“Financial performance-based assessment of companies’ competitiveness: Evidence from the Norwegian Shipbuilding Industry”

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FINANCIAL PERFORMANCE-BASED ASSESSMENT OF COMPANIES' COMPETITIVENESS: EVIDENCE FROM THE NORWEGIAN SHIPBUILDING INDUSTRY

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Abstract

The Norwegian maritime industry is at the forefront of green technology development, with shipyards playing a crucial role in testing, verification, and development. However, the industry faces challenges such as high personal costs, increasing competition from abroad, and cyclical market trends. This study aims to assess financial performance as indicator of firm-level competitiveness based on a set of 12 financial measures and test the hypothesis of the positive impact of portfolio diversification on shipyards' competitiveness.

The analysis utilizes data from four large construction yards and four medium-sized construction, repair, and maintenance yards in the Møre region. The methodology involves constructing a Shipyard Competitiveness Index with sub-indices for liquidity, profitability, solvency, and efficiency. Regression analysis is conducted to investigate the impact of ship variety, as a diversification parameter, on the competitiveness level.

The obtained results reveal that during the analyzed period (2009–2020), companies in the group of large shipyards had better financial performance until 2017, while on the contrary, the second group of shipyards in the same period showed an increase in their competitiveness index. Moreover, the findings proved the presence of the positive relationship between diversification of portfolio and competitiveness index.

This study contributes valuable insights for the Norwegian shipbuilding industry, highlighting the importance of financial performance assessment in measuring competitiveness. The study provides a foundation for future discussions on fostering sustainable growth and innovation within the maritime sector.

Keywords maritime cluster, diversification, Shipyard Competitiveness Index, Ship Variety Load, Ship Construction Load

JEL Classification G11, L20, L25

INTRODUCTION

Norwegian shipyards have established themselves as prominent players in the global maritime industry, driven by a unique combination of factors that contribute to their competitive edge. One of the defining features of Norwegian shipyards is their unwavering commitment to embracing innovative technology and solutions. These shipyards have consistently demonstrated a proactive approach to adopting cutting-edge technologies, allowing them to stay ahead of the curve in a rapidly evolving industry.

Furthermore, Norwegian shipyards benefit from their strategic proximity to design, equipment, and service suppliers. The close geographical proximity allows for efficient collaboration and seamless integration of various elements in the shipbuilding process. This proximity fosters strong partnerships, facilitates knowledge exchange, and streamlines the supply chain, resulting in streamlined operations and accelerated project timelines.

During the last decade, Norwegian shipyards have emerged as key players in constructing four main types of vessels: offshore service vessels for the oil and gas sector, expedition cruise ships, ferries/speedboats, and well boats. Despite facing challenges during the offshore crisis in 2014 (Koilo & Grytten, 2019), Norwegian shipyards have traditionally held a strong position in the construction of offshore vessels. However, it is noteworthy that their market share in this segment began to decline as early as 2010. In the earlier years, when the offshore market was relatively small, Norwegian shipyards enjoyed a dominant global market share, ranging from 20 to 35 percent between 1990 and 2005. However, their market share has gradually decreased over subsequent years, stabilizing at approximately 7-8 percent in recent times (Menon, 2021).

The decline in the share of Norwegian shipyard market in the offshore ship construction since the early 2000s can be attributed to two primary factors. First, increased competition has emerged from countries withlower labor costs, notably China, as well as other Asian and European shipyards. This increased competition has impacted the market dynamics and posed challenges to Norwegian shipyards' market position. Second, during the offshore boom many large Norwegian shipyards had already filled their order books well in advance. This meant that they had secured substantial orders and commitments, and as such operating at margin leading to limited availability and capacity to undertake new projects. As a result, even though shipping companies initially preferred Norwegian shipyards with comparable delivery times, they may have opted for competing shipyards in other countries due to their ability to offer shorter delivery periods and capacity constraints at the Norwegian shipyards. Therefore, the combined effect of intensified competition from countries with lower labor costs and the limited availability of Norwegian shipyards during the offshore boom has contributed to the reduction in their market shares. Furthermore, the improved quality by the foreign shipyards has prompted some shipping companies to select alternatives abroad. Over the past decade, Norwegian shipyards have had a market share of about one-third of all expedition cruise vessels word wide. The majority of these ships were built for foreign cruise lines. The conversion process from building offshore vessels to cruise ships incurred significant costs and necessitated substantial changes in internal work processes, logistics, competence requirements, and the establishment of new value chains with equipment suppliers. Despite the promising outlook of this market, characterized by high growth and newbuilding contracts, the cruise industry was abruptly halted by the onset of the COVID-19 pandemic in 2020.

In the niche sector of well boats for aquaculture, Norwegian shipyards have achieved a dominant position, constructing approximately 71 percent of all boats since 2010, including those listed in order books. The remaining vessels in this category are built in Spain, Turkey, and Poland (Menon, 2021). However, Norwegian shipyards face a weaker position in the ferry and fast boat segment, accounting for only 6 percent of the global market over the past decade. Moreover, the vast majority of ferries and fast boats constructed by Norwegian shipyards have been delivered to domestic shipping companies.

In light of Norwegian shipyards' diminished competitiveness in the construction of "easier to build ships" such as tankers and cargo carriers for deep-sea/short sea operations, deliberate strategic decisions were made to redirect their production towards smaller yet more intricate vessels. Consequently, over the past decades, Norwegian shipyards have encountered a dearth of newly secured orders, and, in total, Norway's overall market share in the global shipbuilding industry over the past decade amounts to a mere 0.8 percent.

Norwegian shipyards encounter strong competition from Turkish shipyards, which compete in various ship segments that are also constructed by their Norwegian counterparts. Spanish and Polish shipyards also compete with Norwegian shipyards across a wide range of vessel types, although their market share within the core market of Norwegian shipping companies is relatively lower compared to Turkish

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shipyards. In the domain of fishing vessels, Denmark emerges as a significant contender, while Chinese shipyards demonstrate strong competitiveness in offshore vessel construction.

