Material Management for Critical Equipment

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ABSTRACT

Failures of production and safety critical equipment can directly affect company's key performance indicators (KPIs) and ultimately lead to catastrophic consequences. The means for minimizing possible such consequences as well as downtime and safety equipment unavailability are usually related to interventions for repairing or replacing the failed equipment. These interventions can have a variable duration depending on the complexity and on the readiness of resources needed to fix the problem (e.g.: specific materials, specialized team to perform the repair, etc.). When materials are required, reactive purchases may occur, which most likely will lead to urgent and costly orders and freight, possible error in the equipment specification or in the quality assurance. The main purpose of this paper is to reinforce the importance of a robust process to define critical equipment maintenance strategies, ensure material management and to discuss the impacts of it all on the working capital and in the service level.

1. INTRODUCTION

For the offshore oil and gas industry, a recent research conducted by GE [2] shows a financial impact of a range of $38 to $88 million dollars per year related to expenses of unplanned downtime (in average 27 days of outage per year). As per the research, this impact is mainly driven by repair costs, including labor costs, transportation/logistics and equipment/spares [1].

Many challenges are faced by the industry in general when attempting to reduce operational downtime. Among them, it can be highlighted: different or unusual maintenance approaches (lack of standardization), control over spares; losses of competence vulnerability, both internally and at suppliers; inefficient order process design; adequate coordination across the whole supply chain; identification of critical equipment; establishment of stock level; stay within the budgets, etc.

In addition, lack of or incomplete equipment data set in company's asset maintenance planning tool may contribute, directly or not, to a less safe and/or efficient operation, such as:

- Production efficiency losses due to incorrect deliveries of materials.
- High amount of free text orders reducing accuracy in orders and increased supply chain costs.
- Reduced efficiency in the spare part acquisition, consequently in the optimization of spare parts in stock.
- Limited overview of material administration and material flow.
- Increased HSE risks due to longer unavailability time of safety critical equipment.

Thus, many potential opportunities for lead time of critical equipment improvements can arise from the effort to overcome these challenges, such as by reviewing or defining robust approaches to perform the repair / maintenance, contracts optimization, materials management, prioritization criteria, etc.

2. OBJECTIVES

Aiming to boost efficiency and to reduce cost, companies must concentrate their efforts to rationalize investments. This paper focuses on providing a systematic approach that can enable companies to reduce their financial and safety risks in case of failures of critical components or systems by focusing on to reduce the time to restore their function to as minimum as reasonably to be practicable.

3. O&G CONTEXT

The material management rational is based on a method to assist companies to increase availability of safety and production-critical equipment in a cost-efficient way, by avoiding reactive purchases and urgent orders, expensive freights, wrong equipment specification and reorders and, at the same time, promote compliance with external and internal requirements regarding availability of parts considered critical and spare

parts governing procedures.

a. *ANP Requirements*

ANP (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis) is the Brazilian national regulatory agency that sets technical resolutions to promote safe oil and gas offshore operations. The ANP Operational Safety Management (SGSO) requirements (Technical Resolution 43, 2007) clearly states that the Asset Operator needs to ensure that all critical equipment and systems somehow related to Operational Safety are included in inspection, test and maintenance plans (13.3.4), as well as to establish a Material supply planning (13.2) [2]. Furthermore, the investigation report of the accident in the FPSO Cidade São Mateus issued by ANP [3] established recommendations to prevent reoccurrence of similar accidents which are currently mandatory for all offshore O&G operators. At least two of these requisites are related to material management, such as increase awareness on the stock management impact in operational safety (R33) and perform studies to identify minimum inventory and ensure minimum inventory availability during all operational phase (R34).

b. *Material management in the context of Maintenance Timeline*

The total time to perform a maintenance is illustrated in Figure 1. It represents an example of breakdown of the activities that are to be done after an equipment failure. It covers from the time the maintenance personnel identifies the failed equipment up to the time the repair is concluded and the equipment function is restored.

