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Information System Design for Material and Interim Product Store Department in an Indonesian Small Shipyard

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Abstract

The ship production process at shipyards involves complex and critical information that must be managed effectively to ensure timely project completion. Ambiguities or delays in information exchange among departments can result in project setbacks and increased costs, which reduce revenue and undermine competitiveness. To address this, each department involved in ship construction must adopt an information system that ensures efficient communication both internally and across departments. Key information includes requirements for raw materials, consumables, workforce, production facilities, equipment, and the production methods used at each stage—factors that directly affect cost allocation. In many small shipyards across Indonesia, information is still processed and shared manually, leading to significant delays and inefficiencies. There is an urgent need for a digital information system tailored to the specific functions of each department and designed to facilitate smooth interdepartmental interaction. However, prior to system development, it is essential to understand and map the information flows within and between departments. This study focuses on the materials and interim products department, a critical part of the ship production process. The aim is to identify and map the internal information flows of this department and propose a suitable digital information system for implementation in small-scale Indonesian shipyards. By doing so, the research contributes to improving production efficiency and supports digital transformation in the domestic shipbuilding industry.

Keywords: Information System; Small Shipyard; Material and Interim Product Store Department; Interdepartmental Communication; Information Flow Mapping; Digital Transformation

1. INTRODUCTION

Indonesia is home to approximately 250 shipyards, most of which are classified as very small shipyards with production capacities below 1,000 GT [1], based on Schlott's shipyard classification [2]. These shipyards primarily focus on ship repair and new ship construction, utilizing production methods such as the Hull Block Construction Method (HBCM) and pre-outfitting. In contrast, modern shipyards around the world have adopted more advanced technologies, such as Integrated Hull Construction, Outfitting, and Painting (IHOP), to improve their shipbuilding processes [3].

Despite their potential, Indonesian small shipyards face various internal and external challenges that hinder their productivity and competitiveness. Studies have suggested strategic solutions such as enhancing production technologies, integrating digital systems, and fostering collaboration within maritime industry networks [4][5][6]. Among these, the integration of digital information systems and increased adoption of ship production technologies have resulted in improved efficiency and accuracy [7][8]. The benefits of digital transformation in shipbuilding are evident; for instance, Hyundai Heavy Industries utilizes real-time data and digital twins to optimize its production processes, achieving a 15% reduction in material waste. Similarly, Fincantieri's use of AR/VR-based planning simulations reduced processing time by 20%, while IoT applications have led to fuel savings of up to 15% [9]. Moreover, digital twin technologies implemented in large shipyards have enhanced production flexibility and speed [10]. Other innovations include the Virtual

Assembly Activation System for Shipbuilding (VASSS), which simulates crane operations and block erection [11], as well as integrated systems to oversee new ship constructions across multiple shipyards [12]. Given these advancements, the development of a digital information system tailored to small shipyards could offer significant benefits, especially for those with similar production capacities. Such a system would support the implementation of computerized processes throughout the shipbuilding cycle. It also facilitates timely and accurate coordination between departments—from design to finishing—by ensuring a smooth flow of critical information [13][14].

The ship production process itself consists of several interdependent stages that must be executed sequentially: design, steel cutting and fabrication, base structure assembly, hull construction, machinery installation, piping, and finishing [15]. Each stage involves multiple departments, including design, production, logistics, marketing, and quality control, which require specific yet interconnected information such as material specifications, labor needs, and appropriate work methods. In the absence of an integrated information system, delays, duplication, and production errors often occur, negatively impacting product quality, project schedules, and overall costs [16][17].

Therefore, the complexity and dynamic nature of ship production demand a well-integrated and accurate information system [18][19]. The adoption of such systems is essential for small shipyards to adapt to a digital environment and maintain global competitiveness [20]. However, many small shipyards in Indonesia have not been able to implement integrated systems like those in larger yards due to limitations in resources and digital infrastructure [21]. A practical approach to overcoming this barrier is to initiate digital transformation gradually, beginning with operational units that involve high-frequency data interaction. The Material and Intermediate Product Store Department is one such strategic unit, as it plays a central role in managing internal logistics and maintains direct interaction with nearly all other divisions.

