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Contract Management Control and Monitoring System for the Royal Malaysian Navy – Post Survey Validation via Top Management Experts

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Abstract: The improvement of naval ship operational availability remains a critical aspect to navies worldwide. Despite sophisticated methodologies and complex In-Service Support Contracts in place to achieve high operational availability, even the most advanced navies are still struggling to strike a balance between availability targets, budget and regulatory restrictions. This situation is also applicable to the Royal Malaysian Navy. A Contract Management Control and Monitoring System (ConCaMS) was developed to target both human and machinery related factors affecting naval availability or so-called Downtime Influence Factors. These factors are identified and prioritized based on their severity based on Delphi methodology. The resulting system is validated via top management experts that concluded in unison the benefits of ConCaMS especially in improving availability.

Keywords: Improving naval availability, Downtime Influence Factors, Contract Management Control and Monitoring System (ConCaMS), Post-Survey Validation, top management experts.

1. Introduction

The Royal Malaysian Navy (RMN) alike its counterparts worldwide strives to achieve high Ship Availability whilst accomplishing its vision of becoming a World Class Navy [1]. Operational availability (Ao) of naval ships is defined as the number of days the warships are available for operational tasking in a year. It also reflects the sustainability of the naval force in showing off presence and deterrent capability [2]. Upon handover of ships to the navies the In-Service Support (ISS) phase begins [3]. The ISS contract is to perform the management, logistic services, engineering and training required to support the naval vessels in order to operate and perform its function through its lifecycle. The ISS phase of a naval vessel will typically constitute 70% of the through-life cost of the vessel [4], therefore it is an important area to be attended to. In addition, [5] presented an indicative value of losses due to downtime, stating that for a ship valued at USD500mil and 30-year target service life, would lose the navy approximately USD50k/day if the ship is not operational.

A compelling study by [6] recently in 2015 resurfaced more recent interest in naval ship Ao by explaining that warships are complex in nature and that studying availability of naval ships would require consolidation of all factors from concept to ISS phase. The author recommended a new design concept based on Ao of warships with the associated support systems to achieve the best balance between Ao and life cycle cost (LCC) along the vessel's operational life. LCC studies are life cycle costing has long been recognized as one of the essential techniques for sustainable development [7]. An example of the LCC Tree as disclosed by the author is displayed in Fig. 1.

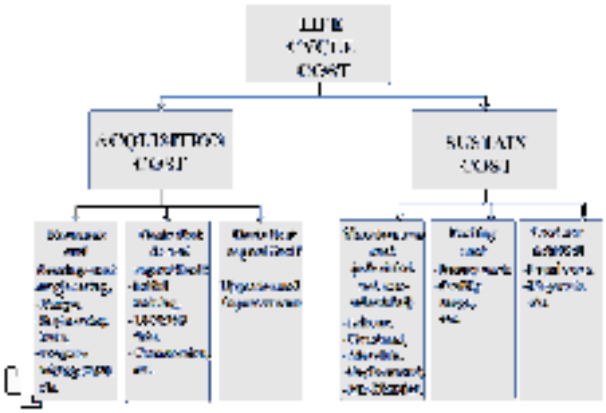

Fig.1 Life Cycle Cost [7]

All ISS contracts have Ao targets to achieve. Even established navies such as United States Navy (USN), Dutch Navy, Royal Navy United Kingdom (RN), and Royal Australian Navy (RAN) have successfully devised and implemented strategies that improved their fleet availabilities whilst regulatory, quality and cost performance measurements are being imposed [3].

In simple terms, to date there appears to be no generic "best suited methodology" in place. In accordance to Reliability Analysis Centre, Operational Availability (Ao) is not just a function of design but also of maintenance policy, the logistics system, and other

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supportability factors [8]. A Contract Management Control and Monitoring System (ConCaMS) is a decision-making support tool to continuously track, manage and control the In-Service Support (ISS) contracts with the necessary feedback and recovery information enabling faster decision making, assist maintainers and store keepers as well as trainers and all other stakeholders to have a better appreciation of their individual contribution towards improving availability figures. This ConCaMS tool may also be used internationally to compare contract performance [3]. A display of the ConCaMS input and output is reflected in Fig.2.

Fig.2 ConCaMS display input and output

The recommended ConCaMS mechanism for collection of daily data on availability is reflected in Fig.3. The actual availability is compared to the targeted availability to reflect the current contract performance on a daily basis. Where the actual availability is lower than the targeted availability, a recovery availability is automatically calculated for the benefit of the contract manager.

