TRANSNAV
http://www.transnav.eu
the International Journal
on Marine Navigation
and Safety of Sea Transportation
Volume 15
Number 4
December 2021
DOI: 10.12716/1001.15.04.03

Assessment of the Concept of the New Methodology for the Evaluation of Ship Planned Maintenance System

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ABSTRACT: The paper presents an attempt to develop better and cheaper methodology for evaluation of the quality of the ships' computerized Planned Maintenance System databases. A concept for the better methodology has been developed following many times verified rule that faster and cheaper is better. The concept of the methodology has been checked in operation, tested on four different databases. Results of the evaluation performed by the concept are compared with an expert evaluation using old, verified methodology, performed on same databases. Comparison valuated the concept, bringing the verdict if it is functioning or not, showing that the old and verified rule is not functioning every time.

1 INTRODUCTION

The creation of a methodology for an evaluation is process which takes several steps from defining the problem, developing the solution and finally testing the operability of the solution [10]. Fully operational evaluation methodology for the quality of the Computerized PMS (Planned Maintenance Systems) for ships has been developed in 2017 [12]. After development, the methodology has been tested and released for free use. Since then, quite a large number of databases has been evaluated using the methodology, either for scientific or for economic purposes.

Several unwanted characteristics or flaws were identified during the use of the methodology. The process of the evaluation requires an expert with advanced knowledge of the marine engineering (senior engineering rank), knowledge of the Company structure and policies (usually from the company or very well versed about the Company) and advanced knowledge of the used computerized PMS system. Another drawback of the evaluation methodology is that evaluation takes several hours per database. Therefore, the evaluation of the quality of the PMS database become costly operation and shipping companies quite often accept PMS database without proper and efficient quality control. Drawbacks in the methodology and the need for constant improvement [8] were a driving force for the development of the new methodology which will be without listed flaws.

1.1 *Non-disclosure condition*

Shipping companies allowed access to their data strictly under no disclosure condition. All identification details (either the ship or the company) are removed from the article.

2 THE METHODOLOGY CONCEPT

Development of the solution was the next step after defining the problem [10]. A concept of the new evaluation methodology has been created, following the idea that the simpler is the better [1], with intention to be simple enough that an ordinary skilled person can evaluate any PMS database without preparation or special knowledge. Another concept design condition was based on the principle that faster is better [2], the evaluation time of the database quality is shortened to less than half an hour. Another condition introduced for the concept was that it should be operable on any type of computerized PMS, obtaining same results.

Several researches pointed that most common deficiency in the computerized databases was missing information [3, 6]. In line with that idea, the concept for the new methodology is trying to establish link between the quality and the quantity of the data in ships' computerized PMS databases. To minimize the time needed for the evaluation, only a randomly chosen sample of the database should be analysed, not the whole database [4, 5]. This will ensure that the time for the evaluation is short and cheap. In this case, several pumps, randomly chosen should act as a sample for the testing.

The basic idea of the new concept is very simple, it is basic. The idea stems from already stated fact that the most common deficiency in computerized databases is a missing of information [3, 6]. Therefore, the concept is derived from the idea that the larger amount of information in a database means that the database has fewer flaws. If this is true, the evaluation of the quality of the ship's computerized Planned Maintenance database could be reduced to a mere counting of the data in the database. This procedure does not require knowledge of systems and mechanical engineering and can be performed by anyone. It would create significant savings in the process of the control and the development of the database and reduce the total cost of the system.

Testing the operability of the solution (concept) was performed in two stages, each stage had separate research objectives. The objective of the first stage [11] was to determine the functionality of the concept. Second stage of the testing had to determine if results obtained by concept are corresponding to the quality of the DB established by an expert.

3 THE FIRST STAGE TEST

In order to determine the functionality of the concept, a randomly chosen evaluator, with average skills, performed evaluation of a database. Database evaluation was performed on the Company premises, by a student of Marine Engineering.

Overall evaluation of the database [11], based on the concept, was that DB quality is good, with note that improvement should be performed with spare parts and equipment details and maintenance plan.