The implementation of a digital information system in this department is projected to yield substantial improvements in operational efficiency. Prior studies report outcomes such as a 65% improvement in lead time and enhanced communication speed by warehouse management systems (WMS) [22]. Additionally, RFID-based warehouse management has been shown to increase warehouse capacity from 7,200 to 10,980 cartons, reduce loading time from 50 minutes to 18 minutes, and cut the number of required workers from 8 to 4. Inventory accuracy has also improved significantly—from 80% to 99%—while loading and offloading times were reduced from 60 minutes to just 20 minutes [23].

This digital system also accelerates the response to material requests from production lines, as availability data and request histories can be accessed in real time by relevant divisions [24). In the same vein, the system serves as a reliable reference for work plan preparation, helping to minimize schedule disruptions caused by logistics errors common in manual systems [25). Consequently, such systems not only streamline work processes but also reinforce coordination among departments.

Lastly, developing this digital system forms the initial foundation for broader information system integration across departments within the shipyard. A bottom-up development strategy has proven more effective for organizations with low digital readiness [26]. Hence, the primary focus of this research is to design a digital information flow system for the Material and Intermediate Product Store Department as the first step toward establishing a fully integrated shipyard information system. However, this effort must be grounded in a development methodology that aligns with the unique conditions and constraints of small Indonesian shipyards [27].

2. METHODS

The general framework of information flow within the Material and Intermediate Products Department has been previously identified by Firmansyah et al. [17]. The overall flow of information entering and exiting this department has been mapped (see Figure 1). Incoming information to this department originates from the Design and Production Planning Department, the Facility Management Department, and the Quality Control/Quality Assurance (QC/QA) Department. Outgoing information from this department is directed to the QC/QA Department, the Production Department, and the Executive Management, respectively.

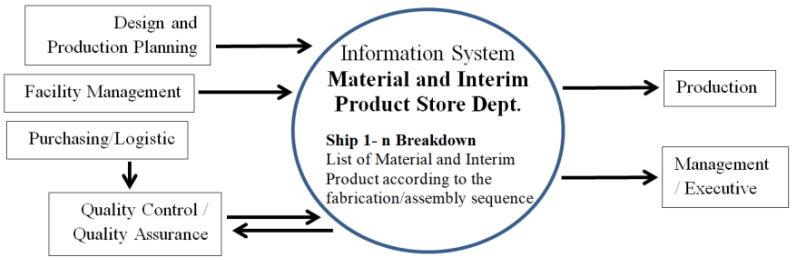

Figure 1. General framework of information flow in the Material and Interim Products Department [17]

This study collected data from the material and interim products department involved in the shipbuilding process in a small shipyard in Indonesia. Data was gathered through interviews with the department head. The study meticulously identified the flow of information entering this department from other departments and the information outputs to other departments involved in the shipbuilding process. The results of this detailed identification were then used to design a digital information system for this department.

3. RESULTS AND DISCUSSION

3.1 Information flow in the material and interim product department

During shipbuilding, the material and interim product department generally exchanges information with the logistics, production, QA/QC, and facility departments. The information flow diagram is shown in Figure 2.