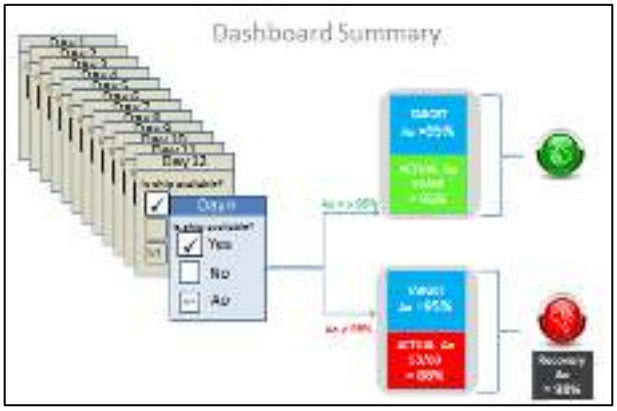

Fig.3 ConCaMS display input and output (Dashboard)

The key concept of the proposed ConCaMS is that Availability can be "simply" expressed as Uptime and formulated as "One minus Downtime" as derived from Hou Na et al [9]. In a nut shell, availability is increased when downtime is reduced. Downtime is caused by a list of human and machinery related factors. These factors are called Downtime Influence Factors (DIFs). Hence, holistic efforts should be placed on improving the DIFs [10].

The application of the ConCaMS is centered around the improvement of 15 severe DIFs identified via a 7-stage Delphi study [11]. The severe DIFs ranked from most to least severe are reflected in Table 1.

Table 1: Severe DIFs ranking.

Severe DIFs	Rank
Corrective Maintenance	1
Cashflow Shortages	2
Maintenance Policy - Priority on Type of Maintenance	3
Awareness of Importance of Maintenance / Attitude – including hiding problems from becoming official.	4
Complexity and efficiency of existing contract	5
Scheduling Issues	6
Spares Availability	7
Maintenance Budget Allocation	8
Knowledge Management incl Training, Knowledge, Skills and Systems	9
Equipment and Systems - Main Propulsion	10
Availability of Original Equipment Manufacturer (OEM) Expert Support	11
Availability of Facilities	12
Availability of Local Vendor Support	13
Equipment and Systems - Auxiliaries	14
Impact of Parallel Contracts to Schedule, Genuinity of Spares, Professionalism of Repair Team etc.	15

This paper summarizes findings of the Post-Survey Validation conducted with leading maritime top management experts in Malaysia that did not take part in the early Delphi rounds, as the final phase to conclude the complete research on availability improvement for the RMN ISS contract.

2. Post-Survey Validation Method

A post-survey validation questionnaire was developed to independently confirm the findings of this newly developed availability-oriented contract management model designated as ConCaMS. The methodology was adapted from Ramasamy [12] where a post-survey expert validation took place to confirm the final framework produced.

Other common validation methods in the engineering field consists of analysis and evaluation of physical data measured on site [13]. This method could be applied to measure equipment readings onboard the navy vessel, however would not offer an all-encompassing approach in measurement on human-related factors. In addition, the method could not assist in understanding the inter-relationships between equipment and human-related factors. A post-survey validation was selected to be

applied due the fact that the new discovery of factors in this exploratory study is ahead of the technology to decipher them. There has not been any data collection on these newly discovered factors in the past, and there is no existing knowledge and experience on data collection method and mechanism on these DIFs to date. It requires a new technology and a shift in the mindset to enable collection of quality and purposeful data on the severe DIFs, which has only recently been introduced with the development of ConCaMS and its associated dashboards. Categorization of downtime to be recorded daily in accordance to the newly discovered severe DIF categories such as unavailability due to lack of knowledge and training, due to complexity of existing contract or caused by maintenance policy requires a different technological approach and mechanism that has not existed to date in the RMN and local ISS industries.

2.1 Post-Survey Expert Selection Criteria

Judgmental sampling was applied to identify the best suited experts for the study. The sample does not need to comply to quantitative research as the results will not be analysed in view of inferential statistics but with the view to better understand the problem areas based on expert opinions in the field. This type of sampling can also be referred to as non-probability sampling [14]. Other researchers have similarly used expert opinions to study maintenance downtime distribution [15]. Size of sample and the appropriate number of experts was decided according to Baker and Edwards [16] who provide guidance and advice on sampling size for qualitative interviews based on a set of succinct "expert voice" contributions.

