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Revisions of the SMS maintenance procedures based on Computerized PMS data

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Abstract. According to the International Safety Management Code, every cargo ships of 500 gross tons and over must establish Ship Safety Management System that is documented in a Safety Management Manual. This document is prepared by the Company and contains rules regarding maintenance of the equipment, particularly recognized critical equipment. Those rules must be included into ship's Planned Maintenance System, another requirement of the ISM Code. Maintenance periods in rules are based on several factors, while the Company experience in the operation and maintenance of the ship and its machinery and equipment is emphasized and analyzed in this paper. Analysis of records from different Computerized Planned Maintenance Systems obtained from several companies show that each company implemented their experience in the system. At the same time, the results show that very few modification of machinery maintenance intervals have been made with the proactive approach based on acquired experience and new knowledge.

1. Introduction

International Safety Management (ISM) Code has been created with the intention to establish an international standard for safe operation and management of ships and pollution prevention. As one of the most important tools, the Code requires a Safety Management System (SMS) to be established by shipping companies. *A Safety Management System is a systematic approach to managing safety*" [1] in the shipping industry. SMS should introduce and implement a policy and create guidelines for the Company to implement duties and responsibility imposed by the Code. Safety Management System Manual is defined as a document prepared by the Company where all procedures required by the Code are documented and compiled [2]. These procedures should identify critical equipment whose sudden failure can result in a hazardous situation. Furthermore, specific measures should be defined to improve their functional reliability, including periodic testing and the establishment and use of alternative configuration in the event of sudden failures. Safety Management Manual (SMM) is based on systematic approach to maintenance, where inspection methods and maintenance intervals should be based on [3]:

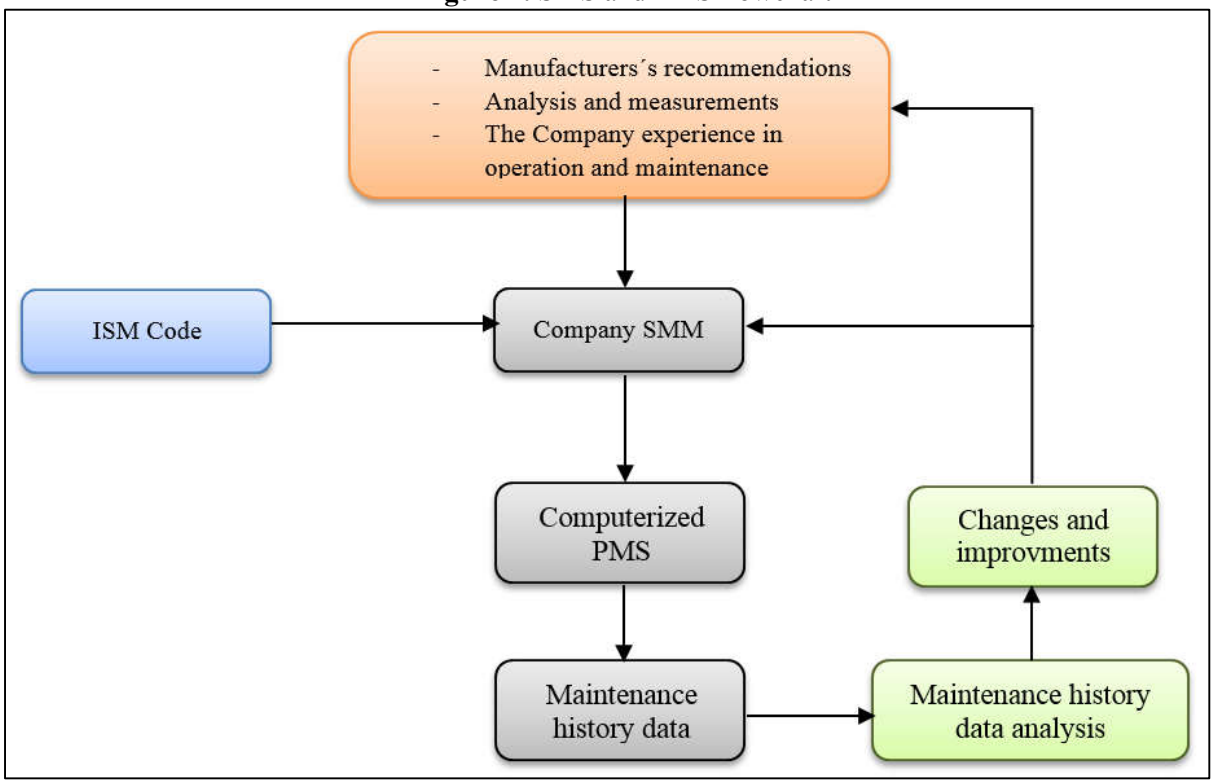
- manufacturers' recommendations and specifications,
- analysis and measurements (i.e. lube oil analysis, vibration analysis),
- the company experience in the operation and maintenance of the ship and its machinery.

