ERGONOMICS, PSYCHOLOGY AND COLOR IN SHIP CABIN DESIGN

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ABSTRACT

In naval architecture, comfort can be defined as the effects of impacts of ship motions, sound and vibration from different sources, heat and humidity on crew members as well. The lexical meaning of comfort is a state of physical ease and freedom from pain or constraint. Therefore, naval architects should take into account more parameters for comfort of crew member onboard. In this study, the effects of paint colors for interior walls, furniture choice, light distribution for indoor and light source supply, and allocation and aesthetic choice in a furniture selection for crew that feel most comfortable is investigated.

Keywords: Comfort,crew member,

1. Introduction

The definition of comfort level for ships is the acceptable sound (or acoustic) intensity level, vibration intensity, and light distribution, improved air quality in hotel service area as well as the ergonomics to work and live. On the other hand psychological and physiological effects of the ship environment on human beings must be taken into account to explain comfort. In this study interview with the users technique has been used to understand the meaning of comfort, other then sound, vibration and motions, for crew.

The production stage of a ship can be carried out by aid of design. Designing process includes determination of visual characteristics, production methods and estimation of cost. Another aspect defines design as a guideline or strategic route to obtain desired features by means of specifications, parameters, processes, and costs, while considering social, environmental, and legal limitations [1]. Social and environmental limits are related to crew comfort which effects the safety.

Ergonomics is a scientific disciplinary whose primary objective is to determine the characteristics of equipment, which will be designed and used by people, by regarding psychological and physiological compatibility with human nature, and work efficiency. In other words, ergonomics deals with the relations between humans and their environment [2].

It is necessary to consider psychology of crewmember during the design stage of a ship, but this is not normally the case. Psychology is a science which examines behaviors and mental health of humans. Since every design process interacts with humans, a design, which neglects psychology, is not complete. Especially, tactual sense and eyesight have important impacts on human psychology.

Crew and officers work and live in the same ship during long or short trips. In this period, deckhouses become very important for them. It is why, ship owners, designers, and producers have to give due importance to design of deckhouses.

This study investigates living areas in conventional ships by regarding effect of hierarchy to placement of cabins in superstructure, requirements of crew, and parameters for providing comfort for crew.

2. Living and WorkingAreas n Conventional Ships

2.1 Superstructure

Superstructure of a ship is a living and working place where wheelhouse, dining and entertainment rooms, offices, and accommodation spaces are located. This place must fullfill the needs of ship crew. All the compartments such as control rooms, offices, cabins, miscellaneous rooms, etc. in the superstructure are located by considering their relationships with each other. Making this kind of settlement is to ensure that the people and materials go from one place to another in the shortest possible way [3].

Living and working on a ship require a hierarchic system which determines the characteristics of accommodation areas such as location and size. The captain of a ship is placed on the top of this hierarchic system. Then, the ship is divided into two parts. where Second captain is in charge as the first one on deck department, and the second one is machinery department where first (chief) engineer is in charge. In this system, there is a chief-aide relationship between the people who work in same department and a crossed superior-subordinate relationship between the people who work in different departments [4].

Bridge deck is placed on top of the superstructure for controlling the ship, performing safe maneuverability by providing wide and clear sight. There are chief's office, owner cabin and/or chief engineer's room below the bridge since they must be close to wheelhouse due to their hierarchic status. The other compartments for officers, crew, and their living, working, leisure needs are located according to ship hierarchical necessities.

Every place that seafarers rest and relax called accommodation area such as sleeping rooms, hospital and mess room. Living and working in ship is though and dangerous, therefore has the great importance to provide the necessary living standards in ship. For this reason, many different institutions such as ILO, IMO, SOLAS and classification societies have made these standards into written rules to be followed when designing and producing a ship's cabin [5].

2.2 Comfort of Crew in a Ship

2.2.1 Ergonomics

In order to create a healthier, more efficient and to decrease work accidents in daily life and work environment, it is necessary making compatible the goods, equipment and machines used by people with the physical and spiritual structure of the person as much as possible [6]. Ergonomics is a working system used by all disciplines. Ergonomic factors must be considered during ship design stages. Factors that will facilitate for sitting, standing, moving, and reaching situations of employees in the ship should be regarded. Furthermore, feedback should be taken from previously designed ships. It must be meticulously determined what should and should not be done, what are the human tasks, what kind of personal characteristics are there and which are the environmental factors.

2.2.2 Psychology

Psychology is the science of studying and investigating the underlying causes of human behavior and mental processes [7]. Each decision made in the design process has an impact on the psychology of people who use that environment for living and/or working. Especially in working environments, employees need to feel psychologically ready to do works. The employers must keep the disturbing elements as minimum level as possible and keep employees psychology at the best possible level in the environment where employees work or live. People who work on board spend most of their lives at sea and this tough situation can break down psychology of seafarers for many different reasons over the course of time at sea. When designing a ship, the social environment needed for crew living on this ship should be made and the light, sound, vibration and air-conditioning factors of the ship cabin should be taken into consideration carefully which affect the psychology of the person. Also the psychology of the person can affected by selected furniture, wall color, carpet color, texture of the used materials.

2.2.3 Area

While ship cabins are designing, one of the first design parameters is specifying cabin area. The size and position of this room can vary depending on the size of the superstructure, the hierarchical status, class rules and the wishes of the ship's owner. Classification societies are mainly based on the minimum size of the living space for the ship cabin as prescribed by IMO, ILO and SOLAS. Well designed and equipped accommodation spaces raise employees' morale, comfort, and standard of living in the sea, and vice versa poor designed spaces decreases [8].