Hence, all above mentioned prove that the competitiveness of the shipyards has been weakened over the last decade. Historically, Norwegian shipyards deliver special vessels within given vessel segments, and this will probably continue in the future, but to a lesser extent than before. The long-term market situation of Norwegian shipyards will depend on the development in the markets to which it has historically been supplied, adjacent growth markets and possibly completely new market segments. Therefore, examining the financial situation of shipyards' portfolios and market segment choices appears to be a significant factor in enhancing their competitiveness and is worthy of investigation.

1. LITERATURE REVIEW

1.1. Shipyards' place in the maritime cluster

The shipyards hold a pivotal position within the maritime value chain and are an integral part of the Norwegian maritime cluster. Porter (2000) defines a cluster as "... geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate". Reve (2001) defines a business cluster as an "agglomeration of companies that interact in all parts of the value chain or value network within an industry". The primary distinction between the two approaches lies in that the Scandinavian perspective, wherein a cluster entails an emphasis on network establishment, co-creation, collaborative innovation across the value chain, as well as a mitigation of risk associated with investments in green and novel maritime technology.

In Norwegian practice, the terms network, innovation system, and cluster are used interchangeably, in the same sense. Freeman (1987) defined national innovation systems as the network of institutions in the private and public sector, which, through activities and interactions, took the initiative to, import, modify and spread new technology. A network consists of interconnected nodes that are independent of each other. These nodes can be individuals or groups of actors, including both human and technical entities. The network serves as a conduit for connecting diverse abilities and knowledge among these nodes (Törnqvist, 1997; Castells, 2000).

The role of shipyards as a central hub in the innovation process should be emphasized, as they serve as testing grounds for new technologies, products, and solutions at full scale. Furthermore, shipyards play a crucial role in facilitating the exchange of knowledge and the adoption of new technologies within the maritime sector. Their contribution to fostering innovation holds immense value. In the maritime industry context, a shipyard refers to an advanced workshop that encompasses activities such as construction, equipping, repairs, maintenance, and retrofits of existing ships.

Vessels within the maritime industry are constructed and equipped based on designs provided by independent ship design companies or the shipyards' own design units. To meet the specific requirements of different vessel types, shipyards source equipment from a diverse range of manufacturers, encompassing both standard components and specialized systems. Standard equipment typically includes propulsion systems, propellers, and bridge solutions, while specialized equipment varies depending on the particular vessel category. For instance, well boats can be equipped with advanced fish handling systems. Throughout the shipbuilding process, shipyards rely on a variety of services such as electrical installation, staffing, and engineering support. Orders for these vessels are placed by shipping companies that operate on behalf of cargo owners, oil companies, seafood producers, and other stakeholders within the maritime industries (Figure 1).

It is believed that shipyards can be considered competitive when they offer equal quality as their rivals and establish a reputation for delivering high-quality products. However, in order to truly be competitive, shipyards must also ensure that

