International Journal of Manufacturing Economics and Management
ISSN 2784-1278 ISSN-L 2784-1278, Vol. VI, No. 1 / 2026
https://doi.org/10.54684/ijmem.2026.6.1.14

COMMENTS ON MAINTENANCE ACTIVITIES CARRIED OUT ON BOARD SHIPS AND IN SHIPYARDS

Elisabeta Buzilă[1], Mihaela – Greti Manea[1], Emil Manea[2], Paul Burlacu[1], Alexandru Pintilie[1]

[1]"Mircea cel Bătrân" Naval Academy, Fulgerului Str., No. 1, 900218, Constanța, Romania
[2]Constanta Shipyard SA, Constanta, Romania, Greece Branch Office, Lagoumizi Str., No.24, Athens, Greece

Corresponding author: Elisabeta Buzilă, burlacu.elisabeta@gmail.com; elisabeta.buzila@anmb.ro

Abstract: The operation of ships in demanding and dangerous hydrometeorological conditions contributes significantly to the structural damage of both the hull and the on-board systems and equipment, which inevitably leads to the shortening of the ship's technical compliance period. In addition, there are several economically disruptive factors, such as the evolution of the prices charged by shipyards for the execution of maintenance and repair works, or the prices in the market for the acquisition of the material resources necessary for these works. Classification societies are the ones that impose, through specific rules, the maintenance standards for ships. To ensure compliance with the requirements, ship owners and operators must demonstrate that their ships are in satisfactory technical condition and are properly maintained. The challenges posed by meeting maintenance standards on board ships are generated by the constant change of location (port of operation) and the absence of offshore service stations. Therefore, the planning and execution of maintenance activities are of critical importance. Maintenance and repair work required to be carried out in accordance with maritime vessel maintenance management systems cannot be fully performed without resorting to a shipyard for dry-docking. Dry-docking is carried out at predetermined time intervals because of the need to comply with the standards imposed by classification societies regarding the integrity of the vessel's underwater hull and/or the functionality of onboard systems, installations, and equipment. An important issue concerns the planning of activities to be carried out in the shipyard, both with the vessel in dry dock and alongside the quay. The management of shipping companies must take measures to improve and develop maintenance management systems both on board vessels and during dry-docking periods. Consequently, maritime shipyards must also undergo processes of transformation, adaptation, and improvement of organizational performance to meet customer requirements. This paper aims to highlight certain aspects related to both on-board vessel maintenance and the management of maintenance and repair works carried out with the vessel in dry dock in shipyards. Issues related to corrective, preventive, predictive maintenance, as well as reliability-centered maintenance, are addressed.
Keywords: shipyards, onboard maintenance, repair activities, shipyards management.

1. INTRODUCTION

Maintainability [1], refers to the total set of actions carried out to maintain a product. To evaluate it, one must know both the frequency of these actions (which depends on the frequency of failures) and the distribution of the time required to perform them. One of the major causes of maritime accidents is improper maintenance and poor-quality repairs of the ship's hull and onboard equipment during operation. As noted by the authors of study [2], who conducted a probabilistic analysis (using the Fisher distribution curve) of the occurrence density of failures caused by these factors, inadequate maintenance plays a significant role. Existing literature often presents results that focus on the maintenance of specific onboard equipment and systems. Maintenance as an integrated process has been less explored, likely due to its inherent complexity. In this paper, several findings relating to the Planned Maintenance System are discussed.

As highlighted in [3], effective computer-aided maintenance planning requires accurate, complete, and up-to-date databases. These databases must be easy and fast to use, without requiring highly specialized personnel, and the software must be compatible with any type of maintenance planning approach. In the same direction, paper [4] proposes the use of a specialized test designed to assess the quality of a database used for maintenance planning. The authors focused on evaluating the Planned Maintenance System as a whole, diagnosing the associated database, establishing a standard for improving database quality, and identifying the issues encountered during its development.

Recognizing the complex challenges involved in planning ship maintenance activities (often caused by insufficient or outdated databases), the authors propose an interesting solution for modernizing ship repair and

maintenance operations by leveraging advanced technologies such as Digital Twins (DTs) and the Internet of Things (IoT), which enable efficient, real-time data collection, [5]. In their study [6], Mihanovic, Ristov, and Belamaric examine new information technologies that can be integrated into the Planned Maintenance System. Technologies such as cloud computing and advanced diagnostic tools enhance the use of computerized systems in the maritime sector, leading to more effective maintenance of onboard systems and equipment and improving the reliability and availability of ship systems.
To further support planned maintenance activities, Japan conducted the Digital Twin for Ship Structures (DTSS) project [7], which analyzed fatigue phenomena and structural stress responses under real navigation conditions by combining hull monitoring with numerical simulation techniques. The authors of [8] explore examples and analyses of various repair and maintenance strategies, including corrective; predetermined (inspection-, usage-, and time-based); proactive (risk-based and reliability-centered); predictive (condition-based and prognostics and health management); and prescriptive approaches. For each strategy, the authors present process diagrams that can be applied in computer programming.
The present work follows the same direction, focusing on the schematization of processes involved in maintenance activities both onboard ships and within shipyards—a topic continuously explored in the authors' previous research, [9–13]. The significance of process schematization (and thus the novelty of this work) becomes clear when viewed through the lens of Enterprise Resource Planning (ERP) systems, which integrate software solutions to support the management and automation of shipyard processes, including maintenance operations.

2. MATERIALS AND METHODS

2.1. Theoretical considerations

Qualitatively, maintainability is the capability of a product to be inspected, maintained, and repaired within a specified period and under defined conditions. The main quantitative indicators of product maintainability are, [14]: the maintainability function, the mean repair time, and the repair rate.
The maintainability function considers the "Recovery Time" of a defective product as a random variable. If M(t) represents the probability that the product is restored within the time interval [0, t], then the maintainability function of the product over that interval is expressed in its general form as follows:

$$M(t) = P(T < t) \tag{1}$$

If the number of repairs per unit of time is a constant quantity, μ, then the probability of achieving maintenance increases with time and the maintainability function can be determined based on the exponential law with the relationship:

$$M(t) = 1 - e^{\mu t_i'} \tag{2}$$

where t_i' is the time when the repair is carried out. The Median Time Repair (MTR) is defined as the ratio of the total repair time of a product, $\sum_{i=1}^{n} t'_i$ and the number of repair cycles, n, respectively:

$$MTR = \frac{\sum_{i=1}^{n} t_i'}{n} \tag{3}$$

where t_i' represents the repair time in which each cycle is carried out. Repair rate, μ, is defined as the number of repairs of a product in the unit of time. According to the definition, it follows that the repair rate is the inverse of the median time repair, MTR, respectively:

$$\mu = \frac{1}{MTR} \tag{4}$$

Maintenance and repair systems rely on the logical organization of tasks according to available resources, the use of automated data processing, the reduction of maintenance, repair, and storage costs, and the prevention of unexpected downtime by addressing damage, malfunctions, continuous wear, and other issues. The key factors that strongly influence a product's maintainability include: product accessibility, the availability of spare parts or subassemblies, and the qualification of personnel and service support.

