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A Descriptive Study of the Software-Ergonomics in Maritime Planned Maintenance Systems

A survey analysis from the onboard personnel point of view

Bachelor thesis in Marine Engineering

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BACHELOR THESIS 2018:37

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Saga Livia Eiriksdottir

Samuel Lopez Rengstig

Abstract

The study is primarily based on a web-based-survey. Included are also literature reviews and a semi structured interview. The aim with this descriptive study analysis project is to survey; from the onboard personnel's point of view: The software-ergonomics and user-friendliness in maritime planned maintenance programs. The hypothesis is that the dissatisfaction is widespread among the software users, who are responsible for handling the maintenance on board. A semi-structured online survey created in Google Forms was sent out to the Swedish merchant fleet. A total of 94 responses are presented. 39.4 % of the participants in the survey answered that their overall satisfaction of the planned maintenance system on board is either:

- Neither satisfied or unsatisfied
- Unsatisfied
- Very unsatisfied

We obtained many diverse and valuable answers in form of concrete ideas and suggestions for improvement from the users included in the 39.4 %. The overall and general impression is that all areas, but especially the non-user-friendly; is according to the user: lacking in quality.

When interpreting the survey results, the underline is that the dissatisfaction from the staff on board is greater than it should be - but not as widespread as believed it would be.

The conclusion made from the data collected is that it is not the consensus, but the planned maintenance system does have substandard quality in some or all parts of the program.
Maintenance programs reviewed are 51.1 % Consultas and 44.7 % AMOS. It does not state anywhere which version of the program the user is working with.

Sammanfattning

Studien är baserad på en webbaserad enkät-undersökning, litteraturstudier och en semi-strukturerad intervju. Syftet med detta forskningsprojekt är att från ombordpersonalens synvinkel; undersöka underhållsprogrammens mjukvaru-ergonomiska egenskaper och användarvänligheten i de maritima underhållssystemen. Hypotesen är att missnöjet är utbrett bland användarna som ansvarar för dokumentationen av underhållet ombord. En semi-strukturerad onlineundersökning som skapades i Google Forms skickades ut till den svenska handelsflottan. Totalt 94 svar presenteras. 39.4 % av deltagarna i undersökningen svarade att deras inställning till underhållssystemet ombord är antingen:

- Varken nöjd eller missnöjd
- Missnöjd
- Mycket missnöjd

Vi har erhållit många olika och värdefulla svar i form av konkreta idéer och förslag till förbättringar från användarna som ingår i de 39.4 %. Det övergripande intrycket är att alla områden, men särskilt det icke-användarvänliga: är det som brister i kvalitet. Vid tolkning av undersökningsresultaten så sammanfattas att missnöjet från personalen ombord är större än det borde vara – men det är inte lika utbrett som hypotesen påstått.

Slutsatsen från de insamlade uppgifterna är att det inte är den övergripande enigheten, men att det planerade underhållssystemet har undermålig kvalitet i vissa eller alla delar av programmet. Underhållsprogrammen som granskats är: 51.1 % Consultas och 44.7 % AMOS. Det anges inte någonstans vilken version av programmet som användaren arbetar med.

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Terminology

AMOS - Management software from SPECTEC

Consultas - Consultas Maritime, software from Kongsberg

Tm Master - Maintenance system Tero marine

Sertica - Planned Maintenance System from Logimatic

PMS - Planned Maintenance System

DOS-program - Disk Operating System

SUI - Sjöfarten utbildningsinstitut

HP - Högskolepoäng: Where 1.5 credits corresponds to full-time studies during one week of work, or 40 hours of study including self-study.

SUS – System usability scale

IACS – International Association of Classification Societies

DNV GL - De Norske Veritas Germanischer Lloyd

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Introduction

It is believed that maintenance planning is the key to a well-managed engine room. Therefore, we want to investigate further if there is a consensus on all ships that the maintenance system is substandard. What parts do they classify as substandard and if they could; what would they improve, include, or exclude?

‘’A well designed and effectively implemented maintenance management system not only helps the company to meet the safety and pollution-prevention objectives established by the ISM code, but is also a sensible investment in the protection of a very valuable asset.’’*(IACS, 2008)*

The organization on land requires to have insight and thorough documentation of the onboard maintenance. The information required can in some cases feel excessive, and that not much thought was put into the demand. Meaning that the computerized documentation that should have been a helpful tool, is instead a very time-consuming process. On land an immense amount of money and resources have been spent on tuning and refining all types of obstacles and side effects derived from working with non-user-friendly software. The theory is that the impact from working with strenuous software on board could have consequences on how things are administered on board merchant vessels. When a company or an organization gets computerized; this is usually with the aim to increase the productivity and cut the time of work implemented in that part. When it comes to the quality of the software on board, IT Director Tasos Makris, says “Without any doubt, the quality of software on board vessels needs improvements “(*“Software quality in the maritime sector - SAFETY4SEA,” n.d.).*

The more computerized maritime management becomes; more programs are getting forced into the maintenance program. This could be a good thing if it was not for the interface of the program: The more elements included, the more demanding it is to navigate in it.

From our experience being on board various ships in the merchant shipping industry, we have encountered many and diverse opinions about the machinery planned maintenance systems. The overall consensus from our point of view is that the software is substandard, undeveloped and overwhelming.

Purpose

The aim of this essay is to be taken into consideration for future development and implementation of onboard planned maintenance programs. We want to survey the users opinions about their PMS. This could: with further research and implementation; eventually lead to a reduction of stress. Stress that may occur when working with non-user-friendly programs could be minimized or eliminated if a more ergonomically designed program was used. We want the software to advance to the advantage of the onboard personnel and fulfill its purpose of being a practical asset.

Delimitations

The answering frequency of the web-based-survey resulted in 94 answers. Maintenance programs vary. 51.1 % Consultas and 44.7 % AMOS. It does not state anywhere which version of the programs the user is working with.

Incomprehensible, irrelevant and incomplete answers are excluded. The analysis coverage is based on the Swedish merchant fleet. The information and data presented does not desire to be regarded as representative for all interests.

Physical health aspects of working with computers on board is not include in this report.

Hypothesis:

We believe that the dissatisfaction is widespread among the software users who are responsible for handling maintenance on board.

Research questions

- *Is the consensus of the onboard personnel that the planned maintenance system has inferior quality?*

- *Which parts of the planned maintenance system do they feel is inadequate and is it the same for different planned maintenance programs?*

- *Is the planned maintenance software considered ergonomically designed?*

- *Is the planned maintenance program used less than it could be because the onboard personnel believe it is unmanageable?*

- *Are there any concrete ideas for improvement from the onboard personnel who feel that the programs have inferior quality?*

Background

This thesis is a descriptive study from the onboard user's perception. The study includes the negative aspects of working with software that is not ergonomically designed. Is the consensus that the onboard personnel are unsatisfied with their maintenance programs, and what consequences can this have for the person working with the software?