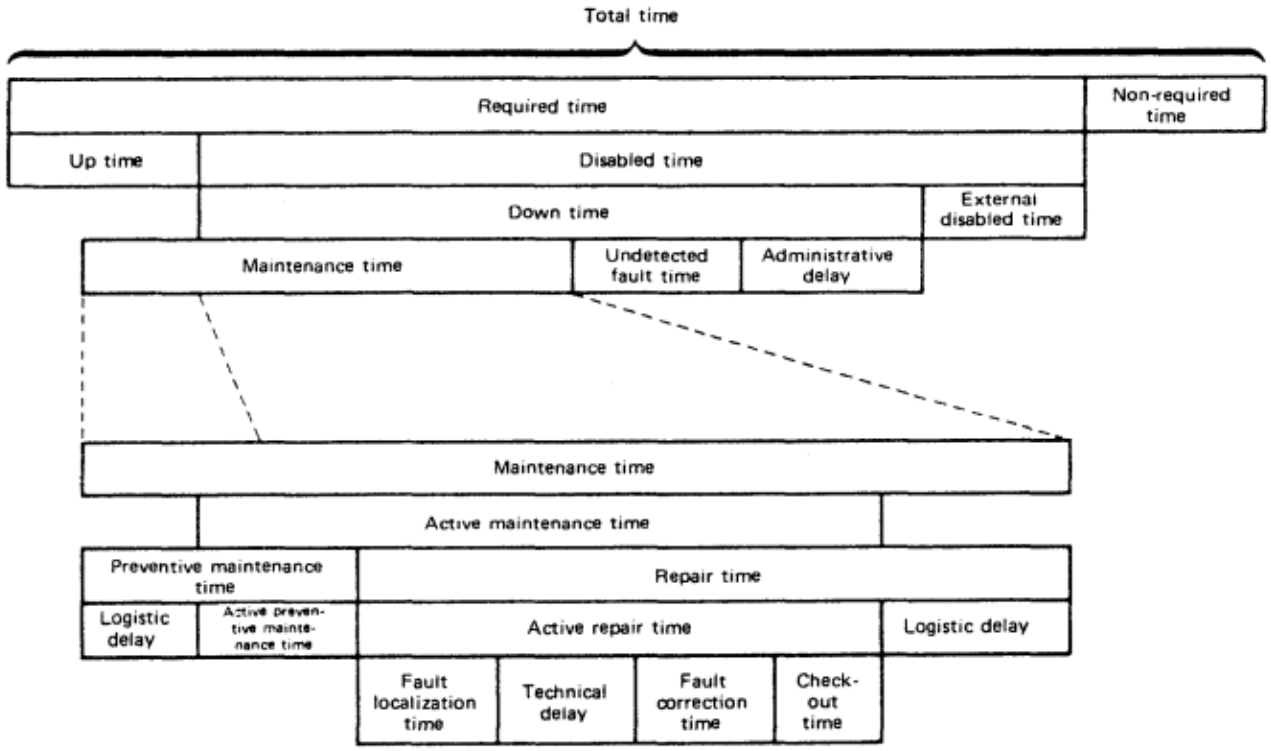

Figure 1 –Maintenance Duration Breakdown [4]

For production and safety critical equipment, reactive purchases can be necessary, leading to urgent orders, expensive freight, wrong equipment specification and overspend. Figure 2 illustrates typical corrective maintenance main process and how it flows with time. The bars duration (represented by its length) includes all maintenance related challenges, such as specifying proper actions deriving on equipment failures, specifying what is needed to perform the corrective maintenance as efficient as possible, selecting the appropriate material to restore equipment function, purchases process, logistics maintenance team mobilization, equipment repair and function restoration.