Product accessibility refers to the ability of a product or technical system to allow easy disassembly and assembly of each component, part, or subassembly. This characteristic directly affects product availability by influencing work efficiency during maintenance and repair operations and, consequently, the overall effective operating time of the product. Thus, for a given level of reliability, improved accessibility increases total utilization time.

Spare parts and subassemblies are also essential factors affecting maintainability, based on aspects such as: their availability, their characteristics, and the way they fit or integrate within the product. The presence or absence of spare parts directly conditions maintainability by determining the supply schedule. Their characteristics greatly influence the optimization of the repair process—particularly the interchangeability feature, defined in [15] as "the ability of an entity to be used in place of another, without modification, to satisfy the same conditions." Interchangeability may be total (allowing a part or subassembly to replace another without any modification, regardless of time or place) or partial (allowing replacement only if dimensional, geometric, or other adjustments are made).

Personnel qualification and service quality are equally fundamental to achieving maintainability. Repair time is influenced by the skill and experience of the personnel performing maintenance and repairs.

Maintenance comprises all operations—inspection, troubleshooting, repair, improvement, and more—that preserve the product's ability to operate safely and continuously at optimal overall cost. Figure 1 illustrates the structure of maintenance types for repairable products, emphasizing planned (proactive) maintenance and unplanned (reactive) maintenance, with particular attention to maintenance performed following a product shutdown.

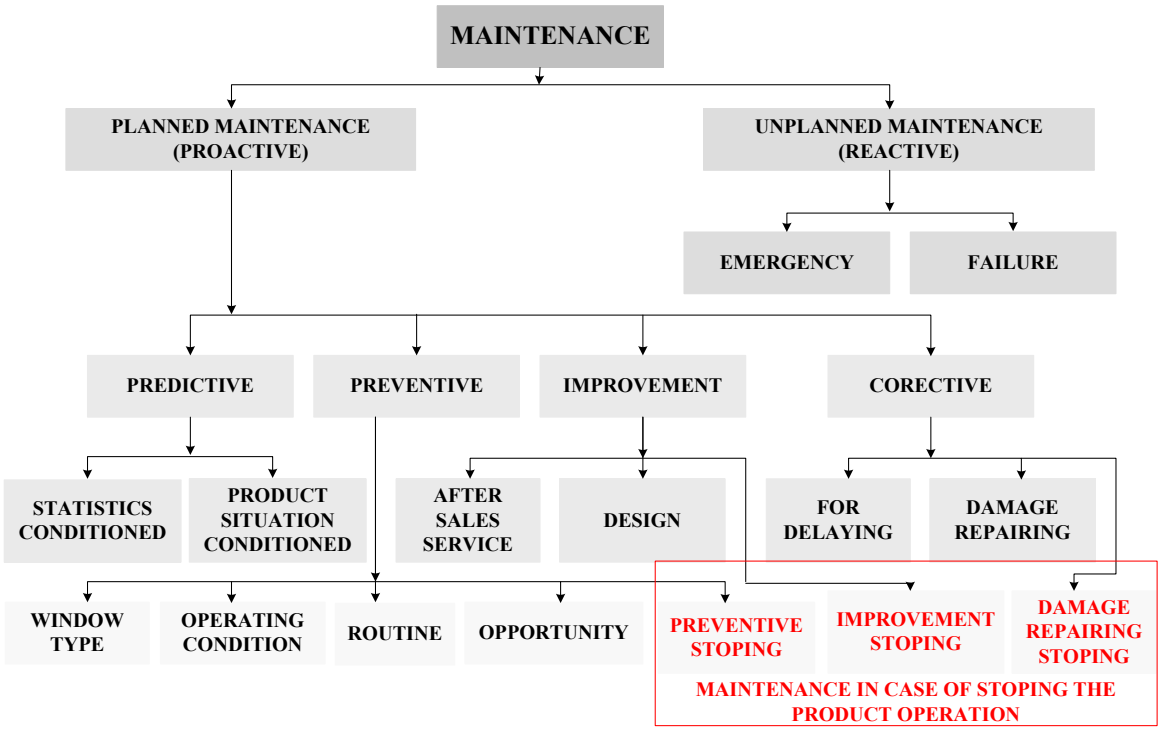

Fig. 1. Structure of maintenance of repairable products (adaptation after [16])

Preventive maintenance [15, 17] consists of maintenance, inspection, and repair activities carried out periodically at predetermined intervals. Its purpose is to prevent excessive wear and failures, keeping products in operational condition for as long as possible according to a Maintenance Program (MP).

Predictive maintenance [15, 17] schedules maintenance and repair tasks based on observable changes in the physical condition of equipment (failure indicators) and actual operating parameters. Its goal is to perform the necessary maintenance at the right time to maximize product life without increasing the risk of failure.

Corrective maintenance [15, 17] is defined as maintenance performed after a defect has occurred, restoring the equipment to a condition in which it can once again perform its intended function. In corrective maintenance, activities focus on tasks conducted at regular intervals to ensure that the product (and its critical components) remains operational at optimal parameters.

The effectiveness of a maintenance program is evaluated based on the product's life cycle cost (including critical component costs), rather than solely on how quickly the equipment is returned to service.

2.2. Ship maintenance

Classification Societies establish the technical standards for the design, construction, and operation of cargo and passenger ships, as well as for onboard installations, systems, and equipment. They verify that ship design and construction projects comply with these standards and periodically survey ships to ensure continued compliance throughout their operational life.

A ship may remain in class if, in the opinion of the classification society [18], the maintenance of its structure, systems, installations, and equipment is carried out in accordance with the society's rules and requirements, as demonstrated by the results of periodic or occasional inspections. The purpose of the classification society is to confirm the structural integrity of the ship, the condition of essential hull components and appendages, and the proper functioning of propulsion systems, steering systems, power generators, and other onboard systems and equipment.