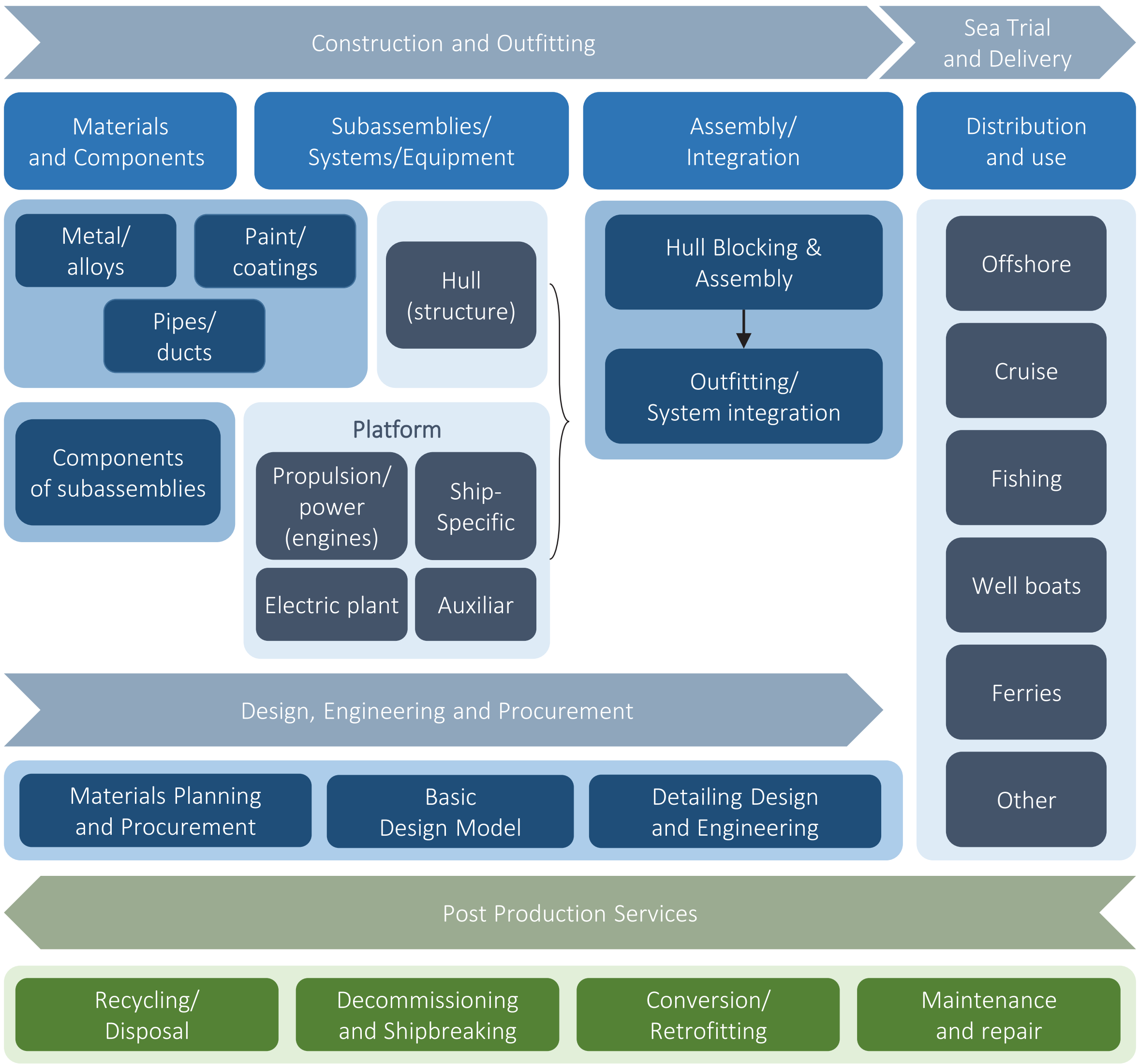

Figure 1. Shipbuilding direct and reverse value chain

their prices are as low as those offered by their competitors (Black et al., 2009). The competitiveness of shipyards is often attributed to their ability to compete effectively in the markets. This competitiveness is determined by a combination of price and quality factors. As mentioned earlier, shipyards face challenges in competing with international counterparts primarily based on price. Therefore, it becomes essential to explore the precise definition of "competitiveness".

1.2. Competitiveness and competitive advantage

Strategic growth plays a vital role in enhancing competitiveness as it reflects an organization's ability to expand its operations both domestically and internationally, serving as an indicator of its overall business health (Sledge, 2005). Competitiveness, in essence, can be categorized into three distinct levels of analysis: firm-level competitiveness, cluster-level competitiveness within industries, and national competitiveness. Each level offers unique insights into the factors influencing the competitive landscape and performance of businesses.

The concept of competitiveness, originally linked to international trade, was first introduced by classical economist David Ricardo through his theory of comparative advantage (Ricardo, 1817). In more contemporary perspectives, the notion of competitiveness has expanded to encompass a country's capacity to elevate its standard of living. As artic-

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ulated by Tyson (1992), competitiveness can be defined as "our ability to produce goods and services that can withstand international competition while ensuring that our citizens experience a rising and sustainable standard of living".

Building upon the work of Porter (1991), the concept of competitiveness has evolved to incorporate not only traditional factors such as profitability, cost management, and pricing, but also the quality of products and technological innovation. Consequently, competitiveness is now recognized as a dynamic concept that can improve the quality of life through adaptation and technological advancements. Porter (1998) further emphasizes the economic significance of clusters, arguing that they create more favorable market conditions. Additionally, Langlois and Robertson (1996) focus on the role of technological externalities, which emerge from shared technological information and knowledge spillovers within a cluster.

At the firm level, competitiveness is explained by two fundamental concepts in business theory: the market-based view and the resource-based view (Berger, 2008). World-class companies gain a competitive advantage through factors such as market impact, lean operations, and a balanced organizational culture (Smith, 1995). Grant (1991b) emphasizes the significance of the resource-based approach in shaping strategic decisions, emphasizing the interplay between resources, capabilities, competitive advantage, and profitability. This comprehensive understanding enables the establishment of sustainable competitive advantage over the long term.

Therefore, assessing competitiveness for shipyards involves analyzing their strengths, weaknesses, opportunities, and threats within the competitive landscape. According to Menon's report (2021a), the competitive advantage of Norwegian shipyards is attributed to the following factors:

- Proximity and trust within the cluster. The close proximity and mutual dependence between businesses in the cluster have fostered strong informal relationships and information sharing, creating a foundation of trust and cooperation.

- Work culture and organizational structure. The flat organizational structure and collaborative work culture in Norwegian shipyards facilitate quick decision-making and adaptability during construction processes, leading to increased productivity.

- Specialized expertise in customization and prototyping. The Norwegian shipbuilding industry possesses advanced problem-solving skills and the ability to tailor solutions to meet specific requirements.

- Innovation within the maritime industry is driven by cluster-based collaboration, with shipyards serving as pivotal innovation hubs. The value chains in Norway's maritime sector facilitate extensive cooperation among stakeholders, including shipping companies, ship designers, equipment manufacturers, system integrators, and shipyards. This collaborative ecosystem enables the joint development of new vessels and technological solutions. Crucially, shipyards play a central role in this innovation process by providing a vital platform for testing, piloting, and refining new technologies, products, and solutions.

However, the competitive advantages have weakened in recent years. There are several reasons:

- Other European countries, notably Turkey, have developed their shipbuilding industry with lots of similarities to the Norwegian counterpart, but with considerably lower labor costs.

- Outsourcing of numerous tasks, including staffing services, by Norwegian shipyards to international suppliers has resulted in a diminished level of flexibility within the construction process. Consequently, this has not only undermined the shipyards' internal competence, but has also had a varying impact on the competence of subcontractors. It is noteworthy that enhanced flexibility in the construction process also holds inherent benefits, underscoring the need for a comprehensive reassessment of this aspect.

- Changes in pay conditions for contracted foreign staff have led to an increase in personnel costs.

- Norwegian shipyards have found themselves stuck in a detrimental cycle characterized by a compromised financial stability and diminished liquidity, thereby constraining their prospects for pursuing new investments and impeding their capacity to secure adequate financing for their newbuilding projects. This difficult financial position subsequently poses an increased risk for shipowners engaging in contracts with Norwegian shipyards.

1.3. Shipbuilding life cycles and diversification for increased performance

The evidence provided substantiates the correlation between the shipbuilding market and global maritime transport demand, which is influenced by the performance of international markets and the fluctuations in the volume of maritime trade (Rusu, 2011). As a result, the shipbuilding market exhibits a cyclical nature in line with the broader maritime industry.

The cyclical patterns observed in economic activity continue to be a focal point for researchers (Grytten, 2020) and industry professionals (Papademos & Lucas, 2003). It is widely recognized that investment and construction activities also follow cyclical trends in their development. Economic upswings are constrained by factors such as market saturation and external influences, which set limits to the extent of growth that can be achieved.