Planned maintenance system (PMS)

The onboard maintenance program is as software where you plan, manage and overview all the maintenance for a specific vessel. In the PMS system it is possible to plan, managing and monitor the maintenance both from the vessel and ashore. The PMS helps with the planning of different maintenance intervals for different components, managing crew competence and finding job instructions. It also facilitates to divide the workload on board and preserve the components of the vessel in functional condition. There are several different maintenance software available. All PMS on board must be approved by an approved classification society.

Before the use of planned maintenance systems

Before the use of planned maintenance systems; the maintenance on board was done using corrective maintenance. Meaning that the servicing of a component is performed either when the component would no longer function properly, or by following the guidelines from the component manufacturer. This is not always an effective way of working due to sudden failures in components, and the fact that no work planning could be achieved. This lead the companies to start using preventive maintenance or planned maintenance. Which means that by maintaining the components continuously, the life expectancy of the component will most likely increase. The result will be a reduction of sudden errors and breakdowns in the components. The early planned maintenance programs were implemented using a card-based system.

Usability

The website *usability.gov* describes usability as "the quality of a user's experience when interacting with products or systems, including websites, software, devices or applications" *("Usability Evaluation Basics," 2013)*. Usability can be used as a measurement to get the users opinion about the effectiveness, efficiency, and overall satisfaction of a program.

Usability is not only a single factor in a system. It is a combination of different characteristics including:

- **Intuitive design**: A nearly effortless understanding of the architecture and navigation of the site.
- **Ease of learning**: How fast a user who has never seen the user interface before can accomplish basic tasks.
- **Efficiency of use**: How fast an experienced user can accomplish tasks.
- **Memorability**: After visiting the site, if a user can remember enough to use it effectively in future visits.
- **Error frequency and severity**: How often users make errors while using the system, how serious the errors are, and how users recover from the errors.
- **Subjective satisfaction**: If the user likes using the system
  ("Usability Evaluation Basics," 2013)

Regulations

Maritime rules and regulations in the shipping industry are regulated by The International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STCW), International Safety Management Code (ISM), the International Convention for the Prevention of Pollution from Ships (MARPOL) and The International Ship and Port Facility Security Code (ISPS). The planning and documentation of maintenance must be approved by a classification society included in International Association of Classification Societies (IACS). Having an implemented planned maintenance system on board is commanded according to the ISM Code.

The classification society DNV GL have in their 2016 January edition for classification rules stated in Part 7 Chapter 1 Section 1 § 3.1.1 specified the rules for a maintenance system:
"Every ship shall have implemented a maintenance system. Maintenance of the hull structure, machinery, systems and equipment shall be in accordance with applicable recognized standards in the industry or in accordance with procedures recommended by the manufacturer" (DNV GL, 2016).
Today the maintenance programs usually consist of more elements than the ones required by DNV GL. For example: surveys and certificates, stock ordering and purchase, stock control - inventory, safety management, quality management, crew management, energy, and environmental management, etc.

''In the maritime business, owners and companies are dependent on the software to administrate and to be a tool to comply to the rules and regulations; helping their company to maintain a safe and effective workplace. The system today is almost all handled through a database through one common user interface.'' (Algelin, 2010)

Theoretical framework of maintenance implementation

In *"THE STANDARD NAVY MAINTENANCE AND MATERIAL MANAGEMENT SYSTEM (3-M SYSTEM)"* by A.J Ruffini from 1966 he explained the procedure when the navy changed over from one computerized planned Maintenance System to another maintenance system - called: The Maintenance Data Collection System or MDCS. The MDCS was designed to include all maintenance actions done, even if the action was not completed. The planned maintenance system that they previously used was simple and only included the scheduled maintenance, while the MDCS could work with all maintenance: both scheduled and unscheduled. The collected data from the MDCS would then be sent to the company to be categorized into different formats to suit the requirements ashore and afloat. A.J Ruffini confirms that the navy often look inwards towards their own organization, but this time the navy got out of their shell and looked at the air force to see how they work with maintenance and got the MDCS from them. The navy evaluated the MDCS on fourteen different ships for nine months.

While the planned maintenance system they have had before was an improvement - The MDCS was not enthusiastically received by the users. This was due to the fact that the planned maintenance system gave them information in return that they could use and evaluate. The MDCS required the users to send information back to the company without getting anything in return. At least not in a near future. Both systems were designed to improve the overall material readiness and maintenance work for the fleet. But when the planned maintenance system was used, the information was available instantly and with the MDCS the data had to be sent ashore and categorized. The processing was very long due to the massive amount of data that was transmitted and the department responsible for the processing did not get enough resources.

Even though the users were dissatisfied they still sent a massive amount of data to the company. Previously, one ship in the fleet could send in 50 equipment failure reports in one month after the change to MDCS. The number went up to 500-600 reports a month. This meant that the average data collected in one month would be over one million reports and if the data is not categorized it will not be of any use to the fleet.

A.J Ruffini says that "since a computer output is no better than its input, great care must be taken in the establishment of requirements" (Ruffini, 1966).

Methodology

This study is primarily based on a web-based-survey, but also include literature reviews and a semi structured interview.

Survey design

The research strategy exerted in this thesis is a semi-structured, comfort selection survey addressed to the commanding officers on board the Swedish merchant fleet. The starting point is the perception that there is a dissatisfaction on board. This is limited around the theme: Is the consensus of the onboard personnel that the planned maintenance system has inferior quality? Which parts of the planned maintenance system do they feel is inadequate and is it the same for different planned maintenance programs?

The survey starts with a few practical questions and depending on if the respondent is dissatisfied or not; a few follow-up questions will follow depending on the respondent's response.

We mainly used the research methodology book “Social Research Methods” by Allan Bryman (2018), and his guidelines to get a better understanding of how to design a useful and effective survey. We designed the survey in a way that would avoid any leading questions. We did not want the participants to get influenced by the language or phrasing in the survey. Something that eventually could result in them answering differently because of our opinions and our initial hypothesis.

The survey was created in Google Forms and constructed in English. The questions in the survey are nine main questions with a couple of follow up questions depending on the respondents’ replies. They were asked through a semi-structured online survey.

Participants in the survey

The survey was sent out during the period 31 January - 31 March. The link was sent out by email to Swedish shipping companies linked to the organization SUI, whose service provides onboard training for students from Sweden's two nautical colleges, Chalmers University of Technology and Maritime Academy at Linnéuniversitetet. The email was directed to all offices contact details that are provided by SUI. Many of them forwarded the survey to their fleet, a few replied that they could not participate, and some did not reply at all. All answers are anonymous, but with the requirement to state rank and age. In the first question in the survey it is mandatory to state if you have worked on board a vessel in the past 12 months. If you haven't; you cannot continue the survey. This decision was made to make sure that we only receive comments that are relevant to this report.

Literature review

The information in this study was gathered from scientific reports, articles, regulations, books and websites regarding planned maintenance systems, usability and cognitive ergonomics. Most of the information was gathered from databases.

The authenticity and relevance are based on the content of the reports and if the reports were published in forums with a high level of credibility.