"*A Planned Maintenance System (PMS) allows shipowners and operators to plan, perform and document vessel maintenance at intervals complying with Class and manufacturer requirements"* [4]. According to the ISM Code [5] every ship must have a planned maintenance system. Significant part of the PMS works is derived from the SMS and the company experience in the operation and maintenance of the ship and its machinery. Typical example of those works are inspections, measurements and overhauls of electric motors which is caused by the necessity to standardize maintenance period across

the company. Electric motor manufacturers either deliver instruction books without specific maintenance requirements [6], without specified period (‘ *’Since the insulation resistance is an important factor for judging the state of insulation, carry out periodical measurement of the resistance , and record the ambient temperature, relative humidity and weather as well’’* [7]), or give different maintenance period for same equipment (‘’ *Measure insulation resistance monthly*’’ [8], ’’*Measure insulation resistance yearly* [9])

The application of the Computerized PMS during ship exploitation enables the collection a large amount of maintenance data. This information can provide valuable information for decision making for changes to the maintenance policy (plan) and risk reduction measures. With these action can reduce maintenance costs and increase the safety level on board [10], [11].

Figure 1. SMS and PMS flowchart



This paper brings the results of the analysis of the Computerized PMS data and their feedback connection to the SMS. Analysis of the PMS Maintenance history data is performed and potential effects on the Company PMS and SMS are indicated as results of such data analysis. Results described in the paper are addition to the results published in [12] which addressed only shipboard side of this issue. Final conclusion considers both shipboard and shore side.

2. Research

Research is performed on four companies, looking into their PMS databases for the evidence of the maintenance modification requests and/or maintenance modifications without any request. All companies allowed access to their databases under no disclosure condition. Therefore, all details about companies are withheld and will be named A, B, C and D. First two companies’ PMS data modification requests are analyzed before and results are already published [12].

2.1. Company A analysis results

Analysis of databases yielded two improvement requests, both requests are based on the user's experience in the operation and maintenance and both are missing any analysis backing up requests. Only one of them was inserted into PMS as a modification, again without any data analysis.

Inspection of the PMS data modifications, performed by superintendent or system administrator (only system users with adequate access rights for modifications) showed only seven maintenance period modifications from 2001 to 2020. Five of them are performed without any notices why those changes are introduced into the system.

Inspection of all revisions of the company SMS showed that there were no maintenance interval changes since the company introduced the SMS.

2.2. Company B analysis results

Analyzed databases have only one real request for modifying Maintenance plan to increase period of the replacement of ball bearing on auxiliary engine supply fuel pump.

Inspection of the PMS data modifications, showed only one maintenance period modification and no modifications of the maintenance interval in the company SMS.

2.3. Company C analysis results

During the analyzed period of eight years the company with five ships had more than twenty requests from ships for modification of the Maintenance interval, based on the user experience. All requests were backed up with relatively good explanation, but without reliability calculation or analysis.

Most of the modifications, after approval from the superintendent, were included into the PMS creating new maintenance plan.

Inspection of revisions of the company SMS showed that there was one maintenance interval change introduced the SMS. That change was introduced after two similar (almost same) maintenance period change requests arrived from two sister vessels.

