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Proposed Quality Plan for Shipbuilding in Indonesia Based on ISO 10005:2018

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Abstract

Ensuring quality is of utmost importance for the shipbuilding sector, as it involves addressing both the quality of processes and the final products to achieve efficient and cost-effective manufacturing. It has become a standard practice for shipyards to adopt certifiable management systems. ISO 9001:2015 sets out the necessary criteria for a Quality Plan, which is influenced by the company's overall quality policy and contractual obligations. In this context, ISO 10005:2018 offers guidance that can be utilized within the framework of quality plans to meet the specific requirements of a project. Several quality plans for Indonesian shipyards, only adopting ISO 9001 and ISO 10005:2018, have yet to be widely implemented. Thus, this paper adopts ISO 10005:2018 to identify the quality plan of three selected shipyards in Indonesia. The gap analysis technique is used to compare the current state of the quality plan with the desired conditions outlined in the ISO 10005:2018 standard. The identified gaps will determine the areas that require immediate attention and improvement in order to meet the requirements of ISO 10005:2018. The primary objective of this study is to facilitate the creation of a quality plan that adheres to the ISO 9001 and 10005 standards. Based on the comparison results of quality plans according to ISO 10005:2018 in shipyards A, B, and C, the recommendation is to integrate distinct clauses (6.4, 6.7.1, 6.7.3, 6.10, 6.13, and 6.15) to improve the quality plans across these specific shipyards.

1. Introduction

In the past, the shipbuilding industry has predominantly prioritized product quality [1][2]. However, there has been a growing recognition in recent years about the significance of both product quality and the quality of the underlying processes [3]. This holds true, specifically, for the shipbuilding industry [1]. Effective quality management is vital for businesses [4][5] and can significantly impact the acquisition of new contracts [1]. Consequently, there is an increased emphasis on the shipbuilding industry to prioritize both process and product quality. Contemporary production approaches aim to enhance process efficiency and minimize waste [6]. Process quality plays a crucial role in achieving cost-effective production [1]. The shipbuilding process comprises several distinct stages, such as defining owner's concerns, conceptual design, contract design, bidding and contracting, detailed design and planning, fabrication, and sea trials and delivery [7][8].

Ship construction is a complex activity. Fabrication in shipbuilding faces essential requirements from a quality point of view. The advancements in technology and improved planning have enabled the construction of vessels in modules that already incorporate integrated utilities and systems. As a result, these modules can be interconnected with relative ease. This approach offers numerous benefits, including faster construction timelines, cost savings, and enhanced quality control (Figure 1. Shipbuilding flow chart).

Generally, shipbuilding falls under the classification of an assembly-based industry and can be divided into two main components:

- Steelwork: This involves the pre-construction, assembly, and erection of the steel construction of the ship.
- Outfit: The primary emphasis is placed on the installation of diverse systems, equipment, and fixtures within the ship.

The shipbuilding process can be divided into five broad manufacturing stages:

- Raw Material Transformation: At this initial level, raw materials such as steel bars, steel plates, sheet metal, pipes, and electrical components are transformed into individual parts.
- Subsection and Sub-Assembly: The next level of the process entails the assembly and connection of these individual components and steel elements to form subsections and sub-assemblies. This includes the integration of steel, electrical components, piping, ventilation systems, and outfitting elements.
- Hull Blocks or Units: The third manufacturing level results in the formation of hull blocks or units, which are larger assemblies composed of the previously created subsections and sub-assemblies.
- Erection: In the fourth stage, the hull blocks or units are conveyed within the shipyard and assembled onboard to form the complete ship.
- Final Installation and Completion: The fifth and final stage of shipbuilding involves the installation, completion, and trial of internal systems and mechanisms. This critical phase ensures that all the required components are properly installed and operational, ensuring the ship is ready for delivery to the owner.