Search engines:

Web of sciences, Scopos, Summon, Google scholar and Google.

Search words:

PMS, Planned maintenance system, PMS on board, Marine PMS, Software ergonomics, user friendliness, usability, cognitive ergonomics

Interview

A qualitative interview is carried out with a former student at Chalmers University, whom is currently working as a Third Engineer on board a product tanker.

The questionnaire constructed is aimed for a more personal and detailed description of the user experience working with the onboard maintenance programs. The interview was done in Swedish and later translated into English. The interview revolves around and are derived from the five research questions of the thesis, and ten questions from the System Usability Scale (SUS). Many follow-up questions were applicable to the dialog.

System usability scale (SUS)

We started the interview with the ten questions from the System usability scale (SUS). SUS: A Quick and Dirty Usability Scale by John Brooke from Redhatch Consulting Ltd. The questions, which in reality are not questions but statements; are a way to assess the software users sense of the usability of the program. This measuring tool is described by Brook as ‘’quick and easy’’.

‘’SUS has proved to be a valuable evaluation tool, being robust and reliable’’ (Brooke, n.d.).

1. Do you think that you would like to use this system more frequently?
2. Do you find the system unnecessarily complex?
3. Do you think the system is easy to use?
4. Do you think that you would need the support of a technical person to be able to use this system?
5. Do you find the various functions in this system are well integrated?
6. Do you think there is too much inconsistency in the system?
7. Would you imagine that most people would learn to use this system very quickly?
8. Do you find the system very cumbersome to use?
9. Do you feel very confident using the system?
10. Did you need to learn a lot of things before you could get going with this system.

Result

From our own contact with the industry and from comments submitted in the survey form: we are able to interpret that officers and other personnel have spent countless hours working with numerous programs that are considered outdated, unreliable, time consuming and not very popular. In a competitive and still technology evolving industry; ‘’It is well known that the maritime industry has historically been slower to implement technology changes that are regularly adopted quickly at inshore companies’’ *(“The Maritime Industry is slowly embracing technology, but some will be left behind! | Hellenic Shipping News Worldwide,” n.d.)* Even though the maritime industry has been slower to implement technological changes, the land-based industry has a lot of research on the consequences of working with non-user-friendly software. Working with a non-user-friendly software increases the risk of stress related concerns. In the article “Software Usability: Concepts, Attributes and Associated Health Problems. by Grindberga S (2016), computer users frequently suffer from stress syndromes like irritation, fatigue, headache, and stomach problems.

Received survey comments

The last question in the survey is: ‘’How satisfied are you with the maintenance program on board?’’ And if the respondent answered either; Neither satisfied or unsatisfied, Unsatisfied or Very unsatisfied - an additional question would ask the respondent to specify.

Comments on the question:
What would you improve?

1. Adjustment of running hours.
2. Difficult and complicated
3. … Also, clear guidelines and education is needed from the company so that all the crew will follow the same structures when adding or modifying contents. We have a total mess!
4. More user-friendly environment, ability to print items in categories that are not created. For example, if you work with a component from the deck area, you can not get spare parts from the category "Consumables" etc. etc.
5. I would love to have the following functions added:
   -The ability to create orders for spare parts in the spare parts registration sub-system. As it is now I have to check the spare part, write it down or copy and then add it in the Order control sub-system.
   -The ability to create jobs based on a template job. e.g. Create a job for cylinders with the number 601.01.01 and then use this to easily create 601.01.02, 601.01.03...
   -The ability to have Consultas on a tablet/phone and use a barcode scanner to add/remove items.
6. As Consultas is two programs in one. There is a problem that it is not the same numbers for the same equipment in Spare part and Maintenance.
7. Maintenance and spares separated into two different programs is just adding complication.
8. Shortcuts between functions. Easier stock administration. Quick links between c-spare, c-maint. Label printing auto on recipe of stores.

9. First and foremost, the knowledge threshold is too high to enable beginners to easily use the program. People get scared to make mistakes and do not use the program as it should be used. The land organization does not launch all functions due to lack of knowledge.
   Beginners have difficulty in getting an overview of the system.

10. Generally, Amos would need a whole new code base. It is very obvious that the program started on a smaller scale, but after adding features the developers have lost control of it. What you have now is a huge patchwork.
    Assuming that it is the software that sets the limitations, and not the only implementation of Amos that I am currently using: I would also like to see better integration between the features. A typical example might be that if I would like to add an item to an active requisition directly from a context menu in the stock view; instead of having to list the component numbers, enter the order part and then manually add an item to an active requisition. This is just an example of many, where such integration would greatly facilitate my work.
    Otherwise it's mostly fine adjustments in the rather outdated interface, and freer choice of the underlying database that is needed

When the participant had answered all the questions it was possible to add an additional comment:

1. I have previously worked with Sertica. In my opinion is one of the best programs I have used.

2. Consultas lacks the ability to merge orders and spare parts. E.g. when receiving spare parts and acknowledging the arrival of said spare parts in the Consultas program, the spare parts program (also Consultas) doesn't automatically update stock values.

3. As a user you should be able to access the Dashboard. Then AMOS would be okay.

4. Ability to import drawings in the different categories or links to drawings

5. It is important and practical to be able to tag different jobs to different positions on board (e.g. 2nd Officer Nav and 2nd Officer Safety, and not just for only deck-/machine-department

6. TM-Master V.2 is the best system that I have worked with. I've been working with companies that use all features in AMOS and it work very good even though it has its flaws. The problem is usually that the maintenance program is never properly installed and adapted to the ship. So far, I have never sensed that it feels "complete" and I've worked on 16 ships.

7. Generally speaking, the PMS user experience can be valued out of three criteria's. Is the program itself is ok, is the structure of data entered into the program easy to use and how is the usage is looked upon in the working culture.
   If the program is working fine and has a logic and fulfilling set of data inside and the crew use it as a support in the work, then it's all good.
   But if you have a buggy program, incomplete data and the crew works to fulfill the job list instead of maintaining the ship, then you have a bad experience.

8. One weaknesses with Consultas is that it has poor search functions, small icons and does not follow the SFI code to the same extent as Amos does. The maintenance and spares does not share the same database, it may for example be different numbers on a component and its different parts. This is due to incompetence. But generally, it has good functions and the problem is that it is not utilized aboard to a sufficient extent. For example: corrective jobs and insufficient database development from the beginning.