Managing the business cycle requires a keen understanding of the constraints on satisfying economic interests, stemming from declining effectiveness in corresponding economic relations. Therefore, during periods of growing contradictions and limitations, specific measures are necessary to support the reconfiguration of the existing system of economic relations. Diversification, which involves maintaining a broad and varied portfolio, emerges as a tool with significant potential impact. While diversification typically pertains to a company's strategic choice for its activities, it can also serve as an effective tool for (counter)cyclical management (Koilo & Grytten, 2019).

Earlier definitions of diversification primarily focused on the extent of a company's presence in different markets or industries. Gort (1962) provided a definition of diversification as the simultaneous operation of a company in multiple markets, which is deemed reasonable when there is low cross-elasticity of demand for the goods supplied in these markets and when resources cannot be easily reallocated between markets in the short term. Cao (2009) proposes that businesses have the choice between a diversification strategy and a specialization strategy, with the core competence of the enterprise playing a significant role in this strategic decision-making process. Sindhu, et al. (2014) conducted regression analysis using performance variables such as return on assets (ROA), leverage (LEV), size (SIZE), and risk (SROA). Their findings indicate that diversified companies tend to have higher levels of risk compared to undiversified ones, but they also exhibit higher leverage and achieve greater long-term performance. Grillitsch and Asheim (2018) introduced the concept of systemic differentiation as one of the instruments for implementing new industrial innovation policies, particularly in the context of smart specialization.

According to the theory proposed by Menzel and Fornahl (2010), clusters experience a decline when their heterogeneity is not maintained. However, if the heterogeneity increases once again, the cluster undergoes a "backward" movement in the cycle and enters a new phase of growth. This increase in heterogeneity can be achieved through the integration of new knowledge and technologies, as well as gradual adaptation to a changing environment and diversification of companies' activities. A study by Sjøtun and Njøs (2019) supports this notion by providing evidence that the diversification of firms and products, along with the development of new niches, play a crucial role in cluster transformation.

Based on above mentioned, it is proposed a new view on how the shipbuilding companies can move their development "backward" in the cycle, which is presented in Figure 2.

Hence, the integration of new knowledge and technologies (transformation), as well as the gradual adaptation to a changing environment (flexibility) and the diversification of companies' activity can help shipyards to enter a new stage of growth.

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Source: Compiled based on Paolo and Calvosa (2013), Menzel and Fornahl (2010).

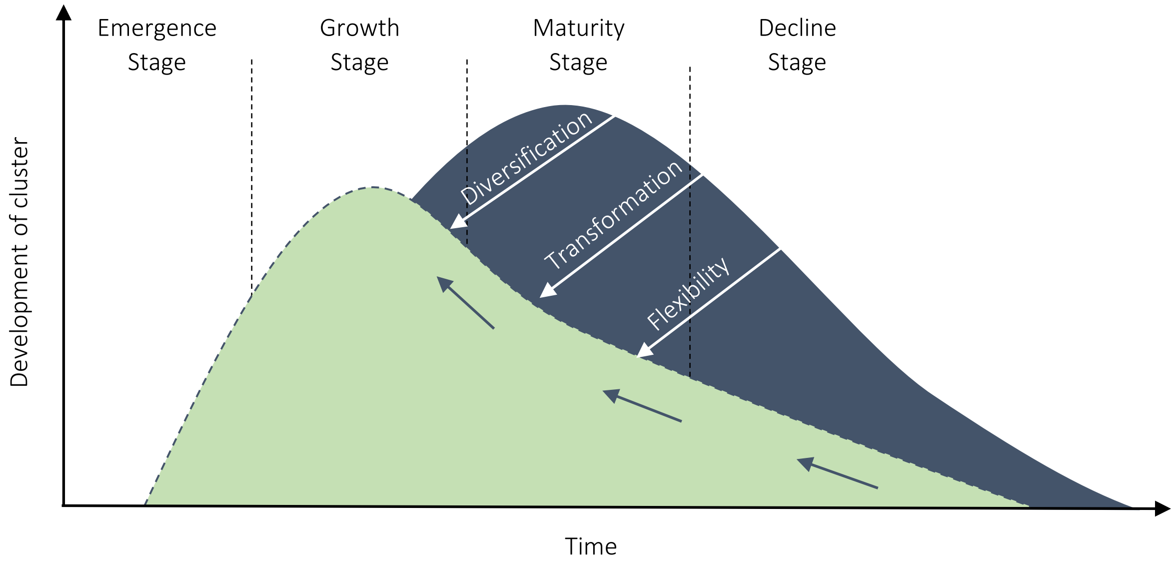

Figure 2. The companies' cycle and transitional growth phases

In conclusion, the demand for ships follows an upward trajectory during periods of economic growth, but experiences a decline during recessions. To secure shipbuilding contracts, shipyards must maintain a competitive advantage. Competitiveness in shipyards is defined as their capacity to successfully acquire and fulfill ship orders in a competitive market (Gasparotti, 2014). The competitive position of shipyards is influenced by a range of factors, including production costs, labor productivity, innovation, global market share, production capacity, and the types of ships built (Gasparotti, 2018). In the dynamic ship market, it is vital for shipyards to demonstrate flexibility and responsiveness in catering to a diverse range of vessel types. These projects require expertise, innovation, advanced technology, and specialization to construct large, sophisticated, safe, and environmentally friendly ships (Ecorys, 2009). By embracing these qualities, shipyards can effectively compete and prosper in the demanding shipbuilding industry.

However, the hypothesis regarding the influence of portfolio diversity on competitiveness lacks comprehensive development at the individual company level. Therefore, further research is needed. Prior to conducting such a study, it is essential to assess the current level of competitiveness among shipyards. This paper focuses on the evaluation of shipyards' competitiveness through financial performance indicators.

2. METHODOLOGY

The current study employs annual time series from 2009 to 2020, extracted from the financial database from the Norwegian central company register at Brønnøysundregistrene (2023), Proff (2023), and Maritimt magasin (2023).

The data are gathered for two groups of companies: I group – large new construction yards, and II group – medium-sized new construction, repair/maintenance yards in the Møre region, Norway.