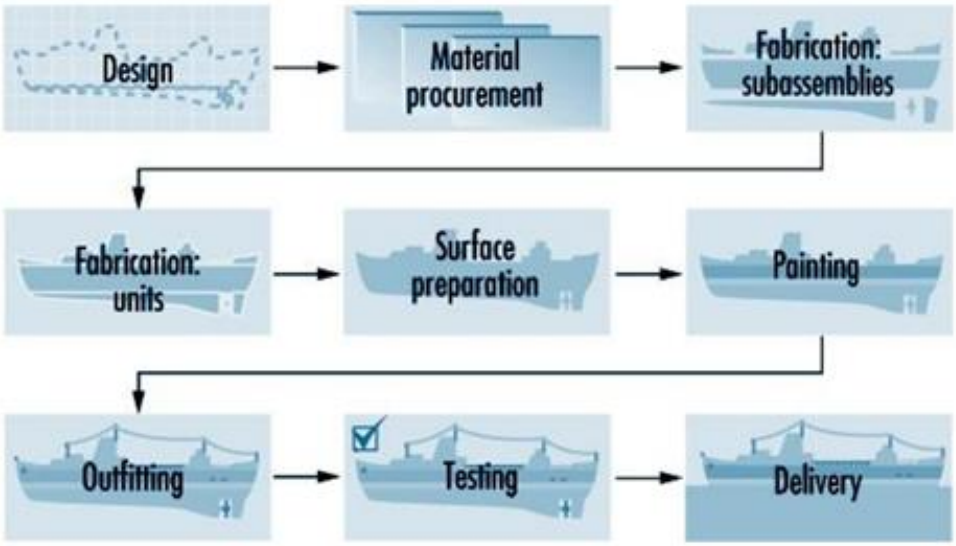

Figure 1. Shipbuilding flow chart [9]

Implementing quality management systems is a highly effective strategy for companies to enhance their competitiveness [10]. ISO 9001 goes beyond being a mere quality management standard, and its implementation offers organizations a rapid path to achieving excellence in satisfying and delighting their customers [11] Recent publications highlight several key areas of focus in relation to ISO 9001, including the motivations, benefits, and strategic outcomes associated with its adoption, as well as its impact on customer perception [12][13][14][15]. Additional research investigates the strategic direction and financial consequences for companies that adopt ISO 9000, the comparison between ISO 9000 implementation in manufacturing and service sectors, prediction models for ISO 9001 certification, the integration of quality and system logic in quality management, and the key elements of effective total quality management [16][17][18][19][20][21]. As evident from the research mentioned, quality management and ISO 9001 continue to be significant subjects of study.

Considerable progress has been made in research focused on ensuring the quality of ships. The technology and the quality of vessels are the most important factors for a shipbuilding nation to take a competitive advantage. A shipbuilding nation needs to stick to a strategy of differentiation focused on the shipping companies which are sensitive to technology and quality [22]. The combination of ISO 14001, ISO 9001, and OHSAS 18001 certified management systems has been established as effective tools for transforming companies that adopt them. The employment of an Integrated Management System (IMS) has demonstrated positive outcomes in improving operational efficiency, enhancing internal communication, facilitating decision-making processes, enhancing the quality of goods and services, and increasing the reliability of products and processes [23]. Additionally, a quantitative evaluation method utilizing fuzzy evaluation is proposed to assess the impact of the fabrication process on shipbuilding quality. This fuzzy evaluation technique can serve as a valuable reference for quality control in shipbuilding and the optimization of construction techniques.

Hmeshah [24] developed a quality management system specifically aimed at ensuring the quality of automated product model data. This involved designing product-specific information models and implementing advanced algorithms to facilitate data processing in practical scenarios. The study introduced the concept of quality in technical domains, examined the quality cost, and highlighted the key characteristics of quality management systems. To assess the influence of the construction process on the quality of shipbuilding in a quantitative manner, a fuzzy evaluation method was employed to gather data for model calculations. The shipbuilding processes were decomposed and a correlation model between construction processes and ship mission reliability was established to determine the influence of the construction process on shipbuilding quality. The installation of ship propulsion shafting was utilized as a case study to measure the impact of the installation process on the overall quality of construction. This served as evidence demonstrating the practicality and efficiency of the proposed approach. This approach offers valuable insights for quality control and process optimization in shipbuilding [25].

In the present day, it has become imperative for shipyards to implement an ISO 9001 quality management system that encompasses established standards, procedures, and a robust quality control system. National shipbuilding competitiveness, future opportunities and challenges for the shipbuilding industry lead to growing demands for quality system requirements and customer specifications. Thus, quality planning in shipbuilding becomes very important, as ships must meet quality standards and requirements. The quality plan is a reference or quality standard that the company has set to maintain product quality so that it conforms to specifications and strategic planning in order to maintain customer satisfaction [26]. ISO 10005:2018 is an international standard regarding quality management, particularly regarding regulation for quality master plans [27]. By proposing the implementation of ISO 10005:2018, it is expected to strengthen the quality management system based on ISO 9001, that has been widely applied in the shipbuilding industry in Indonesia.

The Quality Plan holds significant importance within the framework of quality management systems. It serves as a crucial guide to ensure the quality of products manufactured by the company. The company should possess a comprehensive Quality Plan that encompasses the entire spectrum of quality control, beginning from the inspection of raw materials and production processes to the final output of the products. Its purpose is to maintain and uphold the desired quality standards throughout the production journey.

The quality plan is carried out during the production process, which includes material quality control, production process quality control, and workforce qualifications, especially work that can ultimately affect product quality. The benchmark for shipyard productivity depends on three aspects, namely Quality, Cost, and Delivery (QCD). The third aspect highly depends on the applied technology and ship production management. How to review and develop a quality planning system for the ship production process, according to SNI standards, to fulfill these three aspects.