2.4. Company D analysis results

Analyzing the period of eleven years showed that there were no requests from ships (two) for modification of the Maintenance interval during that time. At the same time, there were no changes in the PMS and no modifications of the maintenance interval in the company SMS.

The result for this company is a surprise, the company has very good records, it is regarded as an example how to implement all required rules and regulations, the company where SMS and PMS are functioning very well.

3. Discussion

Results of the analysis are shown in the Table 1., where the column Summary gives full information on the red part of the flowchart on Figure 1. All analyzed companies have SMS implemented and all have fully functional Computerized PMS. Modification requests regarding adjustment of the maintenance period, based on the user experience, are very rare, on average every ship request modification every eight years.

The SMM revisions regarding adjustment of the maintenance period are almost nonexistent, there is only one revision noted. This result show that indicates that companies missed the opportunity to learn and gain from accumulated data [13].

Table 1. Comparison of the analysis results

	A	B	C	D	Summary
No of analyzed ship databases	11	6	5	2	24
Average inspected period (y)	11.3	4.5	8	10	8.45
PMS modification requests	2	1	23	0	26
PMS modifications	7	1	22	0	30
SMS revisions	0	0	1	0	1

Cumulative results of the research, presented in the Table 1. Are describing twenty four analyzed databases in four companies. Planned Maintenance System was in use on average 8.45 years on every analyzed ship. During that time all ship crews created twenty six PMS improvement requests, connected to the change of the maintenance, mostly in Company C.

Company A PMS modification requests are as follows: an extension of the air compressor system maintenance period and decrease period of cleaning of diesel generator fuel filters. Both requests were inserted into PMS, but in the PMS system there are five more modifications, without any explanation, therefore those results are not to be considered as modifications performed as maintenance improvement. Company B has only one request for maintenance modification which was approved and inserted into the PMS, although explanations of the request are very limited.

Company C had twenty three PMS improvement requests connected to the change of the maintenance created by the crew. Various requests can be found there, from modifying Air Condition suction filter cleaning period (due to sailing in the areas where dirt and dust are clogging it frequently) to changing injector and exhaust valves renewal frequency (attempt of the company to switch to non-original spare parts). Most interesting modification request is insertion of the new work of half yearly measurement of the Forward Mooring Winch/Windlass brake, requested from two sister vessels. That modification was inserted into PMS and later in the Company SMS Manual.

Considering all the requested and approved changes, it can be concluded that little changes were made to the maintenance plan during the considered period. As the collected data can provide a good basis for applying a proactive approach to safety on board as an SSM target, it can be concluded that the data should be used to a much greater extent. Although a framework [3] has been proposed for this purpose, the results presented here indicate the need to improve the monitoring of data analysis results. This could improve the application of PMS as a tool for decision making and optimization of maintenance costs.

4. Conclusion

Performed investigation and data analysis showed that shipping companies have their experience in the operation and maintenance of the ship and its machinery implemented into the SMS with series of requirements and rules. All those requirements were included into the Computerized PMS, creating a set of additional jobs into the system. All inserted maintenance was followed to the letter, all works were performed by the crew on all analyzed ships, verifying that ISM intention is functioning and that all ISM requirements in regards of the maintenance are fulfilled.

Same investigation showed a flaw in this scheme, an area where whole system can and should be improved. This flaw was partially described in previous research which showed that use of PMS Continuous improvement scheme for maintenance adjustments in shipping industry is not sufficient. Further analysis showed that companies did not have efficient follow up of the established maintenance scheme and that analysis of the data of the performed maintenance was superficial or non-existing.

Although all analyzed companies have their experience in the operation and maintenance of the ship and its machinery implemented into the SMS and PMS, all of them failed to establish a scheme to update that experience according daily developments. There were no procedures for rechecking of the maintenance data on board nor on shore. Companies failed to recognize potential savings which or significant risk reductions which the analysis can produce.

The issue described in the paper is mostly unknown in the shipping industry, there are no serious attempt to address it. Therefore, this paper can be considered as a first attempt to highlight its importance and potential benefits from solving it.

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