This study consists of two parts: 1) assessing the financial performance measured as indicators of competitiveness of shipyards; and 2) several regressions are performed on the measurable variables of the dataset to the relationship between portfolio diversification and competitiveness level.

The proposed analysis includes the following steps (Figure 3).

1. *First step:* In the initial phase, a system of indicators is established to capture the financial situation of the companies and an information database is designed. The model incorporates 12 financial indicators, classified into four groups: liquidity, profitability, solvency, and efficiency.

2. *Second step:* Subsequently, the input data is standardized to ensure comparability. Given

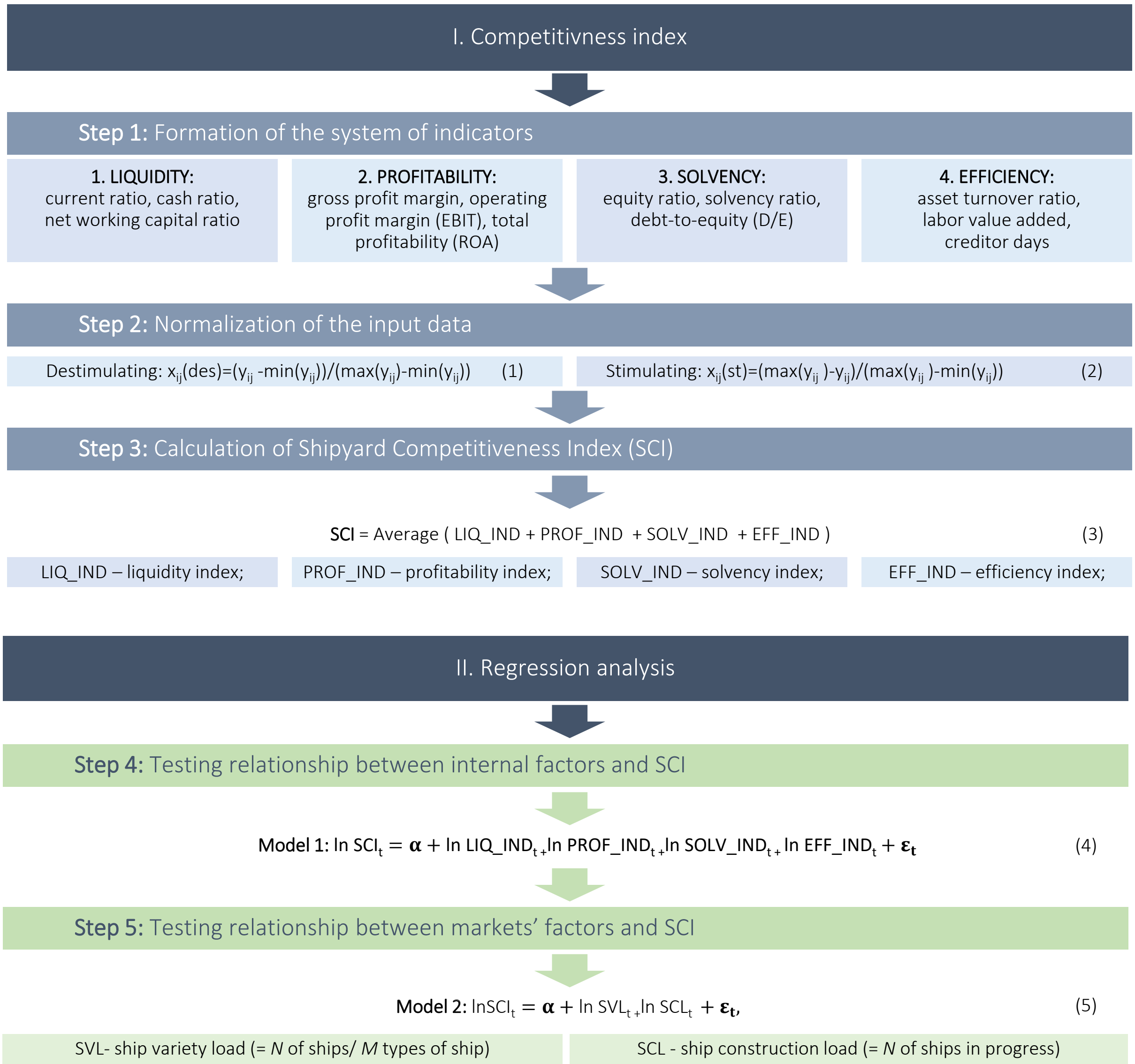

Figure 3. Framework of the study on the relationship between the competitiveness of shipyards and diversification as a strategy

the varying measurement scales of different indicators and their differential impact on the outcome parameter, two distinct normalization methods were employed in this study (Koilo, 2019).

3. *Third step:* Calculating the Shipyard Competitiveness Index (SCI), as average of sub-indices (LIQ_IND, PROF_IND, SOLV_IND, EFF_IND).

4. *Fourth step:* Exploring the relationship between internal explanatory variables and SCI through regression model.

5. *Fifth step:* The last stage was regression analysis. The idea is to test the hypothesis that markets factors: SCL and SVL has an influence on the performance of shipyards. Ship construction load (SCL) is measured as the total number of ships manufactured for the period by shipyard, and ship variety load (SVL) is the proportion of the total number of ships (*N*) and number of different ship types (*M*) built by the yard (during each period).

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3. RESULTS AND DISCUSSION

3.1. Results on Shipyard Competitiveness Index (SCI)

Based on the set of financial data, four sub-indices were calculated to check the financial state of shipyards during the investigated period. The results for group I, which includes four new buildings shipyards, with the main domination in offshore market until 2016, can be depicted on Figures 4 and 5.

Figure 4 shows the tendency that profitability and solvency were sharply weakened after 2011, so it happened longer before the offshore crisis in 2014. What should be highlighted that all shipyards in this group had similar tendency in the development of both: as profitability, as solvency index.