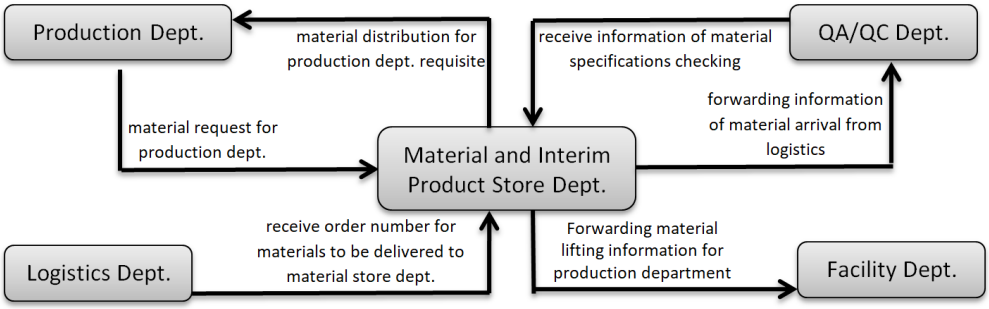

Figure 2. Information flow at material and interim product department in an Indonesian small shipyard

Based on information from the design and planning department, the logistics department provides details related to the list of materials purchased for a specific shipbuilding project. Upon the arrival of materials, the QA/QC department inspects their compliance with the material standards established by classification societies and government regulations. Following this inspection, the facility department is notified to transfer the incoming materials to the material and interim product department. The production department subsequently utilizes these materials to construct the ship according to the predetermined shipbuilding schedule.

3.2 System Design

To facilitate smooth information flow to and from the material and interim product department and based on the identified flow of incoming and outgoing information, the system design for this department can be broadly described as follows: materials in the department are categorized into stock materials and project-specific materials. Accordingly, the application's information forms are divided into two types based on these material characteristics.

For instance, data on incoming and outgoing materials is separated into two categories: for projects and for stock. The application enables users to view project-specific and stock material data information. Additionally, it includes a feature to monitor minimum stock levels and initiate material restocking.

The application also features an interface for managing information flow with other departments connected to this department, such as the logistics department for material arrival updates, the QA/QC department for

inspection and quality reports, and the production department for material requests related to the shipbuilding process.

The system's main menu (Figure 3) displays a dashboard and sub-menus for accessing material data stored in both open and closed warehouses. Users can view incoming and outgoing materials and specify whether the materials are intended for stock or project use. Moreover, the main menu facilitates interaction with other departments associated with the material and interim product department.

Figure 3. Main menu of the information system for the material and interim product department.

Figures 4, 5, and 6 depict interfaces for the logistics, QA/QC, and production departments, which are integrated with the material and interim product department.

The interface for the logistics department (Figure 4) provides information on materials ordered based on purchase orders (POs), including supplier details, order dates, and material arrival times. This interface also allows the flow of information to the QA/QC department for incoming material inspections.

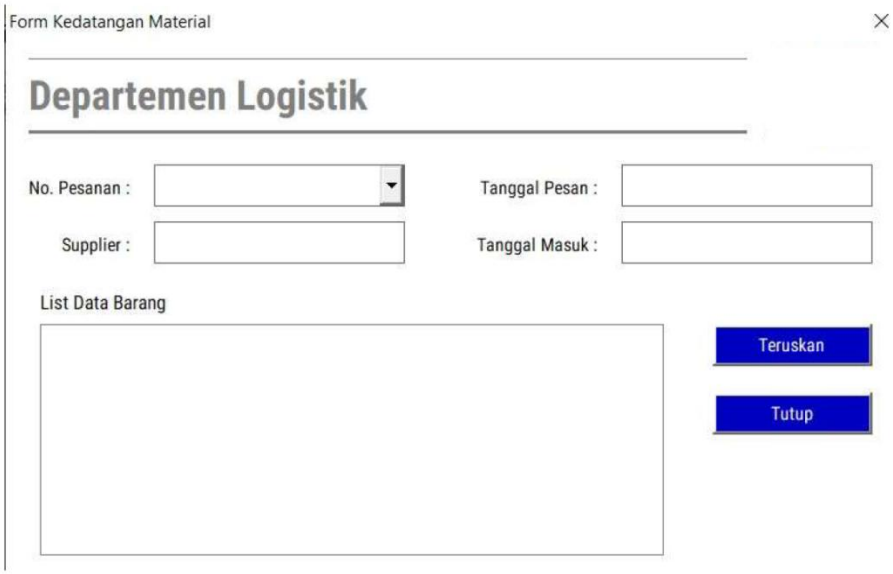

Figure 4. Logistics department connection interface for the material and interim product department.

