The importance of the technical specification of works for the ships repair processes in the maritime shipyards

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Abstract. The technical specification purpose is to include the ship maintenance and improvement works needed to be carried out onboard in a repair shipyard, so that after these works performing to allow for the classification society certification, thus confirming the ship satisfactory technical condition and the relevant requirements of the classification rules were applied, thus confirming the applied management maintenance also. The technical specification has a very important role for the evaluations, done by the shipyard in preparing price and time quotation and the owner / manager, done for the comparison analyzing based on the evidence that the maintenance and improvement workflows performing on board the ship in a shipyard for works depend on the technical specification quality of preparation, which means that had to provide the necessary information in relation to the volume and type of works needed to be carried to the ship hull and structures, machinery, equipment, plants and systems supported by the necessary technical information plans approved by the classification society and the works sheets documentation referring to the followings: work location / equipment thereof number of pieces; types of the works required to be performed on location / equipment; works estimated required to be undertaken on location / equipment. The advantage of a quality technical specification is the limitation of the possibility of ordering additional works during the execution of works for maintenance, upkeeping and improvements on board the shipyard, the costs of the shipyard and the ship being thus maintained at the estimated budgets. The paper purpose is to highlight the advantages of a good quality technical specifications which consists of limiting the possible means of developing additional orders during the execution of maintenance and improvement works on board, thus the shipyard and ship costs being possible to be kept within the original estimated budget margins.

1. Introduction
The notion of performance in the shipbuilding and ship repair industry must be adapted to the complex and difficult to manage processes within the shipyards.

Performance is not an end in itself but the vector that leads to results. The results depend on the level of performance at which employees evolve, performance management being the process that facilitates the creation of an environment in which people feel motivated to make the most of their skills and qualities [1-5].
Performance indicators must be used to measure the effectiveness of the management system processes. Performance indicators measure three elements – activity, profitability and productivity – and by monitoring the results obtained, the activities performed and the costs generated, is the standard of measurement that allows examining and highlighting the viability of the strategies chosen to achieve the proposed objectives [1-5].

Where the results of process monitoring and measurement are not in accordance with the requirements, appropriate corrective action shall be taken.

The use of performance indicators in the activity of an integrated management system is generally characterized by: the obligation to proceed with the activities; repeatability of execution; monitoring activities; correct performance measurement; the possibility of identifying non-compliant processes, with an impact on costs; the application of corrective measures achieving important savings; conducting the entire activity in a systematic and planned manner; predictable and better development; employee accountability [6,7].

Currently, the performance of organizations has a fundamental role in the context in which market competition is becoming tighter, thus, the chance of survival in this competition increases considerably for those organizations that discover and minimize their vulnerabilities very quickly and, moreover, implements high-performance management tools that make it easier for them to detect, explain and solve various shortcomings of management activities, the main objective being to increase competitiveness.

Based on the requirements of the shipping companies, resulting from the updating of the objectives regarding the maintenance costs, shipyard specialised into maintenance works, in order to maintain competitiveness in conditions of economic efficiency, will analyze their performance indicators with reference to [8-11]:

- the percentage of contracting to the number of offers sent;
- percentage of reduction of manufacturing costs / ship;
- duration of the dock cycle by types of ships;
- number of delay days in delivery of ships;
- the percentage of repetition of technical inspections for defects / ship;

so that, through the corrective measures adopted, the basic objectives are not affected:

- constant loading of the equipped docks with ships;
- constant loading of all labor specializations represented by the permanent employees of the shipyard;
- long-term collaboration with shipping companies that are in the portfolio of traditional customers;
- the possibility of starting a collaboration with new shipping companies so that the customer portfolio can be expanded.

The performance indicators necessary to be analyzed as a matter of priority are based on the information of the bidding and programming-planning activities carried out in the shipyards for the execution of the maintenance works, as they are considered to be the leaders for approving and signing a contract.

