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Development of an optimized Framework for Engineering Change Management: A case study for Nautical Industries

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Degree Thesis

Thesis for a Master in Engineering degree

Industrial Management and Engineering

Vasa 2025

DEGREE THESIS

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Degree Programme and place of study: Master
Specialisation: Industrial Management and Engineering
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Title: Development of an optimized Framework for Engineering Change Management: A case study for Nautical Industries

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Date: 10/03/2026 Number of pages: 75 Appendices: 1

Abstract

The management of Engineering Changes during a product lifecycle to improve efficiency, quality and profitability in a manufacturing context is always a challenge.

This thesis aims to propose an optimized framework for the handling of the ECRs within an industrial company in the nautical field. This includes the analysis of the current one in use in the company as a benchmark and the proposal of a digital tool to implement into the company daily operations.

The research combined a qualitative approach with survey, feedback and quantitative approach using the real example.

An optimized framework was developed based on the actual one working on the improvement of the weak points highlighted in the analysis. A software for the digital tool was selected and setup to accommodate the workflow described in the framework.

The objectives are achieved, the workflow results to be more structured, with clear role and responsibility and the use of the tool make the use of it more user-friendly and less time-wasting.

Language: English
Key Words: Engineering Change, Optimization, Framework

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Abbreviation

Acronym	Full Form
BOM	Bill of material
CAD	Computer-Aided Design
EC	Engineering Change
ECR	Engineering Change Request
ERP	Enterprise Resource Planning
HR	Human resource
IP	Process Engineer
KPI	Key Performance Indicator
NC	Non Conformity
NCE	Non Conformity External
NCI	Non Conformity Internal
PLM	Product Lifecycle Management.
PM	Project Manager
PMMA	Polymethyl Methacrylate.
RACI	Responsible, Accountable, Consulted and Informed
TO	Techincal Office

1 Introduction

The nautical world is a wide market with several shipyards manufacturing models of various sizes, prices, types and qualities, from the small fishing boats to multimillion-euro superyachts. To remain competitive the different companies operating in the sector must offer attractive models at competitive prices without compromise the quality, a characteristic that has a high value for the final customer.

The nautical field does not have the economic availability of other sectors, such as automotive or aerospace, this limitation does not allow investment in prototyping and testing before releasing a new model to the market. It is so very important to identify problems and implement continuous improvement technique to maintain the expected quality and improve profitability.

This approach allows companies to combine the flexibility and attention to detail typical of craftmanship with the efficiency of mass production.

These practices, part of the continuous improvement process are managed with the ECR, Engineering Change Request. (Boznak & Decker, 1993)

1.1 Boatbuilding Industry – Beneteau Group

Beneteau was founded in 1884 with the first yard in Croix-de-vie (today Saint-Gilles-Croix-de-Vie). The founder was Benjamin Beneteau. (Pecorari, 2021)

The first boats were small wooden sailing boats called Chalutier, dedicated to fishing. From that time the yard has continued to grow and expand until it became one of the largest groups in the nautical market as it is known now. (Pecorari, 2021).

Over the years, Groupe Beneteau has strengthened its position in the global boating industry through a combination of company growth and strategic acquisitions. This approach has enabled the group to offer to the market a diversified portfolio of brands, each related to specific segments of the pleasure boating sector, that include sailing yachts, motorboats and multihulls. In addition of the boat manufacturing there are also brands dedicated for nautical services such yacht management or charters.

From an operational point of view, Groupe Beneteau has changed its organizational structure switching from a brand-centric management model to a product base one. From 2024, the Boat Division is organized into three distinct Business Units, each one dedicated to a specific market segment. The first one is the Sailing segment, which includes both monohull and multihull sailing yachts designed for performance and leisure of any size. The second is Day boating, focused on motorboats from 6 to 12 meters, designed for recreational use and day trips. The third one is Motor yachting, dedicated to motor yachts between 12 and 24 meters, specific for long-range cruising and offering a luxury product to exclusive customer.

This reorganization reflects the Group's strategic vision to improve specialization, quicker response to market variations and matching the customer expectations in the different segments of the recreational boating industry. (Beneteau Group, 2024).

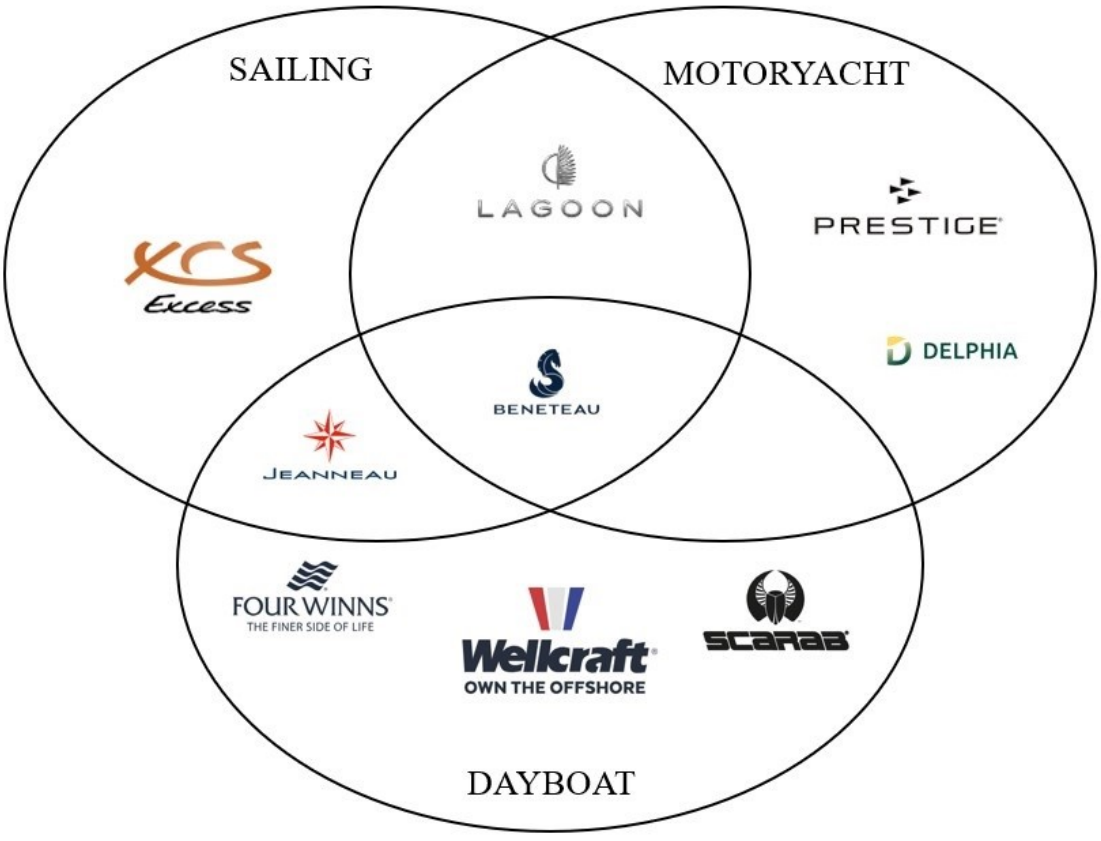

Figure 1 Distribution of Beneteau Brands (Beneteau Group, n.d.)

In terms of industrial environment, Groupe Beneteau has 16 production sites across seven countries: France, Poland, Portugal, Slovenia, Italy, the United States and Tunisia. France continues to be the core of the group manufacturing operations meanwhile the international distribution of facilities let the Group to have a more efficient and optimized division based on different product type, size and volume. It is important to mention that these sites are not exclusively dedicated to individual brands but have been designed to support specific categories of boats with the scope of improve efficiency and scalability.

This thesis is focus specifically on the Monfalcone production site, located in northeastern Italy, which plays a strategic role within Groupe Beneteau's. Originally born to manufacture the Monte Carlo Yachts brand, the site has been restructured in 2022 and since then operates under the name Groupe Beneteau Italia. Currently it is multi-brand site specialized in the construction of large motor and sailing yachts over 60 feet in length. (Beneteau Group, 2023)

Group Beneteau Italia is particularly important for the Prestige M-Line, indeed it is the production site for the brand's flagship multihull models, the Prestige M8 and Prestige M7. These yachts are a new generation of luxury motor catamarans, with the innovative design, large habitability and efficient cruising performance as strong points. (Prestige Yacht, n.d.)

Figure 2 Prestige M8 (Prestige Yacht, n.d)

In addition to the Prestige line the shipyard also manufactures other models, including the Beneteau Grand Trawler 63, a long-range motor yacht designed for long voyages focused on comfort and fuel efficiency and the Jeanneau Yacht 65, a premium sailing yacht that combines performance and comfort.

Figure 3 Beneteau Assembly Line (Beneteau Group Italia, n.d)

The facility covers an area of approximately 45,000 square meters where there are included a dedicated marina and a composite workshop. The site has a workforce of over 200 highly qualified people. It is set up to support semi-custom production, prototype development and thanks to the flexibility of the plant in terms of product it is considered as a centre of excellence in the context of the Group's industrial strategy. (Beneteau Group Italia, n.d)

Figure 4 Aerial view of Monfalcone Yard

2 Research Structure

2.1 Research GAP

Among all the sites, this research is focused on the Beneteau site of Monfalcone which is currently building different models from different brands of the group: Beneteau, Jeanneau and Prestige.

This site has been recently reorganized, and several opportunities of improvement have been identified. The Engineering change process and its management has been considered as part of this company improvement. The old process was tailored on the old product line and site setup making it not efficient, structured and robust for the current one. Having it in place it causes delays in the implementation of improvements and changes, reducing efficiency and improving lack of traceability.

Not having a dedicated framework for managing Engineering Change Requests (ECRs) optimized for the type of product manufactured and the company structure results in:

- Incomplete or missing technical and economic evaluations.
- Insufficient or partial involvement of key project stakeholders, in particular of those with technical and financial responsibilities.
- Limited information flow, traceability and accountability.

2.2 Objective

To ensure profitability and to match the requirements in terms of quality and customer satisfaction, having an ECR process is crucial as highlighted by Maceika & Tolocka (2021, pp 99) especially in a complex manufacturing environment like a boatyard.

Considering the challenges highlighted previously in the research gap, the objective of this thesis is to provide a structured approach that improve the management of Engineering Change Requests (ECRs). First, it required to map the current ECR-related process at the Monfalcone site, offering the current situation of how ECRs are structured and executed. Starting from this, every step of the process will be analysed to identify issues and

inefficiencies. Based on these findings an optimized framework will be developed to handle the management of engineering changes. Finally, the thesis proposes a practical digital tool that can be implemented in daily operations.

The purpose to develop not only an optimized framework but also a digital usable tool to let the company to integrate this into the company processes is adding value not only to the work of the thesis due a real and practical application, but also at the Monfalcone site supporting it to improve efficiency, quality and profitability.

2.3 Methodology

The methodology is a combination of qualitative and quantitative method. It begins with the objective definitions and the literature review to evaluate the best practice in the field on the ECR processes. Interviews, focus groups and questionnaires are used for Data collection and inputs. Some real examples of current ECR have been used as a benchmark and to better understand the process within the real use.

The second step is focus on the development of an optimized framework considering the actual one as a benchmark and collecting data through surveys and real examples.

Based on that a digital tool is used, configured, tested and validated and as the previous steps feedback from the different departments and real examples are collecting. Finally, the methodology includes presenting the results and recommendations for further improvements.

3 Literature Review

The purpose of this chapter is to provide an overview of the knowledge related to the engineering change management topic and the different steps and phases performed within this activity in manufacturing environments.

The review of relevant academic provides a theoretical base valid to understand the process analysis and framework development performed in the following section.

3.1 Engineering Change

The Engineering Changes (EC) have been defined widely among technical and academic documentation and is often use in companies making relevant this process in the organizational activities.

Terwiesch and Loch (1999, pp.1) define the engineering change as:

> *"Engineering change are changes to parts, drawings, or software that have already been released "*

Jarratt et al. (2011, pp.106) offer a more comprehensive definition:

> *"An engineering change is an alteration made to parts, drawings or software that have already been released during the product design process. The change can be of any size or type; the change can involve any number of people and take any length of time"*

The Engineering Changes (ECs) are a very important instrument used to improve product quality, reducing costs, complying with regulations, responding to customer and market feedback. However, if not properly managed, they can introduce risks like delays, cost, additional workload and quality issues.

There are several reasons to create an engineering change. Those include errors correction, safety improvement, to modify and to improve functionality or resolve product quality issues. These inputs can come from different stakeholders, for example, customers may request changes based on their experience with the product, while sales and marketing teams may push for updates to follow new trends. Production teams, suppliers and product

engineering departments often identify opportunities for improvement and even management decision or regulatory changes can generate a need for an engineering change (Jarratt, Eckert, Caldwell, & Clarkson, 2011).

3.2 ECR – Engineering Change Request

An engineering change without the support of a proper process to manage it will not achieve its creation scope. To effectively manage changes, a formalized procedure is essential. This process is known as the Engineering Change Request (ECR).

A process proposal with different steps have been described by Jarratt, Eckert, Caldwell, & Clarkson (2011). This framework has been applied in various industrial contexts, including a case study in the automotive sector (Arnarsson, Gustavsson, Jirstrand, & Malmqvist, 2020), demonstrating its relevance and adaptability to manufacturing environments like the one analysed in this thesis.

Jarratt, Eckert, Caldwell, & Clarkson (2011) describe a structured sequence of steps for managing engineering changes. The process begins when an engineering change is requested, usually via paper or electronic form depending on the company. The form in the request let the requester to explain the reason for the change, assign a priority level and indicate which elements will be affected. After the submission of the request, potential solutions are identified, usually limited to one option for time efficiency purpose. The following step involves an evaluation of the proposed solution in terms of impact on the product and the process, considering also budget, supplier relationships and other relevant considerations. After this, the change request is promoted to the approval phase, where a designated team reviewed it evaluating the cost-benefit analysis to take decision about accept or reject it. If approved, the implementation of the change takes place, immediately or at a later stage, depending on the product lifecycle and the priority of the change, for example, if safety-related issues usually there is a more urgent action. Finally, after a certain period, the change is reviewed to verify if the objectives have been achieved and to document lessons learned for future improvements.