9. My opinion is that Tm Master is The best program to use on board. Easy to use and not too much information.

10. I would like a better search engine and search filters as well as rounds (signing multiple job at the same time)

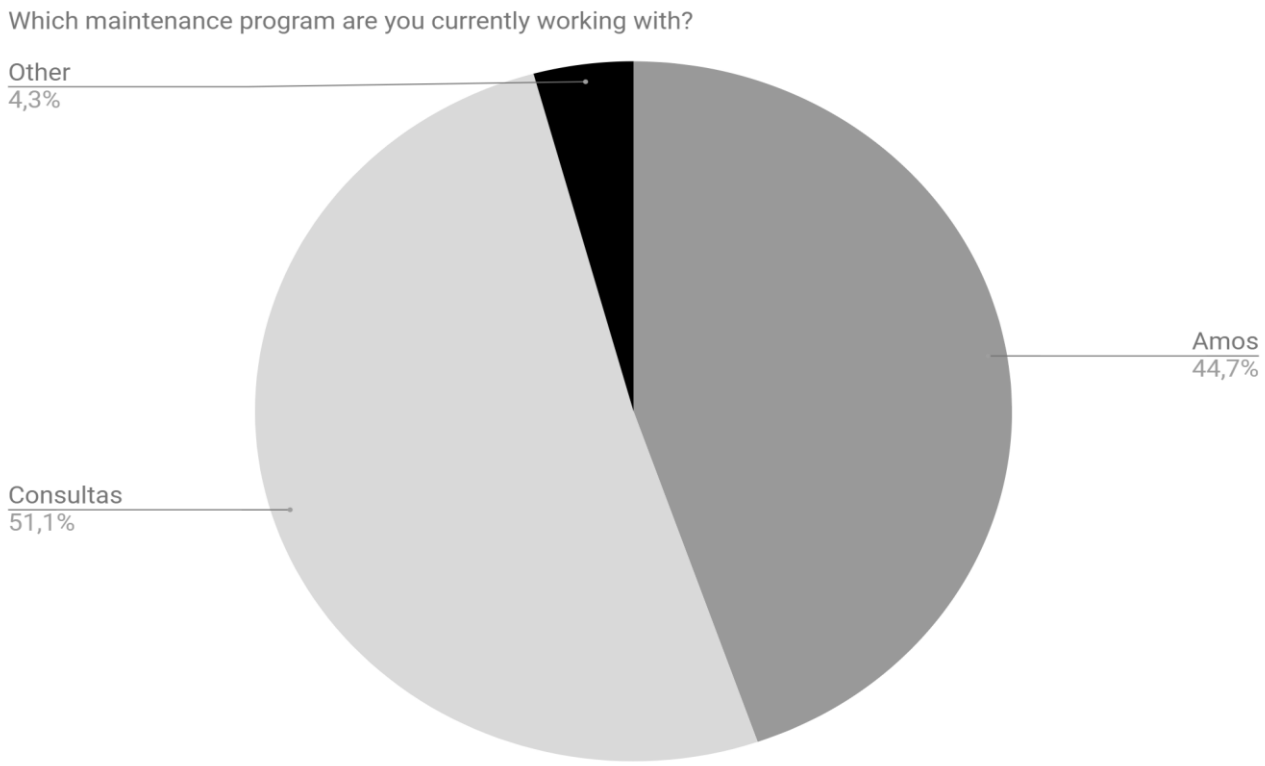
11. The program (AMOS) feels very outdated and needs to be modernized and simplified. I'm old enough to be able to compare it with old DOS programs, and that's not a good customer feedback to receive 30 years later.

12. Have been working with Consultas for 12 years and it is very good. Very good response.

13. AMOS works quite good for our purposes on board but unfortunately the land based organization is not able to use all facilities which would be great if they did. It would also be great if Spectec could be more interested in changing and updating the system according to the customers' needs

Survey result charts

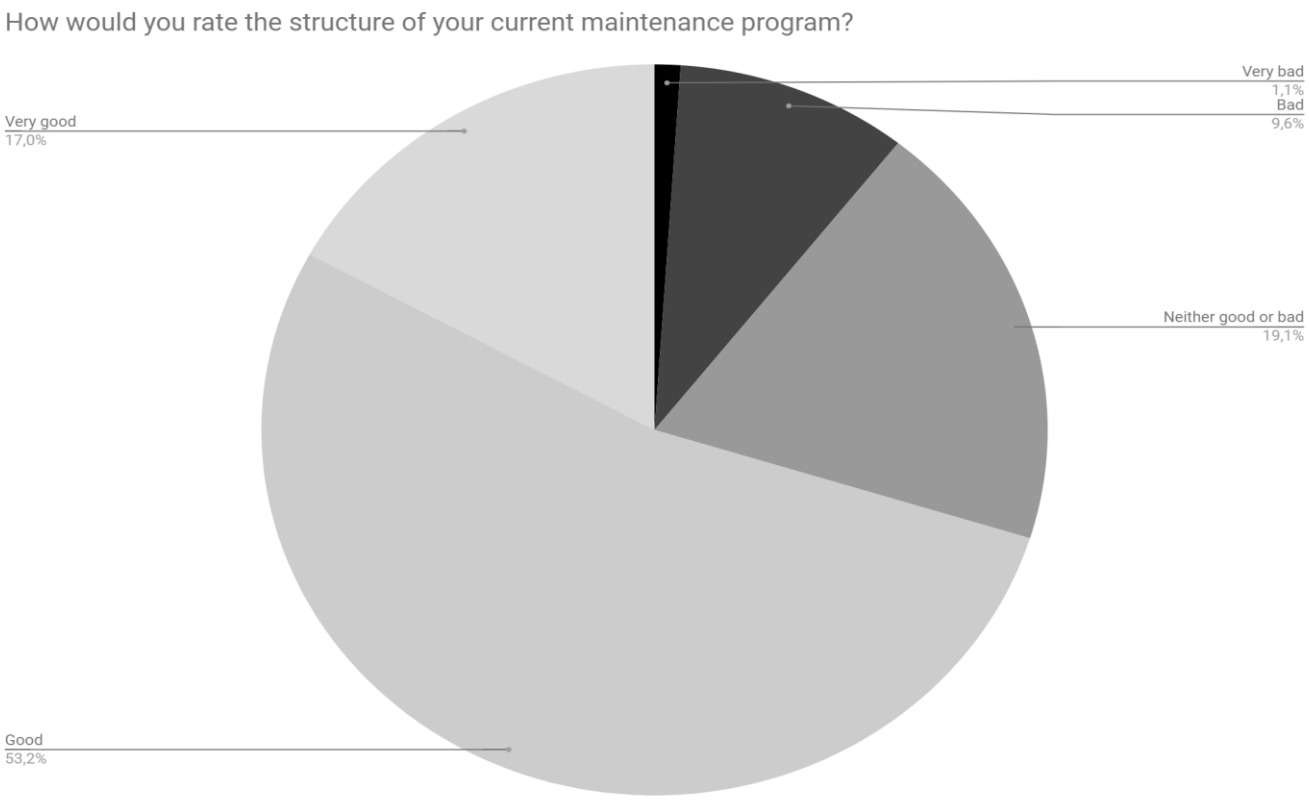
Figure 1



This is the result of question number 5 in the survey. ‘’Which maintenance program are you currently working with?’’ It is the first question that is presented and taken into account when defining the result. This is due to that there were no obvious correlations between the answers from the previous questions that had any impact on the survey result.

94 answers are presented in this figure.