The QA/QC interface (Figure 5) displays inspection results for material specifications and quality received from the QA/QC department. This information determines whether the materials can be accepted into the warehouse. Users can filter inspection results by Purchase Order (PO), project name, type, or supplier. Approved and rejected materials are listed, with reasons for rejection based on shipyard specifications and requirements.

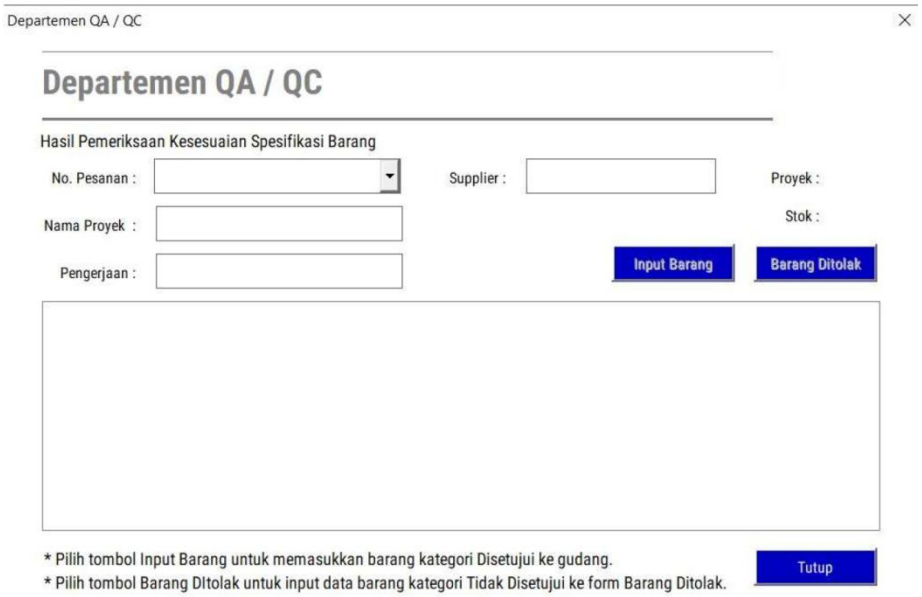

Figure 5. QA/QC department connection interface for the material and interim product department.

The production department interface (Figure 6) displays project material data available in the warehouse. This information includes material requests from the production department for ship construction projects. In addition, on this form, all project material data in the warehouse can be displayed. It also incorporates requests to use shipyard crane facilities to transport materials from this department to project sites.