Other authors, such as Huang, Yee, & Mak (2001), have proposed similar approaches to the ECR process consisting in minor variations tailored to the specific requirements of their respective industrial or research contexts.

3.3 Typical process issues

The literature about the ECR process has highlighted common issues on the process that occur in the daily operation of different companies. Those issues, as described by Lundqvist & Mansson (2013) are affected by several factors.

A limited understanding of the process can reduce the efficiency of the Engineering Change requests (ECRs) and compromise the quality of the outcome. Usually, this situation promotes the use of informal processes and limited the use of the official procedure reducing trust on it and on its effectiveness. (Lundqvist & Mansson, 2013)

Communication plays a main role to ensure the functioning of process. There are several forms and channels, but if not managed properly it could have a negative impact on the decision-making process, the feasibility and lead time as well, as also remarked by Tavacar and Duhovnic (2005).

Since the engineering change process involves multiple functions and departments, together with different stages and levels of approval the responsibility it is considered another key topic. Indeed, without clear accountability for those involved, the process cannot run efficiently, leading to longer lead times and increased inefficiencies.

The lead time from the recognition of an issue to the implementation of the change is always a challenge in every company. Reducing it let companies to improve products and increase profitability over a longer period of their product lifecycle. The lead time is affected by the previous inefficiencies, resources availability, the volume of requests in work in parallel and the activities that are not providing additional values for the implementation like bureaucracy or similar.

3.4 Approval process

Following the steps described previously, after the step known as solution proposal, the change request is reviewed for approval. This is done by a dedicated team coming from different departments with cross-functional skills (Lundqvist & Månsson, 2013).

To support the decision a cost-benefit analysis is evaluated.

The responsibility of the decision is important for the success of the process. In literature, there are different proposals and points of view on it.

As summarized by (Lundqvist & Månsson, 2013) the most effective way is to have only one person to take the decision (Tavcar & Duhovnik, 2005), other solution consider the need to have a cross functional board dedicated for the changes, with the scope to decide which changes are valuable to be implemented and which not, highlighting also topic like the information communication empathizing the need to address the right information to the right people to be able to have a good decision. A poor input addressed to the wrong person raises the risk of taking the wrong decision (Ström, Malmqvist & Jokinen, 2009).

It is important to consider that complex approval process or too many signers could be not time effective, increasing the implementation lead time. (Terwiesch & Loch, 1999a).

3.5 ERP Development

Majority of companies use ERP system in their daily operations. An ERP (Enterprise Resource Planning) system is an integrated software platforms designed to manage core business processes within a company. Those processes could include finance and administration, human resources, supply chain and manufacturing. ERP systems allow a cross functional communication and a database with valuable reliable data to support decision-making across the organization (Khan et al., 2025).

It is common for companies to upgrade or modify their ERP systems even after initial implementation. This is often driven by evolving business needs or the need to improve operational efficiency. ERP upgrades are not always technical updates but could happen also as strategic decisions to extend business functionality. (Domagała, Grobler-Debska, Was & Kucharska, 2021)

Extend the functionality is a process that requires investment in time, resources and money. Different areas of the company need to be involved and processes might be modified. A clear cost-benefit analysis must be addressed to support the decision-making.

When the ERP specification and the company requirements are no more in the same line, there are two approaches to close the gap. (Domagała, Grobler-Debska, Was & Kucharska,

2021). The process customization required the process to changes to adapt to the ERP system to avoid big changes and cost, the second one, the technical customization it requires a customization and development of the standard software. The type of customization could vary case by case. (Domagała, Grobler-Debska, Was & Kucharska, 2021).

4 Current State Analysis

In this chapter, the current procedure and its implementation within the company are described. The performance of the process is then analysed, following the methodology and supported using real example of ECRs within the organization. Based on this analysis, the main challenges that must be addressed to design and implement the new framework are identified and discussed.

Before describing the current ECR procedure in use in the Monfalcone site of Beneteau Group, it worth to contextualize when the use of the Engineering Change is needed in the product development and serial life process of a boat model of the Beneteau Group.

In the Beneteau group, like other boat manufacturers, the engineering change are dedicated to a specific phase of the product life. A new model lifecycle is divided in different phases, that could vary depending on boat size, type or company organization. In Beneteau group, specifically in Monfalcone Site it possible to divide the lifecycle into five main phases.

The first one is the concept phase that represents the starting point in the life cycle of a new boat model. It starts from an input of the marketing team, that identify the need of a new product and define the technical and aesthetical specification required. This is a common process in the nautical field, sometimes, in different brands the input could come from product manager or even from client if it is a very custom product. During the concept phase a preliminary budget is defined in line with the preliminary specification. Sales team or the board, based on the market information and the cost set the target price as well.

Figure 5 Example of yacht first concept sketch (Microsoft, 2025)

Once the concept phase is complete, the project moves into the preliminary engineering phase. At this stage the boat model initially presented by the marketing team through sketches, concept renderings and a preliminary technical sheet is handed over to the engineering team. A feasibility study is carried out to confirm the proposal and specification and it is crucial to work in close collaboration with the concept team to specify the technical requirements. Design loops are often needed before reaching the level of definition necessary to confirm the specification and the design of this stage. During it an updated budget is also presented and evaluated to check alignment with the project's objectives.

Once the feasibility of the project has been confirmed and the main specifications have been finalized, the process moves into the Detailed Engineering Phase. The team works on conceptual and preliminary designs to deliver fully defined technical solutions. This includes the development of 3D CAD models, detailed drawings, material specifications and integration of different systems and components.

The objective of this phase is to provide all the necessary information for production, procurement and all the following design and manufacturing process activities. Engineering teams work in coordination with production, procurement and quality departments to be sure that the proposed solutions are manufacturable, cost-effective and in compliance with rules and standards. Any remaining technical open point are addressed and solved. In this phase also the bill of materials (BOM) is finalized. Industrialization and process engineering are working to setup the manufacturing process and the assembly line, together with tools and work instructions when information is available.

The next phase named “prototype” is the one referring of the construction of first boat which is the prototype of the Serie. At this stage, some technical solutions or documentation related to them have not yet been fully developed. The building process is also under optimization, with continuous evaluation of the theorical solution to verify if are applicable. Feedback and improvement are collected for possible implementation in the pre-series construction. The prototype boat is usually a sold boat that will be delivered to the customer or attend a boat show, so the focus on details and aesthetic is mandatory.

Figure 6. Bavaria Yacht assembly line (Bavaria Yachts, n.d.)

Just after the prototype, the pre-series phase it is an intermediate stage between the initial build and full serial production. At this stage all issues, updates and improvements identified during the prototype are discussed, evaluated and implemented. The team focuses on processing changes and to updated it considering the impact on the cost as well.

Usually in the Monfalcone site this phase lasts about two or three units. This value can vary depending on the type, the size of the boat and the tack time between the units. Market pressure sometimes could also affect the lifespan of this phase.

In Group Beneteau Italy the ECR process is in use only from this phase, after that the package of changes from prototype have been implemented, this to avoid too many ECR to manage and to slow down the process.

Finally, the serial life phase begins and continues until the end of production for that particular model. No major changes are planned during this stage, except for those that could improve profitability, such as supplier changes or adjustments due to component obsolescence. While ECRs can still be issued during this phase most significant modifications have already been implemented in previous stages.

4.1 Procedure Workflow

Similar to the workflows explained in the literature also in the Beneteau factory there is a workflow in place that describe how the ECR are handled and processed. An official procedure is regulating the process for all sites within the business unit (Beneteau Group, 2019). The scope of the procedure is to standardize how are handled and the information included in a ECR such the source of changes, the sender, the reference documentation and the driver of the change.

Based on the procedure information the diagram below explains the main steps of the ECR management.

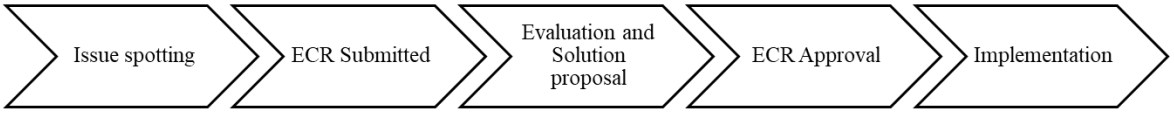

Figure 7 ECR process diagram (Beneteau, 2019)

Those steps are managed in different ways. In particular the ones named ECR submission and ECR approval are managed with a digital tool called Windchill. Windchill is a documental management software where technical information and drawings are stored divided in boat models and type of component. This tool allows a basic workflow to be set-up for approval steps. In case the ECR is rejected could be re-evaluate after the proposal of a different solution.

It is important to mention that the site of Monfalcone use Windchill only to store the technical documentation without the use of the workflow feature. Instead, less common and less structured tools like email or excel files are in use.

4.2 ECR Description

The official document describes the information that needs to be filled in the request.

The sources that can generate an engineering change request are several and often linked to different aspects of product development and production. A quality issue is a typical one, which can be the result of a customer's complaint, an internal non-conformity (NCI), or a supplier's problem (NCE). Another driver is the need to increase production efficiency, proposing a change with the scope of optimizing processes and reducing inefficiencies. Cost reduction is also a motivation that often generate a request, particularly when there is an opportunity to lower the bill of materials without compromising quality or performance or reducing the boat standards as per specification approved.

Changes can also be originated from external factors, such as a supplier’s product modification or updates required for a new model year in the product development cycle. Additionally, requests for product modifications may come from internal teams or even customers highlighting specific improvements. Regulatory developments and product certification requirements represent another critical source, indeed in case of updated standards it is required an updated design. Last, some changes may result in modifications of the product or process that do not necessitate an in-depth study, usually, these are small changes that can be done quickly. The technical office is either consulted or hardly ever involved in such situations.

The first information that is required in the ECR is the responsible, in this case the recipients of an engineering change request are those responsible for evaluating it and they correspond to the various departments within the company as defined in the organizational structure. These include the Quality department, which assures compliance with Beneteau standards and highlight and handle non-conformities. The Industrialization team, which focuses on production processes. Purchase department, responsible for managing supplier relationships and related economical aspect, the Marketing team, which evaluates the impact of changes on product positioning and customer expectations and the Technical Office that oversees the detailed design and technical solutions related to the projects and the validation of those.

With the current procedure it is requested to upload the reference documents, which are based on a company template filled with the information needed to detail the request, for examples, components codes, prices or manufacturing operation details.

The details of the changes made are entered in the form EN-DEV-27, while document EN-DEV-24 is an Excel file that serves as a database (in French) of all changes with their main information. Specifically, in addition to the list of changes, it indicates the criticality, status and project phase in which they are detected. The project phases refer to those described in previous paragraph. There is also a statistical section that serves to monitor and report data on how many actions have been taken, closed or are in progress and the period in which they are processed.

In EN-DEV-27 the requestor must fill all the information for the request in order to share the right data to the flow. The missing of some information could affect the decision on the ECR submitted.

The form displays the main details related to the modification. It begins with the title, which clearly identifies the modification, the model, specifying the boat involved. Next, the severity indicates the level of criticality associated with the change.

There is also a section that describe the type of components added or modified, including information about their stock availability, impact on suppliers, operational activities and labour time. The target boat is indicated as well, referring to the serial number of the implementation, together with the main reason for the change. An additional section is provided to give more detailed information about the items involved if needed. The last information included in the form is the sign list, which represents the approvals required to validate the modification.

The requests are always managed by the Project Manager, who is responsible for overseeing the project from the approval of the concept to the launch and delivery of the various units and their customizations, with the responsibility to match timelines and costs. (Project Management Institute, 2017).

A change notice is issued every time a change request produces a considerable impact on the project. The impacts may include changes in cost, such as an annual change of over

€500 or a change for each boat of more than €10. Changes that affect the appearance of the boat or any of its components also require a formal notice, as do modifications that influence manufacturability or compromise the safety of operators and customers. Specific traceability requirements can follow the same process, along with any impact on inventory levels or existing orders. This procedure, as stated earlier is managed by the Project manager responsible of the affected model. (Beneteau Group, 2019).

Adjustments that can affect product certification or lead times are also considered critical. If the time impact exceeds 15 minutes, a change notice is mandatory. For smaller impacts, the responsible of the EC must perform the activities needed for the implementation including being sure that lead times are updated in the operation schedule of the boat. Material changes or new component supplier also are included in this category, as they can have significant impact on cost and quality. In other cases, the change is managed directly within the various departments without the need for approval. (Beneteau Group, 2019).

In the Italian site the communication of the requests is managed, according to the process, via email, while Windchill is used only for the information database. Windchill, as mentioned earlier, is a document management system, a database in which the codes of the various boat components are created and managed. Every code has 3D CADs and technical drawings attached. This type of software allows tracking revisions and approval flow. In addition to component codes, it also manages information flows such as change requests.

4.3 ECR approval

Approvals are divided in two levels. The first is a technical validation, where approvers validate the feasibility of the change highlighting any critical points. This is a technical validation of the impacts and requirements associated and is carried out by Level I approvers. The second is an approval that make the changes effective and is under the responsibility of Level II approvers.