For the bidding activity, the performance indicators emerge from [8-11]:

- the number of offers sent to customers and the number of offers accepted for contracting the execution of maintenance works depending on: geographical area; the types of ships (oil tanks, bulk carriers, container ships) and their dimensions;
- the number of offers accepted for contracting the execution of maintenance works for which the final invoice was below the estimated budget in the offer of maintenance and repair works related to the maintenance of the ship elaborated on the basis of the technical specification of works drawn up by the owner / technical manager according to: customer profile; geographical area; the volume and type of canceled works.

For the planning-programming activity, the performance indicators emerge from:
number of requests for unfulfilled offers due to lack of validity for docking in the period requested by customers;
the number of contracted vessels that have exceeded the agreed completion deadline;
the number of contracted ships that were delayed on arrival at the shipyard for the timely execution of maintenance works.

Bidding and scheduling activities carried out in the shipyards for the execution of marine ship maintenance works are the result of estimates that operate with fixed data conditioned by variables belonging to a wide range of conditions and limitations such as: the level of the maritime transport market; weather conditions at certain times in the geographical area where the shipyard is located; the type, capacity and age of the vessel; differences in the volume of the final work performed compared to the initial estimate due to the existing technical conditions found on the ship's systems, installations and equipment after the start of the maintenance works [8-11].

The performance indicators characteristic of a shipyard for the maintenance of ships could be those recommended in table 1 [17].

| Table 1. Performance indicators characteristic of a shipyard for the maintenance of ships. |
|----------------------------------|----------------------------------|--------------------------------|
| Objective                        | Performance indicators          | Content                                           |
|                                  |                                 | Financial | Non - Financial                                |
|                                 |                                 | Dock utilization rate | Duration of the dock cycle by ship types and dimensions |
| Availability of resources        | Number of days delayed in delivery of ships because of dock and quay works | Labor consumption for a type of work performed on different types of ships |
| Average production costs per ship | Percentage reduction in manufacturing costs per ship | Consumption of materials for a type of work performed on different types of ships |
| Management                       |                                  | Number of works not accepted for delivery to the client |
| Costs                            |                                  | Number of works submitted more than 2 times until the client's acceptance |
| Directly costs related to sales / allocated costs (indirect) | Commissions paid to agents / brokers | Number of ships by type / size / customer for which late payment penalties have been paid |
| Penalties for ship delivery delays | Value of penalties | Number of offers for the price of additional works accepted at discount values different from the contractual one |
| Additional works                 | Price negotiations | |

| Objective       | Performance indicators | Financial                                                                 | Non - Financial                                                                 |
|-----------------|------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Risk - opportunity | Financial situation of customers | The amount of invoices not collected according to the contractual payment obligations Late invoices for payment by types of customers | The total number of direct relations customers of the site The total number of customer relations through brokers Number of new customers Number of new customers returning by ship to the yard |
| Market share    |                        | Number of customer visits Number of customers lost Order productivity / day Number of suppliers / number of alternatives Number of pollution incidents / ship Number of work accidents / ship |                                                                                   |
| Activity        |                        | Percentage of works claimed under warranty Percentage of defective materials Percentage of materials that arrived late |                                                                                   |
| Operational     | Procedures             | Percentage of repeat technical inspections for defects / ship              |                                                                                   |

Efficiency

- Energy, water, gas consumption / ship
- Effectiveness of maintenance work performed on workspaces and equipment
- Percentage of defects investigated
Management of maintenance / repair operations on board ships within a shipyard represents the process of managing the resources necessary to carry out the operations included in the technical specification. This process (presented in table 2 [17]) comprises two fundamental approaches [3-6]: strategic management: refers to the design of the complex system of maintenance / repair operations of a ship in a shipyard (establishing performance requirements; establishing the volume of works; establishing the technologies for the execution of the works; establishing the necessary number of machinery and equipment; establishing locations for machinery and equipment; establishing the necessary workforce; establishing management and control methods); tactical management: ensures the operation of the system at the designed parameters (work planning; management of works; stock management; quality control).