A quality master plan is a report that delineates the necessary actions, responsibilities, and resources needed for a specific project or object. It is vital to incorporate the corporation's Quality Policy within the plan, as it is frequently a prerequisite set by clients. The Quality Policy should serve as a demonstration of the company's dedication to maintaining high-quality standards across all levels. The creation of the Quality Plan typically occurs at the earliest stages of the project's planning phase. The requirements for a Quality Plan are defined by ISO 9001:2015. The development of the Plan is influenced by both the corporation-wide Quality Policy and the specific prerequisites outlined in the contract/agreement. The quality master plan establishes a framework for conducting inspections, monitoring activities, and carrying out tests. It plays a crucial role in effectively managing resources such as personnel, plant, equipment, and materials to achieve the desired quality targets. Additionally, the Quality Plan addresses the identification and management of risks that may impact the quality of the project.

The Quality Plan should possess flexibility to adapt to changes that occur during the production process. Any changes or adjustments made to the plan should be mutually agreed upon by the relevant shareholder and effectively announced to the project group. For optimal success, the plan should showcase the seamless integration of inspections, project personnel, audits, and tests, as well as the management of records and reports. Please refer to Figure 2. Effective quality planning , "Effective quality planning," for a visual representation of how these elements are interconnected.

Figure 2. Effective quality planning [28].

Until now, there have been few studies addressing the implementation of ISO 10005:2018 in quality planning within industries, including the shipbuilding industry. The application of ISO 10005:2018 can provide significant benefits to the shipbuilding industry and other sectors in their efforts to enhance product or service quality and ensure better process control. According to a study conducted by Pješ č ić , quality planning is crucial as it provides clear guidelines for the execution of processes and production control [29]. Additionally, according to Kharismanto and Pratiwi, ISO 10005:2018, with its benefits in quality planning, includes enhancing confidence, ensuring requirements are met, providing greater assurance, keeping processes under control, motivating relevant parties, and offering insights into opportunities for innovation and improvement. It is highly valuable for designing standard operational procedures [30].

Therefore, it is necessary to standardize the preparation of a shipyard quality plan in accordance with the ISO 10005:2018 standard as a reference for companies/shipyards in preparing a Shipbuilding Quality Plan. This document is created to provide guidance in establishing, reviewing, accepting, implementing, and revising a quality plan. The results of the standardization of quality plans based on ISO 10005:2018 are expected to improve the quality of shipyards in producing vessels so that production costs in shipbuilding can be minimized. Ship quality is by standards, and the owner will accept ship delivery on schedule.

In this study, primary and secondary data on shipyards related to quality plan documents were reviewed. Based on the results of the Quality Plan reviews of several national shipyards that have been accredited to ISO 9001: 2015, the Quality Plans of these companies differ from one another in terms of scope and substance, and presentation system. This study aims to review existing quality plans in shipyards and then improve and implement quality plans for building ships in Indonesian Shipyards based on ISO 10005:2018, which based on a literature review, this has never been studied, especially in shipyards in Indonesia. Improvements made were in the form of documented systems and information in three shipyards that were adjusted to the requirements of the quality management system ISO 10005:2018 and ISO 9001:201.

2. Research Framework

The objective of comparing theoretical knowledge with practical work was to identify any discrepancies or variations between the expected task requirements and the actual conditions that may arise in certain circumstances, where the requirements may not be fully satisfied. In this study, the results of improving existing quality plans were adjusted to ISO 10005:2018 standards using the existing quality plan data, as shown in Figure 3.

The methodology employed in this study involves utilizing the gap analysis method. This method entails comparing the current conditions, as outlined in ISO 9001:2015, with the desired conditions necessary to meet the ISO 10005:2015 standard. Notably, nowadays, most Indonesian shipyard quality plans are still based on ISO 9001. The ISO 10005: 2018 standard in preparing quality plans helps the industry maintain product quality so that product results can meet customer specifications by making a Quality Plan design per applicable standards. The conformity of the quality plan is known from direct observation and interviews with several shipyard Directors. The gap analysis from 3 selected shipyards is measured by the percentage of the ISO 10005 clauses that are fulfilled. The results of the gap analysis obtained have also been discussed with experts.

The shipyards were chosen based on their possession of ISO 9001:2015 quality management system accreditation, which demonstrates their adherence to quality standards and their potential influence on controlling and enhancing the production process. The research consists of several steps. The first stage is conducting a literature study on quality plans that have been applied in the shipyard. The second stage is collecting primary and secondary data on the shipyard by conducting a survey. The third stage is identifying the existing quality plan in 3 (three) selected shipyards. The fourth stage is conducting a gap analysis of the existing quality plan with ISO 10005:2018 standards with practices that have been running in the shipyard. The fifth stage is improving the existing quality plan based on ISO 10005:2018.