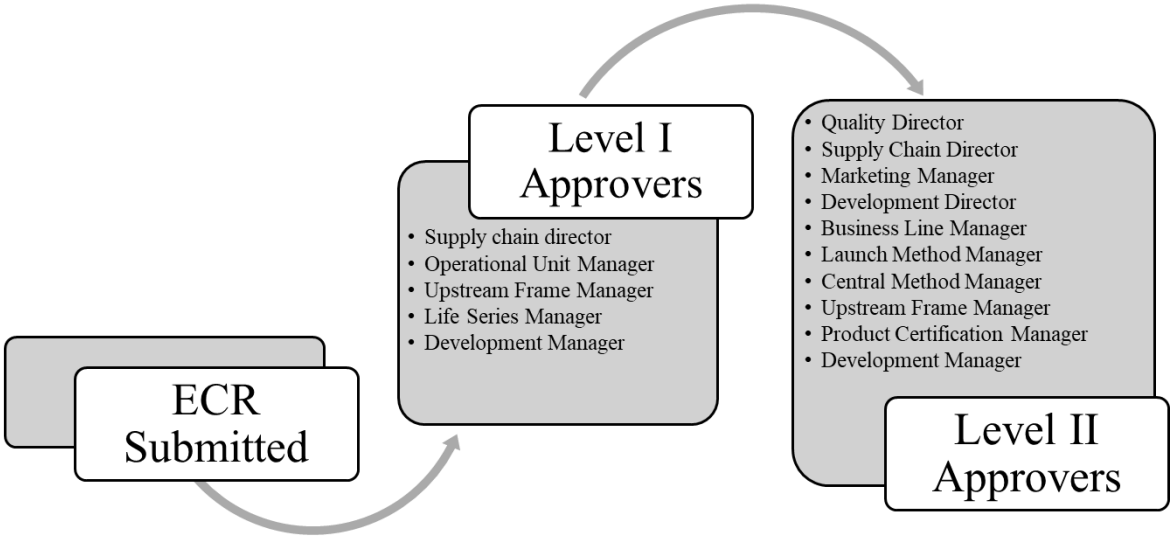

Figure 8. Actual procedure Approval phases (Beneteau, 2019)

Once the request has been approved the implementation phase starts. So, the team is allowed to work on the change. Drawings, once ready, are uploaded on the database and released. Changes in the bill of material or routing are managed using the ERP of the company as the handling of a new supplier.

5 Procedure evaluation

In this chapter, the current procedure at the Beneteau factory in Monfalcone has been analysed using various tools, specifically surveys, interviews and a review of actual real ECR cases. The scope was to identify weaknesses in the process, understand their consequences and implication and highlight potential areas for improvement. These inputs were then used in the development of the proposed new framework.

5.1 Survey

The success and usage of a process depend on how it is structured, well defined and how much is well known within the company or to who need to use it. It could happen that even the best designed process could fail due to the lack of knowledge or training of the utilizer. (Lundqvist & Månsson, 2013)

A survey has been designed and shared with the Monfalcone site group team. Monfalcone have been selected due practically and considering the level of affection coming from the new company organization, so the difficulties of the usage of the process could be spotted easily. There have been chosen 36 people from all the departments.

The goal was to understand how much the company process in the site and in the group is known and gradually understand if the usability is easy or if there is room to improve.

The survey has been designed in Italian for a better understanding of the complete poll. Site HR has been involved for the sharing of the survey giving it a more formal within the company helping to promote the filling of it.

The survey has been done anonymously and has been structured with closed and open questions grouped in different sections. The first one, called General Information, is designed to acquire demographic information about role and years of experience in the company. Based on 18 answers the distribution shows that 44 % are working in the technical office and the majority have been working in the company for more than 5 years.

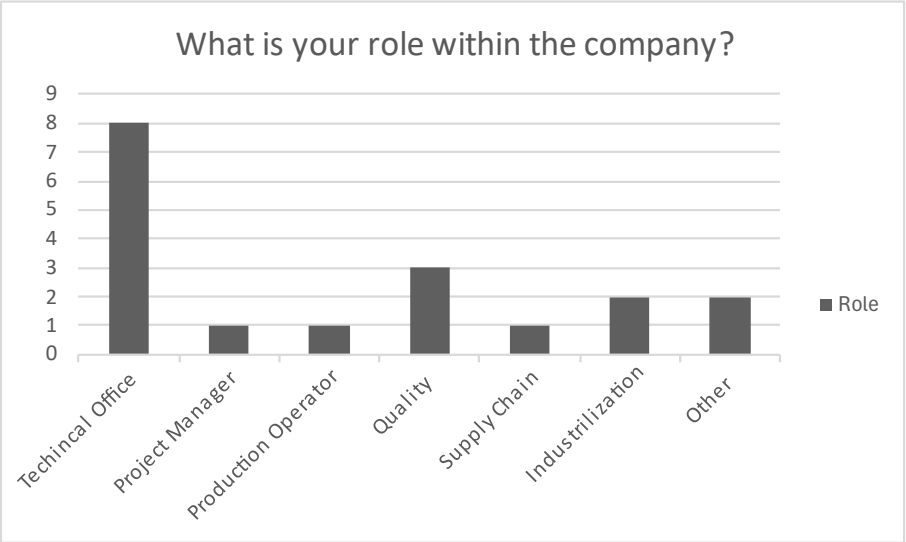

Figure 9 Graphical distribution of the role within the company

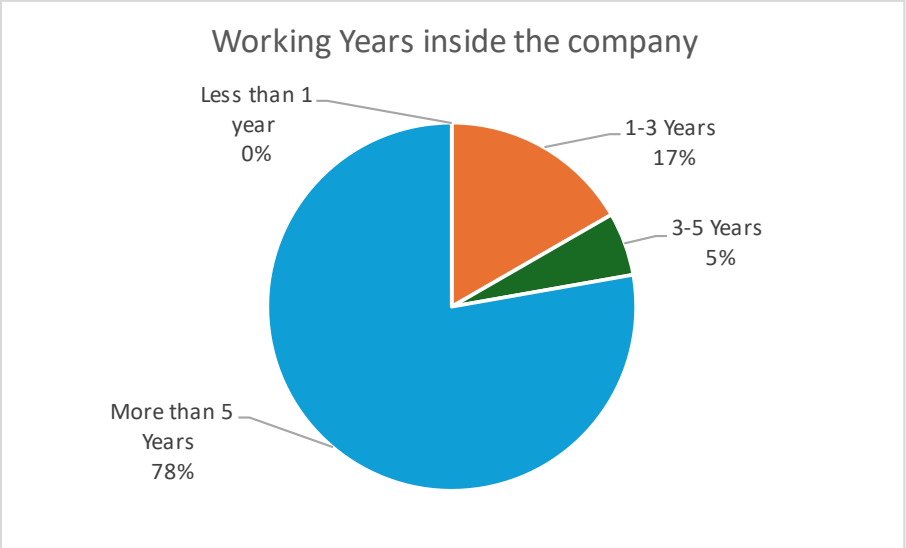

Figure 10 Graphical distribution of the working years within the company

The second section, Understanding of the ECR Process, has been designed to understand the awareness of the Engineering Change Request workflow. Results show that knowledge of the process is limited, only 7 respondents are aware of the ECR process at their site and this value drops to 4 when referring to the group one. The question related to training shown that its appears to be minimal or not sufficient, with only 2 participants reporting that they have received specific instruction on ECR procedures.

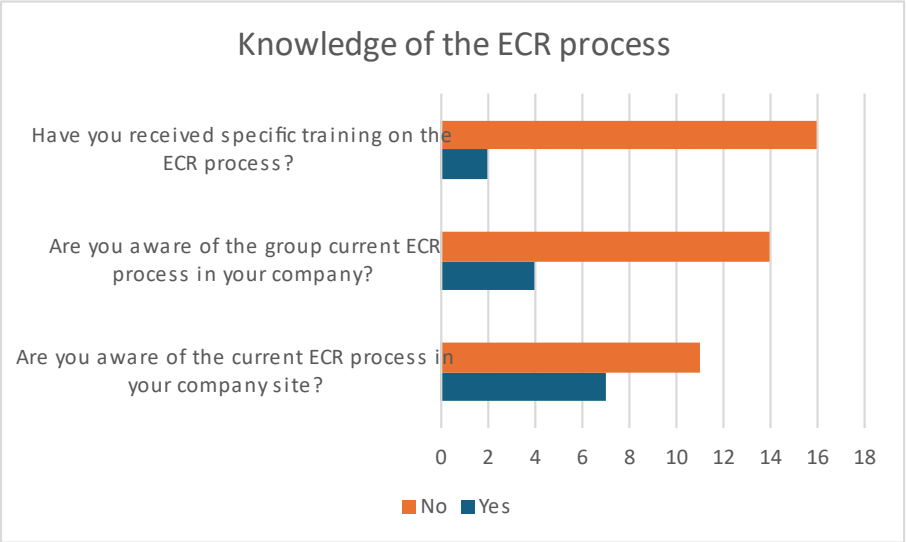

Figure 11 Graphical distribution of the knowledge of the current ECR process

A single question about the involvement in the process has been inserted and the responses indicate that participation is generally low: only 4 people are involved often or very often, while the majority (10) results being rarely or never involved.

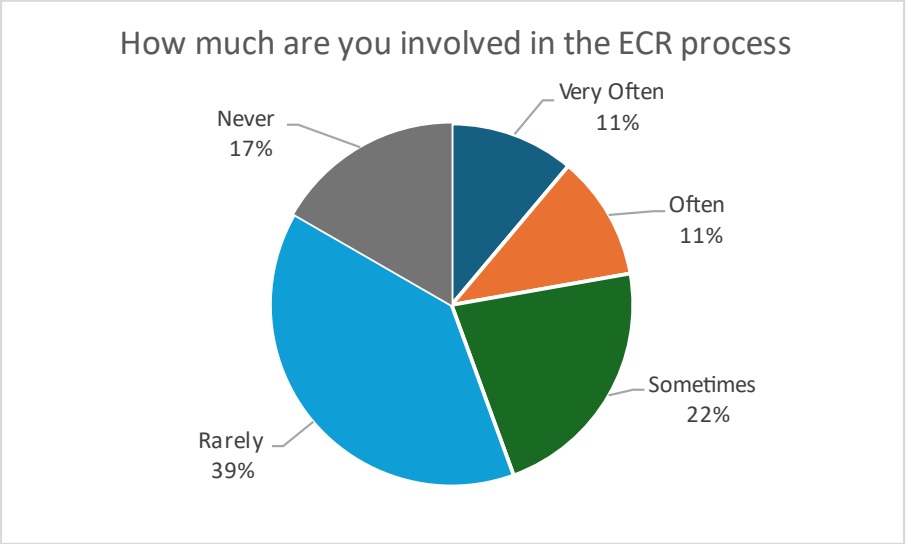

Figure 12. Graphical distribution involvement in the ECR process

The fourth section, Effectiveness of the ECR Process, evaluated how clear is the procedure, the efficiency and the communication. Perceptions of clarity are poor, with 9 answers indicating the process “not very clear” and 3 “not clear at all.” Efficiency in resolving technical issues is also questioned: only 5 find it quite efficient, while 6 rate it as not very efficient and 1 as not efficient at all. When it comes to evaluating costs and benefits, the situation it is slightly better, with 8 respondents considering the process efficient or quite

efficient, but 4 still rate it negatively. Communication during the process is seen as a major weakness: 10 respondents find it “not very effective” and 3 “not effective at all,” while only 5 consider it effective or very effective.

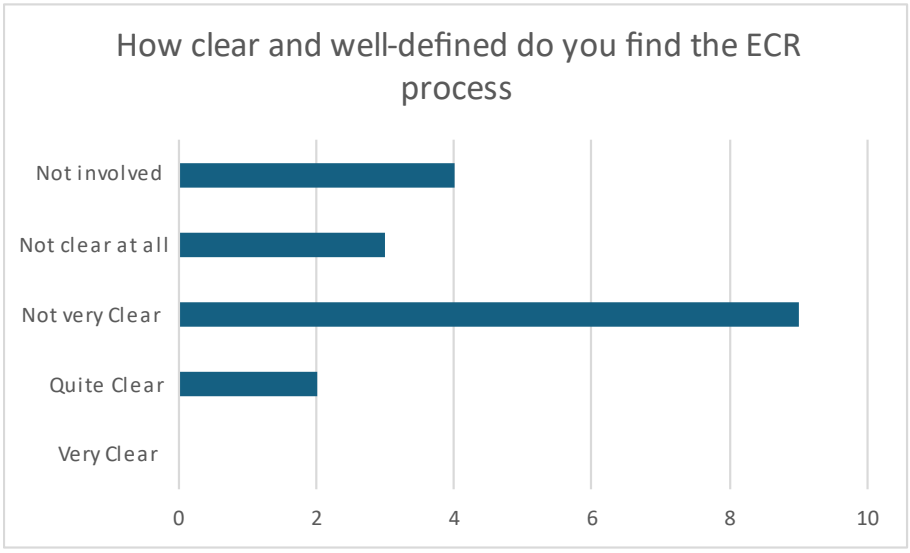

Figure 13 Graphical distribution of definition of the ECR process

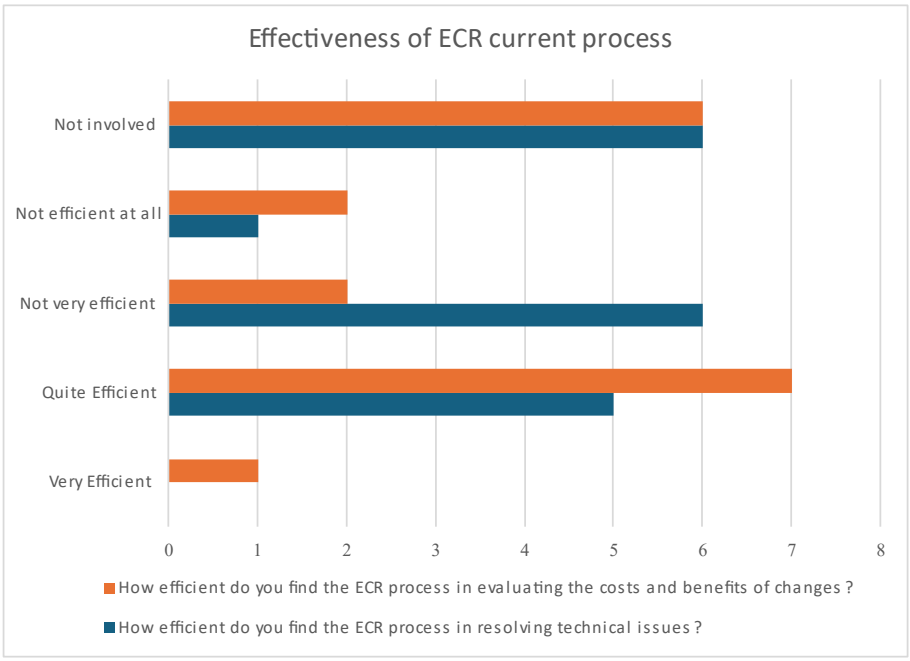

Figure 14 Graphical distribution of effectiveness of the ECR process.

