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PAPER REF:

THE PROCESS OF DYNAMIC MAINTENANCE ON NAVAL SHIPS

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ABSTRACT

Maintenance on a naval ship is a complex a continuous process. In a context of limited resources, many constraints define the day-to-day of maintenance organization and priorities management. To enhance the ships maintenance performance the best decision should be made based in an online decision-making software fed with data from equipment's functioning parameters and its condition. A decision-making system should be validated with some criteria and factors or processes. In this article is present the processes that can influence this decision systems. These processes can contribute to a well-based and self-organized dynamic maintenance database. To define it, it was analysed the state of art in dynamic maintenance, risk-based maintenance, condition-based maintenance, maintenance database and some statistical techniques that can be applied in this field.

Keywords: Dynamic, Maintenance, Naval, Ships.

INTRODUCTION

The motivation for this work is, considering the environment of scarce resources, human and material, to contextualize and define processes analysis to implement a dynamic maintenance based in a decision-making software on Portuguese military navy ships.

The questions that arise when this work began was: How to manage dynamic maintenance in an environment of scarce material and human resources? Why changing decision-making process? What are the consequences of changing? What processes can influence the decision-making?

In ships, there are already some frameworks used for monitor structure, machinery and others systems in ship. It is an example the INCASS (Inspection, Capabilities for Enhanced Ship Safety) developed based on universities studies, classifications Societies, the owners, service providers and other research centers. However, it needs more tests and some development. (Michala et al., 2015)

Ship systems maintenance can be modeled with Dynamic Fault Tree Analysis (DFTA)(Lazakis et al., 2012), but in this specifically work the defined processes should contribute to the decision making process.

In Robinson (2014) "Naval Aviation Squadron Risk Analysis Predictive Bayesian Network Modeling Using Maintenance Climate Assessment Survey Results" questionnaires were prepared for personnel involved in the maintenance of naval air assets, which were then treated with Bayesian methods in order to reduce air accidents. Statistically 80% of air accidents occur due to human error, not only in the manoeuvring of the system but also due to problems related to maintenance.

Brace and Vaughan (2002) apply Bayesian statistics in the mapping of automobile engines in the sense of controlling pollutant emissions and operating performance with a view to monitoring combustion, and consequently reducing malfunctions due to the probable correction of combustion anomalies in a timely manner.

Li et al. (2011) propose a dynamic latent variable model for a dynamic failure detection process where normality breaks are detected in a given process, in this case a continuous stirring process of a tank reactor.

Many literature are available to contribute to the state of art of this work, such as (Cullum et al., 2018)(Wong et al., 2010)(Gaidow & Boey, 2005)(Rasmussen & Svedung, 2000)(Saracco et al., 2012)(Robinson et al., 2014).

This is the beginning of three years of research work in naval ship maintenance military area. In addition, it is believed that with the right processes criteria and model it is feasible and can contribute to a dynamic maintenance management in the future.

THE IMPLEMENTED SYSTEM IN THE ORGANIZATION

According to the publication ILDINAV801 (Marinha[i], 2020) "The life cycle of a ship is defined as the period of time elapsed from its conception to its alienation,…". To keep the ships operational, during their life cycle there may be maintenance interventions that can have three stages of maintenance. The 1st stage, which is at the level of the ship's personnel, the 2nd stage, which is carried out with the support of the Fleet (ENSUP, which is the Surface Ship Squadron) and the 3rd stage, which is at the level of the Ship Management, using shipyards or other outsourcing services. (Marinha[i], 2020) These processes of maintenance and recovery of the operationality of the means are possible through the technical coordination of the various organization corps involved. This technical coordination should be nothing more than an agile and adaptive leadership process according to the planned and unplanned anomaly occurrences that incur preventive and corrective maintenance respectively.

The maintenance cycle is defined as the "time elapsed between entry into service and the end of the first interim overhaul, or between the completion dates between two consecutive interim overhauls." (Marinha[i], 2020) An example will be given of a case of 3rd stage maintenance on a ship in which the maximum responsible is always the captain, but the administrative process is delegated on the departments and respective services and sections. The need for 3rd stage intervention is exposed by the ship, first inserted into a software by the section chief, who has an autonomous process of execution as a writer, the head of service approves as requester, and then the person responsible for the onboard maintenance management process. The work request goes to the Administrative Command (ENSUP) where the need is confirmed and goes to the technical direction (DN) represented by the Ship Directorate. The DN forwards a work request to Arsenal do Alfeite or, if it does not have the capacity, forwards it to another shipyard or company certified for this purpose, Figure 1.