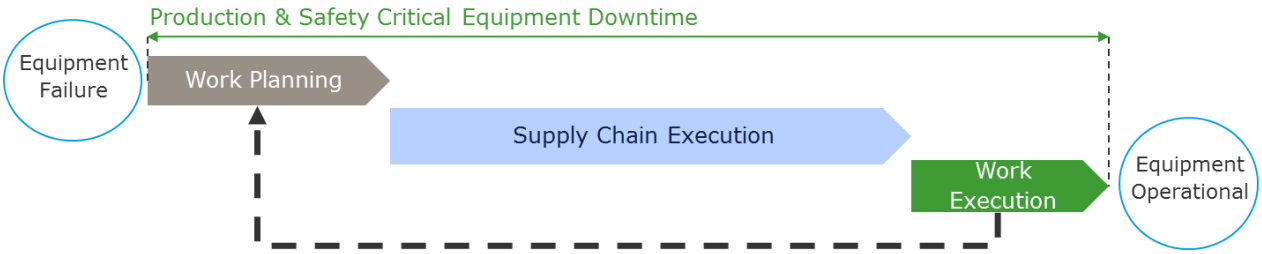

Figure 2 – Non-optimal Corrective Maintenance Process Flow

Companies can enhance material supply planning and stock management focusing on reducing work planning time (gray bar) by specifying proactively proper maintenance strategy and required materials and reducing supply chain execution time (blue bar) by having the specified material available in stock. The impacts of such non-optimal material management approach are more evident if it is on critical equipment (that directly affects production or operational safety), once it can be noted a significant downtime reduction (comparison – bars length – among Figure 2 and Figure 3).

Figure 3 – Optimal Corrective Maintenance Process Flow

4. SUGGESTED APPROACH

The suggested approach is to improve the material data information for a selected sample of equipment, which, as scope, prioritize the safety and production critical tags (parts or equipment). This approach is split in 6 different phases. Figure 4 illustrates these 6 different phases of the suggested approach for material management.

Figure 4 – Phases of a structured Material Management

The 6 phases are detailed below:

A. Inception Phase

During the inception phase the framework is defined and uncertainties/risks addressed, providing a revised plan for execution of next phases. This phase includes:

- Alignment of common understanding of roles/responsibilities and resource expectations
- Definition of Company matrix of project participants (installation/technical discipline responsible)
- Definition of battery limits and quality expectations
- Clarification of main work process elements
- Identification of key success criteria
- Assessment of project risks
- Tag sample and priorities (systems, battery limits)
- Specific tag database

- Key progress parameters and milestones
- Key project risks
- Kick-off meeting agenda and objective

This phase addresses the challenges faced by the O&G operators and main goals, based on assets complexity, critical equipment criteria, tools in place for maintenance register / control such as Enterprise Resource Planning (ERP), available data and resources, order processes, supplier's contracts, among others. As a result of this phase, there will be a defined detailed scope, work process and target, as well as project specific tools and procedures for next phases implementation.

B. Define tag sample

In this phase, it is established a subset of all tags to be included in the scope of work. This is done by extracting tags from the ERP or equivalent tool to a project database, which includes all relevant information for all phases. The tag sample can be selected based on many parameters, such as safety and production criticality.

As a result of this phase, there will be a defined tag selection and a complete database for the strategy definition workshops (Phase C).

C. Define strategies

The equipment function restoration after a failure can be done by replacing or repairing an item. The maintenance criteria are based on many factors, such as equipment price, access to perform equipment maintenance, maintenance crew specialization requirements, area at which it is located (e.g.: hazardous area), applicable inventory policy, among others. The repair and spare part storage strategies for all tags in the tag sample is defined in workshops with installation/technical disciplines responsible and the results of the workshop are uploaded to company's ERP or equivalent tool. A generic work process is presented in Figure 5. Prior to commencing the workshop, basic guidance and criteria for ensuring "best practice" should be defined (e.g. minimum purchase cost before repair is recommended, definition of long lead items).