Efficiency and liquidity do not follow a clear development pattern within Norwegian shipyards (Figure 5). The issue of working capital remains a persistent challenge for these shipyards, both in the past and in the present. It continues to be a significant concern for their financial operations. It should be emphasized that after 2011 the efficiency also weakened.

The same analysis was done for group II, which included four medium-sized new construction, repair/maintenance yards. Based on the calculations on the previous stage, a new index was found – Shipyards competitiveness index for both groups (Figure 6).

Figure 4. Profitability and solvency of the large shipyards during 2009–2020

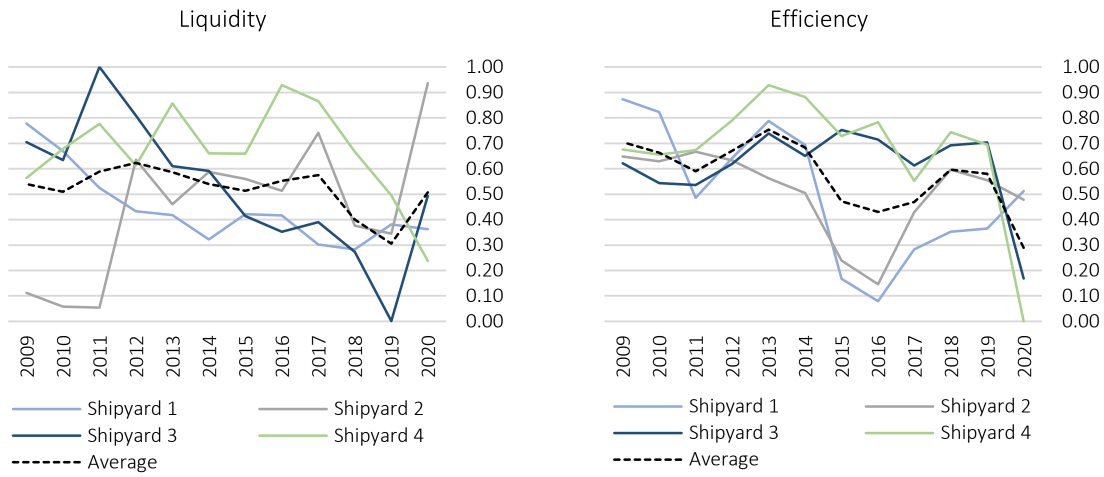

Figure 5. Liquidity and efficiency of large shipyards during 2009–2020

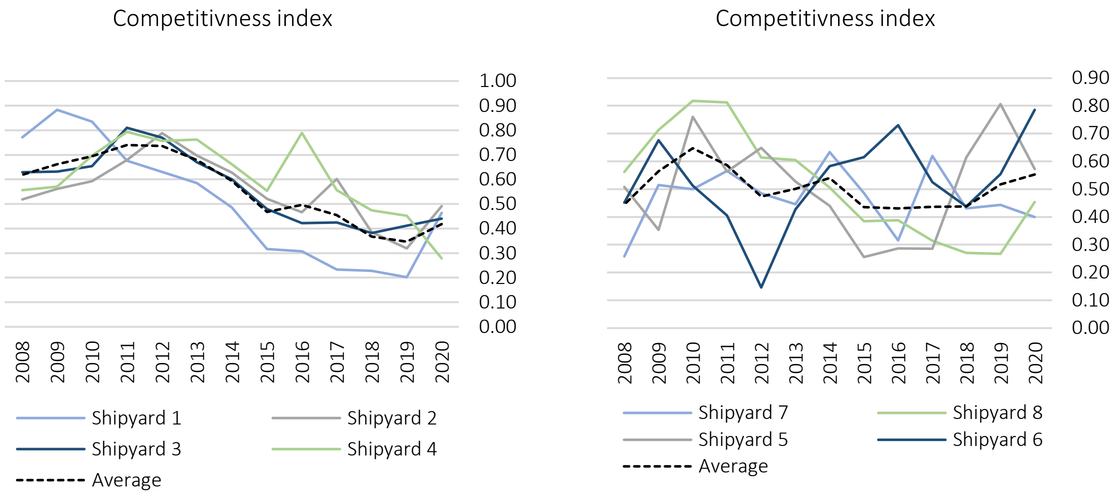

Figure 6. Shipyard Competitiveness Index: group I (left diagram) and group II (right diagram), 2009–2020

It is worth noting that there is a noticeable pattern in the development of the SCI for large shipyards: the index began to decline after 2011, and these shipyards have yet to experience a full recovery. In contrast, the SCI of the last group of shipyards displayed variation throughout the period. This can be attributed to their concentration in different markets and, notably, some of them diversified their activities by expanding beyond the new building segment and entering maintenance and repair services.

If we compare two indices for both groups on average (Figure 7), it can be found that since 2017 medium sized shipyards performed better.

The flexibility and operation in different segments of shipyards in category II can help to explain the observed situation. It is crucial to examine this phenomenon in light of the theory that emphasizes the significant role of portfolio diversification in maintaining competitiveness. Consequently, the following section will analyze the impact of internal factors and market conditions on the performance of shipyards, further exploring these dynamics.

3.2. Regression results on relationships between competitiveness and explained factors

This section presents and examines the empirical findings of the study, utilizing two variations of regression analysis. The outcomes of the ordinary least squares (OLS) multiple regression are depicted in Table 1 for the first model (equation 4), while Table 2 displays the results for the second model (equation 5).