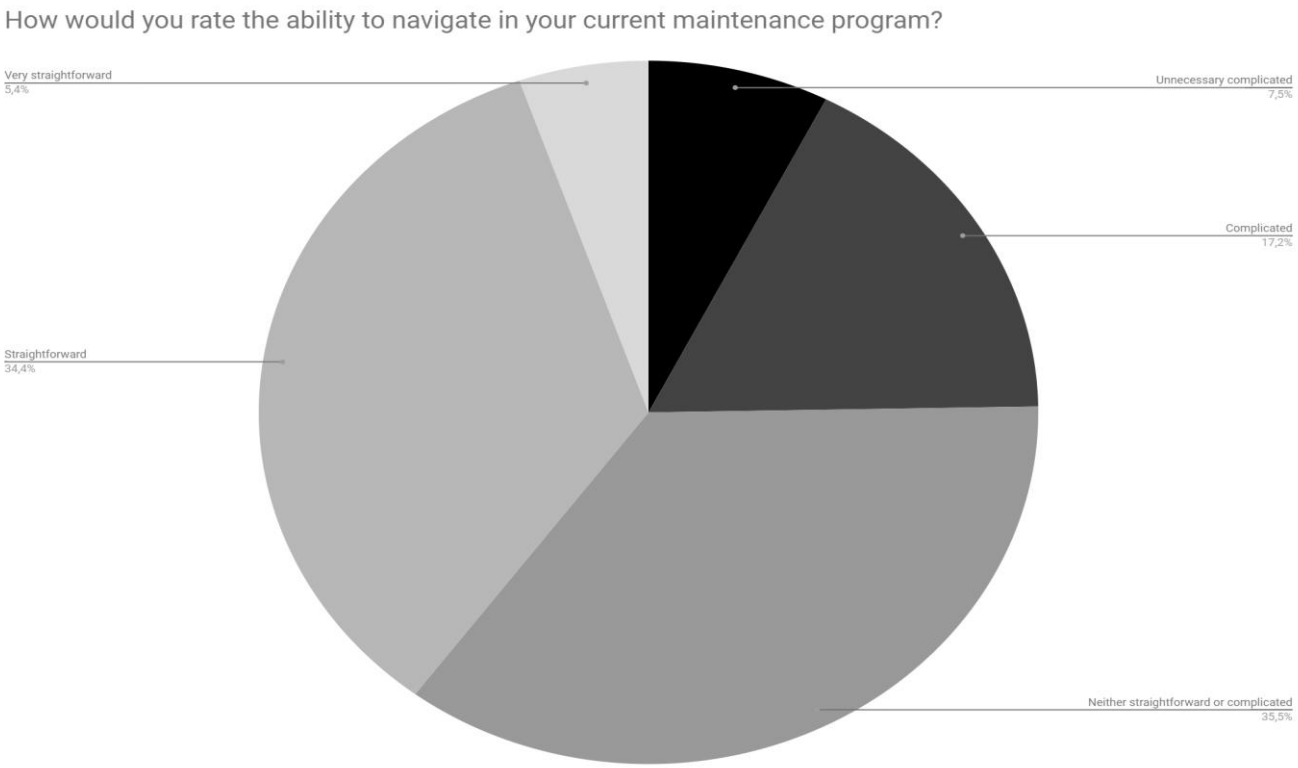
Figure 2



This is the result of question number 7 in the survey. This question is very extensive, and it is difficult to define what the users are considering to be included in the program's structure.

94 answers are presented in this figure.

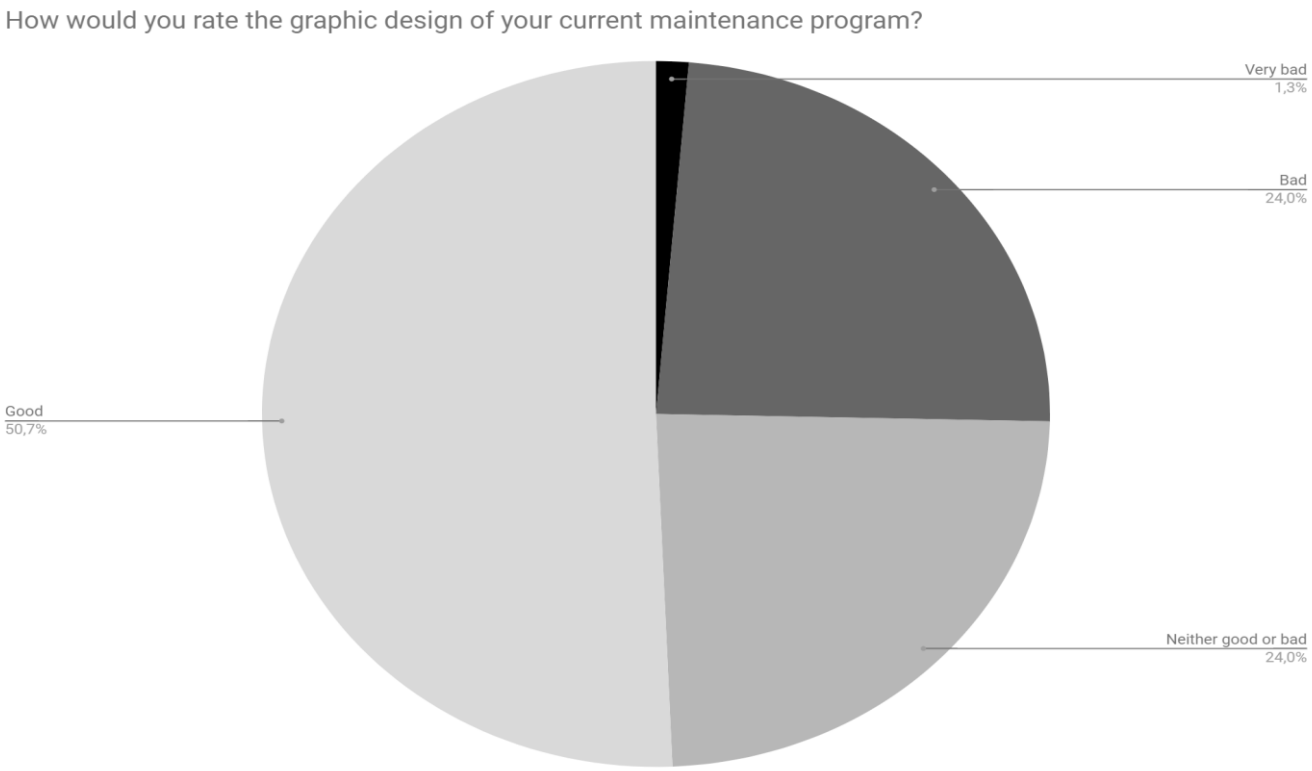
Figure 3



This is the result of question number 8 in the survey. This question is very relevant when it comes to bigger programs with many functions. The user's impression of the navigation abilities could give an insight of how well a program is considered to be logical and user-friendly.

94 answers are presented in this figure.