2.2.1. Maintenance on board ships

The maintenance standards applied on board seagoing vessels are closely tied to the ship classification rules. To comply with the requirements of the Classification Society, owners and operators must demonstrate that their vessels are properly maintained and remain in satisfactory technical condition.

Maintenance activities on board face several challenges, including:

-because ships operate in constantly changing locations, technical systems must function reliably at all times. To ensure redundancy, standby equipment must always remain ready for immediate use;

-since no service stations exist at sea, the planning and execution of maintenance tasks are critically important. These activities must be carried out according to the ship's operating schedule by the vessel's crew, who are trained specialists responsible for ensuring that both the cargo and the ship reach their destination safely.

Maintenance management on board of vessels offers several possible approaches, with the main systems being:

a) Preventive maintenance: involves performing maintenance activities according to a predefined schedule based on time intervals or operating hours. Its purpose is to detect, eliminate, or reduce the degradation of equipment or systems to preserve and extend their useful life by keeping deterioration within acceptable limits, [19].

b) Condition-based (predictive) maintenance: involves performing specific measurements to monitor selected parameters (Condition Monitoring) that can reveal early signs of deviations from normal operating conditions. This enables the elimination or control of stress factors before significant deterioration of components occurs, [19].

c) Reliability-Centered Maintenance (RCM): a structured process used to determine the maintenance needs of equipment, machinery, or systems on board a ship within the context of their actual operation, [19].

d) Corrective (run-to-failure) maintenance: involves operating machinery, systems, and equipment until functional failures occur, after which repairs are performed as needed, [19].

2.2.2. Maintenance in shipyards

It is necessary to involve a shipyard in carrying out complex maintenance and repair works, as part of the maintenance management systems.

To meet, within the required parameters, the technical requirements for safe and efficient navigation, ships must be docked periodically, for the certification of the technical condition and for the correction of defects affecting both the structural integrity of the ship's hull (both immersed and emers) and the installations, equipment and on-board systems.

Both corrective (as-needed) and preventive maintenance are applied within a shipyard to carry out the complex process of docking the ship.

a) Corrective (as-needed) maintenance is used especially on the outer and inner parts of the ship's hull affected by corrosion (when the thickness of the steel plates has fallen below the permissible limits); It is also used in the case of plates deformed due to damage from collisions.

b) Preventive maintenance involves inspections, checks and measurements where they are not possible during navigation (ship operation); it applies both to the hull of the ship and to the systems, installations and equipment specified in the Technical Working Specification.

When selecting a repair shipyard to carry out maintenance work, the Owner/Technical Manager evaluates several factors before issuing the Order for Repair Works, as outlined in the processes shown in Figure 2:

- taking into account the navigation route that the ship travels to reach the shipyard for the start of maintenance and repair works, it must assess the deviation costs as correctly as possible;

- estimating the maintenance budget based on the Ship Repair and Maintenance Offer prepared by the shipyard, which reflects the pricing and time assessments derived from the Technical Specification provided by the Owner/Technical Manager;
- considering the approximations of time and price made based on the information included in the Technical specification that the Owner/Technical Manager of the vessel must develop an estimated budget, corresponding to the Works Offer prepared by the shipyard;
- considering the estimated time of carrying out the works (specified in the Works offer) must estimate the daily costs;
- to determine the shipyard's capacity to carry out, qualitatively and on time, the maintenance and repair works included in the Works Offer, it must carry out a technical evaluation of it.

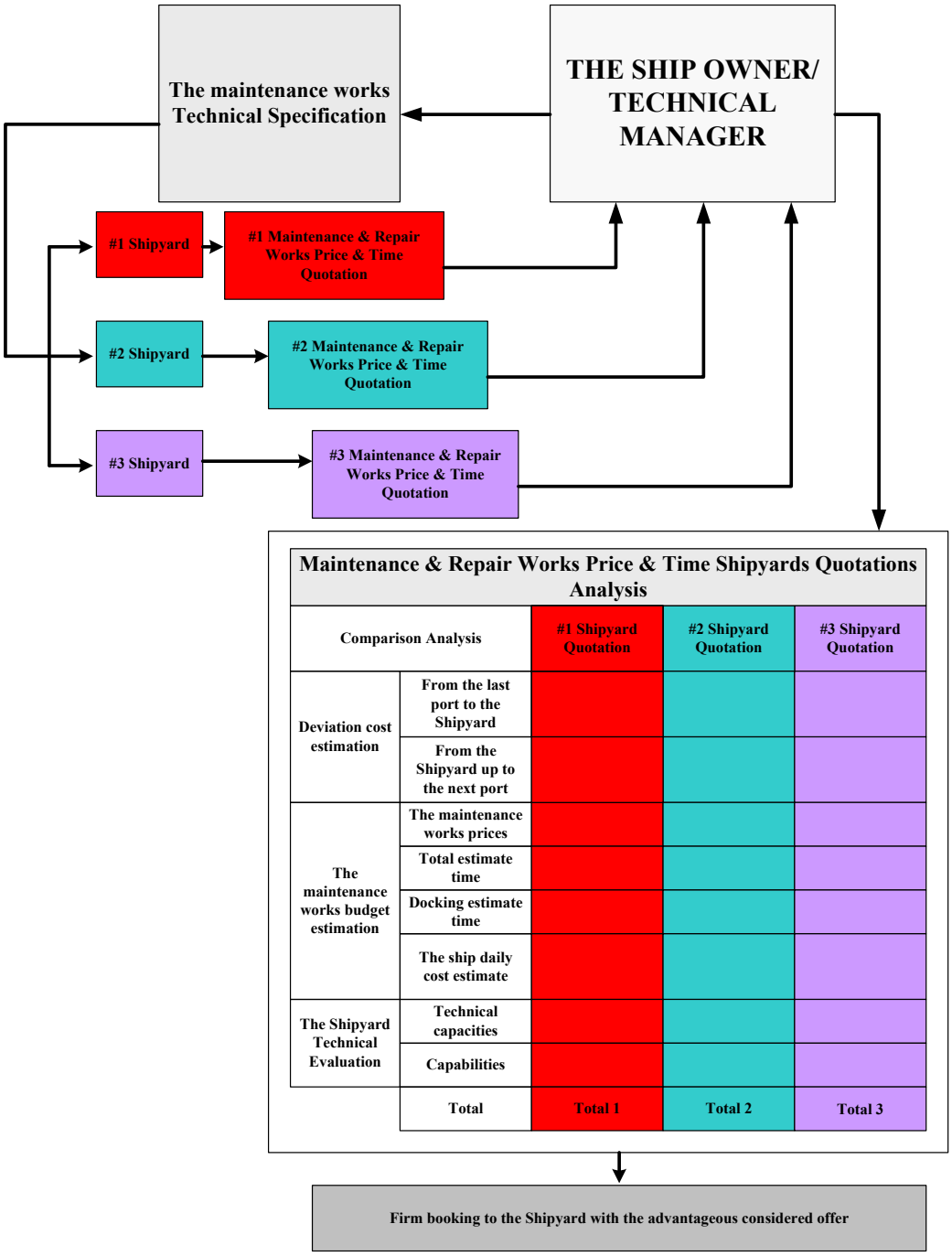

Fig. 2. The process of evaluating the Ship Repair Works Offers received from the shipyards