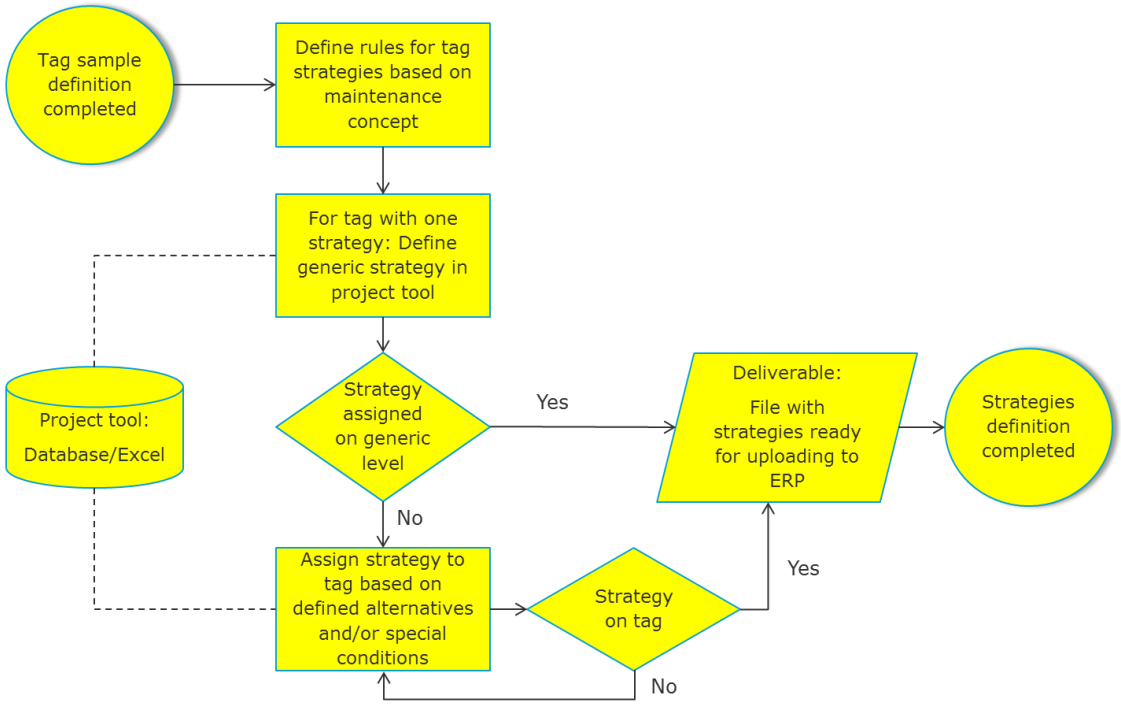

Figure 5 – Generic Work Process for Maintenance Strategies definition

As a result of this phase, there will be a defined repair and storage strategy for the defined scope of work.

D. Define Bill of Material (BOM)

Prior commencing to define BOM, the prioritized tags to be included in this scope should have been defined. For each tag a BOM will be prepared in line with the defined repair strategy for the tag. The Bill of Material (BOM) is a structured list of the components that make up an equipment, product or assembly. This list, as minimum, contains the object number of each component, the quantity and unit of measure [5].

In the case of tags with missing information in available documentation to fulfill quality requirements of a BOM, or with insufficient information to allow the identification of material number, a separate list (deviation list) is established to record and gather such tags for further decisions.

All decisions taken by this assessment are presented for each discipline responsible for his/her review and approval in a specific meeting. As outcomes, a list with the information necessary to establish BOM for the individual tags is delivered.

As a result of this phase, robust and structured Spare Part List and BOM are established and are ready to be uploaded to the ERP tool, reducing potential errors of specification and enabling proactive material requisitions.

E. Define Stock

The stock status for material numbers affected by the assessment is exported from ERP tool in order to couple it to tag data and repair strategies. For each material number, a new recommended minimum and maximum stock level is to be defined and presented for approval in workshops with discipline responsible. Recommended minimum and maximum levels will be based on recommended best practice for stock level. This shall be high enough to cover vendor's delivery times, sufficient to coupe with demand, but not so high that the company loses money because of high inventory costs [6]. The stock level is illustrated in Figure 6.