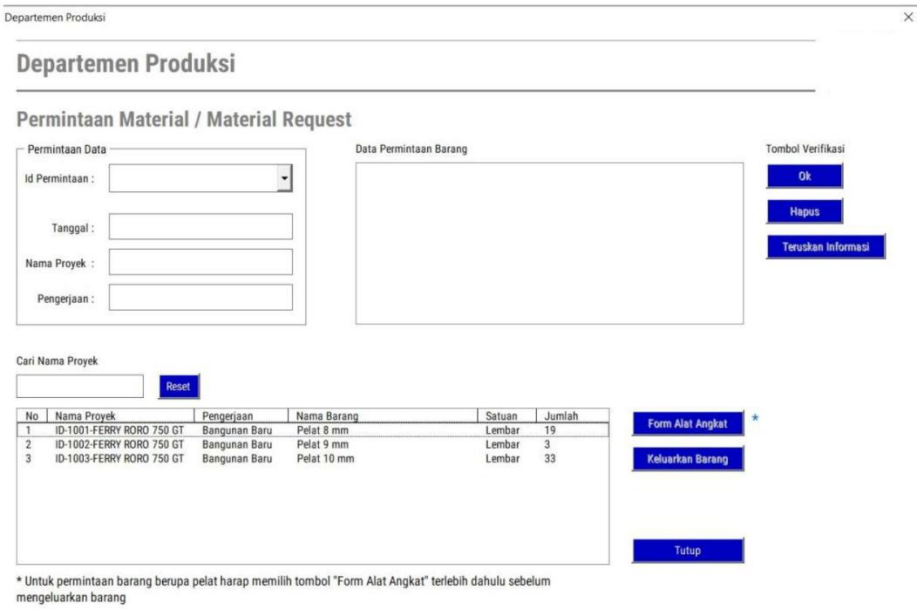

Figure 6. Production department connection interface for the material and interim product department.

3.3 Case Study: Materials for the Construction of Ferry Ro Ro 750 GT

The object of the material in the case study for implementing the information system in this research focuses on the required material of HS-04 block of the Ferry Ro-Ro 750 GT. Block HS-04 is one of the blocks derived through the *Product Work Breakdown Structure* (PWBS) method for the Ferry Ro-Ro 750 GT (Figure 7). The ship construction method employed by a small shipyard in Indonesia adopts the *Hull Block Construction Method* (HBCM), in which the ship is broken down into blocks, sub-blocks, panels, and down to the smallest construction components before construction can proceed.

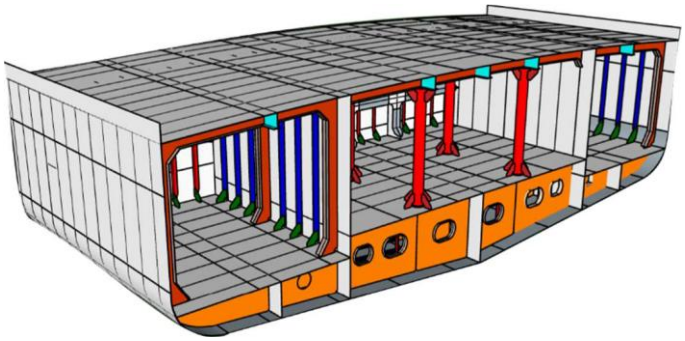

Figure 7. Block HS-04 Construction of the Ferry Ro-Ro 750 GT

Based on this breakdown, material requirements for block HS-04 include plates of various thicknesses, L-profiles, welding electrodes, and paint. The material requirements, such as plates obtained from the nesting plan, are summarized in Table 1.

Table 1. Material requirements for the construction of Block HS-04 of the Ferry Ro-Ro 750 GT.

Materials	HS-04 block material requirements of Ferry Ro-Ro Ship 750 GT	
	Number of unit	Unit
Plate 20 ft thickness		
8 mm	19	Sheet
9 mm	13	Sheet
10 mm	33	Sheet
12 mm	2	Sheet
Profile L (6000x75x7) mm	56	Bar
Electrode (Ø 4mm)	58	Box @5 kg
Paint		
Primer Coat	7	Can @20 ltr
Sealer	1	Can @20 ltr
Anti Fouling	1	Can @20 ltr

3.3.1 Input Data for the Informatin System

Input of incoming materials for project needs

Before items are recorded in the warehouse database, the QA/QC department's inspection results must be received. This information categorizes items into two groups: approved items, which can be stored in the warehouse, and rejected items. The QA/QC department's information is displayed in Figure 8.

