EVALUATION OF SOFTWARE QUALITY ATTRIBUTES FOR VESSEL TRACKING MANAGEMENT SYSTEM (VTMS)

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ABSTRACT. Software quality and assurance becomes inevitable as the non-functional requirements continue to gain more popularity than functional requirements. Even some system could resolve some problem, but if non-functional requirements been neglected, at that point the solution may be impractical. The system with least features and quality characteristics will lead to low demand and failed-to-market. The aim of this study was to evaluate the quality in use attributes for Vessel Tracking and Management System (VTMS) adopted from the latest ISO/IEC 25010 quality model in the perspective of users' satisfaction. Five properties of quality in use are explicitly evaluated which are effectiveness, efficiency, satisfaction, freedom from risk and context coverage. A study was conducted through observation and survey to evaluate all five quality in use attributes of VTMS and to explore the relationship between each quality in use attribute to determine the overall users' satisfaction. Generally, this study provides an early empirical evaluation of the practical value of case study method. Firstly, from the VTMS perspective, the system provide a great 100% in functions coverage (completeness) although there are two (2) functions need to take immediate action in terms of accuracy so make up total 98.4% for effectiveness. On the other hand, the efficiency which measure the response time for each VTMS main tasks was 92.83%. It is concluded that all five (5) quality in use attributes scores more than 75% which are above the MMEA's minimum requirement on overall users' satisfaction.

Keywords: software evaluation, quality in use, ISO 25010, software quality attributes

INTRODUCTION

Quality requirements or non-functional requirements become more important than functional requirements in deciding the success or failure of the software system (Pohl & Rupp, 2011). Quality requirements are defined as specific criteria that customer wish to be included in the new system-to-develop rather than specific behaviors. Although quality is an essential value for every organization, the actions taken to ensure it is often an afterthought in the development life cycle or even worse been eliminated. Therefore, it will affect the business goals such as insufficient budget; delay and time-to-market issues (Tavassoli, 2007).

Vessel Tracking and Management System (VTMS) is one of the core systems used by Malaysian Maritime Enforcement Agency (MMEA), Prime Minister Department. VTMS was purposely developed for tracking and monitoring all MMEA's vessels position, vessel asset management and support communication transmission. VTMS consist of several modules to support various types of maritime process. One of the most essential modules is Maritime

Domain Awareness (MDA). MDA is defined as an interdisciplinary field of study that focuses to utilize available data sources to produce maximum awareness of activities in the maritime environment. Time after time, stored information becomes large in volume, contrasting, and disorganized. Therefore, system analysts' jobs become more challenging to dive in the datasets, and to generate decisions (Chen, Chong & Yin, 2014). The effectiveness and efficiency of the VTMS usage play an important role to ensure the quality of decision support and decision making can be generated as it required.

Two main objectives of this study are, 1) to evaluate the 'quality in use' for VTMS adopted from the new ISO/IEC 25010 quality model, which are effectiveness, efficiency, satisfaction, safety and context coverage and find out the total level of users' satisfaction achieved, 2) to explore the relationship between the each quality in use attributes.

Goal Question Metric (GQM) approach was used in order to realize the study analysis and design. The GQM approach presents a way for a project or an organization to clearly define goals and sub-goals to be achieved. These goals were clarified down to requirements of data to be collected before analyze and interpret the results with respect to the original goals defined earlier (Vladimir, Harjuma, Markula & Oivo, 2010).

Thus, two (2) main research questions in this study which are:

RQ 1: What is the degree of each quality in use attributes adopted by ISO 25010 quality model to evaluate the overall VTMS users' satisfaction?

RQ 2: Does each quality in use attribute correlated to each other?

RELATED WORKS

The significance on software quality development indicate how software product could fulfill customers' needs (Lagrosen, 2005, Valle & Avella , 2003). Most of the case normally, the customer doesn't have an idea on what they require and wish for. Besides poor understanding about the requirements, others limitations and incapability of the computing environment and shortfall of understanding of the domain problems have difficulties in communication to the system engineer. For instance, eliminate information that is believed to be clear, and identify requirements that contradict with the requirements of other customers or users. However, developers and system analysts need to play a big part in ensuring user's understanding of requirements (Wu et al., 2009).