When preparing the Ship Repair Works Offer, the shipyard aims to secure the contract for the execution of the maintenance works. In doing so, it considers several key objectives: ensuring a steady workload for the docks;

maintaining consistent employment across all specialized workforce categories; fostering long-term collaboration with traditional maritime clients; and creating opportunities to begin partnerships with new shipping companies in order to expand the existing customer portfolio.
Additionally, when drafting the Ship Repair Works Offer, the shipyard also takes into account several other factors: the likelihood that competing shipyards in the region may also be approached by the Owner/Technical Manager to submit offers; the complexity and volume of the works identified as leading tasks; the shipyard's current portfolio of confirmed maintenance orders and the workload expected during the period covered by the offer; and the type and profile of the shipping company requesting the offer, especially if it is not one of the shipyard's traditional clients.
Upon receipt of the Technical Specification of the Works from the Owner/Technical Manager of the ship, the shipyard must evaluate it (with reference to the duration and price of the works) in order to prepare the Maintenance and Repair Works Offer necessary to be carried out - following the process presented in Figure 3.

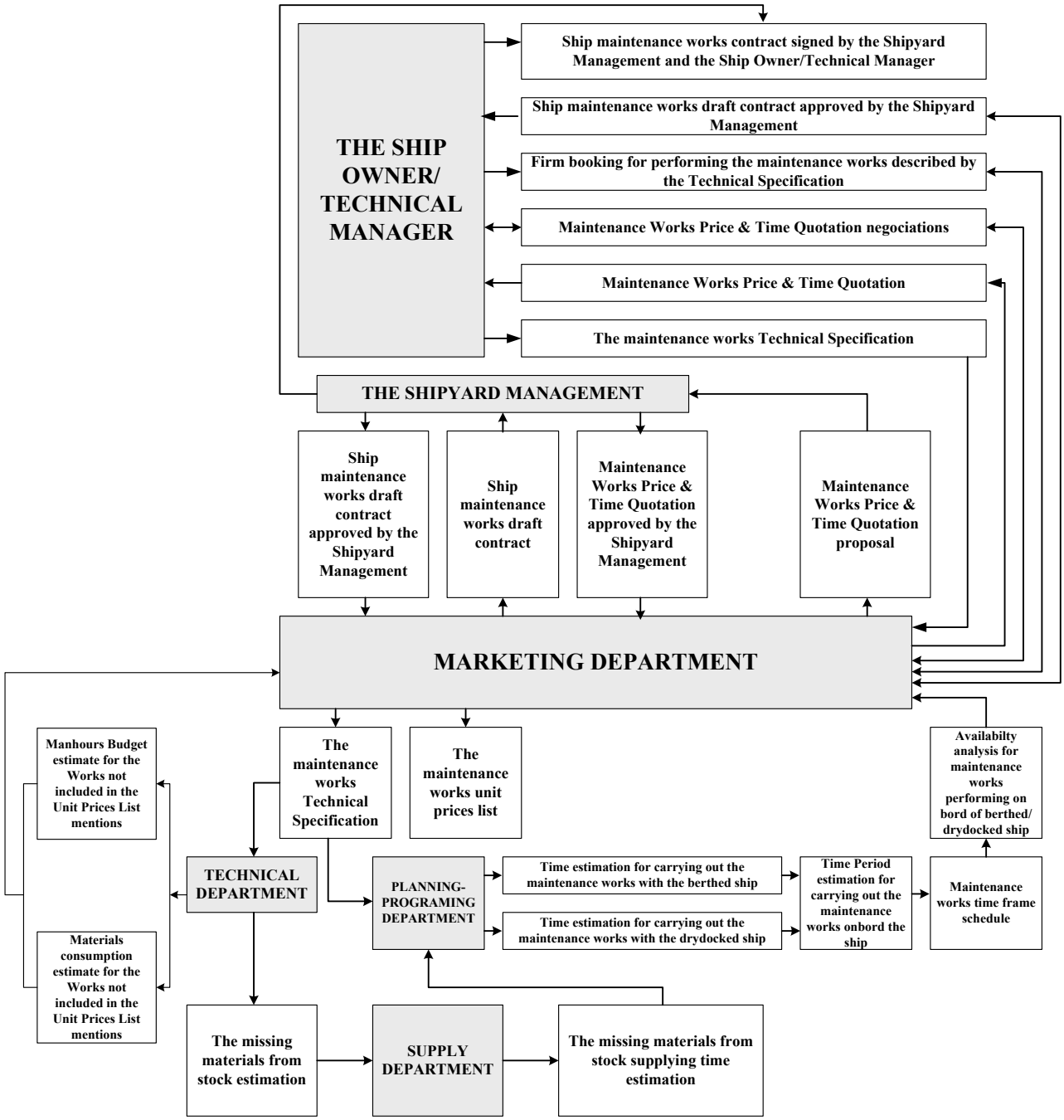

Fig. 3. The contracting process in a shipyard

Marketing Department shall:
-send to the Technical and Planning/Programming Departments, the technical specifications of the works, to be

evaluated and analyzed;
-corresponding to the prices charged by the shipyard, for the works mentioned by the Owner/Technical Manager, elaborates the unit price list;
-for the processes and works carried out, it has the obligation to count the relevant information received from the Technical, Supply and Planning/Scheduling Departments;
-for the maintenance and repair works to be executed, elaborates and sends to the shipyard management (for approval) the Project Offer for Works;
-after approval, this offer must be submitted and brought to the attention of the Owner/Technical Manager;
-in order to obtain a firm order, it carries out the negotiation process (through various accepted means – telephones, written or electronic correspondence, etc.)
Once the firm order is obtained from the Owner/Technical Manager, the department performs the following actions: prepares the Draft Ship Repair Works Contract and secures management approval before sending it for signature; informs the Technical Department and the Planning/Scheduling Department so they can begin preparing for the execution of the ship's maintenance and repair works, according to the processes shown in Figure 4.