Adler and Adler [17] advised that the best answer is simply to gather data until empirical saturation has reached since some qualitative researchers argued that as little as one expert opinion can add value to the area of research. The criteria to be fulfilled by the Post-Survey Validation Experts (PSE) was defined as follows:

i. In excess of 20 years of working experience, having similar or higher position than Top Management Experts in earlier rounds of Delphi.
ii. Stakeholders at very senior position, with interest in the subject matter and who would benefit from results in their work field in the future.
iii. Recognized as leading maritime experts in In-Service Support (ISS) and naval ship maintenance.

Since the ConCaMS was developed with inputs from 35 experts and top management experts from the niche field, there was only a limited balance of Top Management Experts qualified to take part in the Post-Survey Validation.

2.2 Post-Survey Expert Demographics

The participants were selected from Top Management of Shipyards, RMN and Malaysian Maritime Enforcement Agency (MMEA) fields based on their most recent and remarkable contributions to the Maritime and Defence industry in Malaysia, categorically recognizing them not only as leaders but also as Subject-Matter Experts (SME). Table 2 contains the participant's demographics.

Table 2: Post-Survey Experts Demographics.

No	Organisation Type	Working Experience	Designation/ Job Function
1	RMN	28 years	First Admiral/ Head of Engineering
2	Shipyard	24 years	Executive Director Shipyard
3	Shipyard	42 years	Managing Director Shipyard
4	RMN	34 years	Rear Admiral/ Chief of Strategic Management
5	MMEA	40 years	Rear Admiral/ Director of Maritime Safety and Surveillance

2.3 Research Questions

The questionnaire administered was subdivided into three sections consisting of Section A, a 25 minutes demonstration of the ConCaMS, Section B, a 10 minutes feedback on the demonstrated model and implementation considerations and Section C, further feedback. These sections were aimed at answering a list of research questions and research objectives as contained in Table 3.

Table 3: List of Research Questions towards achieving Research Objectives.

Research Questions (RQ)	
RQ1a	What are the human and equipment related downtime influence factors (DIFs) affecting ship availability?
RQ1b	How can the DIFs affecting ship availability be-ranked and prioritized?
RQ2a	How do the DIFs impact the contract and project management elements of the "iron triangle of cost, time, quality and scope"?
RQ2b	Is it possible to improve ship operational availability by improving DIFs?
RQ2c	What areas can be improved when faced with budget constraints, if RQ2b is positive?
RQ3	Is it possible to develop an index based on ranking of the DIFs to indicate the severity of the DIFs?
RQ4	Is it possible to develop a new model to assist stakeholders to better understand the availability concept and assist contract managers to monitor and control the contract

Research Questions (RQ)	
	better?
RQ5a	How can the developed model assist the various organizations in their ultimate effort for improving the ship availability?
RQ5b	How can the model assist contract managers in managing their contracts better?
RQ5c	How can the model assist policymakers, maintainers and logisticians, as well as other stakeholders to contribute better in improving ship availability?
RQ5d	How can this model and associated research findings specifically benefit other navies implementing ISS contract, and generally benefit other engineering industries as well?

3. Results and Discussion

The results obtained from the Post-Survey Validation are summarized in Table 4.

Table 4: Post-Survey Validation Questionnaire.

No.	Question
1	The real data extracts taken from the ISS Contract Implementation used to populate the model are a fair representation of the actual Patrol Vessel situation up to now.
2	Prior to the publication of the papers described in prelude above, there were no guideline on how to improve availability throughout the ISS contract period.
3	Up to now, the system used to monitor ship maintenance activities for ISS contract only reports defects and unable to pinpoint to problems areas or severe factors that impact most on ship availability.
4	Up to now, the system used to monitor ship maintenance activities for ISS contract is unable to assist the stakeholders to project or predict future potential problems impacting negatively on ship availability.
5	Up to now, the present attempts by stakeholders to improve availability are by random effort or equivalent effort only as there has not been any guidelines.
6	Due to existing inability to focus on defined factors that impact availability negatively, there is an unclear area on accountability within the Navy between executive branch, technical branch and logistics branch, and between the Navy and external parties including ISS contractor, vendors and OEMs.
7	Based on the demonstration of the model and the achieved results, are you convinced that concentrating efforts on the identified severe factors is highly likely to improve the availability?
8	Based on the demonstration of the model and the achieved results, are you convinced that adhering to the 'availability-oriented contract management model' will improve availability of the naval ships?
9	Based on the demonstration of the model, would the model assist contract managers in managing their contracts better and assist policymakers, maintainers, logisticians, and other stakeholders to contribute better in improving Ship Availability?
10	If the availability of the fleet of naval vessels is successfully improved, would this impact positively towards the Navy's overall preparedness and readiness in multiple dimensions such as improved capability, greater flexibility in assigning ship tasks, improved efficiency, saved cost in unnecessarily having to purchase new vessels, less work stress onboard current high-availability vessels, etc.