There are various definitions of quality attributes. Quality attributes have been defined as nonfunctional requirements of a component or a system (Meiappane, Chithra & Venkataesan, 2013). For 1061-1998 IEEE Standard, identified software quality indicates the level to which software holds a desired combination of attributes. In addition, ISO/IEC 9126-1 which introduced a well-known quality model adopted worldwide consist of six types of quality characteristics, which are functionality, reliability, usability, efficiency, maintainability, and portability. All these main characteristics have its own sub-characteristics that detail out the functions and metrics of the characteristics.

Software quality can be defined as a level to which a software product satisfies required needs when used under required situations. A recent study by Gordieiev et al. (2014) performed an evolutionary analysis of software quality models from the pioneer software quality model by McCall to the latest ISO 25000 series standard. Table 1 shows the most popular software quality models since 1977 that involved in their study.

ISO 25000 series was released as a latest creation of International Organization for Standardization requirements document relate to the quality evaluation of the software standardization. This new generation does not merely refines a better software quality model, but a re-

markable process in models evolution that affected changes in the software engineering domain (Wagner, 2013).

Table 1. The most popular software quality model Gordieiev et al. (2014)

Name of Quality Model	Publication Year	No. of Characteristic	No. of Sub-Characteristic	Author
McCall	1977	11	35	John McCall
Boehm	1978	8	18	Boehm
Carlo Ghezzi	1991	8	-	Carlo Ghezzi
FURPS	1992	5	25	Grady R. & Hewlett Packard
IEEE	1993	6	19	IEEE
Dromey	1995	4	13	Dromey
ISO 9126-1	2001	6	19	ISO
QMOOD	2002	6	-	Bansiya
ISO 25010	2010	8	31	ISO

ISO 25010 still has the same purpose and intentions as previous editions, where it is intended to provide general guidelines for modeling quality for all software applications. The standard states that for particular usages, "tailor the quality model giving the rationale for any changes", and that "the set of characteristics associated with a characteristic have been selected to be representative of typical concerns without necessarily being exhaustive.

Errors and faults are unavoidable when it comes to the development of software systems that may lead to inconsistencies (Mohamed & Sohil, 2013). These inconsistencies not only presences at coding phase but also in requirement elicitation and design phase until the implemented of the software product. Therefore, users' satisfaction was crucially hard to fulfill in the specific context of use. In developing a safety-critical system, there will always be challenges and constraints to be faced. Other than the budget allocated, quality requirements, such as reliability, robustness, and safety present the most highly challenges (Ali & Robert, 2013). Poor understanding requirements can contribute to misunderstandings between the developers and the customers that can cause threats to the quality systems.

METHODOLOGY

This section describes the process of evaluation of software quality attributes for VTMS. Firstly, a quality requirement was identified from the Vessel Tracking Management System (VTMS) usage. Five quality in use attributes were evaluated based on ISO 25010 quality model which are effectiveness, efficiency, satisfaction, freedom from risk and context coverage. Secondly, specification of the evaluation was determined based on the identified requirement.

Two (2) methods were used in this study which is observation and survey. Observation is required for effectiveness and efficiency quality attributes while the rest, were evaluated using survey (questionnaires). Observation method took place in users' real place or scenarios such as in the office, operation room, and vessel. A survey by questionnaire was conducted for two (2) weeks. Distribution of the questionnaire was random to every offices and vessel. Lastly, the results of the case study were presented to the MMEA management.

VTMS CASE STUDY DESIGN

Figure 1 shows the overview of the case study design. The case study offers deeper understanding of the phenomena under specified study.