3.2.1. Model 1. Internal factors

Based on the regression analysis conducted on models 1 and 2, it can be concluded that the ob-

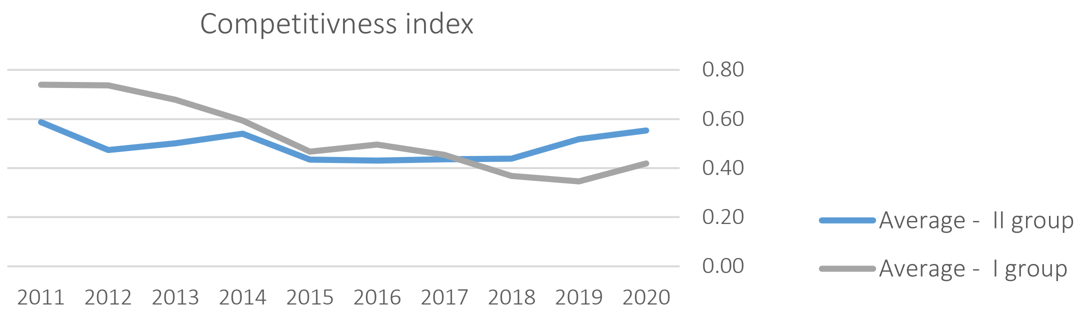

Figure 7. Average Shipyard Competitiveness Index, 2009–2020

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Table 1. Results of ordinary least square (OLS) regression analysis based on the first model

Parameter	Shipyard 1	Shipyard 2	Shipyard 3	Shipyard 4
LIQ_IND	0,13	0,26	0,17	0,04
PROF_IND	0,11	0,32	–0,01*	0,05
SOLV_IND	0,36	0,06	1,05	0,87
EFF_IND	0,28	0,24	–0,02	–0,09*
Parameter	**Shipyard 5**	**Shipyard 6**	**Shipyard 7**	**Shipyard 8**
LIQ_IND	0,16	0,30	0,08	1,49
PROF_IND	0,05	0,08	0,31	–0,57*
SOLV_IND	0,23	0,14	–0,53	0,99
EFF_IND	0,49	–0,22	–0,20	0,30

Note: * is not a significant factor at $\alpha = 0.05$.

served R-squared values, ranging from 0.82 to 0.99 across different shipyards, indicate a substantial relationship between the Shipyard Competitiveness Index (SCI) and internal factors, as well as market conditions factors (such as SVL and SCL) of shipbuilding firms. Moreover, with a significance level of α = 0.05, the evidence is sufficient to support the hypothesis of a relationship between the SCI and these factors.

When it comes to model 1, here the EFF_IND parameter in both groups had a negative impact on performance at some shipyards, all other internal parameters showed a positive impact on the resulting indicator. It is important to note that the efficiency index is derived from three key parameters: asset turnover ratio, labor value added, and creditor days. In the case for most shipyards, an increase in labor value added had a significant impact on reducing efficiency. This fact explains the situation: the price of ships tends to be higher compared to foreign counterparts due to higher labor costs.

3.2.2. Model 2. Markets' factors

The findings reported in Table 2 indicate that the coefficient for SVL shows a positive correlation with SCI as the dependent variable (with the exception of Shipyard 3 and Shipyard 5). This relationship is statistically significant at a significance level of 5%.

In terms of the association between SCL and SCI, the results consistently show a negative relationship, except for Shipyard 2 and Shipyard 5 where it is positive. This relationship is also statistically significant at a 5% significance level.

In other words, having a higher ship variety load, indicating a diverse range of ship types constructed by the shipyard, was advantageous for Norwegian shipyards. However, the overall ship construction load, representing the total number of ships constructed, had a negative impact on their performance. This suggests that focusing on a greater variety of ship types rather than simply increasing the number of ships constructed was more beneficial for the Norwegian shipyards. Indeed, 1% of increase of SVL for Shipyard 4 led to 0,54 % improvement of competitiveness index, which was the highest among shipyards. It should be noted that those shipyards that had a negative relationship between SVL and explained variable, like Shipyard 5 and Shipyard 3, underwent a significant transition from the offshore market to an entirely different segment, which was not without challenges: in 2016, the Shipyard 5 completed its last construction of offshore support vessels (OSCV) and subsequently shifted its focus to a diverse range of ship types in its construction portfolio. These included fish carriers, car ferries, and aquaculture vessels. It is worth noting that during this transitional period, the shipyard

Table 2. Results of ordinary least square (OLS) regression analysis based on the second model

Parameter	Shipyard 1	Shipyard 2	Shipyard 3	Shipyard 4
SVL	1,11	0,49	–0,59	0,54
SCL	–2,20	1,42	–0,59	–0,22
Parameter	**Shipyard 5**	**Shipyard 6**	**Shipyard 7**	**Shipyard 8**
SVL	–3,60	2,07	0,00	1,05
SCL	0,99	–2,73	–0,32	–0,42

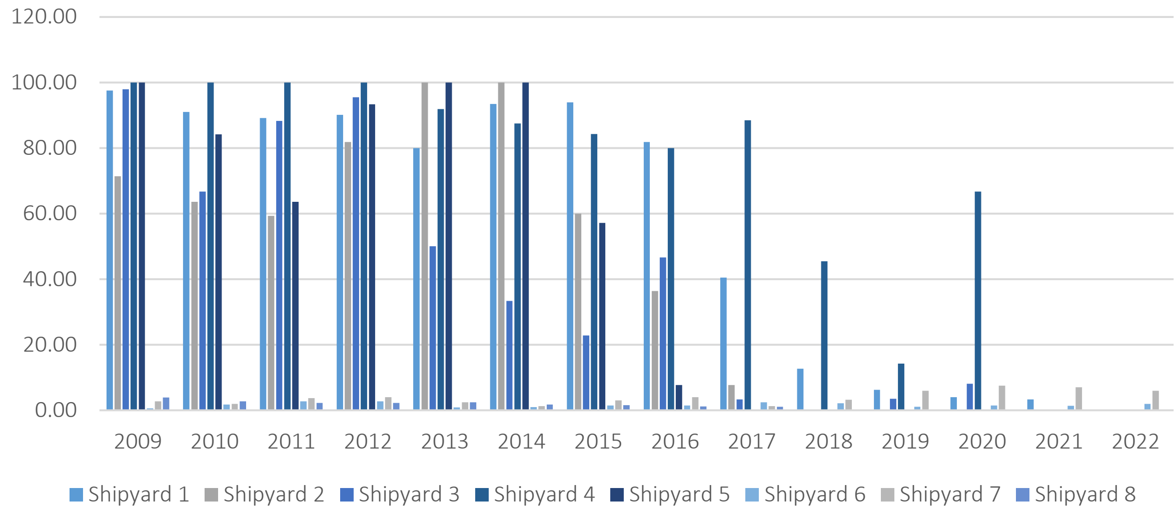

Figure 8. Offshore ship building percentage by shipyards, 2009–2020

experienced a noticeable decline in its Shipyard Competitiveness Index (SCI), indicating the lowest level of competitiveness. The same situation happened to Shipyard 3. Regarding Shipyard 7, it primarily focused solely on supplying fish carriers, operating within a single market. This concentration just in one specific segment raises concerns about the potential risks associated with serving only one industry.