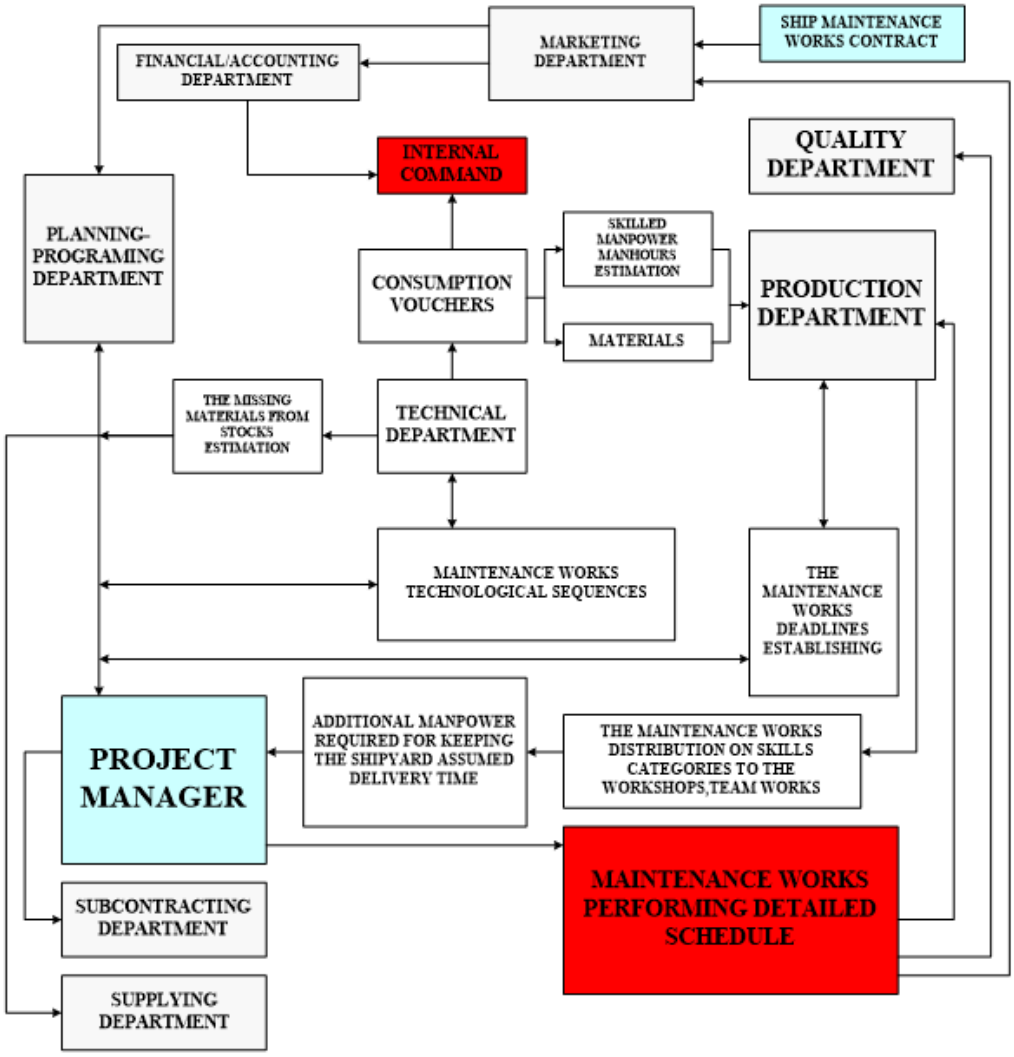

Fig. 4. The process of preparation for the execution of maintenance and repair works on the ship

The Technical Department must:
-inform the Financial/Accounting Department of the need to register the work orders related to the maintenance works to be executed (through the Internal Order) and to take care of the registration of the necessary material invoices;
-sends the work specifications developed by the Owner/Technical Manager of the vessel to the Production Department; informs the Supply Department regarding the start of the process of acquisition of the necessary material resources; prepares, for the Production Department (and its subdivisions), the work orders for all maintenance and repair activities;

-for all the works that the Production Department (with its subdivisions) has carried out, it prepares the invoices that allow the necessary material resources to be provided (from the warehouses of the Supply Department);
-record in the Internal Order all issued work receipts.
The Planning/Scheduling Department shall:
-appoint the Project Manager;
-in collaboration with the Production Department, analyzes the possibilities of distributing the maintenance works of the ship to sections, workshops and work teams, corresponding to the professional categories. Also, execution deadlines resulting from the technological sequences are challenged, in order to fit within the limit of completion of the works established by the shipyard in the Offer approved by the Owner/Technical Manager;
-corresponding to the distribution of maintenance works within the subdivisions of the Production Department, develops the detailed execution plan;
-informs the Subcontractors Department of the need to start the process of subcontracting the works, knowing that additional labor is needed;
-involves the Production, Technical, Supply and Subcontractor Departments in the process of adjusting and finalizing the work execution program, identifying problems, investigating solutions and evaluating alternatives;
-sends to the management of the shipyard the final program of the works to be executed, emphasizing the solutions identified to solve the problems;
-distribute the approved detailed execution schedule for the ship's maintenance works to the following departments: Marketing, Technical, Production, Supply, Subcontractors, and Quality.
The above refers in principle to any shipyard, the application of the management systems for the maintenance of maritime ships being able (in fact and being) adapted to the particularities and specifics of each repair shipyard.