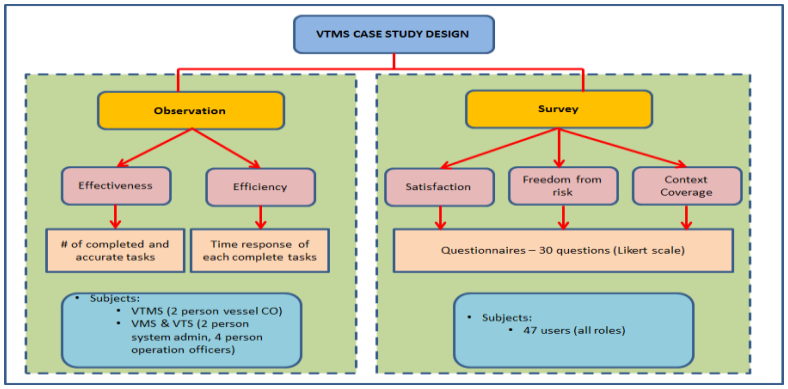

Figure 1. VTMS Case Study Design

Observation

Two attributes have been chosen which are effectiveness and efficiency. Based on effectiveness definition, complete and accurate functions or tasks should be considered. Therefore, 62 tasks have been identified. While for effectiveness, there was 46 tasks have been evaluated. Response time for each task was recorded. Only 46 out of 62 tasks from the first effectiveness test were considered because some of the tasks are meant for another new role that currently still absence of user (role for Search and Rescue (SAR) officer and Air Operation officer). For this observation, 8 subjects were participated where the entire test was evaluated at subject's real live environment.

Survey

The questionnaire was extracted from a numerous of journals (Lew et al., 2012) and then supplemented with questions mapped to characteristics especially suited for VTMS. Table 2 shows the distribution of the questions.

Table 2. Distribution of questions for VTMS survey

Part	Description	No. of Question
A	Demographic	3
B	Effectiveness	5
C	Efficiency	5
D	Satisfaction	5
E	Freedom from risk	5
F	Context Coverage	5
G	Conclusion and comment (if any)	2
	TOTAL QUESTIONS	**30**

The survey consists of 30 questions, and then rolled out to all regions of APMM in Malaysia. After two (2) weeks, 47 data respondents were collected. Respondents were from both VTMS vessel and office versions. These respondents were from various APMM's officers all over Malaysia.

RESULT AND DISCUSSION

The analysis was based on the two methods: observation and survey. The observation must be executed before the survey comes after because the VTMS's users consist of multiple roles. Therefore, each role has its own task.

Observation Analysis

The observation examined each role independently and showed that:

a) All 62 tasks are 100% completed or provided by VTMS.
b) Accuracy testing showed that 96.8% with only two (2) tasks were not accurate:
   - Unable to correctly update the MARSAIL document.
   - Unable to correctly view the air operation report.
c) Both effectiveness and efficiency scores above minimum APMM's requirement.

Sub-characteristics of effectiveness were defined by correctness and completeness. Therefore, user perceptions could be correlated with pragmatic measures. This enables validation of non-intrusive metrics. Hence, the reasoning for designing the questionnaire for subjective evaluation pragmatic characteristics, that could also be evaluated non-intrusively (to calibrate user perception with real measures). Therefore, after the observation, questionnaire that mapped to effectiveness and efficiency of the application were evaluated.

Survey Analysis

Table 3 shows the questionnaire results on users' perspectives. APMM minimum requirement is 75%. Results showed that all quality in use attributes scores above the APMM's minimum requirement. For the correlation analysis, all attributes have positive significant correlations to each other. The strongest relationships were between freedom from risk with satisfaction and context coverage. While the weakest relationships were between the efficiency with effectiveness and satisfaction. From the observation results that although the efficiency scores were great, but it still needs to be improved as a delay could cause dissatisfaction among users. In addition, VTMS need to be fast, accurate and fulfilled users' needs as it is an essential system to the agency.