The current model is considered to have the following general characteristics:

- It is a strong model in Normative and organizational basis.
- It is flexible and adaptive.
- The crossing of data is done based on the common sense of the maintenance project managers.

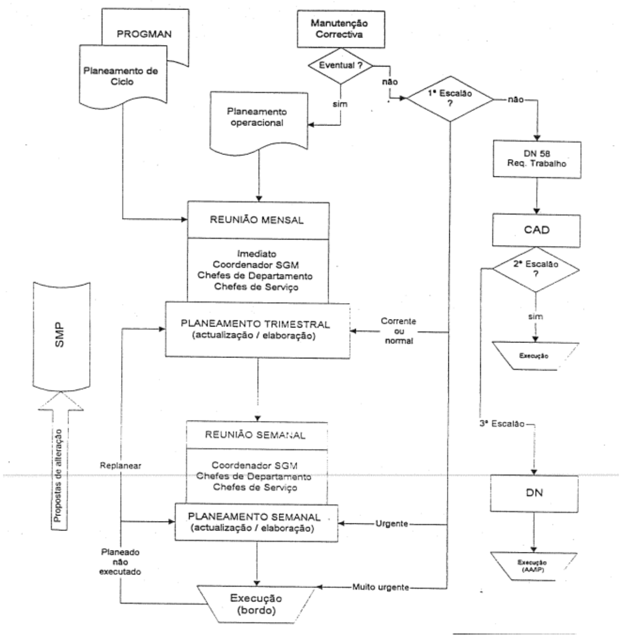

Fig. 1 - Planned Maintenance System in ILDINAV802

Source: MARINHA[ii] (1998)

Although the organization has its own planned maintenance system, it follows the good practices defined in the maintenance regulations: such as EN 13306:2007 – Maintenance Terminology 17 1.6.2, NP EN 13269:2007 – Maintenance – Instructions for the preparation of Maintenance Contracts 17 1.6.3, NP EN 15341:2009 – Maintenance – Maintenance Performance Indicators 17 1.6.4 and NP EN 13460:2009 – Maintenance – Maintenance Documentation (KPI) 18 1.6.5.

The Navy's planned maintenance system has all the preventive and conditioned maintenance operations defined, in which the process of leading the actions is "mechanized", in the event of unexpected anomalies, there may have to be an adaptive process. The current decision model on maintenance actions has strong normative pillars, and a lot of data is generated by the data collection and processing system (SRTD), by the sensors of the ships and by the entities involved. But there is no integrative database of the data, and the SRTD itself does not produce data capable of being treated directly and dynamically with statistical algorithms. In this way, we considered that the implementation systems that allow us to process these data and store them is a dynamic database. To facilitate and optimize the manager in the process, it will be necessary to create an artificial intelligence system based on algorithms that allows and helps the decision process in a dynamic maintenance method.

RESULTS

With some field research it was found that many processes contribute to the maintenance management major process, we have considered the follow: human process, economic process, military process, normative process, the aging process and the process from the process, figure 2 represent a scheme of analysis model.

In this specific case, in the process of organizational change in ship maintenance, five important actions can be considered: Involve, Trust, Inform, Control and Record.

The Ships, the Administrative Command, the Technical Direction, Arsenal do Alfeite must be involved in the process. The various levels of leadership must be trusted and supported: Heads of Service, Heads of Department, Heads of Division, Heads of Production. It must be verified that all the actors involved have training and knowledge of the implemented system. The entire process must be permanently public, communication chains such as email, military messages, notes, official letters, and online situational boards must be used. The control process must be continuous, implementation must be verified at various levels of the maintenance system hierarchy. Registration is one of the most important actions, to verify possible new variables and database data. At the same time, the progress of the implemented change must be recorded. The considered processes will influence the SMP, the intervention databases and history of equipment. Algorithms will be applied to existing databases to support the decisions.