Results of the concept testing were compared with the expert evaluation, performed in 2017 [13]:

"Database on average is in order, database does not require immediate action. There are some areas where action is required:
- some components are without spare parts,
- maintenance plan on some components should be improved,
- some components do not have defined equipment details".

Obtained results were very promising although conclusion was not formed because "small sample should not lead to great conclusions" [13].

4 THE SECOND STAGE TEST

Further testing has been performed, hoping that results will look similar to the results of the initial database, which will verify functioning of the concept. The evaluation of three ship databases was divided into two separate evaluations [9].

The first evaluation was performed using the concept by an ordinary skilled evaluator. Second quality evaluation of computerized PMS databases was performed on same databases by an expert using old methodology. The evaluation was performed on the premises of the shipping company. Analysed vessels are not sisterships, data collected using the concept is presented in Tables 1, 2, 3.

Table 1. Results of information counting of the database A

Equipment name	Equip. details	Spares number	Spare details	Purch. data	Work data
SW cooling pump	5	47	6	2	3
FO Transfer pump	4	40	5	2	2
Firefighting pump	6	49	6	2	5
Bilge/ball. pump	6	43	6	2	3
Cargo pump	6	117	6	2	2
Em'cy FF pump	6	49	6	2	5
Bilge piston pump	5	40	5	2	2
AVERAGE	5.4	55	5.7	2	3.1

Table 2. Results of information counting of the database B

Equipment name	Equip. details	Spares number	Spare details	Purch. data	Work data
SW cooling pump	6	42	5	2	4
FO Transfer pump	6	37	6	2	2
Firefighting pump	6	44	6	2	3
Bilge/ball. Pump	4	46	5	2	4
Cargo pump	5	92	5	2	3
Em'cy FF pump	4	39	4	2	3
Bilge piston pump	5	46	4	2	3
AVERAGE	5.1	49.4	5	2	3.1

Table 3. Results of information counting of the database C

Equipment name	Equip. details	Spares number	Spare details	Purch. data	Work data
SW cooling pump	5	51	4	2	5
FO Transfer pump	6	44	5	2	3
Firefighting pump	5	36	6	2	4
Bilge/ball. pump	5	38	6	2	3
Cargo pump	6	108	6	2	5
Em'cy FF pump	5	42	5	2	4
Bilge piston pump	6	45	4	2	4
AVERAGE	5.4	52	5.1	2	4

The evaluator (with ordinary skills) analysed obtained results and formed overall evaluation about PMS databases. The overall evaluation of databases is summarized:

- DB 1 (database 1) has all chosen components; all of components have linked equipment details. Spare parts are linked to all components, maintenance plan is well designed and tuned. Spare parts details are present as well as extensive purchase data. There are no areas for improvement found during this evaluation.
- DB 2 has all chosen components; all of components have linked equipment details. Spare parts are linked to all components, maintenance plan is well designed and tuned. Spare parts details are present as well as extensive purchase data. There are no areas for improvement found during this evaluation.
- DB 3 has all chosen components; all of components have linked equipment details. Spare parts are linked to all components, maintenance plan is well designed and tuned. Spare parts details are present as well as extensive purchase data. There are no areas for improvement found during this evaluation.

An expert evaluated same databases using the old methodology and the questionnaire [12]. Results of those evaluations are almost the same for all three databases and are presented in the Table 4 (Results are applicable for all three databases). Only major deficiencies are collected in the table, i.e. areas marked with low grades. There are also some other areas where noted deficiencies are minor and no improvement was recommended by the expert.

