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Remanufacturing as a sustainable strategy in Shipbuilding Industry

A case study on Norwegian shipyards

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Abstract.
Shipbuilding industry in Norway, mainly operating in the Engineer-to-order environment, is one of the most innovative in the world in terms of technology and production methods. In this paper we investigate the applicability of the concept of remanufacturing in the shipbuilding industry. The research takes a case study approach to study the topic and also presents an overview of the existing literature on remanufacturing and its benefits for businesses and environment. A five stage framework is proposed for integrating the concept of remanufacturing into the strategic decision making process in shipbuilding companies. This framework would streamline the decision making process of shipbuilding companies entering the vessel remanufacturing business.

Keywords. Remanufacturing, shipbuilding, sustainability, engineer-to-order, strategy

1 Introduction

Environmental friendliness and sustainability initiatives have become a prime focus in all industries including shipbuilding. The industry, an example of a typical ETO environment has witnessed a number of strategic changes to incorporate these initiatives, such as life-cycle focused ship building, cleaner production methods, less polluting fuel and so on (Dugnas and Oterhals, 2008; Kumar et al., 2011). This is primarily due to the specific characteristics of ETO environment, which is known for its high complexity involved in its project based activities, multiple partners involved in the project execution phase and the need for good coordination due to project specific demands (Gosling and Naim, 2009). Despite a growing concern about being green in shipbuilding, investing in such solutions has been considered to be less profitable from the strategic viewpoint of a company. Further, most such endeavours aimed at being green are driven by the need to comply with environmental regulations. (Gehin et al., 2008).

However, end-of-life strategies such as the concept of remanufacturing have given us real life examples of being both profit making and environmental friendly. The remanufacturing concept, for example, have been well studied and applied in various industries (Ijomah et al., 2004; King et al., 2006). Nevertheless, the concept is yet to be widely accepted and adopted in the shipbuilding industry. This paper proposes that remanufacturing is a sustainable and viable business strategy for the shipbuilding industry.

2 Literature Review

2.1 Remanufacturing

Remanufacturing is 'the process of returning a used product to at least OEM original performance specification from the customers' perspective and giving the resultant product a warranty that is at least equal to that of a newly manufactured equivalent' (Ijomah, 2002). The first known application of the remanufacturing process was from the ship industry in the year 1861, where a steam frigate was transformed into an ironclad ship (Ilgin and Gupta, 2012).

As seen in Figure 1, Remanufacturing is different from recycling as the latter involves the collection, extraction and processing of component materials into the same product or a useful degraded material (Ijomah et al., 2004). Further, remanufacturing is more environment friendly, as it minimizes the use of virgin material, energy and has lesser material processing (Sharma et al., 2010).

Integrating the concept of remanufacturing in the business strategy is further more important as it facilitates the product designs suitable of remanufacturing and also reverse logistics needed for the remanufacturing activity. Further, remanufacturing does not hamper innovation as remanufactured products can incorporate innovative solutions in it (Gehin et al., 2008). These factors make it suitable for the shipbuilding industry.

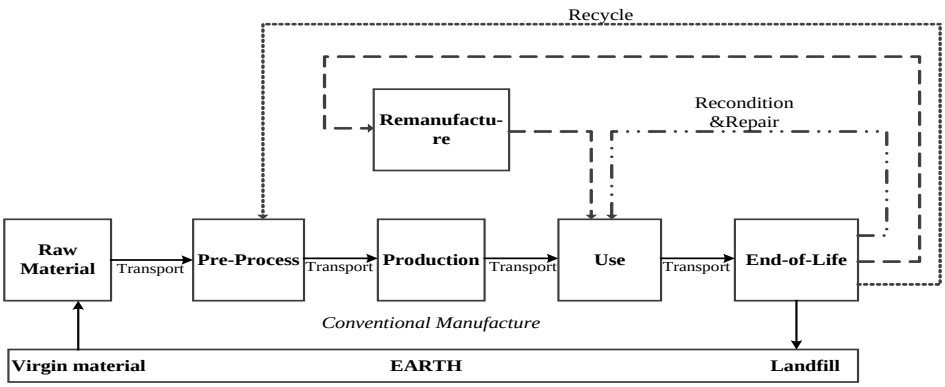

Fig. 1. Remanufacture concept and significance (Adapted from Ijomah et al.(2007))