Table 2. Correlation of information in the management of repair operations.

| STRATEGIC MANAGEMENT | INFORMATION TO BE CORRELATED |
|----------------------|-------------------------------|
| The ship works volume and the performance requirements establishing | ● information provided by the marketing department based on the ship maintenance and repairs works quotation prepared based on the prices and estimated time evaluation required for performing works mentioned by the technical specification prepared by the ship owner/technical manager; ● factors that limit the capacity of performing work at a ship according to information provided by the Planning / Scheduling Department analyze referring to the maintenance work volume by the works types, the shipyard own work force assessment and evaluation and possibly supplementary workforce requirements necessary to be subcontracted to the shipyard specialized collaborators |
| the technology for works execution establishing | ● information provided by the Technical Department referring to the maintenance work volume by the categories of professions, estimates for the manpower by categories of professions, estimate materials needed for maintenance work on ship; checking the materials existence of the shipyard stocks for the considered leading works ● the ship maintenance works execution time analyze according to information provided by the Planning / Scheduling Department estimates for the required time estimates for the drydocked and berthed ship maintenance works performing, the number of locations for execution of works on ship, machinery and equipment location on the ship set locations; the number of work teams and each team sizing; performance criteria for execution of the ship works referring to the the allocation of maintenance works to the workshops and the work teams and timetable for the maintenance works completion based on technological sequences need to be conducted to fit the assumed by the shipyard quoted deadline for completion as approved by the ship Owner / Technical Manager ● All information provided by Planning / Scheduling Department analysis with the Production Department for: the ship maintenance works allocation by the categories of professions to the workshops and the work teams based on technological sequences need to be developed; allocation of tasks and equipment |
| determining the plant and equipment locations and the necessary manpower | |
| the works planning; | |
Table 2. continuation

| STRATEGIC MANAGEMENT | INFORMATION TO BE CORRELATED |
|-----------------------|-----------------------------|
| management and control methods | ● planning procedures based on the ship maintenance works graph detailed execution as the distribution to the workshops and the working teams within the Production Department where it records any possible constraints and limitations that may arise in implementation of the supply scheme of material shortages in the shipyard stocks and to hire by subcontracting of additional manpower necessary to comply with the deadline for completion assumed the shipyard being analyzed and possible alternatives; ● control procedures provided as per the shipyard quality standards |
| the works planning; | ● All information provided by Planning / Scheduling Department analysis with the Production Department for: the ship maintenance works allocation by the categories of professions to the workshops and the work teams based on technological sequences need to be developed; allocation of tasks and equipment |
| management of the works | ● Department Planning / Programming together with Production Department, Technical Department, Purchasing Department, Subcontractors Department in predetermined intervals perform analyzes, regarding the development of the ship maintenance works detailed execution chart in connection with the timing of the works execution, positioning within manpower and material consumption estimated budget, occurred constraints and limitations in carrying out ship maintenance works recorded and propose corrective action, being analyzed possible alternatives |
| stock management | ● during ships maintenance works performing Production Department inform Technical Department on any additional materials needed toward the originally allocated by bills of materials, it frees bills of additional materials and, where appropriate, inform the Supply Department for running actions to supply material deprivation stocks shipyard, with time supply that not to endanger the delivery of the ship |
| quality control | ● Production Department, based on the ship's maintenance works detailed execution chart drafts and submits to the Quality Control Department the QSO inspection chart by technological phases inspection and completion of the ship for a final delivery |

There are many unforeseen situations that affect the industrial environment – affecting lead times and / or resources (material, financial, human) – and thus complicates the project planning process.