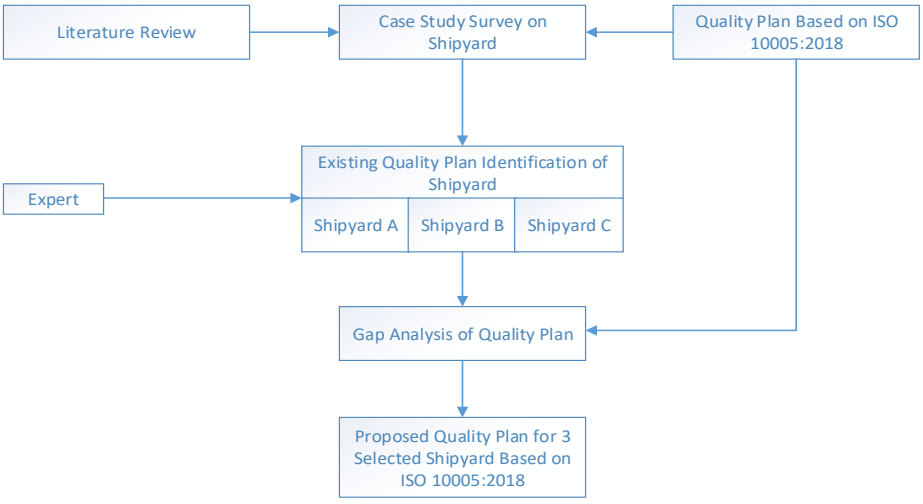

Figure 3. Research methodology diagram

3. Quality Certification and Standards

The International Organization for Standardization (ISO), an international body composed of national standards organizations from more than 160 countries, provides guidance and certification on various subjects. The standards are developed to promote a comprehensive preventive approach and serve as the basis for establishing long-term and sustainable management systems.

Multiple standards exist to ensure product quality, including the ISO 9000 series, which outlines the fundamental principles of a quality management system. These standards set forth the criteria for establishing and sustaining a quality management system, guiding organizations towards sustained success through a quality-focused approach. The ISO 9000 series is applicable to organizations of all sizes, types, and industries [27]. The ISO series 10001 to 10007 offers guidance on various aspects of quality management within an organization. These standards provide assistance in handling complaints related to products, establishing processes for monitoring and measuring customer satisfaction, applying quality management principles in project management, and implementing configuration management practices within the organization [31][32]. In this research, the widely recognized international standards ISO 9001, which are commonly applied in the ship industry, serve as the foundation for the quality management approach.

3.1 ISO 9001:2015

ISO 9001 is a standard that encompasses the essential prerequisites for the implementation of a quality management system, empowering companies and organizations to enhance their operational efficiency and elevate customer satisfaction levels [27]. Quality management in construction companies, particularly in shipbuilding projects, encompasses various elements, including quality improvement, quality planning, quality management systems, quality control, and total quality management [33].

ISO 9001:2015 outlines the criteria for establishing a quality management system within an organization:

a. It is necessary to showcase the organization's capability to consistently deliver products and services that align with customer requirements and relevant laws and regulations.
b. The objective is to enhance customer satisfaction by implementing efficient systems that encompass processes for continual improvement and ensuring compliance with customer expectations and legal obligations.

The requirements outlined in ISO 9001:2015 are universal and designed to be applicable to organizations of any size, type, or industry, regardless of the products or services they offer. This international standard adopts a process-oriented approach that integrates the Plan-Do-Check-Act (PDCA) cycle and emphasizes risk-based thinking. The process approach encourages organizations to plan their processes and interactions effectively. The PDCA cycle ensures that processes are adequately resourced and managed, and opportunities for improvement are recognized and implemented. In summary, the PDCA cycle can be described as follows [27]:

- Plan: Establishes the goals and objectives of the system and its processes, along with the necessary resources to achieve desired outcomes based on customer requirements and organizational policies. It also involves identifying and addressing risks and opportunities.
- Do: Put the planned actions into practice and implement them accordingly.
- Check: Monitor and measure the processes to ensure they are aligned with the planned policies, goals, and requirements. This includes evaluating the activities and outcomes and reporting the results.
- Act: Take appropriate actions to improve the performance of the processes as needed, based on the feedback and insights gained from the monitoring and evaluation stages.

Risk-based thinking allows the organization to identify potential factors that may cause deviations in processes and the quality management system from the intended outcomes. It enables the implementation of preventive controls to minimize adverse effects and capitalize on emerging opportunities.