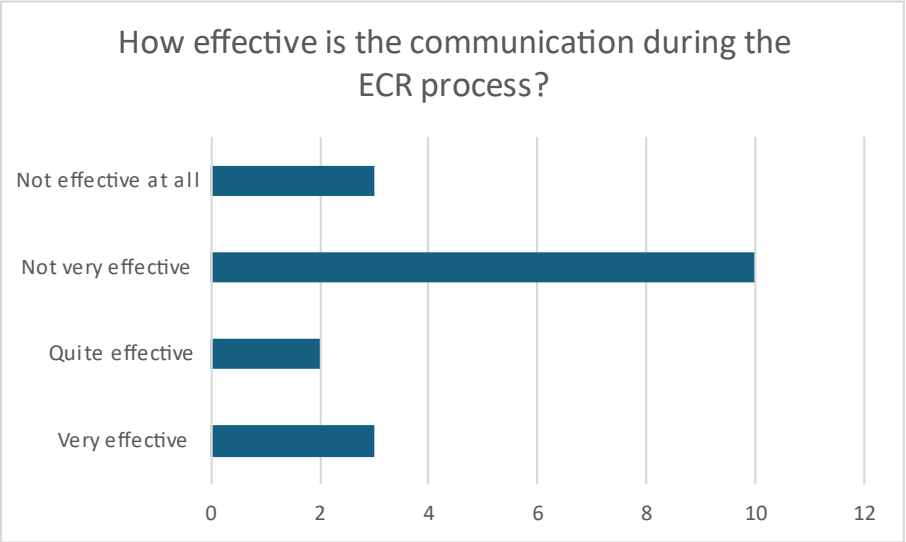

Figure 15. Graphical distribution of communication within the ECR process

The last section, named Improvements and Suggestions, consisted in open questions designed to receive more personal comments and improvement input about the process.

Answer to this section have given valuable input to improve the process. The answer described a current process that even if is flexible and robust it is not well known and used. The main proposals which can be used to streamline the process are a better communication between different departments, involving the project manager as a contact person and a clear specification of roles and responsibilities within the company to avoid any grey areas. A better traceability and clearer and more structured workflow, integrated with other company processes with the use of tool, that could even be the current ERP, as suggested, has been indicated as beneficial.

Recommendations include organizational improvements like organizing weekly platform meetings to review all requests and involve production teams, planners and industrial engineering in these discussions. Others responded highlighted the importance of training, so everyone knows and understands the process and the different team are aligned in the use of it.

The full result summary of the survey has been inserted in the thesis as Appendix A.

5.2 Examples of current ECR

Following the survey three real examples of improvements have been examined and evaluated based on their process and success of implementation. The evaluation has been performed with interview with the roles more involved during the process, checking technical documentation and final results. Doing this test helped to understand the complete process from beginning to implementation and together with the survey results allowed to highlight the weaknesses or bottleneck.

The improvements that have been discussed are the following:

1. Wooden bulkheads colliding with the composite hull.
2. Change of type and supplier of the bathing ladder.
3. Hull Windows – from PMMA to Glass

5.2.1 Case 1 - Wooden bulkhead colliding with the composite hull

This is a typical example of efficiency improvements coming from the fixing of a design error. The forward cabins of a model of boat manufactured in Monfalcone are designed and built as modules that, once assembled in a dedicated area outside the boat, are lifted inside the hull. The placement must have a specific longitudinal, transverse and vertical position relative to a specific reference point. Due to some low tolerances, it is necessary, in every boat, to manually adjust the length of these bulkheads, with numerous trials, to position the module correctly otherwise there is collision with the inner skin of the laminate hull that does not let to reach the requested position. This operation results in an increase of installation hours, compared to those assigned in the boat assembly cycle, increasing inefficiency.

Figure 16. Example of Wood – Composite hull interaction

This situation has been initially noticed by the production team that has shared it to the process engineer that performed a check to find causes and effects. IP once confirmed the need of it formally request the modification. Since the cutting of the wooden panels has been purchased from an external supplier, the updated documentation has been shared with it. In this case the different departments have managed the process independently and the communication took place verbally or via email.

The interviews performed with the process engineer and the designer have confirmed that the modification process, even if have been not followed the official one, has been considered successful due the release of the new technical specification to the supplier. However, the modification has never been implemented in the supply and the issue is still affecting every boat in production causing always the inefficiency described above.

This situation it is clearly a loss for the company because, even if an investment in terms of design hours has been sustained, the improvement expected has never been implemented, making the investment not effective.

Summarizing, the cost of redesign has not been tracked and without a place where this information could be accessible to everyone, it was not possible to learn from this mistake to prevent it from being repeated in following units or projects. There was also no control over when the supplier implemented the modification, resulting in the issue continuing to happen even after eight units, as the supplier has not updated the cutting plans.

This situation affected not only the production efficiency or cost of the boat but also the morale of the operators and the team since efforts has been made but the final results was not successful causing also a loss in the trust of the process.

5.2.2 Case 2 – Change of supplier (Bathing ladder)

Another typical case of an Engineering Change Request (ECR) involves the replacement of a supplier for a specific component. This kind of changes may be driven for cost-saving reason or issues related to the continuity of supply or quality of it. In the case under consideration, the discontinuation of a bathing ladder from the original supplier requested an intervention from the team to have a proper replacement.

The supply chain team reported the issue to the Project Manager, who requested the identification of an alternative solution. The designer in charge of it identified quickly the alternative solution. The replacement component met both the technical requirements and the budget constraints. Within a few days, the new component was validated and ordered in time for installation on the next boat in production.

The process ran smoothly and demonstrated effective cross-functional collaboration. However, due to the relatively low economic impact of the component in relation to the overall Bill of Materials (BOM) of the boat, the change was not formally recorded in any ECR process. This highlights a critical point: minor changes, even when managed efficiently, may not be included in the formal traceability process due the limited impact.

5.2.3 Case 3 – Hull windows – from PMMA to Glass

The market feedback of a yacht model is crucial for its success. Happened to a particular model that after the presentation of the prototype the perception of quality of the hull windows was not the one expected from a boat of this level, even despite the good overall feedback of the yacht.

This particular model has a wide glazing area on the hull to let the guests to enjoy the sea views from the cabin. The material selection for those windows needs to take in consideration the sea pressure for safety reason, impacts, weight, quality perception and cost.

Considering the different factors the PMMA has been choice for this component. However, the aesthetics and perception of richness of the glass have a higher value for the possible customer. This feedback has been processed from the marketing team that requested the change of the material to glass.

For this request the requester took also the responsibility to collect the information about the upgraded solution, the possible schedule for the implementation and the cost, both direct and investment cost.

With all the data collected a decision has been taken, in this case from the management, due the possible strategic impact and on the price of the boat due to the cost rising. From technical point of view a feasibility study and the structural dimensioning have been provided from the engineering team.

The implementation serial number of the boat has been detected and the technical office, purchase and supply chain team worked together to make it happen and at the end the result has been achieved successfully.

Also, in this case all the steps of the official procedure have been not followed properly, indeed the communication and the approval have been organized via email and meetings, raising the risk of missing information to right person or uncertain status of the request due a loop in discussion. (Abollado Rojo, Shehab & Bamforth, 2017). This is also a typical situation of unofficial procedure (Lundqvist & Månsson, 2013), that has been followed on purpose to avoid too much bureaucracy and perform the implementation within a tight schedule.

5.3 Analysis

5.3.1 Surveys results

The survey collected 18 answers that is the 50 % of the poll selected. The poll, even if could be considered limited due the low engagement and total answer received, could be still relevant for the purpose since is a qualitative assessment of the specific Monfalcone site and the variety of the people involved and their engagement in the procedure.

The poll anagraphic is more unbalanced to technical office employee with a long-term relationship with the company. As stated before this is a valuable poll due the core of the engineering change for this kind of product and business is the engineering department that has to perform studies and designs of the changes requested, this statement is supported by the study of Maceika and Tolocka (2021) where the technical changes are rated as the most frequent. The fact that there are several years of experience could highlight the weakness of the process on the long term, on the other hands having a fresh employee could be, in certain situation, an additional value if bring a different point of view or inputs to improve the process.

Looking into the first section about the ECR process, it is clear from the answers that the process is not well known among the participants, in fact more than 50 % of the people state that does not know about it. This trend is even higher when the subject is the Group ECR process, with just few having the knowledge of it. This result is in line with the question about the training received on the process that highlight how almost nobody has received a dedicated training on it.

The form has been created to understand the involvement in the process and the effectiveness of it. Related to this topic there is an unbalanced result towards the not involvement in the process of most of the people, this result is also linked to the knowledge of the process, limiting access to propose or perform improvement.

Among the people that are involved the trend show that the process is not very clear and not so efficient and also the communication is a weak point as stated in the result of the questions in the fourth section. This statement it also comes from who is usually more involved, making more robust the result of the survey. This trend has been also highlighted

in the ECR example. On the other hands from question related to the efficiency has been noted that the process is more effective in the cost-benefit calculation and this is due the responsibility taken from who is involved and carry the ECR handling to the end.

The open questions confirm that the areas that can be improved are in line with what stated in the other sections and the example giving suggestions for improvement as well. Specifically, more training and improving robustness, traceability and communication. Furthermore, the use of the ERP system used in the company has been seen as an improvement as well, adding value to the thesis which scope is to implement a digital tool for the handling of those requests.

5.4 Current procedure improvement area

Based on the analysis of the current procedure together with the survey and the use real examples of changes needed and how have been handled it is possible to define the weakest areas of the current process in the Beneteau Group, Monfalcone site.

5.4.1 Knowledge of the process

From the survey results, it has been possible to state that the knowledge and understanding of the process is not well shared among the different roles in the company. This is a common situation that affects many industries. Happen that the knowledge is mainly shared among the roles that are directly and more often involved in the changes. (Maceika, 2021) (Lundqvist & Månsson, 2013).

The lack of general knowledge affects the handling of those requests and the tracking of them as highlighted by Tavcar and Duhovnik (2005) where they raised the importance of having a detailed process and the understanding of it among all the participants to achieve a quick and reliable implementation of the Engineering Changes. So, based on the previous statement, it is mandatory to improve this area and a well-known process will increase the use and the trust on it promoting new input and improvement ideas also from who is involved in the manufacturing but not directly in the changes, like the operators.

5.4.2 User Friendliness

Based on the results in the sections and considering the procedure analysed, especially the document EN-DEV-27, there are many passages and approval signs to be performed. Too many passages or approval signs make slowing the process and discourage the people to follow it or even use it. This has been also highlighted in the real case example where the successful changes have been implemented not following the official procedure.

Not having a specific tool designed to manage the ECRs it also affects the perception of the user friendliness especially among who are usually less involved in the process with a limited knowledge of it.

5.4.3 Accountability of the roles

Even though the roles within the process are clearly defined and a two-level authorization procedure is in place, it has been noted that involving too many approvers reduces accountability. Both the promoter and the processor of the request tend to feel less responsible, same happens to the authorizers, whose shares the individual responsibility.

It is important to divide the responsible to perform the change and the authorizer. The first one needs to take accountability in the analysis of the impact, provide reliable information and perform the change within the constrains. The second one, the authorized, with the support of the data provided by the rest of the team, must take accountability in the decision about the implementation of the change and in which timespan.

It is important to note that could also be not only the process but also the attitude about the changes approach that could affect the accountability. Having a company culture that promote this practise it helps to avoid accountability issues. (Jarratt, Eckert, Caldwell, & Clarkson, 2011).

5.4.4 Database Missing

In the Monfalcone site an official database of the change request is not in place, this makes difficult to track all the requests, where they come from, who oversees closing it, the cost evaluation and status of it. This makes also difficult to have a summary or report about the impact of the changes and the efficiency in implementing. The use of several ones in the

process reduces the reliability of the data due the risk of being not complete and the trust on the process from who is using it.

This aspect is particularly relevant for future projects. Indeed, maintaining historical records of engineering change requests can support the lessons learned process, help prevent the recurrence of similar mistakes and let the reuse of previously validated solutions (Arnarsson, 2020).

5.4.5 Lead time

Based on the current procedure, as illustrated in the example above, the lead time between the submission of a request and its implementation is often significantly long. The reason for this delay is mainly due to challenges in prioritizing tasks across multiple projects and the limited availability of resources allocated to manage engineering changes. It is important to highlight that especially engineering team could be in the situation to have several projects at the same time, requiring to prioritize time and resource between the different activities.

Another factor is the process itself, that if handled manually, has a high risk to have activities in stand-by or not notified correctly.

6 Framework

From qualitative and quantitative the analysis, the weaknesses in the existing process have been identified. For the process to be more efficient, there is a new approach to the management of the ECR in the Beneteau Monfalcone site. The design of this new framework is based on the existing one, with input and upgrade made to improve on various aspects covered in the previous chapters.

6.1 Challenges Evaluation

In the previous chapters the current process has been analysed and the weak points of the process highlighted considering the impact on the process and on the company.

In this paragraph those challenges have been evaluated with the goal to propose an improved new framework.

To improve the knowledge of the process and the user-friendliness it is important to identify the core information required for each request. This helps to prevent unnecessary complexity and excessive data entry, which can make the process time-consuming and discourage operators from following the procedure or even suggesting improvements. In addition, a training or a dedicated tutorial it is crucial to promote a culture of continuous improvement practise and motivate the people in the different roles to use the process.

Speaking about accountability of the roles, it refers both to the person that is responsible to perform the improvement and for the ones that are in charge of the approval.

To avoid grey zone regarding who is in charge to be the responsible person for the improvement a RACI matrix is suggested. The matrix must be discussed with the different users of the process. To improve accountability of the approver of the request, compared to the actual procedure, specific approver role for the different type of request is suggested. This approach makes sure that approvals evaluate a change within their expertise or area of competence making them the most appropriate to validate it. The proposal for the new procedure is described in a dedicated paragraph of the thesis.

The implementation lead time is a key topic for the profitability in a serial production, earlier the improvement can be implemented earlier it is possible to re-pay the investment

and have an economical gain. To reduce it, it is possible to work on different variables: resources availability, process optimization and priority. (Jarratt, Eckert, Caldwell, & Clarkson, 2011).