2. The role of the technical specification of works in improving the performance of shipyards

The role of the technical specification is to include in its content the maintenance, upkeep and improvement works necessary to be performed on the ship in a repair shipyard, so that following the performance of these works to obtain the certification of the classification society, being thus confirmed that the ship is in a proper technical condition and the maintenance management is properly applied. Therefore, the period of carrying out the maintenance works of the ship at the dock and quay in a shipyard is a key indicator of performance in achieving the objectives of the two management systems involved in the process, as presented in table 3 [17].
Table 3. The objectives of the management systems regarding the period of carrying out the maintenance works of the ship at the dock and at the quay.

| Objective            | Ship Owner / Technical Manager                                      | Shipyard for the execution of ship maintenance works |
|----------------------|---------------------------------------------------------------------|-----------------------------------------------------|
| Strategic            | Confirmation of the application of the maintenance management system on board the ship | Constant loading of equipped docks with ships      |
|                      |                                                                     | Constant loading of the existing workforce         |
| Market share         | Number of ships that have carried out maintenance work on the same site | Number of traditional customers performing ship maintenance work only on site |
|                      |                                                                     | Number of new customers who returned to the shipyard after the first collaboration |
| Availability of resources | The period of time during which the ship will be taken out of operation for performance | Dock utilization rate |
| Costs                | Number and volume of additional work ordered above the initial technical specification | Consumption of labor by types of works             |
|                      | Number and volume of work performed on board during the ship's stay at the shipyard | Consumption of materials by types of works          |
|                      | Number of papers not accepted for submission to the Classification Society | Number of works not accepted for delivery to the client |
|                      | Number of days delay in delivery of the ship when performing dock and quay work | Penalties for delays in the delivery of the ship    |
| Operational          | Number of pollution incidents / ship                                 | Productivity / day                                  |
|                      | Number of work accidents / ship                                      |                                                     |
| Efficiency           | Consumption of energy, water, fuel, oil, per ship                   | Consumption of energy, water, gas for ship works    |

When drawing up the technical specification, the conditions will be mentioned, according to the standards of the integrated management systems, and as far as possible, details regarding certain special access measures necessary to be taken for carrying out works and the type of cleaning work required to be performed on the fuel, oil and ballast tanks, and others shall be indicated from the point of view of environmental management, as well as the estimation of the quantities of waste necessary to be discharged from these locations in the shipyard. Carrying out maintenance and repair works on board the ship in the shipyard according to the technical specification thus implies the application of the standards of integrated management systems with reference to quality, health, occupational safety and environment, according to the presentation in figure 1 [17].
Figure 1. The role of the technical specification in the management of maintenance works in the shipyard.
From the point of view of quality management, for each work that requires the final confirmation of the classification society, it is verified:

- the documentation necessary to carry out the work with reference to:
  - class certificates for materials used by the shipyard and for those made available to it by the ship;
  - class certificates of the ship's equipment which are the subject of maintenance work on board the ship at the shipyard, this being the responsibility of the ship;
  - the plans and documentation approved and approved by the classification society for the body structures, systems, mechanisms and equipment involved in carrying out maintenance works on board the ship in the shipyard, this being the responsibility of the ship;
  - the certificates of competence of the shipyard personnel performing maintenance works that are subject to these requirements by the classification society;
- the quality of the work performed at the position.

From the point of view of occupational health and safety management, it is verified that the conditions for preparing the work in terms of access, lighting, ventilation are ensured. From the point of view of the management of the environmental conditions, the ensuring of the conditions of cleaning and observance of the requirements for storage and recycling of material waste is verified and of the waste resulting from the maintenance works on board the ship in the shipyard, being registered the waste taken from the ship, the emptying of the sewage and residue tanks.