Additionally, this global standard incorporates the quality management principles outlined in ISO 9000. These principles emphasize customer focus, process approach, engagement of people, leadership, evidence-based decision making, continual improvement, and relationship management. It is essential to emphasize that this international standard does not impose obligatory obligations.

a. For Uniformity in the structure of different quality management systems
b. Alignment of documentation with the article structure and this international standard
c. The use of specific terms from international standards in the organization [34]

3.2 Correlation between ISO 9001:2015 and 10005:2018

ISO 10005:2018, the latest edition of the standard, supersedes and updates the previous edition (ISO 10005:2005) with technical revisions. The primary objective of this standard is to offer guidance on quality plans, whether integrated into a comprehensive quality management system or implemented as an independent management activity. In both scenarios, the quality plan serves as a bridge between the specific requirements of a process, product, service, project, or contract and the relevant work methods and practices. For optimal effectiveness, quality plans should align with other relevant plans [34].

ISO 9001 and ISO 10005 are applied in construction projects to ensure quality standards are met. Quality plans play a crucial role in various projects by helping achieve the desired levels of quality. Although the company's overall Quality Policy may remain consistent, it is important to consider the complexity of individual contracts, supply chains, and the

relevant codes, standards, and legislation. ISO standards are designed around a process-driven approach, which involves systematically identifying and managing processes within organizations and their interactions.

ISO 9001:2015 and ISO 10005:2018 both emphasize the importance of risk-based thinking. However, it should be noted that these standards do not mandate the use of specific formal methods or documented processes for risk management. Instead, the integration of risk management into the overall quality management process is essential. There is a correlation between the two standards, as depicted in Table 1, highlighting their alignment in terms of addressing risk within quality management.

Table 1. Correlation between the clauses in ISO 10005:2018 and ISO 9001:2015 [34]

The clause in this document	Heading	Clause ISO 9001:2015
Clause 5	Development of a quality plan	4.1, 4.2,6.1, 7.1.1, 8.1
Clause 6	Content of the quality plan	7,9,9,10
6.1	General	8.1
6.2	Scope of the quality plan	4.3, 8.2
6.3	Quality plan inputs	8.1,8.2,8.6,9.1.1
6.4	Quality objectives	6.2, 9.1.1
6.5	Quality plan responsibilities	5.3
6.6	Control of documented information	7.5
6.7	Resources	7.1
6.7.1	Provision resources	7.1.1
6.7.2	Materials, products & services	8.2
6.7.3	People	7.1.2, 7.2,7.3
6.7.4	Infrastructure and environment for the operation of processes	7.1.3, 7.1.4
6.7.5	Monitoring and measuring resources	7.1.5
6.8	Interested party communication	7.4, 8.2.1, 8.4.3
6.9	Design and development	8.3
6.9.1	Design and development processes	8.3.1 to 8.3.3
6.9.2	Control of design and development changes	8.3.6
6.10	Externally provided processes, products, and services	8.4
6.11	Production and service provision	8.5.1, 8.5.5,8.5.6
6.12	Identification and traceability	8.5.2
6.13	Property belonging to customers or external providers	8.5.3
6.14	Preservations of outputs	8.5.4
6.15	Control and nonconforming outputs	8.7, 10.2
6.16	Monitoring and measurement	8.1, 8.6, 9.1
6.17	Audits	9.2
Clause 7	Operation and control of the quality plan	7,8,9,10
7.1	Review and acceptance of the quality plan	7.5.2,8.1,8.2.1,8.2.3
7.2	Implementation and monitoring of the quality plan	7.2, 7.3, 7.5.3, 8.1, 9.1.3, 9.2
7.3	Revision of quality plan	7.5.3,8.2.4,8.5.6
7.4	Feedback and improvement	9.3,10.1
Note	Correspondence between clauses does not imply conformity.	

4. Existing Survey

An existing survey was conducted to find out the quality plan clauses based on ISO 10005:2018 that have been applied to a shipyard. The three selected shipyards are shipyards in Indonesia that have implemented ISO 9001:2015, namely shipyards A, B, and C. The structure of the quality plan of 3 selected Indonesian shipyards is shown in Table 2. The contents of the quality plan are evaluated by referencing the guidelines outlined in ISO 10005:2018, particularly focusing on clause 6, which provides detailed information regarding the components of the quality plan.

Table 2. Comparing Quality plans based on ISO 10005:2018 at Indonesian shipyards

ISO 10005:2015	Shipyard A	Shipyard B	Shipyard C
6.1 General	-	-	-
6.2 Scope of the quality plan	√	√	√
6.3 Quality plan inputs	√	√	√
6.4 Quality objectives	-	-	-
6.5 Quality plan responsibilities	√	√	√
6.6 Control of documented information	-	√	√

ISO 10005:2015	Shipyard A	Shipyard B	Shipyard C
6.7 Resources	√	√	√
6.7.1 Provision of Resources	-	-	-
6.7.2 Materials, products, and Services	-	√	√
6.7.3 people	-	-	-
6.7.4 Infrastructure and Environment for the Operation of Processes	√	-	-
6.7.5 Monitoring and measuring resources	√	-	-
6.8 Customers and other interested parties' communication	-	√	√
6.9 Design and development	√	√	√
6.9.1 Design and development process	√	-	-
6.9.2 Control of Design and development changes	-	√	√
6.10 Externally provided processes, products, and services	-	-	-
6.11 Production and service provision	√	-	-
6.12 Identification and Traceability	√	√	√
6.13 Property belonging to customers or external providers	-	-	-
6.14 Preservation of outputs	-	√	√
6.15 Control of nonconforming outputs	-	-	-
6.16 Monitoring and measurement	√	-	-
6.17 Audits	-	√	-

