbuilding, with a focus on human-centricity, smart technology, digitalization, and cyber-physical systems, to improve efficiency, reduce engineering time, and provide a competitive advantage through cost- and time-saving innovations (Seppälä et al., 2023). Within the SEUS framework, our research centers on representing shipbuilding activities with a focus on prioritizing human-centric approaches. This paper contributes to that overarching goal.

Specifically, in this paper, the human-centric approach in shipbuilding with a structured activity mapping framework was described as proposed in the SEUS project. The service blueprint representation of shipbuilding activities inherently focuses stakeholders as the activities are arranged for stakeholders, not for tasks. This is a significant improvement over the perspective where people are regarded as resources like in the case of Bruce (2021). Furthermore, specific values can be associated to activities through the detailed and rich representation of activities by utilizing the CBAM method. This human-centric approach with detailed value association enabled by the proposed structured activity mapping framework would be comprehensively applicable whether activities are about ship production or about customer involvement.

Furthermore, interaction and collaboration of actors are the most important part of activity management whether the activities are about strategies and contracts or about production and test. Representation and management of collaboration and coordination of diverse shipbuilding stakeholders are particularly important for human-centricity in the era of digital transformation. Note that *smartness* can be assessed based on how rich co-creative activities were done in various parts of shipbuilding activities. For example, shipbuilding activity staging, that is, determining which actors are involved in what phase in collaboration with which other actors should be effectively supported in the proposed activity mapping framework.

Moreover, to address after-sales services, such a human-centric approach is very important. Considering the use stage, various stakeholder experience data can be obtained as well as diverse artefact data so that truly data-driven ship experience design could be realized as explained in (Kim, 2023). We believe people aspects are getting more and more important as digital technologies are utilized in more and more parts of ship design, production, operation and use stages. The proposed activity mapping framework would work as a major enabler for smart data-driven ship design and ship experience design as a high-level planning tool addressing vast range of ship design and building stages and as a detailed information provider for activities. In this way, the activity mapping with service blueprint representation would make a significant next-generation shipbuilding competitiveness management tool.

Future work on this activity mapping research would include the following tasks. Efforts will be made to accommodate different shipbuilding contexts and shipyard characteristics in a structured manner in shipbuilding activity maps. This will allow repositories of diverse ship design and building cases so that smart data-driven ship design and building can be supported. Immediate future work will address systematic development of cases. This will entail selecting and combining scenarios from

various shipyards, each with distinctive priorities and contexts. This will be structured with four main aspects: shipyard activities for planning and building phases, strategic mapping of activities during design phase, defining ship owner activities related to customer experience during operation and use stage, and scenarios focusing on systematic considerations guided by diverse data-driven methods. How specific collaborations were done in previous shipbuilding cases can be captured and represented as knowledge so that future shipbuilding cases will exploit this. With digital technologies, collaborations are happening with wider partnership and these kinds of knowledge would be important as closer feedback from various stakeholders are enabled in such a collaboration.

CONTRIBUTION STATEMENT

Author 1: Conceptualization; methodology; supervision; writing – original draft, review and editing.
Author 2: Conceptualization; data curation; investigation; visualization; writing – original draft, review and editing.
Author 3: Conceptualization; writing – review and editing.

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