The quantity of requests for improvement may be high in the product's life span. As already discussed, it happens in certain phases, where it becomes difficult to handle all requests either simultaneously or in a short span of time. (Bhuiyan, Gatard, & Thomson, 2006). An optimized process can reduce wasted time and minimize delays in decision-making and approval.

Increasing the availability of resources give the possibility to handle multiple requests in parallel, accelerating their release into production.

Due to limited resources, the greater priority has to be given either to the improvements providing higher benefits from a financial point of view or to the ones related to the safety and keys aspects of the product itself. Prioritization is not always easy and requires a decision-maker capable of evaluating the available data. Considering factors such as severity and cost analysis, this individual can effectively help and drive the team in identifying the most critical requests for the project and push them to focus on it. More complete and accurate are the information provided in the request the more reliable is the cost-feasibility analysis and easier and reliable will be the choice and the priority assigned.

Lead time is also under the influence of additional factors such knowledge of the process and lack of user-friendliness. Improving those areas will have a positive impact on it.

The implementation of a digital tool and the reduction of the use of unofficial process, handled manually, it also provides benefits in term of robustness and tracking of the requests, increasing efficiency, communication and reducing risk of errors with a gain in terms of lead time implementation. (Abollado Rojo, Shehab & Bamforth, 2017).

The final critical challenge in the current engineering change request process is the absence of a unique database accessible to the whole team where the requested submitted can be stored and managed. To effectively store this information, the adoption of a digital tool is recommended, one that can also manage the workflow and the approval process.

Standardizing the type of data entered in each request is essential to reach an adequate comparability with the possibility of further analysis and lesson learning.

The implementation of a digital tool will support the point above, indeed having a structured tool that manage requests, sends notifications and has a workflow process of submitting information relevant to the relevant person in the framework, will improve the efficiency in communication and information handling, reducing risk in errors and in waste time, improving the lead time for implementation. It will also be beneficial in terms of tracking, information storage and reporting. Downside, if too many constrains in the workflow, it will reduce the flexibility, increasing, in certain situation the use of an unofficial procedure. (Abollado Rojo, Shehab & Bamforth, 2017).

6.2 Workflow Proposal

The ECR, engineering change request, needs to be processed in a workflow to be approved and implemented.

The process is divided into three main stages: before approval, approval and after approval as per Jarret er al (2024a) proposal. The first stage it starts after an issue is spotted and the ECR created. Then, selected the responsible, there is a solution proposal, a feasibility and an economic analysis. More loops could be required before the finalization of the proposal. Once the ECR is completed with all the information required; it is submitted to the approval phase. At this point it is evaluated and could be approved or rejected. If rejected could face an additional loop ending with the propose of a different solution, In case of approval, it's starts the third phase that is the implementation, with the finalisation of the manufacturing drawings or documentation needed followed with the change in the BOM and all the different activities needed.

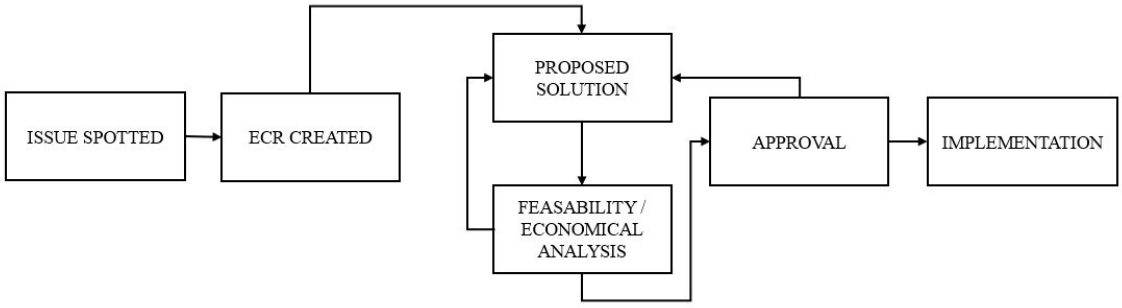

Figure 17 New Framework process proposal

In company that have the continuous improvement approach they are usually sharing the issues and problems that occur among all employees. Doing that, inputs for improvement do not come only from areas of expertise but potentially from anyone.

An input could come from the operator in production, that installing components see that a slightly change in the design can improve the labour time making easier the installation. Another example could be that from after sale comes feedback about a recurrent issue and will be worth to fix it also for new boats, avoiding after sale cost and improving the trust of the clients in terms of reliability. Typically, could also happen that a supplier can suggest some improvement to make a component cheaper to manufacture with an advantage in term of purchasing cost. Those are just a few examples of common inputs and from where an ECR is created.

To make a decision regarding the implementation of a change, it is necessary to have all the data of the request available so a complete and comparable picture is doable, same for a reliable tool for subsequent monitoring and forecasting of future costs.

Select a responsible, who is the coordinator and/or executor to perform the ECR activities needed for the implementation it is always a challenge with the risk of lacking in coordination. (Wänström, Medbo, & Johansson, 2001). Three main approaches to responsibility have been discussed and evaluated. In the first approach, the requester is the one who submits the change request and so became also the responsible to collect the information from various departments and, once the work is completed, sharing it with the authorizer. This method ensures reliable requests thanks to the accountability of the requester, but it can be very time-consuming and sometimes it reduce responses and

involvement from different departments, as the requester only consulted them. In addition, it may limit the pool of requesters since some roles might not be interested in handling the entire process. In certain situations, this approach could also end up in a micromanagement behaviour from the responsible if is not well supported by the different roles consulted.

The second approach assigns accountability to the authorizer. It is receiving the request and has to collect the necessary information to conclude the analysis useful to make the decision for approves or rejects the change. This allows the authorizer to focus on requests that appear to have higher priority, even before completing the full process for all of them, and to reject some at an earlier stage. In some cases, this speeds up the process, but too many requests handled by one person or role could overload this position and make the process less robust. As in the previous approach, the different departments act only as consultants, with the same downsides. (Lundqvist & Månsson, 2013).

The third approach involves a responsible person who is best suited for the type of change request submitted. This person can, if needed, consult other departments to gather missing information. Once the request is completed with all the necessary data, the authorizer can evaluate it and decides if approve or reject it. Considering the organization of the Monfalcone site and the accessibility of documentation and information, the third approach is preferable.

Speaking about authorizers, considering the involvement of different departments, for example: Industrialization, Engineering, Purchasing, having one single authorizer that even if consulting those department could have in anycase the downside of micromanagement.

To avoid this situation, a two-level authorization has been proposed, with a similarity of the actual procedure. The first level is more like a feasibility gate, where the dedicated department related to the improvement type of the request is in charge to validate it, and let the final authorizer to do the final green light.

In this passage it is useful to have the RACI matrix highlighted in the previous paragraph where there are the different roles assigned to the different category of the change request.

Figure 18 New Framework approval process.

In the evaluation of the actual procedure there are some boundaries that limit the authorizer area of responsibility. The idea is to not overcrowd the list of changes with very small updates that have very little impact on the product but that can still be time-consuming to handle it in the ECR Process. Considering that in the new framework developed has been decided to keep the same constrain as the actual procedure.

It could also be possible that due the type of changes requested or the impact of it, the authorizers listed in the procedure could need a green light from higher level managers before authorizing the change. This as mentioned is determined due the impact of the changes in terms of product cost or process, or the implementation of new product features that are part of a wider strategy of the company. To handle that it is possible to set boundaries, similar with the lower ones described before, that over a certain limit the Project Manager cannot authorize the ECR without the approval of the manager.

Set those boundaries could not always be easy, because can vary between the models, due the different product cost or it is not possible to prior establish the requirements.

This kind of ECR is rarely and out of the normal routine of the process, so have been decided that instead of the upper boundaries during the evaluation phase, the responsible or authorizer if consider a change valuable to be discussed at higher level they can bring it to managers.

6.3 ECR Description

The ECR submitted and evaluated within the process must include all the information necessary for both the approver and the person responsible for performing the analysis and implementation. (Jarratt, Eckert, Caldwell, & Clarkson, 2011), (Lundqvist & Månsson, 2013). These details should have a standardized format that allow historical traceability and comparisons over time. For this framework, the selected information represents the most commonly used data points, adapted to the manufacturing processes and products of the Beneteau Yard and based on the current procedure. The elements chosen for this framework are:

1. Description of Issues / Improvement

The request come from an issue or an improvement proposal. In this field there is the description of the problem from where the modification come from. From this description the person/ team in charge to analyse it and propose a solution can understand the context and the reason of the change. Could be also the case that the improvement is more related to purchasing, supplier or supply chain, so not a real issue is spotted but just an improvement in terms of cost.

2. Suggested solution (Optional)

In this field is already proposed a solution. The reason of this field that is not meant to be mandatory is to provide an initial suggestion could be useful for the team. Sometimes there are some improvements that come from a different area of expertise and the input provided could be helpful in later stages.

3. Boat Model

This indicate the model of the boat on which the problem was found and the modification is required. If it is a part common to multiple models, it is necessary to indicate all those that may be involved.

4. Stage of issues spotted

For tracking and understanding purpose, it is important to identify the stage at which the issue was detected. This information is valuable for decision-making and process

improvement as it indicates whether the issue or even a potential improvement was identified early in the process or only at a later stage, or even later by the customer. The stages have been limited to the main phases of boat manufacturing: material incoming, composite lamination, pre-assembly, assembly, delivering and testing and after-sales. An additional category, “Other,” has been defined to include situations that are not directly related to manufacturing phases but can still have an impact, such as material obsolescence.

5. Modification Requester

Similar to the original process, the requester for the change, who is usually the issue spotter is indicated in the process. This will help who will process the request to have someone to refer in case of more information are needed.

6. Priority Level

This field indicates the priority of the issue or improvement request. (Jarratt, Eckert, Caldwell, & Clarkson, 2011). To simplify the evaluation process, three levels of priority are defined, the first one is High Priority that includes changes with high severity, such as safety-related or structural issues that must be implemented for product integrity or user safety. Also includes improvements that bring significant benefits in terms of reduction of cost, increase of performance or process efficiency. The second one is Medium Priority that covers functional improvements or changes that improve usability or reliability but are not critical for safety or structural integrity. These changes are valuable but not urgent. At the bottom there is Low Priority which refers to minor improvements, such as aesthetic changes or optimizations with limited impact. These do not affect the product’s functionality or safety and can be planned for future implementation.

7. Improvement type

This field is required to define the type of improvement expected from the change request. Improvements can take different forms. (Jarratt, Eckert, Caldwell, & Clarkson, 2011). A product improvement refers to improvement made to the product to increase its quality or functionality, increasing the final value for the customer. Process improvement, on the other hand, involves modifications to the product or manufacturing process that do not

affect the final quality or functionality but with the scope to improve production efficiency, such as reducing time or simplifying steps. Cost reduction contains all the improvements that keeping same quality and performance of the final product or component can lower the cost, usually of the bill of material. This usually happen due optimization of the design of the different parts. Other potential areas of improvement is a change of supplier, which may be occur due several factors such as cost, quality, delivery performance, reliability, or strategic alignment. Obsolescence management addresses the discontinuation or unavailability of components or material with the proposal of an alternative and the historical tracking of the change.

8. Direct Cost modification

Economic impact for the serial boat divided in Material and Assembly hours. This information is essential for economic analysis. An estimated value can initially be entered to give a magnitude to the request and then defined in detail in following studies. The higher the reliability at the beginning the lower is the risk of not matching the economical goal after the implementation.

9. Investment cost

This represent the investment that is needed to study and implement the modification. (Jarratt, Eckert, Caldwell, & Clarkson, 2011). It can be divided into design cost and investment in materials or non-recurring costs for implementation. This is important to evaluate the return on investment or if it is necessary to act on the selling price of the boat to repay it. Evaluating this it also helps to manage the possible workload of the resources, internal or external.

10. Implementation serial number

The implementation serial number is important for planning the work necessary to make the modification, which involves evaluating resource loads, the time required for redesign, and the possible Capex costs needed. It is also important information for coordinating procurement, as an incorrect assessment of the implementation of the modification can lead to either an unmet need in production or the creation of obsolescence and unusable components, which are a cost and inefficiency for the company. The knowledge of the

implementation serial number is also important for cost tracking purpose for after-sales and for future analysis in terms of saving and return of investment.

11. Progress status

This field indicates the current status of the Engineering Change Request (ECR). A new ECR is set with the status "*Draft" and* refers to the phase when the request is under preparation and has not yet been submitted for review. Once is ready the ECR is submitted to evaluation, the status is change to "*Under Revision*". The request stay in this status until is reviewed. Only after has been evaluated from all the authorizers could switch the status to "*Approved" or "Rejected*" stage. If the change proceeds, it enters the *"In Work"* phase, during which the team is working to implement it. In some cases, the process may be temporarily or permanently stopped, which is indicated with the label "*Blocked*". This can occur due to strategic decisions, technical constraints or lack of resources. Finally, when the change has been fully executed, the status becomes "*Completed*." This final stage is reached once the Change Notice is released with all required documentation and the implementation aligns with the agreed serial number of the boat.

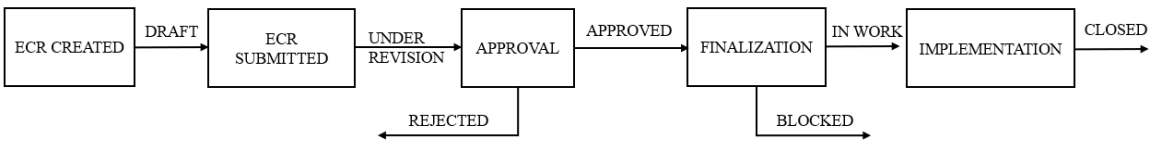

Figure 19. New Framework Status Summary

If the target serial number changes during the process, this must be communicated and updated accordingly.

Accurate tracking of implementation status is essential for follow-up activities and KPI measurement.

12. Creation Date

It is the date when the change request has been created. It is useful for follow-up, traceability and KPI.