Remanufacturing is already in practice in a number of industries such as the automotive and aerospace industries (Gray and Charter, 2007). Further, in contrast to other secondary market or used products, remanufactured products are characterized by better reliability and quality, because the remanufacturing process involves the complete disassembly of all the components in the product and restoration and replacement where needed (King et al., 2006).

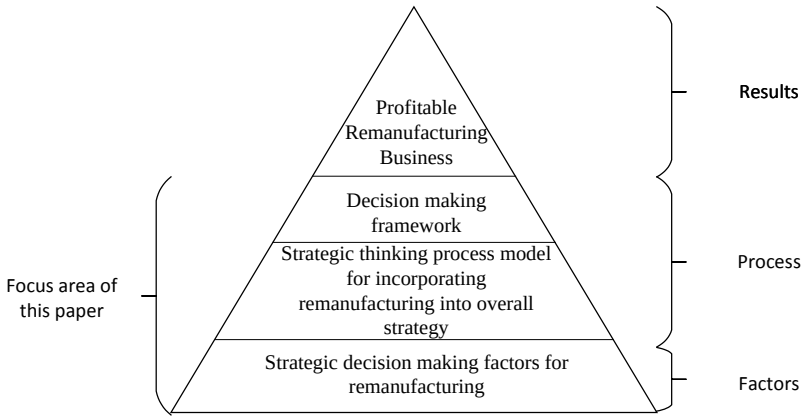

Fig. 2. Remanufacturing decision making framework and focus area of the paper (Adapted from Subramoniam et al., (2009))

In order to streamline the analysis of this research, the authors selected a decision making framework proposed by Subramoniam et al.(2009). As illustrated in Figure 2, this paper focusses on the last three stages of the framework, i.e decision making factors, strategic thinking process and the decision framework for applying the remanufacturing philosophy into the shipbuilding company's decision making process.

Sustainability in Strategy.

In order to identify the theoretical linkage between sustainable practices and strategy, we selected the natural resource based view (NRBV) proposed by Hart (1995). The NRBV view is relevant for any company that operates in close interaction with the environment, as in the case of the shipbuilding industry. Hart (1995) argues that in the long run, business strategy will be *'constrained by the ecosystems'* and companies' capabilities to tackle the environmental challenges would determine its competitive advantage.

The NRBV would remain relevant only if the strategists in companies and organisational theorists make efforts to understand the potential of environmentally oriented resources and capabilities in creating competitive advantage for the companies. In order to aid this, he presents the NRBV with three interconnected strategies, one of which is the *product stewardship strategy* (Hart, 1995).

The concept of product stewardship attempts to reduce the life cycle environmental costs of the products by either redesigning the existing products to reduce liability or by developing new products with lower life cycle cost (Hart, 1995). The concept of remanufacturing was found to have close alignment with product stewardship strate-

gy, thus further strengthening this paper's argument that remanufacturing is a viable sustainable strategy.

3 Research Methodology

A case study method was preferred because of two reasons, firstly, the research focussed on the 'how' and 'why' areas of the topic. And secondly, the investigators had little control over the events and the focus in strategies is always on the contemporary activities in the company (Yin, 2009). The article draws on information collected from three different sources, namely interviews, formal discussions and literature review. The literature review for this research was supported by an in-depth pre-study covering 35 research articles pertaining to the topic.

For the interviews, semi-structured style was preferred as it provides more flexibility to both the interviewer and interviewee. It helps both the parties develop ideas and questions more widely on the issues raised in the research (Denscombe, 2014). The interview process is summarized in the table below.