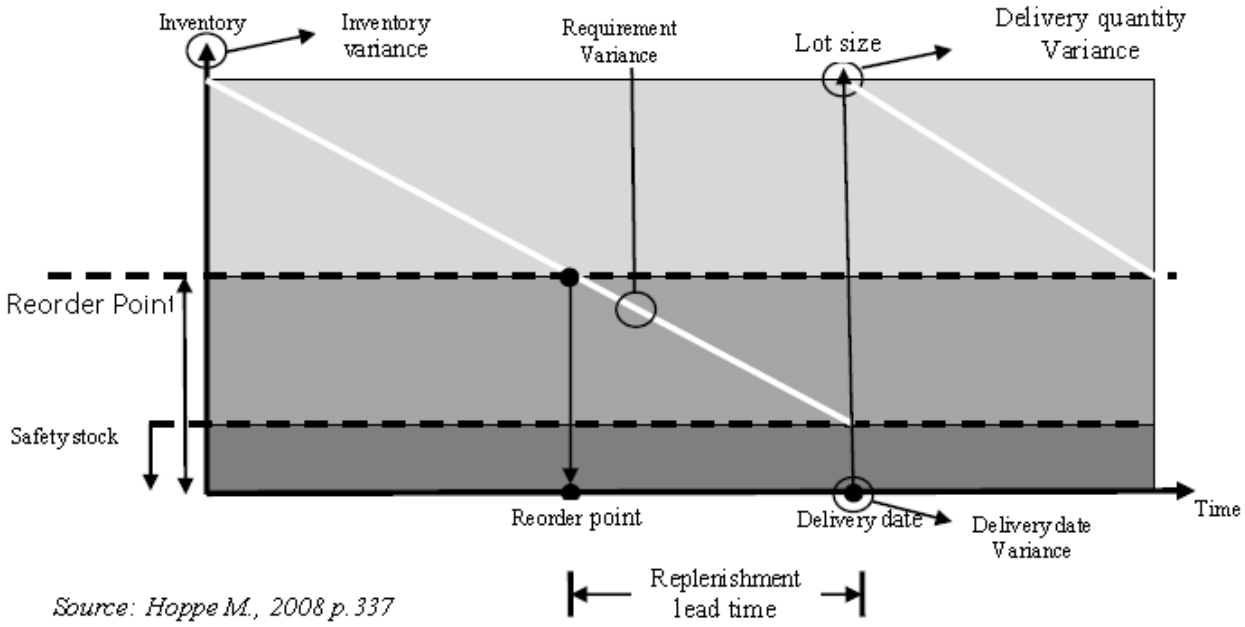

Figure 6 – Effect of lead time on stock management [6]

The costs are usually associated to company's service level target, which is the expected probability of not hitting a stock-out during the next replenishment cycle or the probability of not losing sales, determined by the level of stocks. **Error! Reference source not found.** shows an example of total operating costs as the sum of maintenance costs and purchasing costs [7].