13. Closing date

Like the creation date, also the closing date is necessary to monitor when the request has been implemented for follow-up, traceability and KPI.

The parameters described above are needed to detail the change request in terms of information of the modification, the responsible and the impact on the product. Those parameters need to be filled during the creation process and could be modified with more reliable information during the process. Needs to be collected in a database and be available for reports and follow-up. Those information needs to be handled with a specific tool that allow an easy fill-in and the storage of it. Plus, the tool must manage the approval workflow and direct the request to the right handler/ responsible. The tool topic will be taken in detail in the next chapter.

6.4 RACI Matrix

As anticipated in the paragraph 6.1, to improve accountability of the roles during the feasibility study and the execution of the ECR a RACI Matrix needs to be in place in the framework.

A RACI matrix, known as Responsibility Assignment Matrix is a tool that defines the responsibility of different roles for activities, task or deliverables in a process. (Graffius, 2020)

RACI is an acronym for Responsible, Accountable, Consulted and Informed. The term Responsible indicates the person who is tasked to perform and complete the work; The Accountable person is the one who is ultimately responsible for the correct completion of the task and ensures that it meets the required standards. There must be only one accountable person for each activity. The Consulted role includes those who provide input, expertise or advice during the process; indeed their contribution is essential for quality outcomes, even though they do not execute the task themselves. Finally, the Informed role refers to individuals who need to be updated on the progress, status and results of the activity, without actively participating in its execution. (Graffius, 2020).

In the specific case of the ECR process at the Monfalcone site of the Beneteau Group, the RACI matrix is used to define the departments responsible for analyzing and executing the ECR first-level approval, with the appropriate consulted and informed roles depending on

the type of ECR. The accountant of the ECRs is always the Project Manager, that is considered the second level authorizer.

As described earlier the change notice that are possible to be reviewed are product Improvement, process improvement, cost reduction, change of supplier and obsolescence management.

In terms of company departments involved in the process are engineering, industrialization, purchase, supply chain, quality, product marketing, production and PM.

Table 1 Workflow RACI Matrix

	Product Improvement	Process Improvement	Cost Reduction	Change of supplier	Obsolescence Management
Engineering	R	C	R	C	C
Industrialization	C	R	C	C	I
Purchase	I	I	C	R	C
Supply chain	I	I	C	C	R
Quality	C	I	I	C	I
Production	I	C	C	I	I
Marketing	C	I	I	I	I
Project Manager	A	A	A	A	A

6.5 ECR Implementation Notification

Once the engineering change has been processed, approved and implemented, it is important to share the information about the change to the other departments that could be affected, with the specific documentation useful for the purpose.

The information needs to be shared among Production, with technical drawing, operative instruction and material pick up list with the reference of the implementation serial number of the boat from when the change is in place.

Quality department has to be involved to make them aware of the differences that could affect the quality control of the incoming materials or the boat assembled.

The traceability of the change it is critical and for the after-sale team is beneficial to have the knowledge of the changes implemented, the impact on the material or the new installation procedure. This because in case of an issue during the use of the boat who will follow the service is capable to make the right diagnosis and provide the right material to perform maintenance or fixation.

If the ECR has an impact on the product feature or aesthetic the marketing and sales team must be involved before the change and after as a confirmation from when is in place and how the final solution looks like or is working to be able to present it to the possible future clients.

7 Digital Workflow

According to Rojo Abollado et al (2017) the use of a digital workflow is more effective compared to a manual one. Considering this statement could be useful to handle the process described in the framework in previous chapter with a digital tool as well. There are several ways to develop a tool for this purpose. A dedicate tool could be purchased or developed in house. There is also the possibility to develop an additional feature to an existing software already in use in the company.

In this case the third type have been selected to not add one additional software or different applicative in the company, that already has several of them to manage different processes or documentation.

On the portfolio of Beneteau Group there are three software that can handle this ECR process: Windchill, already cited, IFS and Microsoft 365.

7.1 WINDCHILL

Windchill is a PLM (Product Life Management) platform developed by PTC.

This software is widely used in the market on the industrial field for the centralized management of all the data of product and related processes. With Windchill it is possible to store, organize and manage the technical documentation included CAD model with the possibility to integrate it directly to a CAD software. Windchill has also the possibility to set approval workflow, have a handling of revision end even organizes the Bill of Material. (PTC, 2025).

In the Monfalcone Site as stated before, Windchill it is used limited to store and handle the technical documentation, 2D and 3D drawings.

7.1.1 ECR Management

Windchill has a dedicated section to manage the change notice.

Once a change notice is required the user has to handle it inside the system. There is a specific function called ”New Change request”. This function requires to fill an excel form with the information the procedure required such material changes, boat model and serial

number implementation. Beside that there is the economical information used as a support of the decision making.

The request it sent to Workflow when all the information has been filled in. The system automatically selects the appropriate approver based on the change make an impact as per setup of it.

Once in the workflow the change is formally recorded and a notification is sent to all users included in the designated mailing list, so all the relevant stakeholders are informed and aligned.

Process Notification

Process: WF-AM_BJT-AM-25-8863, CX4MA - AMELIORATION FRIGO CARRE - FRIDGE IMPROVEMENT IN SALOON, A.1
Process description:
Activity name: Notification
Activity description:
Subject object: CX4MA - AMELIORATION FRIGO CARRE - FRIDGE IMPROVEMENT IN SALOON

Library Name: CHANGE NOTICE - AM
Library Creator: GROUPE BENETEAU, Administrateur
Host Organization: Groupe Beneteau
Library Description: None

The Following Change Notice has been validated / L'Avis de Modif ci-dessous a été validé.

Document: CX4MA - AMELIORATION FRIGO CARRE - FRIDGE IMPROVEMENT IN SALOON
Click on the link above to view the document/ Cliquer sur le lien ci-dessus pour consulter le document.

Figure 20 Example of Windchill EC Notification

7.2 IFS - STARBOARD

IFS Starboard is a cloud base software platform that integrates both ERP (Enterprise Resource Planning) and PLM functionalities. As ERP software IFS is use in the company to collect, store, manage and interpret data from many business activities. As ERP, IFS is used to manage the operation of a company, track material, issue orders, check status and progress of a project.

IFS, originally, has not a fully developed workflow for the change request. In place there is a simple one to manage the change in the bill of material.

The input comes from the designers that insert these changes using a dedicated Excel form, which includes the essential information related to the material changes requested.

This workflow does not have a proper formal approval workflow but serves only to share in a standard template the information to the Master Data team, which is responsible for updating the Bill of Materials (BoM) of the boat within the ERP system.

Due to the absence of an approval process and the limited scope of information provided this procedure cannot be considered a proper Engineering Change Request (ECR).

In order for the process to be aligned with the requirements of the ECR, the system would need development. This would involve implementing a structured workflow, increase the data completeness and introducing validation steps to match the dedicated framework and assure the right level of traceability, accountability and compliance with change management best practices as described in the previous chapters.

7.3 MICROSOFT 365

Microsoft 365 is a cloud-based suite that is designed to support and promote collaboration, data management and workflow automation within organizations. The suits include vary applications and software like SharePoint, Teams, Power Automate. Microsoft List is one of those and is specific designed to let users to manage structured information and automate processes. Indeed, allows teams to create, share and manage lists of different kind of data like tasks, issues or even use it to handle change requests. This application let the user to customize the structure with various column types like text, multiple choice, date or responsible, making it very user-friendly. Additionally has the possibility to use conditional formatting and multiple views (grid, calendar, gallery), making it one of the most versatile tools for operational tracking. (Microsoft, n.d.)

In the Engineering Change Request (ECR) context, Microsoft List provide a solid structure that let to insert the key attributes such improvement type, priority level, responsible department and implementation status of a change request. Users can start from predefined templates or build custom lists to their workflow. The workflow can be managed with Power Automate, another suite of Microsoft dedicated to automating workflows with conditional actions, alerts and custom rules.

Microsoft List strong points are the flexibility, user friendliness and the easy integration with the different Office suites. Those points are making Microsoft List a valid alternative for the ECR even if no possibility of integration into PLM or ERP software.

7.4 Comparison

In the framework of continuous improvement and digital transformation, the implementation of structured tools for managing engineering changes has become a strategic priority for industrial organizations such Beneteau Group. All the platform in use within the company, Windchill, IFS Starboard and Microsoft List's have been successfully integrated into the company operation in same of the sites.

As described in the previous chapters, Windchill is primary used for the technical and documental aspect with CAD integration and IFS Starboard is focus on the management of product, process, operative and financial activities.

A summary of the main feature of the two software is in the following table

Table 2 Software comparison

	Windchill	IFS - Starboard	Microsoft 365
Technical Documentation / CAD integration	High (2D/3D, Creo, Catia)	No	No
Document Revision tracking	Yes	No	No
Approval Workflow	Yes	Yes	Yes
BOM handling	Not implemented	Yes	No
Routing	No	Yes	No
Cost information	Not implemented	Yes	Manual
Cross-Function integration	No	Yes	No
Notification	Yes	Yes	Yes
Flexibility	No	No	Yes

Considering the different functionalities of the three software platforms currently in use within the Groupe Beneteau: Windchill, IFS Starboard and Microsoft 365 and considering the operational requirements of the Engineering Change Request (ECR) process, the team has opted for a two-step implementation strategy.

The first step consists in adopting Microsoft 365, selected for its usability, easy implementation and immediate availability. This solution suits for short-term response to the operational needs of the Monfalcone site, enabling quick and efficient management of change requests.

The second step will be the integration of the ECR process into IFS Starboard, with the goal of aligning change requests with the operational workflows managed within the ERP system. This decision is part of a long-term vision of centralize the activities on the same software across the whole Beneteau Group.

Windchill will continue to play a key role as the technical documentation repository essential for engineering departments across the organization.

The decision to develop and integrate the Engineering Change Request (ECR) process within IFS Starboard adds significant value to this thesis, as it aligns with the Groupe Beneteau's long-term digital transformation strategy. Once IFS is fully deployed, this functionality will be directly implemented across all sites.

7.5 Setting of the Tool

The Engineering Change Request (ECR) framework proposed and described in the previous chapters must now be translated into the digital tool to make it usable in daily operations. This transition from conceptual design to practical application is a critical step in the implementation of this process within the organization.

There are several steps to align the framework described previously and the tool to have it correctly functioning:

7.5.1 Design of Information Forms

Information forms must be developed to capture all relevant data associated with the ECR that reflect the structure defined in the framework.

Microsoft list has as a strong benefit the flexibility. It is possible to use a standard template and tailored it with the information needed according to the framework.

There are three possibilities to fill the different item of the form; the first one is free response, the second is a choice between a predefined choices and the third one is to choose an employee. This is possible due List is part of the Microsoft environment used within the company and all the employees are in as users.

The information requested in the framework are the following:

Table 3 New ECR form

Characteristic	Input
Description of Issues / Improvement	Open answer
Suggested solution (Optional)	Open answer
Boat Model	Predefined choice: Model A Model B Model C
Stage of issue spotted	Predefined choice: Material incoming Composite Lamination Pre-assembly Assembly Delivering and testing After sales Other
Modification requester	Not needed – Automatically filled by software
Priority level	Predefined choice: Low Medium High
Improvement type	Predefined choice: Product improvement Process improvement Cost Reduction Change of supplier Obsolescence management
Modification Responsible	User choice from employee database
Direct cost modification	Open answer
Investment cost	Open answer
Implementation serial number	Model A - 003 Model A – 004 Model B – 015
Status	Predefined choices: Draft Under Review Approved Rejected In work Stopped Closed
Creation date	Date selection
Closing Date	Date selection by rules

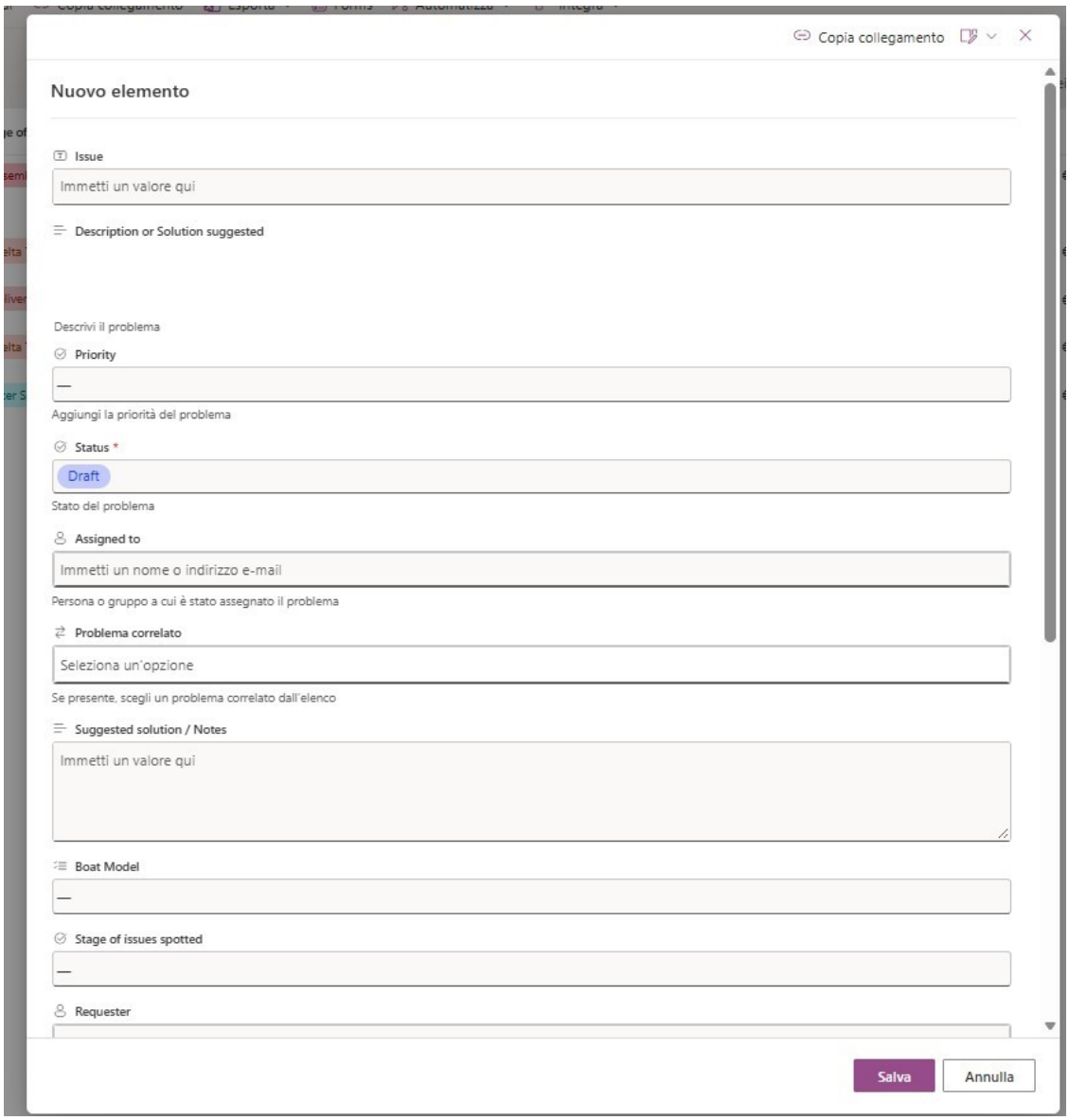

Figure 21 Microsoft List – New issue Form

7.5.2 Definition of the rules

Different choices define the involvement of different departments with the scope to have only the right person in the information loop. To have this possible, Microsoft List let to setup rules, that based on the choice, send notification or make action.