3. CASE STUDY

In a highly competitive industrial field (such as shipbuilding and ships repair), where data and information protection ensure a favorable position on the market, case studies are extremely difficult to present. The authors of this paper, benefiting from the support of Constanta Shipyard S.A. (manifested for almost 3 decades), can present, for interested readers, a perspective on the complexity of naval maintenance and repair processes.
In the context of the "Industry 4.0" concept, the management of any shipyard is interested in programming, modeling and simulation of different processes (new constructions and or maintenance), even going as far as the virtualization of shipyards. An Enterprise Resource Planning (ERP) information system is a complex software solution whose main role is to ensure the planning of activities, the management of the company's resources (human, material and financial) and the monitoring and control of internal processes, ensuring data transparency, access to information and streamlining the decision-making system.
As underlined in the introduction of this paper, the authors' efforts focused on the schematization of the processes involved in maintenance and repair activities both on board ships and in shipyards (Figures 1-4), the development of an ERP information system customized to a certain shipyard, implying imperative the elaboration of the process schemes that underpin the shipyard's activities. Of course, each shipyard is unique, it has a particular specificity of activities and processes. However, there are also common elements, which can be found in the profile of any construction site. This paper proposes the schematization of these processes that are found in the maintenance activities of ships within any shipyard, constituting a valuable starting point for any provider of software solutions that aims at the personalized computerization of processes within a shipyard.
The components (Figure 5) of the ERP information system implemented in the Constanta Shipyard are [20]: Primavera Project Management for project activity planning; Charisma Human Capital Management for the management of the organizational structure; Microsoft Management Console for daily task scheduling; Charisma Access-Timesheet for the calculation of hours worked; Charisma ERP – having two components: portfolio management and production; Integration interfaces between system components and modules.
It is important to specify that, for the Constanta Shipyard S.A., which is a complex shipyard, which includes both new buildings and ships repair works, many of the processes and activities carried out enter a complex interaction.
For the maintenance and repairs activities of the ships in the Constanta Shipyard S.A., the main process lines (Figure 6) were identified as follows:
-Process Line 1. The portfolio of contracts, which involves the planning of activities, the allocation of human resources, the allocation of material capacities (machinery), the monitoring and control of projects.
-Process Line 2. Technological budgeting of material resources, which aims to establish the need for raw materials and the supply needs.

-Process Line 3. Management activities, which refer to the maintenance and repair activities of machinery, systems and equipment, including the necessary investments for fixed assets.
-Process Line 4. Planning activities, which aim at planning the supply of materials, consumables, equipment, machinery.
-Process Line 5. Maintenance and repair activities themselves, which aim at weekly scheduling of activities, issuing work orders and controlling the fulfillment of activities.
-Process Line 6. Material inventory management, which involves the configuration of management activities and accounting processing of inventories.
-Process Line 7. Subcontractors, which refer to the activities carried out by subcontractors.
-Process Line 8. Completion of work, which refers to the handover of the vessel to the client.

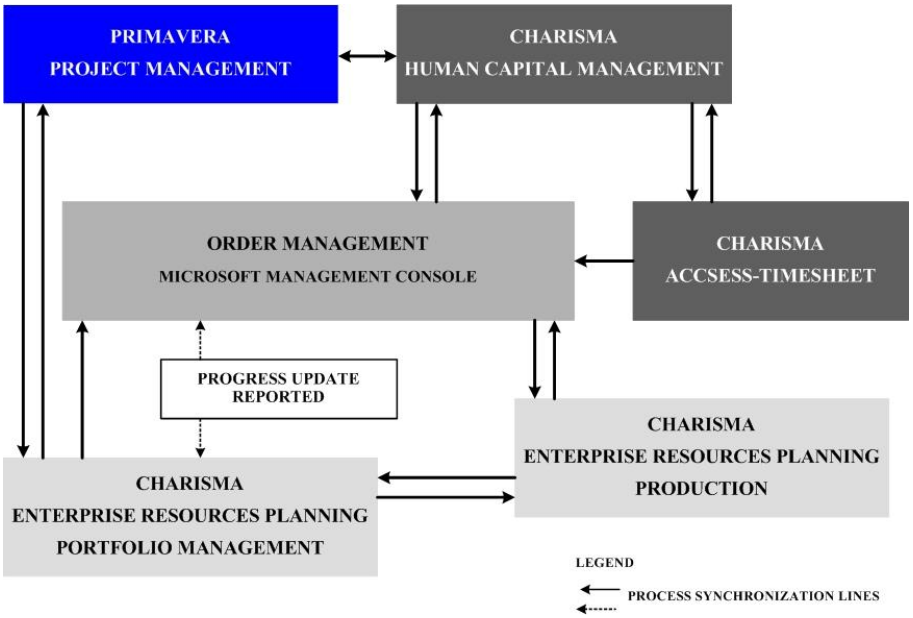

Fig. 5. Components of the ERP information system of Constanta Shipyard S.A., [20]

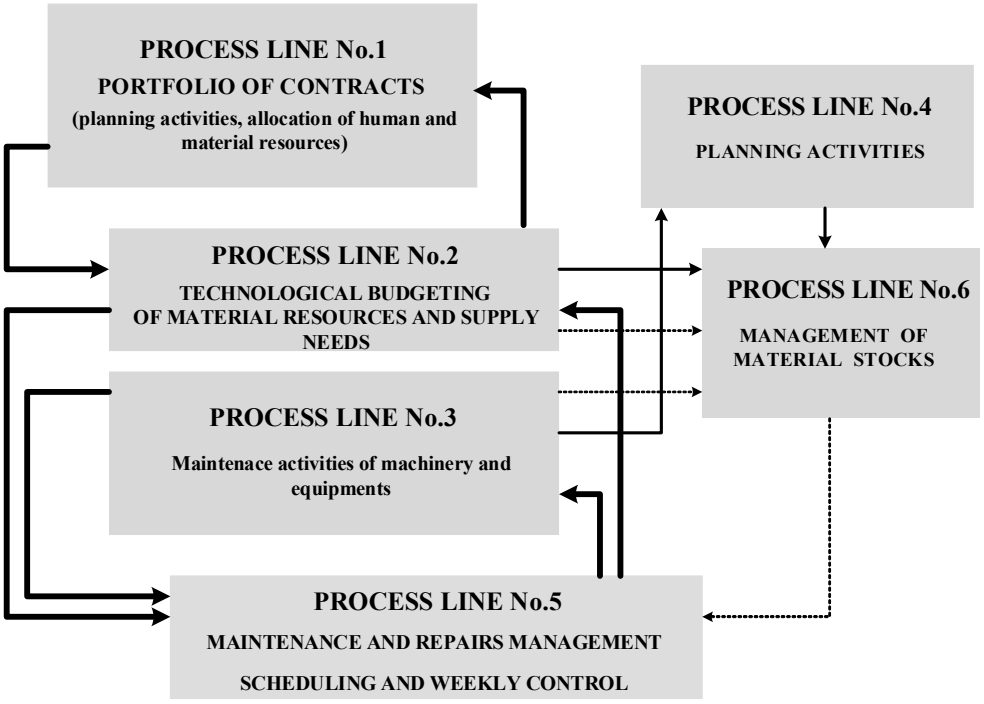

Fig. 6. Process lines for the ship′s maintenance and repair activities, specific to Constanta Shipyard S.A.

The above-mentioned process lines, considered as main lines for ship maintenance and repair activities, are supported by three support process lines:
-Support Line 1. Human resources and payroll.