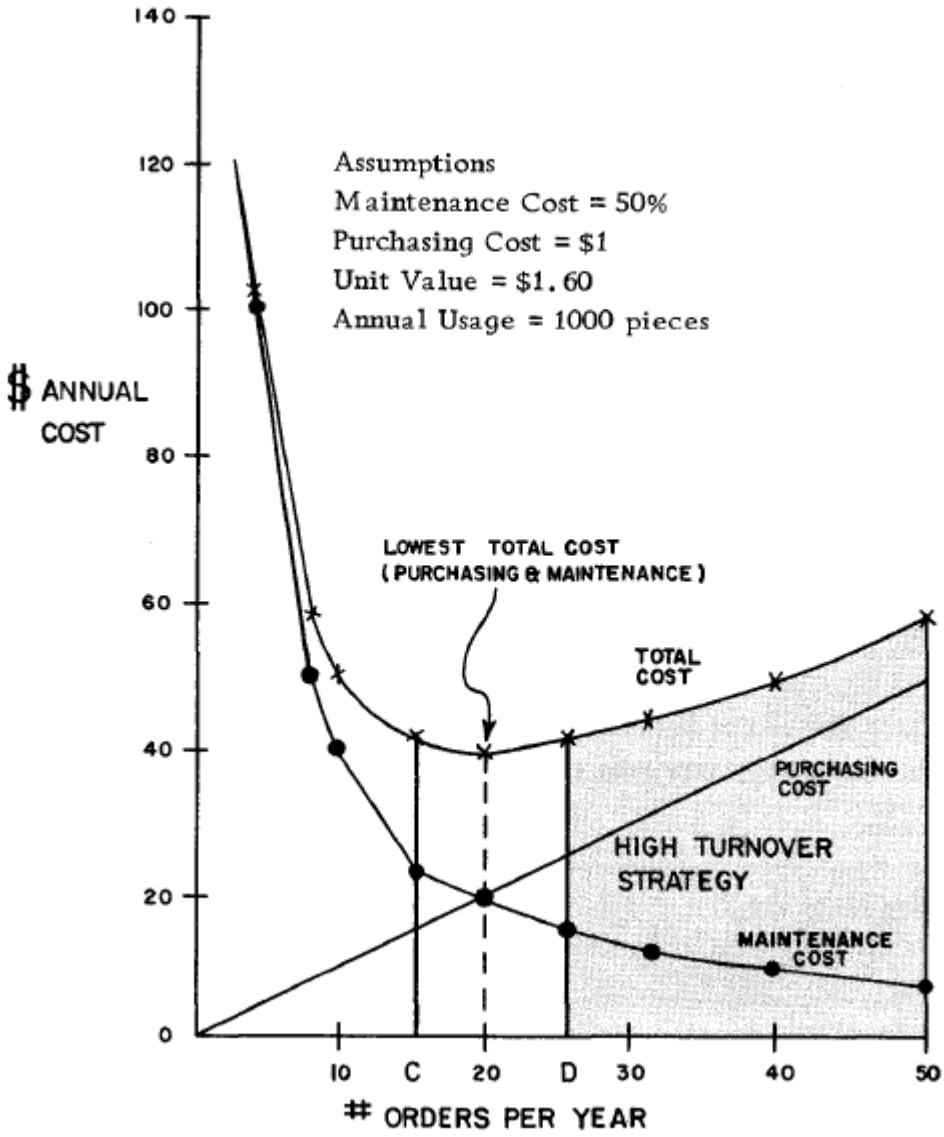

Figure 7 – Inventory costs versus ordering strategy [7]

As a result of this phase, storage level can be defined and uploaded to the ERP tool to ensure availability of critical parts at a cost and effective way.

F. Quality Check

The parameters considered for stock level definitions can change with time and need to be updated. For instance, materials become obsolete; project improvement opportunities are put in place, which may change material specifications; material consumption history can change over time, which can bring potential reliability analysis; contracts can be made or terminated, etc. Then, this suggested approach for material management is subject for continuous improvement loop in order to cope with all relevant changes that have potential to impact over assumptions and decisions taken.

5. CONCLUSION

Without an inventory management process in place, companies tend to overspend to restore critical equipment function, since these failures can lead to huge losses in terms of downtime. For these cases when reactive purchases are necessary, the company losses its bargain capacity and pays for equipment urgency and expensive freights. This immediacy may also lead to collateral effects, such as wrong equipment specification and purchases, sometimes forcing to recommence all supply chain process.

This paper provides a structured approach for a robust material management process that enables

operators to increase efficiency and safety with an appropriate service level set by proactively determining the best strategy for critical equipment function restoration, correct equipment specification, stock definition, material requirement planning, equipment price negotiation and freight optimization.

6. REFERENCES

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