Table 1. Interview process overview

Type of Interview	Respondent position in the organization	Number of formal interviews	Number of Informal interviews
Case Company A			
Face to Face	Deputy Managing Director	1	2
Face to Face	Manager Planning Department	1	1
Face to Face	Senior Business Analyst	1	2
Case Company B			
Face to Face	CEO	1	-
Telephonic	Sales Director	1	1

3.1 Research Questions

This research aimed at studying the applicability of the concept of remanufacturing in Norwegian shipbuilding industry and how the concept can be incorporated in the strategic decision making process of the industry.

3.2 Case companies

The case companies selected for the research were two Norwegian shipbuilding companies who have been in the shipbuilding business for nearly 100 years. The following paragraphs provide an overview of the case companies.

Case Company A.

Being the largest among the two case companies both in terms of resources and scale of business, the responses from this case company was not just restricted to the

shipyard alone, but the mother group of the company of which the shipyard was a major business division. The strategy for the shipyard was driven by the main strategy of the group.

Case company B.

Operating at a much smaller scale and specialized in a different portfolio of vessels, case company B had a different approach to strategic thinking. They had more short term strategies and are one of the very few shipyards in Norway that still carry out both ship repair and new ship building activities simultaneously in their yards.

Table 2. Case companies overview

Case Company	**Company A**	**Company B**
Size (Employees)	800-1000	200-300
Customer base	Worldwide	Mostly European clients
Major competencies	Design and customized offshore vessels	Alternate fuel powered and hybrid vessels
Business areas	New Building, Designs	New building and repairs
Project Portfolio	Offshore	Ferries and Cargo

4 Findings and Discussion

The literature review carried out as part of this research work revealed that the sustainability focus in strategies of the shipbuilding companies has been mostly driven by profit motives. Further, as identified by Hart (1995), the most practical step is improved production methods and better control over the companies' activities.

The major findings from the interviews summarized in Table 3 also points towards a similar observation. The deductions and findings in Table 3 are categorized into 3 sustainability issues in the industry and the way forward. As mentioned in the Table, most respondents opined that an innovative and environmentally friendly production concept is the way forward. The interview also revealed the need for a framework to successfully implement such a concept. These findings further strengthen the view of the paper that remanufacturing is a potential sustainable strategy in the shipbuilding industry and is yet to be studied in detail in the industry.

The framework illustrated in Figure 4 was developed through a series of iterative steps, where the findings in the literature were correlated with the findings from the interviews. This was then cross checked with the interview respondents for improvement until a desired result was obtained.

The proposed framework is divided into five different stages. The first stage begins with the receipt of a new ship order from the client, followed by overall strategy stage, resource capability stage, environmental regulations and finally organizational factors. Each stage consists of a set of decision boxes and subsequent action stages.

The description for each decision stage in the framework is as following:

1. Is remanufacturing a financially viable approach? 2. Is the existing design of the core designed to be remanufactured? 3. Are any alternate solutions available? 4. Is it

compatible with the current business strategy of the firm? 5. Can the business strategy be modified? 6. Does the changed business strategy align with the stated mission and vision of the firm? 7. Does the company have necessary resources to execute the project? 8. Can the missing resources be acquired at an affordable rate? 9. Will the remanufactured product comply with existing and future environmental regulations and standards? 10. Will it comply with the existing standards and regulations? 11. Can improvements be made to the product to ensure compliance? 12. Has the company established local facilities and communication channels to in order to coordinate the activities with the stakeholders? 13. Is the company working in a business environment that supports and promotes remanufacturing?