Furthermore, the content of the Quality Plan in each shipyard is different. Shipyard A, clause 6.2, the structure of the contents of the Quality Plan describes the scope of work in the contract and agreement chapter. A simple overview of the requirements for a shipbuilding project can be used as input for the quality plan in clause 6.3. These requirements are described in the technical specifications chapter of the ship to be built, where in the description, there are regulations, conditions, and classifications that must be met. The responsibilities of each person involved in the shipbuilding project, article 6.5, are explained in the form of an organizational structure chart which can explain the reporting lines of the personnel involved in the project. Regarding the control of documented information, clause 6.6 of Shipyard A does not explain how to maintain documents and records of its activities. The keel laying plan and building layout are shown on the quality plan. This is as explained in clause 6.7.4, infrastructure and the environment.

For clause 6.2 on the content structure of its Quality Plan, Shipyard A describes the scope of work in the contract and agreement chapter. A simple review of the requirements for a shipbuilding project can be used as input for the quality plan in clause 6.3. These requirements are described in the technical specifications chapter of the ship to be built, where in the description, there are regulations, conditions, and classifications that must be met. The responsibilities of everyone involved in the shipbuilding project article 6.5 are explained in the form of an organizational structure chart which can explain the reporting lines of the personnel involved in the project. Regarding the control of documented information in Article 6.6, shipyard A does not explain how to maintain documents and records of its activities. The keel laying plans and building layout drawings are shown on the quality plan. This is as explained in clause 6.7.4 regarding infrastructure and the environment. Monitoring and measuring the resources in clause 6.7.5 displays the master schedule and drawing schedule to monitor the progress of the shipbuilding project. However, the quality plan does not show the calibration and verification of the tools used. Clause 6.8.,

Shipyard A lacks a designated representative responsible for communicating with customers or other relevant parties and defining the communication approach. Clause 6.11 Production and service provision, the production process in shipbuilding projects is explained by Strategic Building, Block Division & Erection Sequence, and Sequence Assembly. The Quality Plan has an Inspection Test Plan chapter to ensure the shipbuilding requirements are met, clause 6.12. For Clause 6.16, Monitoring and measurement, it is necessary to determine what needs to be monitored and measured in implementing a shipbuilding project in the Quality Plan, which displays an inspection test scheme and a list of inspection tests.

Shipyard B, for clause 6.2, directly explains the project's purpose, scope, and description in its Quality Plan. Clause 6.3, a list of references is displayed as a reference in the shipbuilding project. In Clause 6.5, the responsibilities of each person are explained in the form of an organizational structure chart. Clause 6.6 describes the personnel in charge of maintaining the shipbuilding project documents. Clause 6.7.2 explains the specification, purchase, control, and storage of materials to be used. Clause 6.8 explains that the Quality Plan includes project correspondence. In Clause 6.9.1, the quality plan must consider specifications, quality characteristics, and applicable regulations. If there is a change in design and development, it must be stated in the Quality Plan how it will be controlled, reviewed and who has the authority to approve or reject changes. Shipyard B states this in the contract review chapter. The Inspection Test Plan chapter is also shown for clause 6.12 and clause 6.16. To monitor the implementation and effectiveness of its quality plan, Shipyard B describes in detail the conduct of internal audits and management review, clause 6.17.

Shipyard C, for clause 6.2, directly explains the project's purpose, scope, and description in its Quality Plan. Clause 6.3, a list of references is displayed as a reference in the shipbuilding project. Clause 6.5 explains the responsibilities of each person in the form of an organizational structure chart. Clause 6.6 describes the personnel in charge of maintaining the shipbuilding project documents. Clause 6.7.2 describes the specification, purchase, control, and storage of the material

used. Clause 6.8, Quality Plan, includes project correspondence. Clause 6.9.1 must consider specifications, quality characteristics, and applicable regulations. If there is a change in design and development, it must be stated in the Quality Plan how it will be controlled and reviewed and who has the authority to approve or reject changes. Shipyard C states this in the contract review chapter. The Inspection Test Plan chapter is also shown for clause 6.12 and clause 6.16.