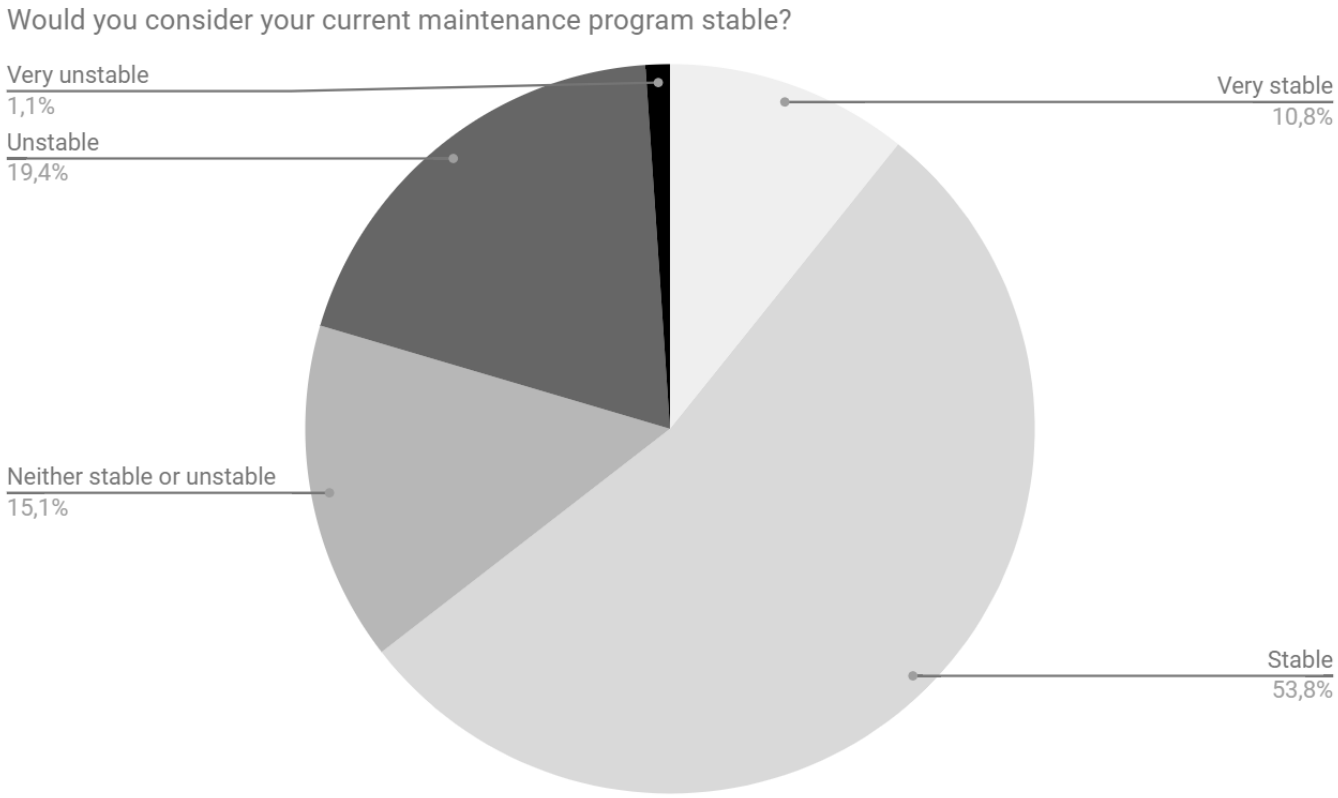
Figure 4



This is the result of question number 9 in the survey. This question could be defined as merely a matter of taste, and how we as users regard the design of the program as pleasant. Well-designed programs could be considered more modern, and in that aspect be believed to be better than others.

94 answers are presented in this figure.

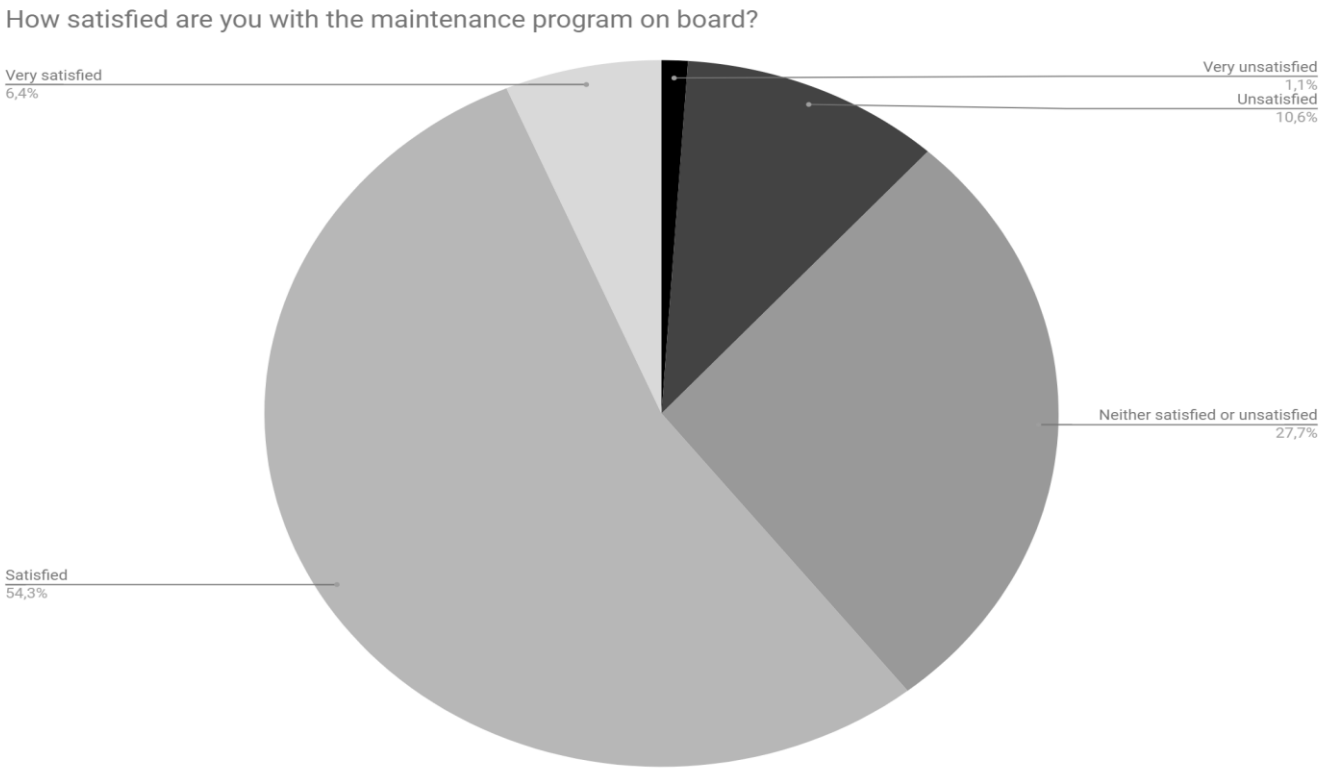
Figure 5



This is the result of question number 10 in the survey. The term stability is derived from the physical characteristic of an object that will not tip or fall. When it comes to software; it is describing a probability if a computer might crash, freeze or cause any other similar problems. Stability in a program where important information is handled is a very relevant issue.