The shipyards in Group I exhibited better performance until 2017, when they had in their portfolio almost offshore ships, and the oil and gas market was on the growth. However, following the offshore crisis, most of these shipyards transitioned to other markets, and this shift was not without challenges. The large newbuild shipyards almost exclusively built offshore vessels until 2017 (Figure 8).

During a period of high order intake and a strong economy, the productivity of shipyards had already started declining since 2011. The decline accelerated following the fall in oil prices in 2014, resulting in a halt in new contracts for offshore vessels. Despite having large order books, construction activity for offshore vessels dwindled and essentially ceased by 2017.

It took several years for the large shipyards to diversify their portfolio and venture into new vessel types. However, this diversification came with high conversion costs and increased risk, particularly in new construction projects. Furthermore, the demand and willingness to pay for vessels in segments such as cruises, car ferries, aquaculture, and fishing were relatively low, leading to significant financial losses and weakened solvency for the large shipyards. Weak profitability was also observed during the years of the offshore boom.

On the contrary, shipyards in Group II, which had prior experience serving different market segments before the crisis, exhibited a more positive trend in strengthening their Shipyard Competitiveness Index since 2017. Within Group II, the medium-sized shipyards can be roughly categorized into two groups: those specializing in offshore vessel construction (Shipyard 5) and those focused on other market segments. Overall, the medium-sized shipyards have maintained a diversified portfolio of vessel types over the past decade and have shown greater improvements in productivity compared to the larger shipyards. However, it is important to note that overall profitability has remained relatively weak. In recent years, the medium-sized shipyards have witnessed significant growth in the well boat and aquaculture vessel segments, which have become their most prominent areas of operation.

4. FUTURE STUDY

Despite the recovery of the offshore oil and gas market, it remains challenging for shipyards to regain a significant share in this market. Nevertheless, there is a promising potential in several areas for the ship-

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building industry, e.g., strengthened by attractive digital business models, using circular economy with the implementation of industrial symbiosis, it will be a good opportunity for all value chain actors to try to be established and share a larger portion of the recycling business.

The retrofitting of offshore vessels with zero or low-emission solutions. This presents an opportunity for shipyards to contribute to sustainability efforts by upgrading existing offshore vessels to be more environmentally friendly. It should be highlighted that the Norwegian maritime cluster has a great potential and opportunities to accelerate retrofitting process: the latest technology is not just available for newbuild ships, the majority of the existed vessels on the water by mid-century can be retrofitted to run on scalable zero emission fuels. According to report "Offshore Circular Economy" (Green Shipping Program, 2022), currently, there are 1,000 offshore vessels in circulation, 100 of them in Norway. Many are relatively new. Many vessels can be converted for use in the growing offshore wind market. But other markets, including deep-sea, are also very relevant.

Increased use of digital tools, automation and robotization. Norwegian shipyards are to a small extent automated, especially compared to other types of industry in Norway. This is due both to the fact that many of the work processes are difficult to automate, and to the fact that the vessels are not standardized and are built in small series. In addition, Norwegian shipyards have not had sufficient financial muscle to invest enough in construction and production equipment, and methodologies. New digital tools, such as virtual prototyping and digital twins, should be able to contribute to more detailed planning early in the process and to faster implementation of new solutions.

With the insights and data derived from the digital twin models, shipyards, shipowners, and operators can not only enhance the environmental performance of existing vessels, but also inform the design and construction of new, more sustainable vessels. This opens up opportunities for innovative business models that prioritize environmental sustainability throughout the vessel's life cycle. For example, shipyards can explore partnerships with technology providers and environmental consultants to offer retrofitting services and solutions that help vessel owners transition to low-emission technologies. By leveraging the digital twin platform's capabilities, shipyards can identify and recommend specific retrofit measures tailored to each vessel's unique characteristics, maximizing its environmental performance.

In summary, by leveraging the digital twin's capabilities, shipyards, shipowners, and operators can drive sustainable practices, offer retrofitting services, establish performance-based contracts, and provide value-added environmental reporting.

CONCLUSION

This study aimed to examine the financial performance of Norwegian shipyards, as a measure of their competitiveness, based on 12 financial indicators, categorized in four groups, such as liquidity, profitability, solvency, and efficiency. Furthermore, the hypothesis that a diversified shipyards' portfolio provides a strategic advantage and increases competitiveness during market downturns was explored in this study.

The analysis mapped the competitiveness levels of shipyards based on financial indicators from 2009 to 2020, utilizing the Shipyard Competitiveness Index as a measure. Regression analysis was employed to investigate the impact of ship variety, as diversification parameter, on the competitiveness index.

The results indicate that large shipyards performed worse after 2017, while the second group of shipyards witnessed an increase in their competitiveness index during the same period. Moreover, the analysis showed that the competitiveness index began to decline after 2011 for the large shipyards. The study suggested that the situation can be explained by the fact that the medium-sized shipyards in the Møre region have demonstrated a modest diversified portfolio of ships over the past decade compared to larger yards, and their ability to undertake a wide range of repair and modification projects contributed to their revenue stability and resilience. Thus, the findings from the regression analysis proved the positive influence of diversification on enhancing shipyards' competitiveness and financial strength.

Considering these results, the article puts forth ideas for exploring new growth pathways within shipyards. Embracing sustainable business models and strategies can facilitate value creation and promote sustainable practices.

AUTHOR CONTRIBUTIONS

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