The rules to make it work are the following:

Table 4 Microsoft List ECR Rules definition

#	Rule syntax	Attribute	Action
1	If *Boat Model* is	Model A	Send a notification email to *Project Manager Model A*
		Model B	Send a notification email to *Project Manager Model B*
2	If *Improvement Type* is	Product Improvement	Send a Notification email to TO Manager, Product Marketing
		Process Improvement	Send a Notification email to the Industrialization Manager.
		Cost Reduction	Send a Notification email to TO Manager, Industrialization Manager
		Change of Supplier	Send a notification email to Purchase Manager, Supply chain
		Obsolescence management	Send a notification email to Supply chain Manager and Purchase Manager
3	If *approval status* is	Approved	Change value on *ECR status* to Approved
4	If *approval status* is	Rejected	Change value on *ECR status* to Rejected
5	If *approval status* is	Submitted	Change value on *ECR status* to Under Review
6	If *ECR status* is	Completed	Change value on *Closing date* to current date

7.5.3 Approval Workflow

Microsoft Lists, as part of the Microsoft 365 environment, offers the possibility to configure and run approval workflows. Two main options are available for managing the approval process, each differing in complexity and in applications involved:

1. Approvals via Microsoft Teams

This is the simplest and most cost-effective solution. It allows users to manually initiate approval requests with the selection of the appropriate authorizer based on the type of change. The tool allows to have a waterfall authorization flow with history of it. This method requires user intervention and carries the risk of incorrect role assignment. This alternative it is included in the standard Microsoft 365 package and can be implemented without additional costs.

The notifications are integrated in the office package, with emails and Teams notification that are linked directly with the issue in the list. The Figure 22 shown an example of the approval notification. Similar ones are also sent to inform the different roles of the creation of the ECR.

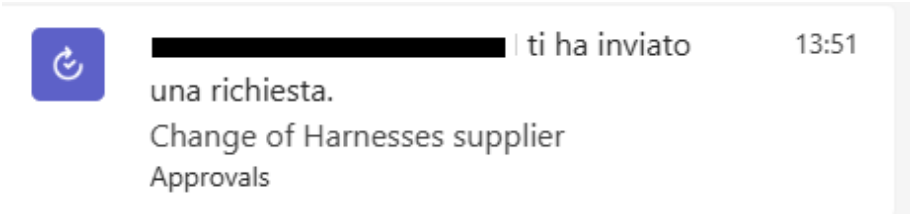

Figure 22 Microsoft List Teams notification for approval

2. Automated Workflow via Power Automate

Power Automate has an advanced and automated approval process. Based on predefined rules and a dedicated workflow, Power Automate can automatically route the ECR to the correct approvers and manage a two-step authorization process. Power Automate is an additional feature of Microsoft 365 and it is not part of the Microsoft 365 package in use inside the company. To activate this functionality, additional licenses would need to be purchased for all users involved in ECR management, significantly increasing IT-related expenses.

Considering the two alternatives the company has chosen to not increase IT expenses, implementing the manual approval method via Microsoft Teams for the initial deployment of the ECR process tool considering the long-term strategy to use IFS.

Using the manual method increase the risk of ECR sent to the wrong authorizer, reducing the effectiveness of the process. To minimize this risk the RACI matrix, previously defined and shared with the team, serves as a reference guide. This matrix describes roles and responsibilities based on the nature of the change and define the impacted departments and approvers.

7.6 Reporting and Dashboard

With the data available in the system, it is useful for the different stakeholder of the process to have a summary of the status of the ECR situation in terms of ECR performed, number

of them and even a cost evaluation. The output of this phase is a report and dashboard to easy access to the information.

Microsoft list has an intuitive dashboard where all the ECR are listed and it is possible to filter considering the different parameters. On top of that different visualization options are available: Dashboard view, Table view, Calendar view and other customize views.

For example, in the figure 23 has been selected the view to see the different ECR grouped based on their status.

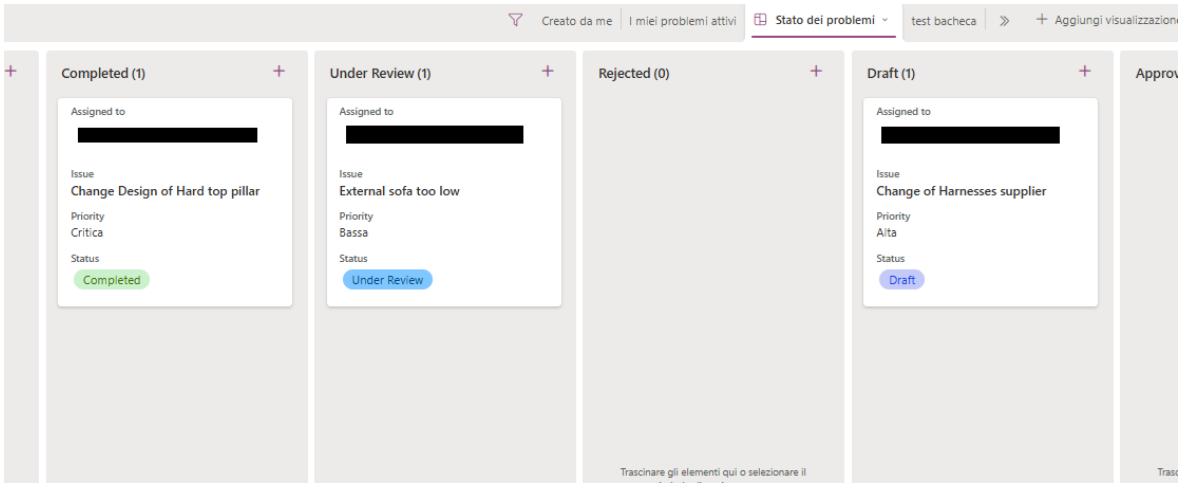

Figure 23 Example of a Microsoft list Dashboard

There are dedicated pages that allow us to see also a summary of the status of the ECR, with a specific section for the ones assigned to the user, that helps to focus on the ones a user is responsible for.

For reporting and data analysis, it is possible to export it to an Excel spreadsheet.

7.7 Testing and Validation

The scope of testing and validation is to verify system functionality in a test environment through real-case simulations and collect feedback from key users.

This phase is important to understand if the process is user friendly and achieves the requirements of the framework, but also it is necessary to spot and highlight the technical issues of the system like bug or rules and workflow wrongly set up. Once the test has been performed and it possible to state that the system is stable, reliable and reach the initial

requirement it is possible to give the access to the whole team to implement the tool in the daily company routine. For a successful implementation it is important to train the people involved about the right use of the tool and considering that will take a certain amount of time before everyone are using it correctly. This phase, that is out of the scope of this thesis, it is particularly important to user engagement and to reduce failure rates. (Hodgins, 2016).

To perform the validation some real examples has been selected and tested it in the workflow. These examples were carefully chosen to represent different types of requests, ensuring wide coverage of the various scenarios that may occur throughout the project lifecycle.

The following Engineering change have been selected:

1.Improvement of external loose furniture

2.Re-Design of Hard Top Pillars

3.New supplier for electrical Harnesses

7.7.1 Improvement of external loose furniture

Following input from Product Marketing, with the support of customer feedback from several delivered hulls, it was observed that the external sofas selected for the deck furniture had a very low seating height, making them uncomfortable to use. A version of the same sofa with a slightly higher seat would improve onboard comfort and is therefore considered a product improvement.

Using the new process, a Change Request (ECR) has been created by Product Marketing, describing the issue in detail.

The fields were filled in as shown in the following extract:

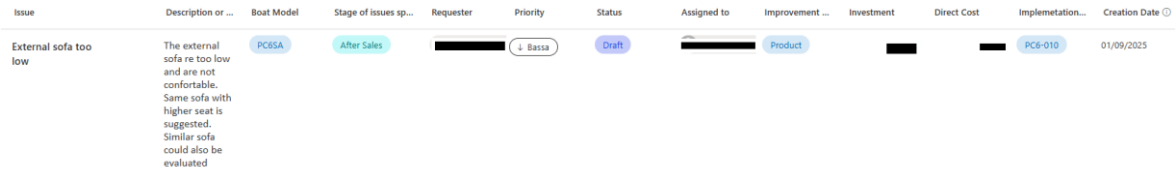

Figure 24 Microsoft List issues list example

The improvement has been classified as a Product Improvement and the request has been automatically routed to the Technical Office and Project Manager for visibility. Notification of a new ECR creation have been issued and the right role received it, proven right setup of the system.

A responsible person from the Technical Office has been assigned by the TO Manager that received the request as per procedure. The system allows also the creator to assign the ECR to a specific person and if needed can change it in a second time. This let a bit of freedom in the process. It is important then that the team is aligned to avoid ECRs being assigned to the wrong responsible person.

For this specific ECR the assigned engineer, part of the Exterior Style department, reviewed the request based on the provided requirements. In this case, the Product Marketing inserted additional input in the dedicated section of the tool useful in guiding the technical analysis.

The possibility of obtaining a raised version of the current sofa has been investigated with the existing supplier, to avoid discontinuity between hulls. The supplier has confirmed that the same product was available also with a 50 mm higher seat, achieved using longer legs. The Purchasing department, responsible for supplier negotiations, has been also informed that the economical condition remains unchanged compared to the current version.

These findings, combined with feedback from the Supply Chain regarding the remaining stock of the current model, completed the feasibility study. The target hull for implementation has been also identified.

Once the feasibility study has been completed, the process moved to the approval phase, which is structured in two levels. Based on the RACI matrix, the responsible have indicated the two approvers in the approval request form.

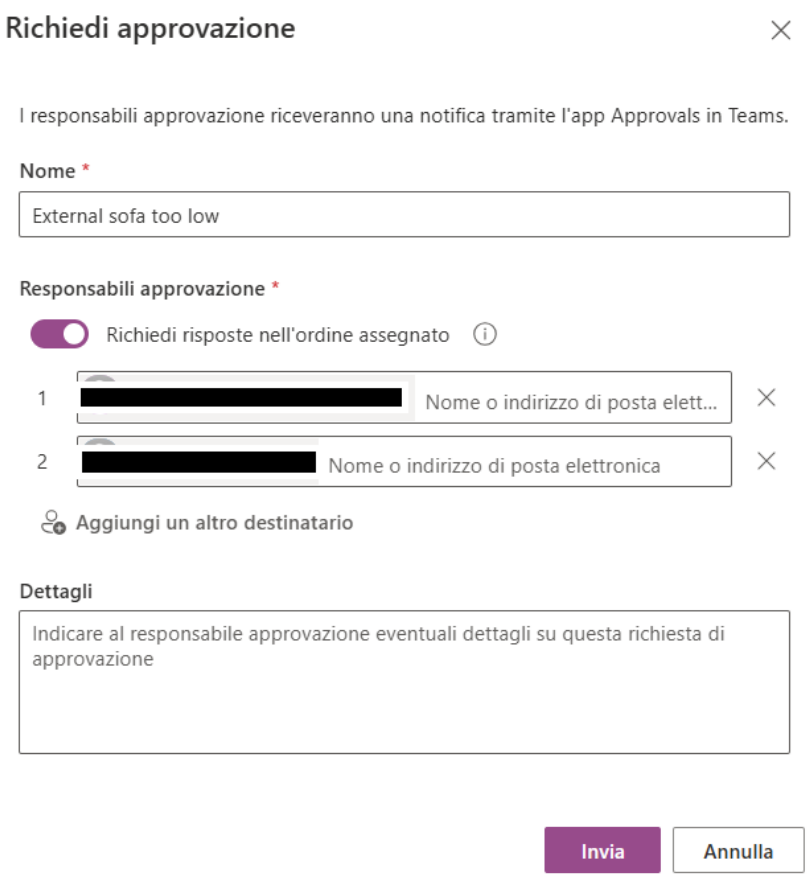

Figure 25 Microsoft approval – request form

The Level 1 approval has been successfully completed. Although Level 2 approval is normally under the responsibility of the Project Manager but in this case since the cost remained unchanged and no obsolete parts were involved it could be skipped as per framework specifications; however, the responsible has requested this approval as well.

With the ECR approved, the implementation phase began. All relevant departments have been informed of the change and the team has worked together to make the change effective.

Engineering has created and added the new part's codes to the Bill of Materials (BOM), with the support of Master Data team and IP linked the new material to the correct operation.

Once these activities have been completed, the same responsible person who initiated the request has marked the ECR as closed, confirming the final cost and the hull number for implementation. Automatically, the tool registers the final date as well.

7.7.2 New Hard top pillar

A request for the redesign of the hard top pillars has been made as part of a product marketing campaign to improve the appearance and appeal of a specific model.