-Support Line 2. Accounting refers to the activities regarding the financial-accounting records.
-Support Line 3. Management accounting, which involves activities related to the income and expenditure budget.
It should be noted that, being an internal work tool (protected by copyright laws and data privacy rules), the ERP information system implemented in the Constanta Shipyard was designed in Romanian, which does not allow the inclusion of suggestive screenshots for the graphical working interface of the ERP system.

4. RESULTS AND DISCUSSIONS

4.1. Objectives of maintenance in the shipbuilding industry

The complexity of industrial production activities and the significant rise in the value of new equipment have shown that the average operating time between failures, along with the duration and quality of maintenance and repair work, are critical factors influencing equipment availability and overall enterprise profitability. Therefore, maintenance—encompassing both upkeep and repair activities—must be regarded as a strategic investment in the future.
The change, in recent years, in the role and importance of the maintenance activity has been determined by the following factors: considerable increase in the value of the new equipment purchased, due to its constructive and functional improvement; increasing the complexity of equipment by increasing the degree of mechanization and automation of processes; increasing losses caused in the event of damage to equipment or its standing in repairs; continuously increasing maintenance costs and increasing their share in the cost of products; increasing the number and share of personnel employed in the maintenance activity.
A well-organized and properly implemented maintenance system provides significant economic benefits by reducing machine downtime and production losses, ultimately contributing to lower product costs. When maintenance is planned and executed on economic principles—performing repairs quickly and with high quality, and applying efficient methods for reconditioning used parts—tensions may arise between the maintenance and financial departments, as well as with the production department. There is often a tendency to reduce the financial resources allocated to preventive maintenance. However, this approach usually produces the opposite effect, leading to increased corrective maintenance costs due to a higher frequency of unexpected failures. As corrective maintenance becomes more frequent and more expensive, fewer resources remain available for preventive maintenance, creating a vicious cycle from which the industrial unit can hardly escape.
To balance these seemingly conflicting viewpoints, equipment maintenance must be given its proper importance within the industrial organization, with clearly defined responsibilities for all parties involved. At the same time, maintenance must be organized in a way that allows all specific issues to be addressed as efficiently as possible, with economic criteria becoming a priority in most situations.
In the current economic climate, marked by crisis conditions, the rapidly expanding private sector is expected to redefine the role of maintenance—from a supporting auxiliary activity into a strong logistical and technical function that positively influences overall enterprise efficiency. Complex maintenance work will increasingly be carried out by specialized companies equipped with advanced tools, devices, testers, control systems, and high-performance technological maintenance equipment, as well as qualified personnel. Repair units specializing in particular models or types of machinery will perform all necessary repairs, but only for their specific equipment categories. Their personnel are more familiar with the machinery, its repair characteristics, and the root causes of failures, enabling them to eliminate defects quickly and effectively.

4.2. Tasks of maintenance in the shipbuilding industry

The tasks of the maintenance department will be oriented on the following main directions:
-formation of mixed teams made up of production and maintenance personnel with foresight and consultancy attributions for more difficult situations;
-selection of specialized units for cooperation according to economic and quality criteria, contracting interventions;
-collecting, systematizing and capitalizing on the behavior of the equipment in operation to improve maintenance programs, reduce material consumption, optimize spare parts stocks, establish the optimal time to replace the machines.
The general objectives of the maintenance will orient the entire activity of the unit over a longer period, depending on the level of development, these being: safety objectives: quantified by the high reliability coefficient of equipment susceptible to critical failures; availability targets; objectives regarding the maintenance budget; long-term objectives of equipment management and maintenance. aiming at increasing the availability of the technological line

5. CONCLUSIONS

The authors believe that the evolution of maintenance will be carried out in the following directions:
a) application of an operational maintenance computerization system;
b) better consideration of maintenance at the stage of design, procurement and installation of equipment in the enterprise;
c) transfer of maintenance operations called "level 1" to directly productive workers whose level of training will be higher;
d) the development of remote maintenance monitoring systems will lead to the application of preventive or conditional maintenance;
e) Cooperation in maintenance will be developed through scientific foundation, control and good administration, which will allow: the establishment of a group for maintenance methods within the enterprise; improving the technical-material supply activity; development of the maintenance computerization system and its operationalization.
The main maintenance developments in the future are schematically presented in Figure 7.

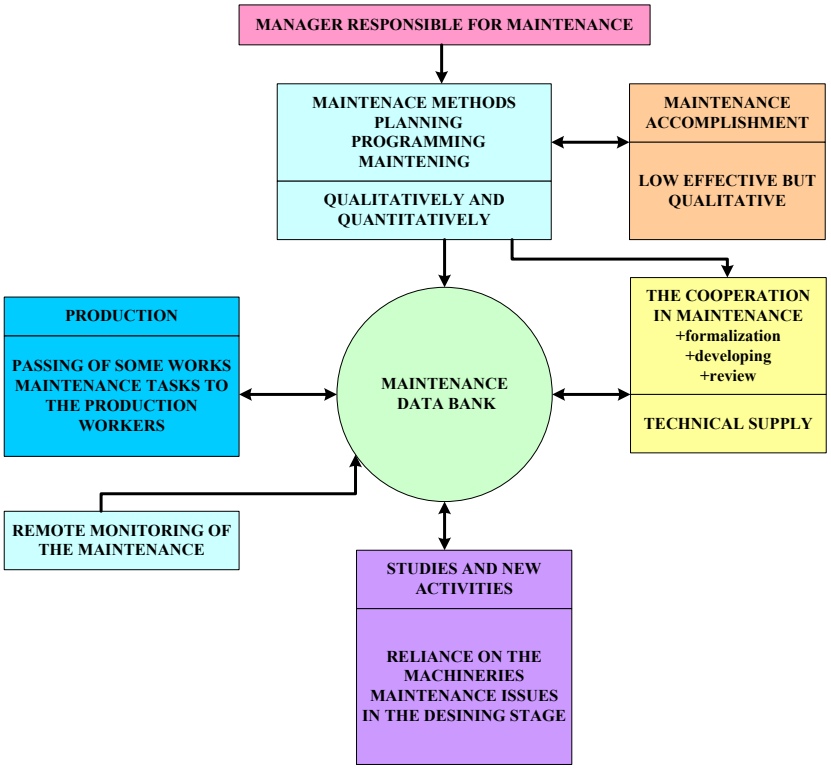

Fig. 7. Evolution of maintenance

As the same trends are valid for the maintenance of maritime ships, the management of shipping companies will take measures to improve and develop maintenance management systems both on board ships and with docked ships, so that, implicitly, maritime shipyards will be subjected to processes of transformation of adaptation and improvement of organizational performance to meet customer requirements.
The management of shipyards, through its functions of planning, organization and training – coordination, will establish the objectives for improving performance, will choose the ways to achieve them and will develop strategies and policies for the bidding processes, contracting, preparation of the execution of the works, carrying out the execution of the works, handing over the ship, testing and proofing, preparation and approval of the Minutes of the Executed Works, preparation of the Final Invoice, issuance of the Guarantee.