Table 4. Old methodology analysis results for all databases

Question	Priority	Grade
16. Is the alarm system and its testing program entered in the DB?	1	1
17. Is PMS self-improvement program inserted into the DB and is there control mechanism for PMS DB self-improvement program?	1	1
20. Are jobs created and grouped according to multiplier principle?	2	2
21. Are all the same type jobs, coming from different sources, synchronized?	2	1
22. Are all the same jobs, resulting from different requirements (sources), merged?	2	1

Overall opinion of the expert, based on the extensive inspection of all three databases:

- Databases have an average grade of 4.3, which is relatively good overall evaluation grade. There is frequent usage of the system by several on-board users and several office users, which is by itself good sign.
- Databases appear to have all components, and look to be in good order. All components are marked properly and uniquely, according to their shipboard location and markings. The data about the manufacturer, the type and the serial number is entered to all relevant items as required. Maintenance plan is well designed and tuned, all jobs required by company policy are included in the DB as well as all jobs required by flag state rules and regulations and by the Class society. Fire detection sensor list has been inserted into the DB together with the testing plan. Spare parts are linked to all components, together with purchase data and details.
- Two areas require immediate attention; PMS self-improvement program has to be established as soon as possible in order to report and supervise DB and its functioning and alarm testing program needs to be inserted in the DB to enable supervision of this segment. Another three items are with intermediate priority, improvement is also needed but that does not have to be performed as soon as possible. There is a multitude of examples in databases where same job is scheduled twice, for example an overhaul is required (scheduled) due to manufacturer recommendation, at the same time there is overhaul scheduled due to Class Survey.
- Databases also have examples where same job is inserted twice, for work order for example electric motor overhaul is linked to pump and to its motor as well. Also, it is noted that work frequency is not synchronized, i.e., work orders should be grouped to avoid unnecessary paperwork.

5 DISCUSSION

The evaluator with ordinary skills using new concept analysed computerized PMS databases and the duration of that evaluation was 30 minutes per database or 90. Duration of the evaluation performed by expert was much longer, almost four hours per database. Also, the expert's report and discoveries are much more extensive and detailed as expected [7], and it contains a whole series of observations that are not present in the opinion of an ordinary evaluator. That is expected because of the difference in expertise and the difference in the time used for the evaluation. Both evaluations pronounced all three databases to be good, expert gave an average grade of 4.3 (out of 5). Both evaluations concluded that analysed databases have all inspected components and well-established maintenance plan. Main differences of two evaluations are noted in discovered shortcomings of databases and recommendations for the future actions. The evaluator with ordinary skills using new concept concluded that all analysed databases are in order and that there are no areas for the improvement found during his evaluation. Evaluation performed by expert discovered several areas which need the improvement, and above all, two of them are classified as serious deficiencies which require immediate action.

Comparison of two evaluations showed major discrepancy between evaluation results. Although overall evaluation of databases matches, the results of evaluations do not. New concept failed to identify any deficiencies which expert discovered in the database and therefore failed in main purpose of the evaluation which should be to discover problems in the database and to recommend areas for the improvement.

Although there are significant potential savings connected with the new concept (first, the duration of the evaluation is eight times longer, than expert wages are much higher), noted major discrepancies question the meaning of this evaluation.

6 CONCLUSION

Several conclusions about the concept can be formulated, despite relatively small number of evaluated databases. Testing of the concept of on the different PMS verified that the concept is functioning and that it can be used on different computerized systems. Two persons, both fulfilling the condition of average skills, tried the use of the concept and both succeeded to evaluate database(s) without any problem. This is confirming that the concept is indeed simple enough for the use by everybody, as it was intended. Average time for the evaluation was 20-30 minutes which is huge improvement from the time needed for the expert evaluation. Short evaluation time is confirming that another goal of the concept is achieved.

Comparison of results of the second stage tests showed a major deficiency of the concept which was noted in the second stage test in evaluations of all three databases. Concept evaluation did not produce same results as the evaluation performed by the expert, furthermore, concept failed to detect serious shortcomings inside databases which were detected by expert and listed line by line. Although the concept showed great prospect, and evaluation of the first database was very promising, the discovery of those shortcomings in the databases changed the outcome. The concept failed in the primary goal, to perform proper evaluation and determined the outcome. Although databases evaluated in the second stage test had larger number of information linked to them, there were shortcomings which ordinary skilled person did not detect. Despite good initial results, the concept failed to produce satisfactory results and further use of the concept is not recommended.

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