The importance of the technical specification is given by the fact that it is the basis for drawing up estimates regarding the cost and duration of the execution of maintenance, upkeep and improvement works on board the ship in a shipyard. The shipyard draws up the price and time offer following the evaluation of the technical specification drawn up by the owner / technical manager of the ship from the point of view of the following considerations:

- Availability:
  - docks, quays, workspaces, equipment necessary for body work and structures, machines, installations and systems;
  - specialized workforce on the types of works included in the technical specification;
  - materials necessary for the execution of the works included in the technical specification.
- Based on the analysis of availabilities, they can be evaluated:
  - labor consumption by types of works;
  - required subcontracting of labor for certain types of work;
  - necessary supply of materials for the execution of certain works;
  - internal costs for the execution of the types of works included in the technical specification based on the consumption of labor and materials;
  - execution time of the types of works included in the technical specification.

The shipowner / technical manager of the ship following the analysis of the price and time offer prepared by the shipyard can evaluate the following:

- the necessary and time for the supply of spare parts and specific materials to the ship;
- the period of time in which the ship will be taken out of operation between the performance of the works from the technical specification which also includes the time required for the ship to arrive from the last port of unloading to the shipyard and the time required for the ship to arrive from the shipyard at the next port of loading;
- estimated expenditure budget comprising:
  - expenses related to the execution of the works mentioned in the technical specification for maintenance, upkeep and improvements on board the ship in the shipyard;
  - expenses related to the need, in own charge, to supply spare parts and specific materials to the ship for the execution of the works mentioned in the technical specification;
o fixed daily expenses on the ship during the execution of the works mentioned in the technical specification for maintenance, upkeep and improvements on board the ship in the shipyard;

o expenses related to the supervision of the execution in the shipyard of the works mentioned in the technical specification for maintenance, upkeep and improvements on board the ship by the Classification Society in order to extend the class certificates.

In conclusion, the technical specification has a very important role in the evaluations made both by the shipyard at the preparation of the price and time offer and by the owner / technical manager of the ship.

3. Conclusions

Over time, the authors of this paper have been concerned with the subject, looking for solutions to improve the processes of the maintenance and repair of ships in the shipyards [12-16].

It becomes obvious that the execution of the execution processes for the maintenance, upkeep and improvement works on board the ship in the shipyard depends on the quality of the technical specification that must ensure the necessary information about the volume and types of work required to be performed on the body and structures, machines, equipment, installations and systems supported by the necessary technical information from the plans approved by the classification society and from the technical documentation regarding to: technical description location / equipment, their number; the types of works necessary to be performed on location / equipment; the estimated quantitative volume of the works necessary to be performed on the location / equipment. The advantage of a technical specification of quality, consists in limiting the possibilities of appearing the orders of additional works during the execution of the works for maintenance, upkeep and improvements on board the ship in the shipyard, therefore, there is a good chance that the period for carrying out the maintenance work of the ship at the dock and quay will be completed according to the initial estimate of the shipyard, the costs of the shipyard and the ship being also possible to be maintained at the level of the initially estimated budgets.

Additional works during the execution of works for maintenance, upkeep and improvements on board the ship at the shipyard, can not be excluded, considering that when checking the condition of the hull and the structure of the ship in the dock, following the measurements of sheet metal thicknesses, the appearance or evolution of the corrosion of the ship's bottom sheets can be identified and any deformations, ruptures or other damage to the hull structure may also be identified. Also, regarding the machines, installations and equipment, following the performance of verifications and measurements, non-conformities can be identified and need to be corrected by performing parts replacement or repair work on certain subassemblies, which are additional to the original technical specification.

In the case of a technical specification with an unsatisfactory volume of information, a significant volume of orders may appear for additional work, with major implications in increasing the period of maintenance of the ship at the dock and quay and the costs of both parties involved in the process. For the shipyard, the additional works have a negative influence, due to the need for additional labor to cover the additional volume of works commissioned for the ongoing project and due to the immobilization over the estimated term of the technical capacities, thus there is a major risk of being negatively affected and the development of other projects undertaken during that period. For the ship's owner / technical manager, the additional work has a negative influence, due to the additional costs required to cover the additional volume of works ordered and due to exceeding the period of maintenance of the ship at the dock and quay initially estimated, which may have a negative influence on the further development of the commercial obligations assumed by the ship.

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