5. Proposed Quality Plan

The Quality Plan should be adaptable, capable of accommodating changes that may arise during production. To ensure smooth implementation, any changes to the plan should be approved by the stakeholders and communicated efficiently to the project team. In order to achieve the desired outcomes, the plan should exhibit a seamless integration among project personnel, inspections, audits, tests as well as the management of records and reports. In the case of a shipyard implementing ISO 9001, it is necessary to develop a quality plan that aligns with the standard's requirements for every shipbuilding project. ISO 10005:2018, which provides guidelines for quality plans, can be used as a standalone reference document, separate from ISO 9001.

The quality plan has been formulated by drawing insights from shipbuilding industry practices and adhering to ISO 10005:2018 guidelines. It aims to be applicable across various shipbuilding processes. Taking into account the identified clauses, a comprehensive set of quality plans is established. During the development of the Quality Plan, careful consideration is given to potential risks that could impact the quality of the project. The project manager takes the responsibility of identifying, analyzing, and addressing risks associated with the project. These risks are thoroughly evaluated and suitable measures are determined to minimize or eliminate them. It is crucial to integrate this risk management plan with the Quality Plan and establish a strong connection between the two. The concept of risk ownership holds significance in quality-related activities, as risks related to failures and non-conformance are frequently linked to inadequate quality management. The following clauses need to be added to improve the quality plan for shipyards A, B, and C.

Clause 6.4, Quality objective, explains that a quality plan should include quality objectives in shipbuilding projects. The company should clearly articulate its quality objectives, emphasizing the significance of the quality plan and the implementation of supervisory, monitoring, and testing processes during the shipbuilding site operations. The quality objectives encompass aspects such as functionality, suitability for the intended purpose, safety, feasibility of construction, and timely delivery of services. It is crucial to ensure that accurate and timely information is provided to the job site, without any delays in the approval and sign-off processes related to shipbuilding activities.

Clause 6.7.1, Provision of resources, the three chosen shipyards do not include internal and external resources used in the shipbuilding project. The effectiveness of the quality plan in handling change orders is greatly dependent on the competence of both the on-site workforce and the managers/supervisors involved. Their expertise and skills play a crucial role in ensuring the effective implementation of the quality plan and successfully managing any changes that may arise. Clause 6.7.3, People, the quality plan must detail the competencies required in the shipbuilding project. The three chosen shipyards did not detail the competency of the personnel but only explained the duties and responsibilities of the personnel involved in the shipbuilding project.

Clause 6.10, Externally provided processes, products, and services, the three selected shipyards do not include provisions for processes, products, and services provided externally in their quality plan documents. The Quality Plan should include comprehensive information about temporary works, including the monitoring and inspection processes. Temporary works should be in line with a design brief and undergo independent verification of their design. Regular inspections are carried out during the erection or installation phase to ensure compliance with temporary works legislation. Early consideration in the project lifecycle is essential for addressing the requirements and effectively managing temporary works. The specialized contractor is responsible for submitting a site-specific quality control plan to the quality control manager/supervisor for approval prior to initiating work. This plan should outline the methods, inspections, and testing procedures to be employed.

Clause 6.13 Property belonging to customers or external providers regarding products and services provided by external providers is not included in the quality plans at the three selected shipyards. Even though off-site manufactured components/modules undergo rigorous quality controls at the factory, they require vigilant supervision upon arrival on-site to ensure consistent quality. If any guarantee or warranty is provided by the factory, they may require the installation to be carried out by specialist contractors. The seamless integration of these components/modules into the existing framework on-site is vital to ensure they are fit-for-purpose.

Clause 6.15, Control of nonconforming outputs. The three selected shipyards do not include procedures for controlling nonconforming output. All instances of non-conformity are documented and addressed in accordance with the procedures outlined in the Quality Policy. Regular follow-up inspections are conducted to verify that the work aligns with contractual and compliance standards. Each shipyard faces its own distinct challenges. Quality control, quality assurance, and quality management are integral to all aspects of shipyard operations, serving as the foundation for safety, innovation, and the effective utilization of technology. The primary objective of quality is to surpass customer expectations and ensure their satisfaction.

The pursuit of quality management necessitates the cultivation of a proactive mindset that prioritizes problem prevention. By taking preventive actions, the overall cost of quality can be minimized. Adopting a cost-of-quality approach enables a company to evaluate the resources invested in averting subpar quality, as it is an expense that yields no benefits to anyone involved. Achieving accuracy from the outset brings about financial savings, reduces stress, and ultimately results in customer satisfaction. The advantages of formulating a quality plan encompass enhanced trust in meeting

requirements, heightened certainty in process control, and the potential for motivating individuals involved. Moreover, it can shed light on prospects for innovation and improvement, including [35] :