94 answers are presented in this figure.

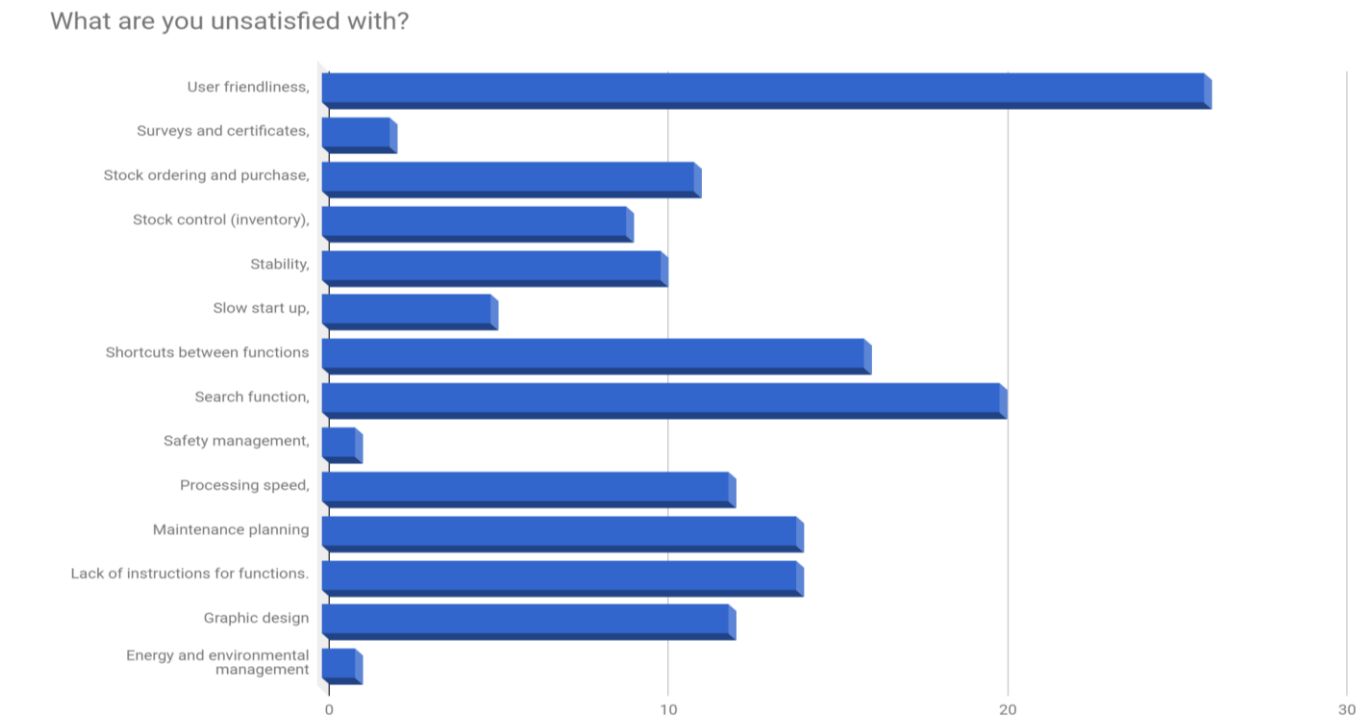
Figure 6



This is the result of question number 11 in the survey. The ability to define someone's satisfaction in this case is only a measure of comparison. A sense of satisfaction or fulfilment received from a program can in many cases only be based on what the individual users have previously experienced in different contexts. This question is the most subjective, because it is the only one that is directly correlated with personal opinions, assumptions, interpretations and beliefs. It can only be based upon observations of measurable facts if the user allows them to be.

94 answers are presented in this figure.

Figure 7



This is the result of question number 12 in the survey. This question is a follow-up question to question number 11.

39.4% of the participants in the survey answered that their overall satisfaction of the planned maintenance system on board was either:

- Neither satisfied or unsatisfied
- Unsatisfied
- Very unsatisfied.

They were asked to specify from a number of suggestions. This is a multiple choice question.

36 answers are presented in this figure.

SUS interview result:

Figure 8

1. Do you think that you would like to use this system more frequently?	3
2. Do you find the system unnecessarily complex?	4
3. Do you think the system is easy to use?	5
4. Do you think that you would need the support of a technical person to be able to use this system?	1
5. Do you find the various functions in this system are well integrated?	2
6. Do you think there is too much inconsistency in the system?	1
7. Would you imagine that most people would learn to use this system very quickly?	3
8. Do you find the system very cumbersome to use?	4
9. Do you feel very confident using the system?	5
10. Did you need to learn a lot of things before you could get going with this system?	1

This is the answer form for the System usability scale (SUS). Completed by the interviewed engineer. For each of the 10 following statements, the number that best descried the engineer's opinion about the program is written in the box.

Calculated SUS result

The users will accordingly to this method have rated each of the 10 statements/questions on a scale from 1 to 5, based on the equivalent agreement.

Calculate the SUS-score:

- Odd numbered questions: subtract 1 from the score
- Even numbered questions: subtract the score from 5
- Multiply the total score with 2.5.

This results in a score out of a range of 0 to 100.

3-1= 2
5-4 =1
5-1=4
5-1=4
2-1=1
5-1=4
3-1=2
5-4=1
5-1=4
5-1=4

$$2 + 1 + 4 + 4 + 1 + 4 + 2 + 1 + 4 + 4 = 27$$

$$27 \cdot 2.5 = 67.5$$

According the Usability.gov ‘’A SUS score above a 68 would be considered above average and anything below 68 is below average’’ (Affairs, 2013)

Survey analysis

This is a study designed by what is called "selective selection", due to the fact that the only participants that were able to answer the survey are the ones hired by companies whom have been listed on the SUI website. This makes it important to analyze the data thoroughly and make a precise analysis on these. Doing this correctly is essential.

Distortion due to lack of response: A large and extensive problem with low response rates is that the result can differ significantly from the actual perception. Data that has not been available can provide a false envision compared to what it portrayed in reality. The response rate is difficult to define because the email including the survey was not sent out directly to the participants. The survey was sent out to the contact person in the shipping company. By the time the emails were sent out, 36 shipping companies was listed on the website of SUI.

The assessment analysis made by us has resulted in that 94 respondents will give us a convincingly correct picture of the perception of onboard planned maintenance systems.

Interview summary

At Chalmers University the students receive a 7.5HP course in maintenance techniques (Underhållsteknik) - and the respondent tells us that the fundamental familiarity and the basic insights in program structures regarding maintenance programs came from that course. But the engineer also indicates and implies to be a very technically inclined person and also a fast learner. The program used in the maintenance techniques course is not the same maintenance program that the engineer is currently using on board, but the engineer is observant and recognizes many connections between the different programs and explains that if you are familiar with either one of them; it is possible to draw a parallel between different functions. The layout and the structure of the programs are similar.