Author contributions: E.B., E.M., M.-G.M.: conceptualization; data interpretation; methodology; project administration; supervision; validation; review and editing. P.B.: data curation (acquisition, analysisand validation); initial draft writing; Alexandru Pintilie: conceptualization; data interpretation; methodology; review and editing. All authors have read and agreed to the published version of the manuscript.
Funding source: No funding source was not involved.
Conflicts of interest: There is no conflict of interest.
Acknowledgements: The authors would like to thank Constanta Shipyard for the support.

6. REFERENCES

1. SR EN 60706-3, (2007), *Maintainability of Equipment – Part 3: Verification and Collection, Analysis and Presentation of Data*, Romanian Standards Association (ASRO), Bucharest.
2. Denev Y., (2023), *Ship Casualties – Reasons and Statistical Analysis*, TransNav – Int. J. Mar. Navig. Saf. Sea Transp., **16**(4), pp. 607–610. https://doi.org/10.12716/1001.16.04.01.
3. Stanivuk T., Stažić L., Vidović Bratić K., (2021), *Assessment of the Concept of the New Methodology for the Evaluation of Ship Planned Maintenance System*, TransNav – Int. J. Mar. Navig. Saf. Sea Transp., **15**(4), pp. 739–742. https://doi.org/10.12716/1001.15.04.03.
4. Stažić L., Komar I., Račić N., (2018), *Evaluation Methodology for Ship's Planned Maintenance System Database*, Trans. Marit. Sci. (TOMS), **6**(2), pp. 109–116. https://doi.org/10.7225/toms.v06.n02.002.
5. Golovan A., Mateichyk G., Gritsuk I., Lavrov A., Smieszek M., Honcharuk I., Volska O., (2024), *Enhancing Information Exchange in Ship Maintenance through Digital Twins and IoT: A Comprehensive Framework*, Computers, **13**(10). https://doi.org/10.3390/computers13100261.
6. Mihanović L., Ristov P., Belamarić G., (2016), *Use of New Information Technologies in the Maintenance of Ship Systems*, Pomorstvo – Sci. J. Marit. Res., **30**(1). https://doi.org/10.31217/p.30.1.5.
7. Fujikubo M., Okada T., Murayama H., et al., (2024), *A Digital Twin for Ship Structures: R&D Project in Japan*, Data-Centric Engineering. https://doi.org/10.1017/dce.2024.3.
8. Park M.-H., Lee W.-J., (2025), *Comprehensive Review of Shipboard Maintenance Management Strategies*, Results Eng. https://doi.org/10.1016/j.rineng.2025.106671.
9. Manea E., Zăgan R., Manea M.G., coordonator ştiinţific Militaru C., (2018), *Managementul calităţii aplicat pentru îmbunătăţirea activităţilor de mentenanţă şi a performanţelor şantierelor navale*, Vol. 1, Editura Dobrogea, Constanţa.
10. Manea E., Manea M.G., (2018), *The Risk Concept and the Impact on the Organizational Performance of Maritime Ship Repair Shipyards*, Proceedings of the International Conference *Advances in Engineering and Management (ADEM)*, Trans Tech Publications, Drobeta-Turnu Severin. https://doi.org/10.4028/www.scientific.net/AEF.34.5.
11. Manea E., Militaru C., Manea M.G., (2021), *Assessments Regarding the Planning and Control of Activities and Resources for Ship Repair and Maintenance Works*, Sci. Bull. Nav. Acad., **XXIV**, pp. 201–210. https://doi.org/10.21279/1454-864X-21-I1-024.
12. Manea E., Manea M.G., Pintilie A., Robe-Voinea E.G., Burlacu P., (2023), *Comments on the Docking of Seagoing Vessels and the Certification of Ship Repair and Maintenance Work*, Sci. Bull. Nav. Acad., **XXVI**, pp. 33–39. https://doi.org/10.21279/1454-864X-23-I1-004.
13. Manea E., Manea M.G., Robe-Voinea E.G., Pintilie A., (2024), *Contributions on the Use of Probability Laws and Statistical Tests in the Analysis of Ship Maintenance Work in a Shipyard*, Sci. Bull. Nav. Acad., **XXVII**, pp. 189–196. https://doi.org/10.21279/1454-864X-24-I1-025.
14. Verzea I., Gabriel M., Richet D., (1999), *Managementul activităţii de mentenanţă*, Polirom, Iaşi.
15. Abrudan I., Cândea D., (2005), *Ingineria şi Managementul Sistemelor de Producţie: Manual de Inginerie Economică*, Editura Dacia, Cluj-Napoca.
16. Söderholm P., (2005), *Maintenance and Continuous Improvement of Complex Systems – Linking Stakeholder Requirements to the Use of Built-in Test Systems*, Doctoral Thesis, Luleå University of Technology, Luleå. Available from: https://ltu.diva-portal.org/smash/get/diva2:991577/FULLTEXT01.pdf, Accessed: 03/07/2026.
17. Verzea I., Gabriel M., Richet D., (1999), *Managementul activităţii de mentenanţă*, Polirom, Iaşi.
18. International Association of Classification Societies (IACS), *Official Website*. Available from: https://www.iacs.org.uk, Accessed: 03/02/2026.
19. Lloyd's Register, (2024), *The Benefits and Opportunities of Data-Driven Condition-Based Maintenance*. Available from: https://www.lr.org/en/knowledge/research-reports/2024/data-driven-condition-based-maintenance/, Accessed: 03/02/2026.
20. Manea M.G., Manea E., (2023), *Shipbuilding—An Analysis from the Perspective of Enterprise Resources Planning System*, World J. Eng. Technol., **11**, pp. 81–112. https://doi.org/10.4236/wjet.2023.111008.

Received: May 23rd, 2026 / Received in the revised form: June 05th, 2026 / Accepted: June 10th, 2026 / Paper available online: June 20th, 2026 © International Journal of Manufacturing Economics and Management.