- Enhances operational efficiency and productivity
- Minimizes variation, waste, inefficiencies, and defects
- Fosters continual improvement in facilities
- Enhances consistency and stability of processes
- Boosts supplier performance
- Enhances profitability
- Increases customer confidence and satisfaction
- Ensures compliance with quality requirements
- In one hand, it brings some good impact on day-to-day operation, such as [35]
- Ensures efficiency and effectiveness of processes
- Streamlines processes, resulting in cost reduction
- Ensures smooth flow of outputs from one department to the next, serving as inputs
- And in another hand, it also bring some good impacts on customers, include [35]
- Formal recognition and management of customer needs and expectations
- Formal procedures for addressing customer complaints
- Effective communication loop established with customers
- Defined metrics for measuring customer satisfaction

6. Result Discussions

A quality plan serves as a vital instrument within a comprehensive quality management program. By effectively outlining areas for enhancement, it enables progress monitoring towards organizational goals. To craft a successful quality plan, it is crucial to first establish organizational objectives and subsequently execute the plan meticulously. Additionally, the quality plan should address customer expectations and delineate strategies to ensure customer satisfaction. In cases involving intricate products or projects, a tailored quality plan may be necessary to cater to their unique requirements.

Developing a quality plan brings forth various advantages, including heightened confidence in meeting requirements, enhanced control over processes, and increased motivation for stakeholders. Additionally, it can shed light on possibilities for innovation and improvement. The essence of a quality plan lies in its continuous development, aligning with identified needs. This is particularly crucial during the early stages of a company's operations, where notable progress is expected. The adaptability of the quality plan is key, allowing for easy modifications to address emerging needs and accommodate the anticipated growth of the company.

Based on the comparison results of quality plans based on ISO 10005:2018 in Indonesian shipyards with shipyard surveys that have been carried out, it can be seen the percentage of ISO 10005:2018 clauses that have been fulfilled by each shipyard. There are 11 corresponding clauses in shipyard A equivalent to 45.83%. Meanwhile, shipyard B has 12 clauses or the equivalent of 50%, and shipyard C has 11 clauses equivalent to 45.83%. In accordance with the objectives of this study, the contents of the quality plan need to be revised by creating a reference framework for the contents of the quality plan in accordance with clause 6 (24 clauses) of ISO 10005:2018.

Shipyard A lacks a designated representative for customer communication and defining the approach. Their Quality Plan addresses production processes and monitoring but lacks a clear structure for responsibilities and references. Shipyard B and Shipyard C have similar structures in their Quality Plans. They both articulate project details, responsibilities, document management, material specifications, handling changes, and inspection testing, with Shipyard B further detailing internal audit procedures and management reviews for quality plan implementation. Both B and C provide comprehensive quality plans with clear organizational structures and procedures.

To improve the quality plan, this research provides several clauses to complete the existing quality plans of Shipyards A, B, and C so that they comply with ISO 10005 standards. Based on the comparison results of quality plans according to ISO 10005:2018 in shipyards A, B, and C, the recommendation is to integrate distinct clauses (6.4, 6.7.1, 6.7.3, 6.10, 6.13, and 6.15) to improve the quality plans across these specific shipyards. The key practical contribution of this research lies in offering guidance for shipyards seeking to independently integrate their certifiable management systems and enhance their customer support processes. The findings serve as a useful reference for shipyards aiming to overcome obstacles and improve their overall operations. The future work requires to implementing of the proposed quality plan in Shipyards A, B and C to ensuring quality is of utmost importance for the shipbuilding sector, as it involves addressing both the quality of processes and the final products to achieve efficient and cost-effective manufacturing.

Hence, the novelty of this research lies in the systematic approach, identification, and alignment of the most frequently integrated clauses. This facilitates the integration process for businesses and provides a foundation for future studies in this area. The readiness score is measured under the assumption that the weight of all clauses is equal. Further research needs to provide higher weighting to clauses that have a major impact on the end product. By observing 3 selected shipyards, this proposed quality plan based on ISO 10005:2018, guidelines has been made for application of shipyards in Indonesia. In further research, the proposed quality plan that has been implemented will be examined for its effectiveness on quality, cost, and delivery in the ship production process.

7. Conclusion

The research emphasizes the significance of a well-structured Quality Plan in shipyard operations, focusing on compliance with ISO standards, customer satisfaction, and adaptability to changing needs. The comparison of Indonesian shipyards reveals varying levels of adherence to ISO 10005:2018, prompting proposed improvements for alignment. Based on the comparison results of quality plans according to ISO 10005:2018 in shipyards A, B, and C, the recommendation is to integrate distinct clauses (6.4, 6.7.1, 6.7.3, 6.10, 6.13, and 6.15) to improve the quality plans across these specific shipyards. The study's contribution lies in refining customer support processes and providing a reference for operational enhancement. Implementing proposed plans in these shipyards is essential for efficient, cost-effective, and high-quality shipbuilding. The research's novelty is in systematically aligning integrated clauses, laying the groundwork for future studies. Future research should consider weighting clauses based on their impact on the final product. The proposed ISO-based quality plan offers a framework for Indonesian shipyards, to be evaluated for its effectiveness in subsequent studies.

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