The engineer describes the relation to the program as manageable, but also very time consuming and not something that the engineer is looking forward doing. The engineer believes that the planned maintenance system is used less by the co-workers than it could be because of their lack of knowledge and involvement in the software.

Discussion

The framework that laid the foundation for this thesis was the perception of a widespread dissatisfaction regarding planned maintenance systems on board. It is obvious that our neutral survey questions did not shed light on the dissatisfaction that we believe is spread among the users of different planned maintenance systems.

When researching previously made studies in this area; we came across a slightly more niche side track: Company software has such an incredibly significant impact on how daily activities within a business unfolds. It appears that it is not only an ineffectiveness or a minor disturbance for the user at that time, but that it can have a major impact on the working environment. What is unraveled is that ripples will appear on the water. Uncertainty and complications can and often will cause stress. *("Reasons and Symptoms of Physical and Psychological Stress On Board Ships," 2017.)* The software-ergonomic consequences have such a big impact on daily working life that it is a serious issue a should be researched further.

In 1995; Harald Reiterer and Reinhard Oppermann from the German National Research Centre for computer Science (GMD) Institute for Applied Information Technology described Software-Ergonomics as: ''A system's quality for particular users, for particular tasks, and in a particular environment. Functional, task oriented and user-oriented issues ... where the user-oriented perspective is the main focus ...'' *(Reiterer & Oppermann, 1995)* In order to fix the quality issue with the planned maintenance program, a lot of time and money has to be invested into this section of the maritime industry. Some high-quality programs may already exist, but the shipping companies may not understand the extent of the problems that are unraveled in this report. Or maybe they are not willing to invest in software when there are other more pressing issues. It is also very time consuming to implement a new program, but if the ship owners are willing to investigate the issue and invest in the software: it could benefit a lot of people and eventually save both time and money in the long run.

One comment from the survey said "First and foremost, the knowledge threshold is too high to enable beginners to easily use the program. People get scared to make mistakes and do not use the program as it should be used...." if this example applies to all users; the time not invested by the ship owner in ensuring that the onboard personnel are confident using the program, and not spending time working inefficiently with the program: may result in financial loss for the company. The time could be used working with more important and more prioritized issues.

Eventually this would result in a more efficient workplace which would benefit everyone in the company.

When interpreting the received answers in the survey: it is understood that the dissatisfaction from the staff on board is greater than it should be - but not as widespread as we thought it would be. Although; this is an incredibly important issue. We do not get the impression that this have been prioritized or discussed before. As stated earlier, the maritime industry has; for a long period of time, been left behind when it comes to technology. Back in the days you left a lot of communication back at home when signing on board. That may have been why the technology was falling behind Today; this is not the case. Being on board today does not mean that you are isolated from the rest of the world. It's time to keep up - and above all to listen to the software-users. The design, user-friendliness and usability are important ergonomic factors. The time spent in front of the computer must in many cases be as good and as optimal for the user as possible. Difficulties and adversities creates a bad atmosphere and stress, and on board and this spreads like disease. As a result; the quality of the work deteriorates (Lal, R. S, & Singh, A. P, 2015). When it comes to the working environment on board, we agree that walking that extra mile is sometimes what it takes to make sure that everything goes as smooth and autonomously as possible.

Conclusion

The conclusion made from the data collected concludes that it is not the overall consensus of the onboard personnel that the software is substandard, but 39.4% of the onboard personnel were not satisfied with the quality of their planned maintenance program and felt that the planned maintenance system does have inferior quality in some or all parts of the program. We were not able to attest if the programs are used less on board than it could be. According to the interviewee this was the case at the interviewee's work place. But one interview is not nearly enough to draw any conclusions. To get a better analysis on this problem we should have had included the question in the survey or interviewed more personnel.
The most valuable research collected was the total amount of 23 comments and concrete ideas regarding the overall impression, experiences, and opinions.

Future research

- Future research could include a survey based on the System Usability Scale (SUS). If used correctly and with a significantly higher amount of participants; it can be used as an analytical guide to portray the software-ergonomic character and usability of the software.
- One study could investigate if personnel who has worked with one PMS got to try another PMS and then rate the program from a usability-test.
- Another study could involve the shipping companies' viewpoint on PMS quality on board.

We believe that this is an unexplored area in the maritime sector. Further research regarding software upgrades on board and the user's experiences with the different programs should be investigated.

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Appendices

Appendix Survey Questionnaire

Question 1

Are you currently working, or have you been working on board in the past 12 months?

Question 2

Please select your age group

- 20-25
- 26-30
- 31-35
- 36-40
- 41-45
- 46-50
- 51-55
- 56-60
- 61-65
- 65+

Question 3

What profession or rank do you have on board?

- Boatswain
- Captain/Master
- Chief Engineer
- Chief Officer
- Electro-technical Officer
- Second Officer
- Second Engineer
- Superintendent
- Third Engineer
- Third Officer

Question 4

Which different maintenance programs have you worked with?

Question 5

Which maintenance program are you currently working with?

Question 6

Check the boxes for the functions you use in your current maintenance program

- ❑ Maintenance (Documentation, Instructions, Planning etc.)
- ❑ Surveys and certificates
- ❑ Stock ordering and purchase
- ❑ Stock control (inventory)
- ❑ Safety management
- ❑ *Add alternative...*

Question 7

How would you rate the structure of your current maintenance program?

- Very good
- Good
- Neither good or bad
- Bad
- Very bad

Question 8

How would you rate the ability to navigate in your current maintenance program?

- Very straightforward
- Straightforward
- Neither straightforward or complicated
- Complicated
- Unnecessary complicated

Question 9

How would you rate the graphic design of your current maintenance program?

- Very good
- Good
- Neither good or bad
- Bad
- Very bad

Question 10

Would you consider your current maintenance program stable? (Freezes, crashing etc.)

- Very stable
- Stable
- Neither stable or unstable
- Unstable
- Very Unstable

Question 11

How satisfied are you with the maintenance program on board?

- Very satisfied
- Satisfied
- Neither satisfied or unsatisfied
- Unsatisfied
- Very unsatisfied

If the respondent answered either Neither satisfied or unsatisfied, Unsatisfied or Very unsatisfied:

Question 12

What are you unsatisfied with?

Which areas are you unsatisfied with? (Check the boxes and/or add your own alternative)

- ❑ Maintenance planning.
- ❑ Surveys and certificates
- ❑ Stock ordering and purchase
- ❑ Stock control (inventory)
- ❑ Safety management
- ❑ Energy and environmental management
- ❑ Graphic design
- ❑ Processing speed
- ❑ Stability
- ❑ Slow start up
- ❑ User friendliness
- ❑ Search function
- ❑ Shortcuts between functions
- ❑ Lack of instructions for functions.

What would you improve?

If you want to add, remove or improve something in your maintenance program please write a comment. (max 500 word. In English or Swedish)