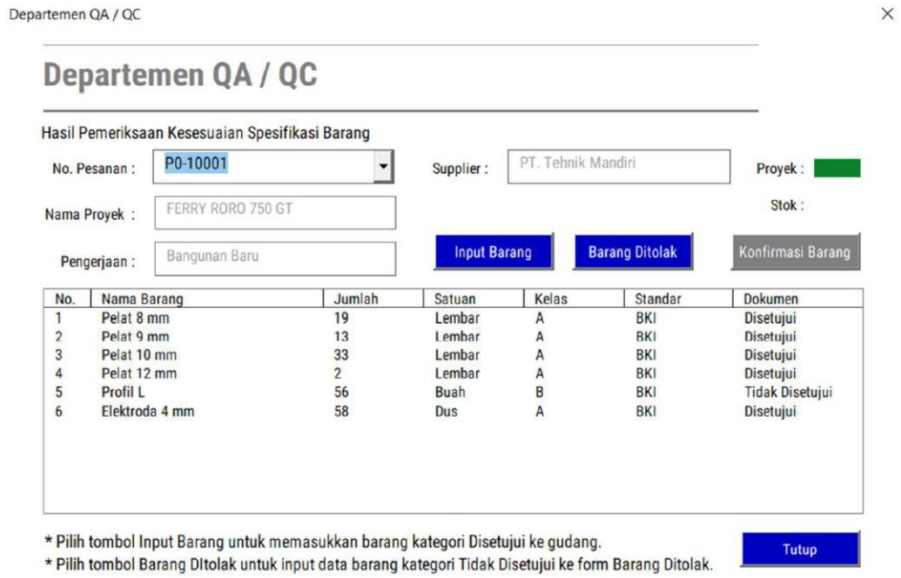

Figure 8. Incoming information display from the QA/QC department

The interface includes two buttons: "Input Items" and "Rejected Items." The "Input Items" button records approved items into the warehouse database, while the "Rejected Items" button displays a list of rejected items. Once the items are entered, the project-related items in the warehouse database can be accessed to review all recorded materials (Figure 9).

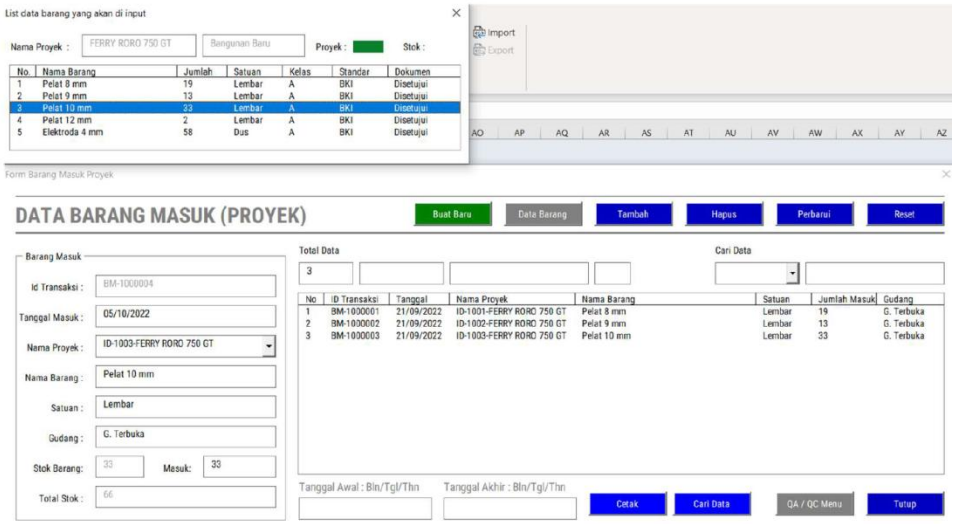

Figure 9. Input display for incoming materials

Input of outgoing materials for project needs

The process of releasing items begins with a material request from the production department. This request includes the details of materials required for production purposes. The warehouse verifies whether the requested items are available. The verification results are forwarded to the production department. Once verified, the materials can be released by entering the outgoing data into the system (Figure 10).