Table 3. Major Findings and deductions from the case study

Respondent	Themes			
	Sustainability in Practice			
	Economic	**Environmental**	**Work**	**Way forward**
Case Company A				
Deputy Director	Increased Return on Equity focus	UN Global compact, cleaner production	Labour welfare, social security, organisational training	Revisiting operational condition, increased efficiency, flexibility
Senior Business Analyst	Cost reduction, judicious material usage	Waste reduction, waste water treatment	-	Improved production methods and designs
Manager Planning Department	Cost reduction, increased vessel efficiency	Lean production, last planner system, enclosed painting, sand blasting facilities	Training, Personal protection	Lean, waste reduction, cleaner and innovative production concepts
Case Company B				
CEO	Joint ventures, innovative business models,	LNG fuelled vessels, hybrid fuels, waste reduction,	Training , abide by the labour laws, employee participation	Environmental financing, favourable government policies, innovative production concepts
Sales Director	-	LNG fuelled vessels, hybrid fuels, waste reduction	-	Better decision making frameworks, improved production practices

The shipbuilding company can analyze a newly placed order based on the framework and then decide if the vessel should be remanufactured or not. Such a calculated approach would help the company take a multi-dimensional approach factoring different elements affecting the success of the vessel being remanufactured. The framework also proposes to document the lessons learnt from each such projects for further reference and assessment.

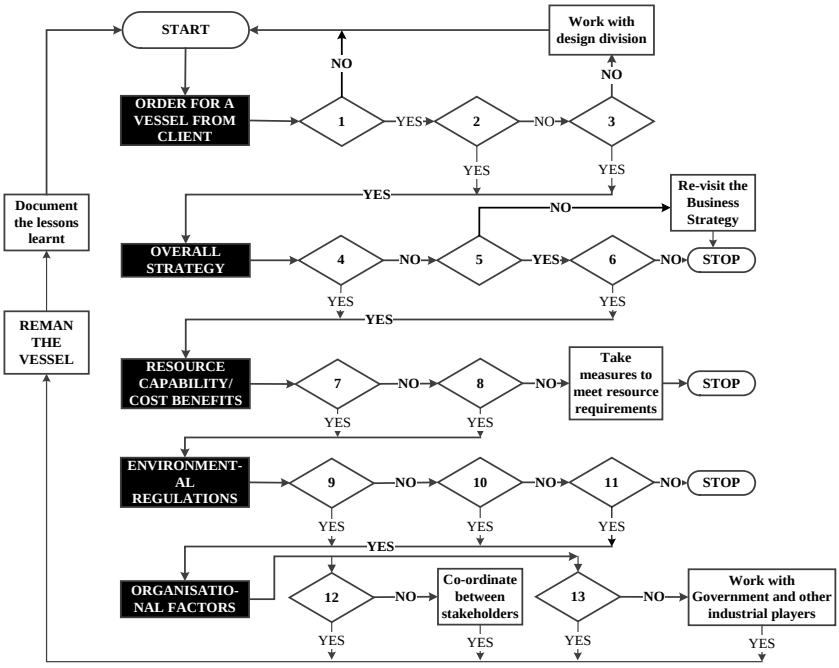

Fig. 4. Framework for integrating remanufacturing into the strategic thinking process (Based on the framework tool in (Dowlatshahi, 2005))

5 Conclusion

The paper studied and analysed the potential of remanufacturing as a sustainable strategy in the shipbuilding industry. An in-depth pre-study was conducted as part of the research. The 35 journal articles reviewed as part of it revealed that even though remanufacturing is a widely studied topic in the automotive and electrical component industries, the scientific literature on remanufacturing in the shipbuilding industry was still lacking depth. It was in this premise that this research work was initiated. The responses from both the case companies also aligned with this view. Subsequently, the authors further studied and analysed the concept and developed a five stage framework that would aid the shipyard in integrating the remanufacturing concept into its strategic decision making process. These strategic decisions with a thorough consideration of carefully selected factors will help the shipyards to successfully launch remanufactured vessels. As explained in the benefits of remanufactured products, these vessels would have the same operability as a new vessel but at a lower cost and lesser environmental footprint. Further, the 13 decision boxes in the framework strive to incorporate the different project specific needs existing in an ETO environment of the shipbuilding companies.

The authors believe that the proposed framework can be adapted to meet the needs of other industries too. However, it should be noted that the framework is not a strate-

gy in itself, but a decision tool for shipbuilding companies' that enter the vessel remanufacturing business. Further research will involve testing the framework in a real industrial setting and also documenting the environmental performance of remanufactured vessels.

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