The answers of the experts are graphically displayed in Fig. 4. The level of concordance was measured in instances of agreement of replies. There was 100% agreement on 8 out of 10 questions, for 2 out of 10 questions 2 respondents specified that whilst they were positively inclined to reply "YES" they had insufficient insight into the day to day operations of the RMN to be able to answer the questions. These answers were recorded as "Not Applicable" (N/A). As the level of concordance was 92% (46 over 50 questions) the questionnaire stage of evaluation and validation could be successfully concluded.

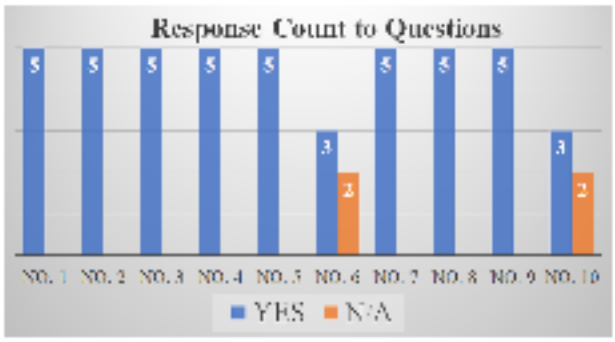

Fig.4 Response count to Question 1 to 10

The selected Shipyard, MMEA and RMN as ISS Industry leaders were able to independently validate the 7-Stage Mixed Method Delphi Results. It is worth pointing out that all five of the validation experts provided positive and complimentary remarks of the model and its associated advantages, in addition implementation concerns were also raised. The key highlights of their remarks are summarized as follows:

i. This study is a new approach in determining Ao, which is currently based on conventional methods.
ii. The proposed methodology is able to determine the factors that contribute to either high or low Ao in a simple manner.

iii. The proposed model with 15 factors would assist the RMN in identifying the key performance indicators and hence assist in the measurement of the overall preparedness reporting.
iv. The RMN could use the ConCaMS model to identify the root causes affecting the readiness of the fleet with an objective methodology that is not easily manipulated.
v. The model can be used to ensure the Navy moves away from procuring spares "just in case" to "just in time" saving money.
vi. The model can be used to tackle ineffective contract management as it provides clear visibility of the critical factors contributing to realising the Navy's efficiency savings initiative to save much needed funds and scarce resources.
vii. The method can be implemented to MMEA for the new projects, in particular identify fleet readiness and assist to improve new ISS clauses. It will assist contract managers in ensuring fleet availability is high as expected.
viii. The approach requires a lot of commitment and effort on data entry, nevertheless there would not be any excuse to monitor closely on a daily basis.
ix. The approach requires full commitment from the top management, however, how to resolve the identified problem has not been explored. This is an opportunity for further research.
x. The model presented consist of equipment and human factor, where human factor is a bit tricky and intangible, in some aspect. Thus, methodology to quantify human factor that contributed to low or high Ao need to be identified.

4. Summary

Results of the Post-Survey Expert Validation points out with 100% consensus that the proposed ConCaMS model addresses the research questions and is therefore a valid system to improve ship availability for the RMN. It is important to point out that all RMN and MMEA top management experts believe in the advantages of the proposed model and it would assist not only in improving ship operational availability but also assist contract managers to manage the contract better. Policymakers, maintainers and logisticians could contribute better in improving availability. They agreed that accountability would be improved and the availability-oriented contract management model (ConCaMS) would ultimately improve Navy's overall preparedness and readiness. It is also worth pointing out from their individual remarks that all five of the validation experts provided positive and complimentary remarks of the model and its associated advantages, in addition implementation concerns were also raised. The current research has also proven the suitability and validity of the Post-Survey Validation method especially on exploratory study as other conventional validation methods using measured data are not befitting.

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