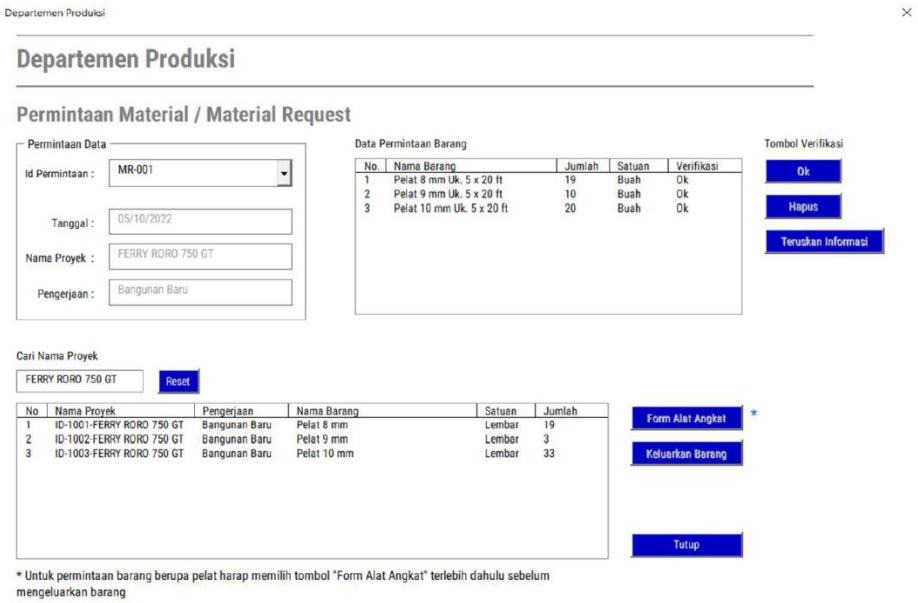

Figure 10. Material request information from the production department

Material release for production requires assistance from shipyard lifting equipment. Requests for these facilities are also processed through the same form (Figure 11).

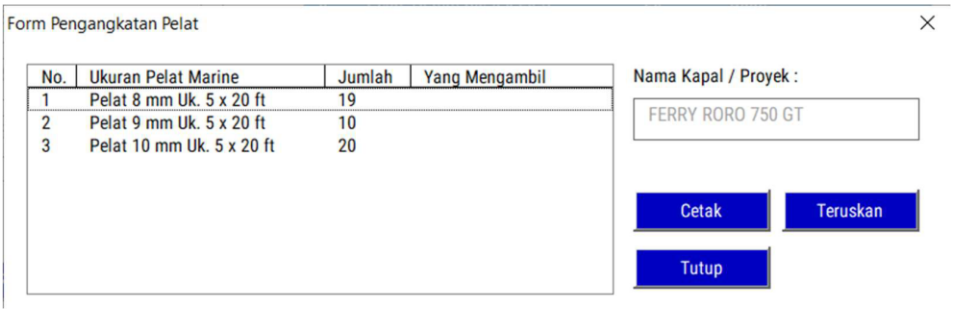

Figure 11. Material transfer request information for plates

Input Form for Purchase Requests

The current stock information in the warehouse database is accessible through the system. The developed information system automatically displays real-time stock status. If a material's availability falls below the minimum stock level, the system will notify the warehouse management automatically. This notification prompts the warehouse management to inform the logistics department to initiate material restocking (Figures 12 and 13).