Table 3. Summary of correlation testing

Quality in Use	% achieved	Correlation Results				
		EF	EC	ST	FF	CC
Effectiveness	76.85		PW	PM	PM	PM
Efficiency	82.98	PW		PW	PM	PM
Satisfaction	76.85	PM	PW		PS	PM
Freedom from risk	79.15	PM	PM	PS		PS
Context Coverage	77.87	PM	PM	PM	PS	

Note:
PW – positive, weak correlation
PM – positive, moderate correlation
PS – positive, strong correlation

CONCLUSION

Overall, this study provides an early empirical evaluation of the practical value of case study method. Two main objectives have been achieved by a case study conducted in Malaysian Maritime Enforcement Agency (MMEA). Firstly, from the VTMS perspective, the system provide a great 100% in functions coverage (completeness) although there are two (2) functions need to take immediate action in terms of accuracy so make up total 98.4% for effectiveness. On the other hand, the efficiency which measure the response time for each VTMS main tasks was 92.83%. Upon user's perspectives, a survey was conducted using question-

naires that consist of 30 questions. Overall, all five quality attributes score above the minimum threshold (75%) and has a significant positive correlation to each other.

Future work remains to be done to complement this evaluation with the other evaluation tasks provided for software product evaluation described in the relevant parts of ISO 25010. Product quality attributes such as reliability, security and portability can be measured in order to achieve a complete quality software system evaluation.

REFERENCES

Ali S., & Robert F. (2013). Industrial Challenges with Quality Requirements in Safety Critical Software Systems. Paper presented at the *39th Euromicro Conference Series on Software Engineering and Advanced Applications*.

Chen C. H., Khoo L. P., Chong Y. T., & Yin X. F. (2014). Knowledge discovery using genetic algorithm for maritime situational awareness. *Expert Systems with Applications*, 41, 2742–2753.

Gordieiev O., Kharchenko V., Fominykh N., & Sklyar V. (2014). Evolution of Software Quality Models in Context of the Standard ISO 25010. *Proceedings of the Ninth International Conference DepCoS-RELCOMEX, Advances in Intelligent Systems and Computing*, 286, 223-232.

Lagrosen, S. (2005). Customer involvement in new product development: a relationship marketing perspective. *European Journal of Innovation Management*, *8*(4), 424-436.

Meiappane A., Chithra B., & Venkataesan P. (2013). Evaluation of Software Architecture Quality Attribute for an Internet Banking System. *International Journal of Computer Applications 62(19)*

Mohamed A. H., & Sohil F. A. (2013). A systematic approach to generate and clarify consistent requirements. *IEEE*.

Lew, P., Qanber Abbasi, M., Rafique, I., Wang, X., & Olsina, L. (2012). Using Web Quality Models and Questionnaires for Web Applications Understanding and Evaluation. Paper presented at *the Eighth International Conference on the Quality of Information and Communications Technology*.

Pohl, K., & Rupp, C. (2011). *Requirements Engineering Fundamentals*. Rockynook, O'reilley Media.

Runeson P., & Host M. (2008). *Guidelines for conducting and reporting case study research in software*.

Tavassoli, D. (2007). Strategic QA Steps to Effective Software Quality Assurance. Retrieved from http://www.meritalk.com/uploads_legacy/whitepapers/Change_WP_Strategic_QA_26-2007-03.pdf

Valle, S., & Avella, L. (2003). Cross-functionality and leadership of the new product development teams. *European Journal of Innovation Management*, *6*(1): 32-47.

Vladimir, M., Harjumaa, L., Markkula, J., & Oivo, M. (2010). Early Empirical Assessment of the Practical Value of GQM Strategies. Presented at the *ICSP 2010*, LNCS 6195, 14–25.

Wagner S. (2013). *Software Product Quality Control*. Springer, Heidelberg.

Wu, Q., Ying, M., Wang, J., Xie, M., Chen, Z., & Chen, J. (2009). A discussion on three critical issues for assuring quality of the users' requirements specification. *Proceeding of 16th International Conference In Industrial Engineering and Engineering Management*, 690-693.