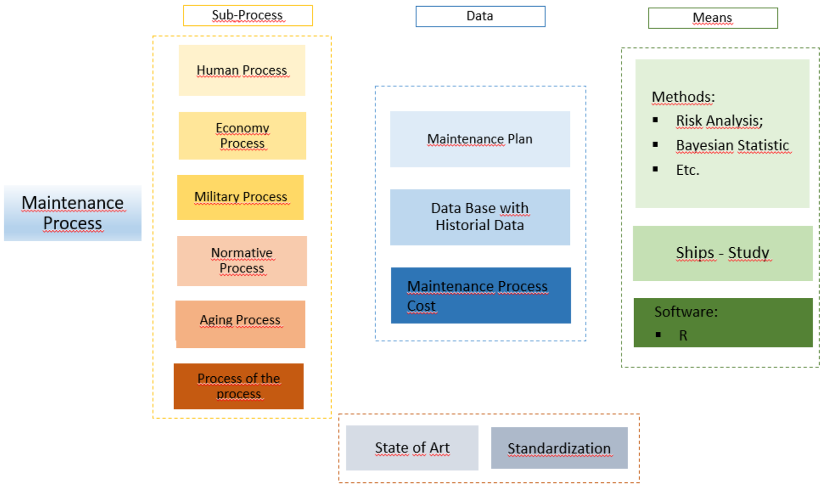

Fig. 2 – Analysis Model

The sub-processes information will contribute with data to the process decision making. These will interact with the define maintenance plan, with the database with historical data and with the maintenance process cost control. To make data useful it is proposed to use a risk analysis, and the development of Bayesian Statistic, using for case study one ship class and a programming software.

With this work, it is believed a strength contribution to the current maintenance management, streamlining the actual process and enhance it with scarce resources.

The change in the nowadays model, considering what some authors referred to be important in the maintenance change, is not only in the process but also in the organization maintenance mindset. From the reality of the organization and the previously existing systems, it is suggested that the change model for application in the Navy maintenance environment is as follows, Figure 3:

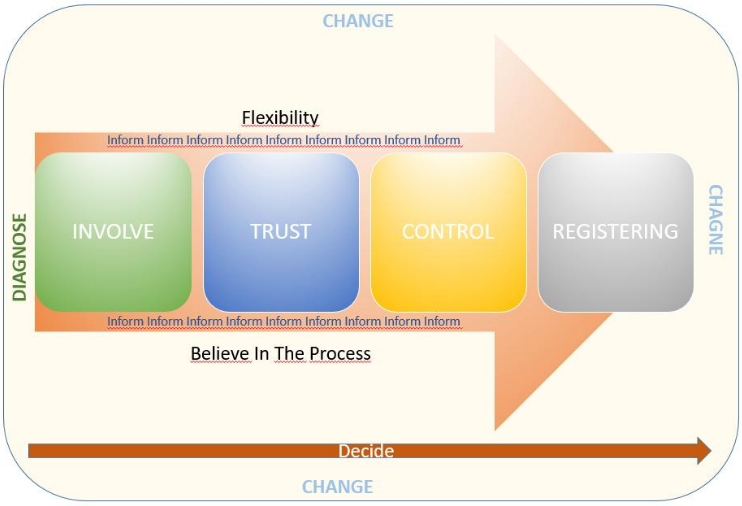

Figura 3 - Modelo de mudança liderança processos de manutenção.

The decision-maker should base his decisions on data, performance indicators of maintenance of the means must be created to support the decisions of the management of the material and personnel dedicated to maintenance, considering the reliability and the tendency of the systems to fail. After implementing the change model, it must be verified whether the change introduced is in accordance with the current situation of the organization, since the model will be introduced with an initial scenario and in the end, it may have already undergone changes.

CONCLUSIONS

Now the initial questions can be answered: The dynamic maintenance management in an environment of scarce material and human resources can be implemented considered also online dynamic databases; the actual decision-making process can be variable depending mostly of the involved people, maintenance strategy should be defined and available for all people of maintenance area; during the changing process people may resist to changes, but it is believed that in a short term the maintenance performance will enhance; the processes that can influence the decision making are: human, economy, military, normative, age and the process itself.

Before implementing a new maintenance management system, it is important to analyze the previous data, the implemented processes, to choose the maintenance procedure that best adequate. We considered that the defined processes are the adequate for start the study of dynamic maintenance, but when it is implemented, the system itself should be maintained dynamic, and some processes may be substituted or updated.

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