The hard top, a stiff canopy whose function is to protect and cover the flybridge from the sun and rain, is supported structurally with metallic pillars. Those pillars are a visible part of the yacht and have to be aesthetically accepted from the Exterior designer. To achieve this result a total redesign of the geometry and a new paint finish have been requested.

The request has been formally entered into the digital Change Request system, with all relevant requirements specified. However, as in previous cases, certain activities occurred outside the system: specifically, the 3D CAD concept files developed by Product Marketing have been shared informally and not attached to the ECR, making them non-traceable within the workflow.

Once submitted, the request has been sent to the Engineering department and to the consulted ones as per RACI. The Technical office manager assigned then the ECR to a specific designer inserting his name in the “Assigned to” field in Microsoft List.

The Engineering department has been focused on the feasibility of several critical aspects. First, it examined the new geometry and its potential impact on integration and structural integrity. Another important topic has been the paint finish, which required validation since the outdoor marine conditions affect the durability. The study has also analysed cost implications, taking into account both the re-engineering process and the direct cost variation. Due the time constrain an important topic to verify has been the procurement of the components, including the supplier in the discussion to match yard request to its lead time.

Product Marketing specified a challenging target hull number for implementation, making the timeline a critical constraint in the feasibility analysis.

The study has highlighted that the proposed solution would require structural modifications, with the need of dedicated tooling and related investment cost. These costs, combined with the engineering activities needed for redesigning the pillars, represented an initial investment. However, thanks to the simplification of the pillar geometry and the

potential direct cost saving of approximately 25%, the investment could be recovered within the production of the three boats.

The Procurement risks has been also evaluated, to understand the feasibility in terms of time constraint from our supplier and has been highlighted the difficulty in sourcing components within the required timeframe.

Upon completion of the feasibility study, the request entered the approval phase, which follows a two-level structure, firstly the level 1 approval has been achieved with the green light of the Engineering department that validate the technical solution proposal. The detailed engineering was still to be done, but the feasibility has been studied. Level 2 Approval, typically the responsibility of the Project Manager, has also been granted. In this case, the decision has been supported with the prove of cost reduction and a limited investment. Despite procurement challenges, the Industrialization department has been consulted as per the RACI matrix and agreed to proceed with implementation on the specified hull, applying a temporary deviation to the production cycle for this component.

The digital tool and workflow functioned effectively throughout the process. Some activities, such as the sharing of 3D files, has been handled and discussed outside the ECR system and were not traceable. While these files are not essential for decision-making they should be made available to the Project Manager on request if needed for better understanding of the change. In any case the technical documentation must be stored and be available in Windchill.

This case highlights both the strengths and limitations of the digital tool: while the structured workflow supports traceability, approvals and departmental coordination, certain informal practices still exist.

7.7.3 Change of harness supplier

During the serial phase of one of the models of the company a concern has been raised about electrical harnesses which are a delicate components on a boat. This component as per assembly routing needs to be installed on an early stage of the assembly before all the interior modules are placed otherwise the placement of it would be more complicated, compromising efficiency and quality. This means that the supplier has to be on time on the

delivery and the product must be reliable to avoid replacement in a later stage that would be difficult as for the same reason earlier explained.

In this specific case the supplier struggled to deliver it on time and the technical support was not at the level expected, causing extra effort to the company technical office to identify solutions to problem related to the supply.

The electrical industrial engineer responsible to support the production, proposes a change, using the List tool. The request has been flagged as purchase change and the purchase department has received, as per rules, the notification of this new engineering change. The IP designates the purchaser as the responsible person in the Team approval.

The purchase department selected a possible new supplier and requested technical documentation to ask for a preliminary quotation.

Once received the quotation, has been shared to support the decision-making process about changing or not the supplier. The Supply chain has been consulted, especially to understand the possible implementation serial number to avoid obsolescence.

Considering the supplier delivery time, the production time and the stocks, it has been decided to use the current supplier kit and integrate it with some customization and only from the following boat to use the completely new harnesses from the new supplier.

The ECR have been then sent to the approval process. Considering the proposal and the economical saving, due cheaper offer from the new supplier, both steps have been approved and the solution implemented. With the order of the new kit the solution have been marked as completed from the responsible of the change.

In Figure 26, the approval interface is shown, where the steps of the process are clearly indicated. All the information related to the request are attached, allowing the approver to easily review the details. Dates are displayed to provide visibility on the approval path and progress. The interface also enables the addition of comments and the two main options Approve or Reject are clearly visible at the bottom for proceed with decision chosen.

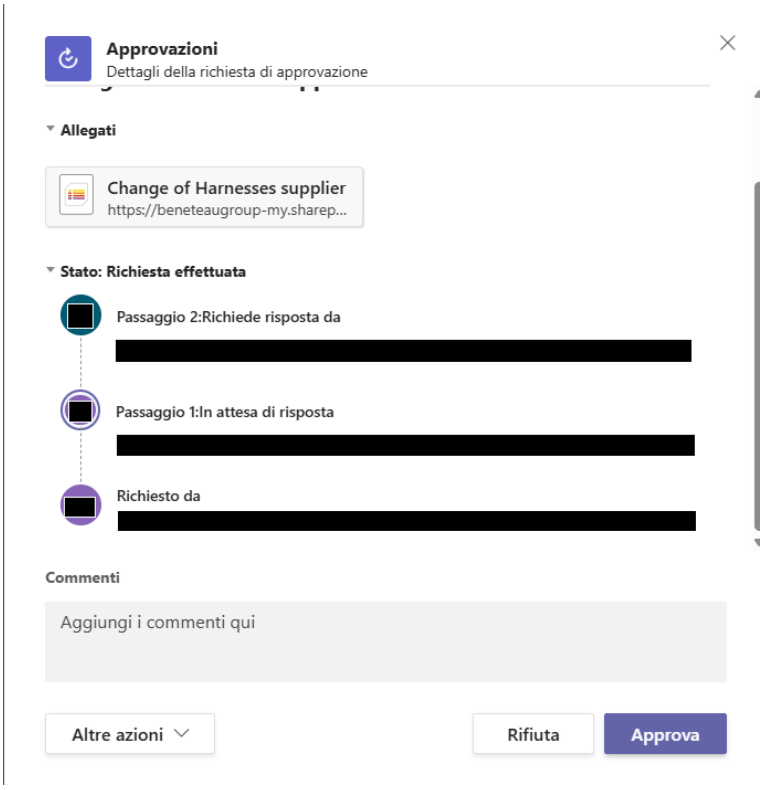

Figure 26 Microsoft Approval – Approval notification

The ECR test has highlighted the pro and cons of the use of this tool. Generally, the feedback from the utilizer is positive, the integration with Teams and Outlook, which are already company tools, makes it very simple to keep track of the activities and the use of the rules to inform the role involved are considered useful as well. Apart the notification has been appreciated the possibility to comments and attach picture on every specific request making the tool a place where to track discussions on it making easy the traceability and the follow-up. The workflow approval is working fine but since is not automate is sensitive on the utilizer input. To improve the robustness a guideline of the use of the tool is suggested to be shared among all the people involved.

7.8 Further Development

Once the tool developed in Microsoft Lists has been completed and made available to the entire Monfalcone site for managing ECRs in daily activities, the short-term phase of this initiative has concluded. Looking ahead to the long-term vision, where the new ERP system, IFS Starboard, will be implemented within the entire group, there is the topic about transfer this procedure into the same software for all sites. In this scenario an upgrade of the ERP

system or a revision of the framework and process would be necessary to have the system that can support the required functionality. Having a common software for the ECR management instead of a site dedicated one enables a global view with the advantages of a common database and the share of the lessons learned.

As anticipated in Chapter Three, the alignment of an ERP system with a process can follow two paths: adapting the process to the system or upgrading the system to fit the process. The second option is usually more expensive and requires the company to perform an evaluation of the benefit, cost and implementation time.

8 Conclusion

8.1 Discussion

The thesis explores the implementation of an ECR process with a dedicated framework and a specifically designed digital tool in the Monfalcone site of Beneteau Group.

There were three initial objectives for the thesis. All of them could be considered achieved, indeed the first one, the mapping of the actual procedure to understand the procedure in the company and find weaknesses, has highlighted areas of improvements. The weakest points of the current procedure have been detected conducting a survey within the Monfalcone site, with the participation of 18 people, equal to 50% of the total poll and analyzing three real examples of engineering change conducted with the actual procedure.

The analysis highlights how the knowledge of the process within the different roles of the company is low as the user-friendliness, making the use of an unofficial procedure more common.

The approval workflow has marked as a weak point due to the several approvers needed to have the EC validate and proceed further with the implementation. Too many signatures have the effect of reducing the accountability of the different roles, reducing effectiveness and increasing time of implementation.

The absence of a unique database has been also indicated critical due to the reduced follow-up, historical traceability and low availability of reliable data for decision-making.

The second objective initially set was the development of a new framework capable of fitting better in the company organization and with the capability to improve the weak areas highlighted in the mapping of the current procedure. This framework has been presented including workflow, approval steps with stakeholders and detailed information about the standard information needed to detail the ECs. In the development of the process, the weak areas of the current procedure have been considered and with the feedback of the utilization provided through a survey, real example of ECR managed and literature input an improved solution have been proposed. The solution aimed to have a more user-friendly process, with fever steps where only specific roles are involved

depending on the origin or the request, improving both accountability and implementation lead time.

A RACI matrix has been necessary to attribute the right responsibility and accountability to help the setup of the digital tool for the right communication flow. This has been necessary due to the actual procedure requested too many approvals signer from vary departments. This causes a lack of accountability from the different signers, slows the process and encourages the use of unofficial procedure as shortcut.

The third and final objective was the development of a digital tool capable of handling the ECR process following the developed framework. This tool improved the utilizer process adherence, let to have a dedicated database useful for traceability, a data storage for decision making and a semi-automated workflow for the approval and implementation status. The tool has been developed using Microsoft List, a dedicated suite of Office 365 in use within the company, providing flexibility and quick integration with the other company processes used in the daily operation.

The development of the developed framework, even if, considering the successful implementation of it via the digital tool proposed, has received a small resistance from the team that has tested it even if has been involved during the development. This is common when a change is proposed within a company, indeed the utilizer tend to follow the old procedure or way of working, even if it is the unofficial ones, because they are not use to the new procedure. Indeed, they compare it with the old one focusing only on the negative aspect or constraint instead of the overall benefit.

8.2 Limitations of the Study

The study presented in this thesis focuses on the Beneteau site of Monfalcone is valid within certain assumptions.

This site is dedicated to the bigger and less volume yacht of the group, the variation in terms of product or volume could affect the effectiveness of the process, so could be partially suitable in other sites and some dedicated customization could be required in the different site of the group.

Indeed, the proposed framework is the result of the current procedure with input from the survey. The survey had a limited poll due only focus on Monfalcone site and the poll in terms of participants is limited to 36 people where only 50% responded. Even with this limitation, the survey could be still considered valid within the Monfalcone contest.

Microsoft List has been used as a digital tool to implement the developed framework into the company operations. List has been recognized as flexible and well-integrated within the activities in the company, however, does not let a completely automated workflow and the responsibility for the change must indicate manually the authorizer based on the RACI matrix, causing a higher risk of wrong role or person inserted.

Microsoft List has been chosen as short-term solution meanwhile the Company ERP software, IFS, will be fully developed to accommodate ECR workflow, linked with the operational features, such BOM, Order handling or Operation planning and released to all the sites of the Beneteau Group.

8.3 Recommendations and future work

To succeed in the use of the tool without reducing its effectiveness, it is important that all the utilizers know the procedure and how the tool works. To achieve this result, it is suggested to the company to plan training sessions dedicated and collect feedback during the use to continuously keep the tool optimized and updated.

In the long-term vision of the process, it could worth, company wise to switch the tool from Microsoft List to IFS, the company ERP, to have more integration with the operational processes and to standardizes it among the whole group and not only limited to the Monfalcone site.

Bridging the gap between issues and improvement, manual processes and digitalization of them this thesis provides a concrete and valuable contribution to address process optimization improving efficiency and profitability in a continuous improvement contest.

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Appendice A: Survey Result

1) What is your role withing the company? (total answer: 18)

Technical Office	8
Project Manager	1
Production Operator	1
Quality	3
Supply Chain	1
Industrialization	2
Other	2

2) How long have you been working at this company?

Less than 1 year	0
1-3 Years	3
3-5 Years	1
More than 5 Years	14

3) Are you aware of the current ECR process in your company site?

Yes	7
No	11

4) Are you aware of the group current ECR process in your company?

Yes	4
No	14

5) Have you received specific training on the ECR process?

Yes	2
No	16

6) How much are you involved in the ECR process?

Very Often	2
Often	2
Sometimes	4
Rarely	7
Never	3

7) How clear and well-defined do you find the ECR process?

Very Clear	0
Quite Clear	2
Not very Clear	9
Not clear at all	3
Not involved	4

8) How efficient do you find the ECR process in resolving technical issues?

Very Efficient	0
Quite Efficient	5
Not very efficient	6
Not efficient at all	1
Not involved	6

9) How efficient do you find the ECR process in evaluating the costs and benefits of changes?

Very Efficient	1
Quite Efficient	7
Not very efficient	2
Not efficient at all	2
Not involved	6

10) How effective is the communication during the ECR process?

Very effective	3
Quite effective	2
Not very effective	10
Not effective at all	3

11) What do you consider to be the main strengths of the current ECR process?

a. Flexibility

b. Cross department communication

c. Type of information included in the current format

12) What do you consider to be the main areas for improvement in the current ECR process?

a. Robustness

b. Communication

c. Use of the project

d. GRP department implementation

e. Traceability

f. Request opening process. Difficulties in identify the approval and the communication of the decision taken is not well shared

13) Do you have any specific suggestions on how to improve the ECR process?

a. Use of a dedicated tool

b. Use of the IRP software

c. A dedicated reference person to specify the priority

d. The ECR should go to the PM and a weekly follow up should be established

e. Better training

14) Do you have any other comments on the ECR process?

a. The ECR at first sight could be seen as time consuming but will help to improve and production feedback should be shared more with the different departments

b. The process should let the possibility to integrate also the documentation that will be affected.