Figure 12. Low Stock Notification on the Dashboard

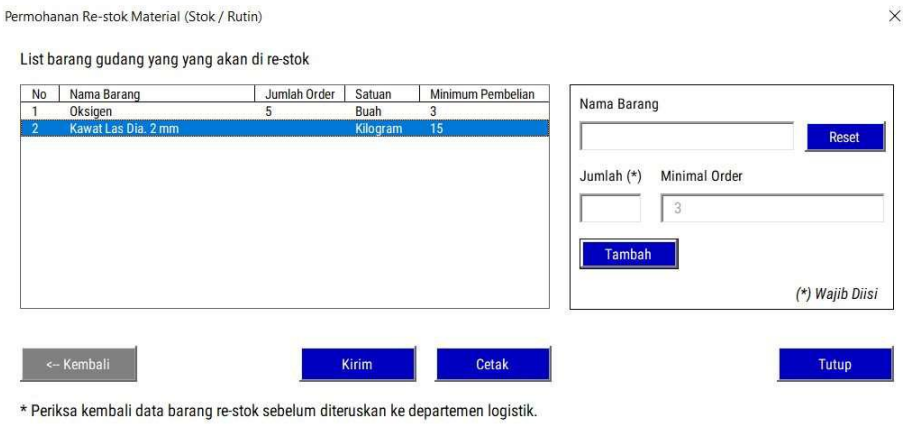

Figure 13. Restock Request Form for Materials with Low Stock Levels

3.4 Discussion

Small shipyards in Indonesia generally still rely on manual information systems in each department for shipbuilding and repair processes and have yet to adopt digital information systems. The evidence is based on the data collection and storage methods, which are still based on manual records in physical documents. Consequently, data management and decision-making efficiency remain low due to scattered data across various departments needing proper integration and coordination. These challenges lead to delays in tasks and increased costs and ultimately affect the overall productivity and profitability of the shipyards.

Shipyards must implement digital information systems in shipbuilding processes to address the challenges, adopting such systems will make shipyard operations more efficient, accurate, and sustainable [28]. Data collection and storage are conducted through computer-based systems, allowing for secure and swift access

[29]. Additionally, decision-making processes can be expedited based on data stored in a centralized database, which can be seamlessly integrated with various departments in the shipyard [29].
Regarding material inventory and demand forecasting, manual systems need help identifying material usage trends. In contrast, digital systems can predict stock requirements, optimize warehouse capacity, and reduce storage costs. Although implementing digital information systems requires significant initial investment for system design, operational costs are expected to decrease over time due to increased efficiency. Moreover, adopting digital information systems will generally enhance the competitiveness of small shipyards in responding to the globalization challenges in the maritime industry.

4. CONCLUSION

The information system developed in this study focuses solely on the Material and Interim Product Store Department of a small shipyard in Indonesia. This department plays a central role in the internal logistics flow and interacts closely with several other departments, namely the Production, Logistics, and Quality Assurance/Quality Control (QA/QC) departments. Information received from the Production Department primarily consists of requests for material release from the warehouse to support ship production activities. From the Logistics Department, the warehouse receives schedules of material arrivals based on existing purchase orders (PO). Meanwhile, the QA/QC Department provides inspection results related to the specifications and quality of newly arrived materials.
In turn, the warehouse disseminates information to support decision-making and coordination across departments. This includes the verification results of material requests received from the Production Department, ensuring that requests are valid and in line with inventory availability. The warehouse also forwards material arrival notifications from the Logistics Department to the QA/QC Department to initiate quality inspections. Additionally, it transmits instructions to the Facilities Department to coordinate the lifting and handling of plates from storage. Finally, the warehouse sends confirmation of the inspected material reception to the Finance Department to support payment processing and inventory tracking.
It is important to note that the system developed in this study is still at the design stage and has not yet been implemented or tested in a real operational environment. This limitation reflects pragmatic constraints in terms of available resources and infrastructure, which are common challenges in small shipyard contexts. Nevertheless, the design process was carried out carefully, using real-world data and workflow insights gathered directly from the Material and Interim Product Store Department of an actual Indonesian small shipyard. This ensures the relevance and applicability of the system in practice.
Looking forward, to fully realizing the benefits of this digital information system, it is essential that all departments involved in the shipbuilding and repair processes implement interconnected systems. However, achieving such full-scale integration in small Indonesian shipyards poses significant challenges, including the need for substantial effort, procedural changes, and financial investment. Despite this, the application of the system at the departmental level represents a clear and concrete initial step toward the adoption of a fully integrated digital information system. This gradual implementation strategy, aligned with the shipyard's financial and operational capacity, provides a realistic and practical pathway for achieving comprehensive digital integration over time.

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