While the space of a ship cabin is calculating, the space occupied by the items in the room is taken into account and non-functional areas are excluded from this account. When designing the room, the room area should be used with maximum efficiency. The locations of the furniture should not reduce the movability within the room and should be avoided in situations that could prevent the personnel from passing in an emergency and cause danger. In addition to the cabin for the ship's captain, ship-owner or chief engineer, there must be an office or living room where they can pass time in the day.

2.2.4 Noise and Vibration

Unwanted voices from many different sources are called noise. Work accidents are more likely to occur in noisy environments. Noise causes bad effects on the human body such as hearing loss, stress, concentration decline, sleep disturbance [10].

There are many noise sources on board, such as main engines, generators, and air conditioners. This noise disturbs the seafarers while working and resting in the recreational areas. When designing a cabin and recreation rooms for a ship, the noise effects should be minimized and optimum locations for the room's location must be found.

Vibrations certainly arise due to machineries, generators, the sea and air. High vibrations can cause discomfort, structural fatigue and deformations, to reduce these effects vibration response levels should not be too high. Short term exposure causes headaches, stress and fatigue; on the other hand, long term exposure can causes hearing loss, sleep aggravation, body agitation [9]. These vibrations are inevitable but can be reduced to minimum levels with a good design. When designing a cabin, vibration sources next to the room should be considered. The cabin should be positioned as far away as possible from these sources of vibration or sources of vibration should

be located as far away from those cabins as possible. Where necessary, vibration absorbers should be used and required vibration insulation should be made.

2.2.5 Indoor Climate and Lighting

The indoor climate has a very big precaution so that people who work in every working environment can feel good and work in focus. In a room when temperature, humidity and ventilation are not at normal levels, the people inside are physically and psychologically affected and feel uneasy. For each person, these normal values are different. It should be suitable for at least 80% of people who use the room to ensure good climate [11].

The lighting on the ship has great precaution for people to see in dark places, to move easily, and for moving fast and safe at emergency case [11]. The possibility of work accidents increases in working environments where there is not enough lighting. In places where there is not enough lighting, the people inside feel uncomfortable and psychologically affected. In the short term and long term, a poorly illuminated environment harms the eye health of people.

Lighting is very important when designing the ships cabin. Sufficient and appropriate lux for the room must be calculated. While the illumination of the cabin is considered, the color of the room and the color of the furniture used are also very important. Every color and all furniture have a reflection in different amounts, and this reflection can sometimes come to a state of inconvenience to the worker. Therefore, when designing the illumination of the room, the required light level should be decided, the position of the light must be carefully adjusted, and the color of the room and items should be decided well.

3. Case Study

The case study of this work was carried out as an undergraduate project [12]. The information was gathered from a survey and the results are given in this work. Each ship design is unique that different factors effect the layout such as purpose of the ship, flag, range etc. In order to improve the design of cabins, it is necessary to take into account different inhabitants and purposes. Every age group, profession group, and gender can change ratings. An online survey of 13 questions was prepared to understand the comfort expectation of officers and crew. This survey was answered by 95 people working on board. The results and comments of this survey are given in this chapter.

3.1 Age and Gender Distribution of Participants

Age has an impact on human desires. Younger people prefer more fun and convenient rooms, while older people prefer more calm and relax rooms. Gender has an effect on choosing the color of the room, deciding the furniture sizes such as chair, table and bed sizes. As a result of the survey it is seen that the number of women working in the ship should not be underestimated. The age and gender distributions of the participants are given in Figure 3.1 and 3.2.

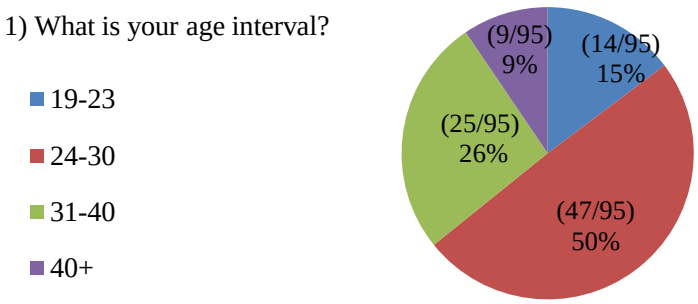

Figure 3.1 Age Distribution

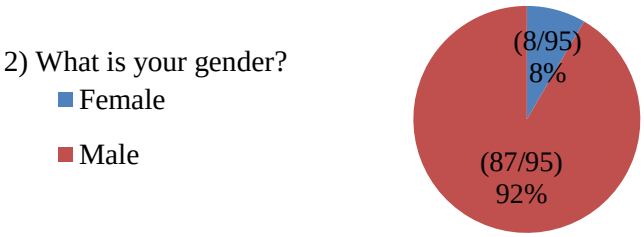

Figure 3.2 Gender Distribution

3.2 Work Experience and Position of Job Distribution

Work experience and past experiences at sea can change people's feelings and thoughts. According to survey results most of the seafarers have 1-4 year experience at sea. The graph of the distribution is shown in Figure 3.3. Life expectancies, likes and needs of every professional group are different. Figure 3.4 shows job position amounts of respondents.

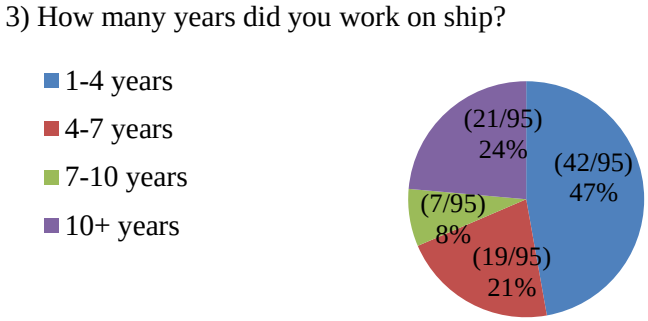

Figure 3.3 Experience Distribution

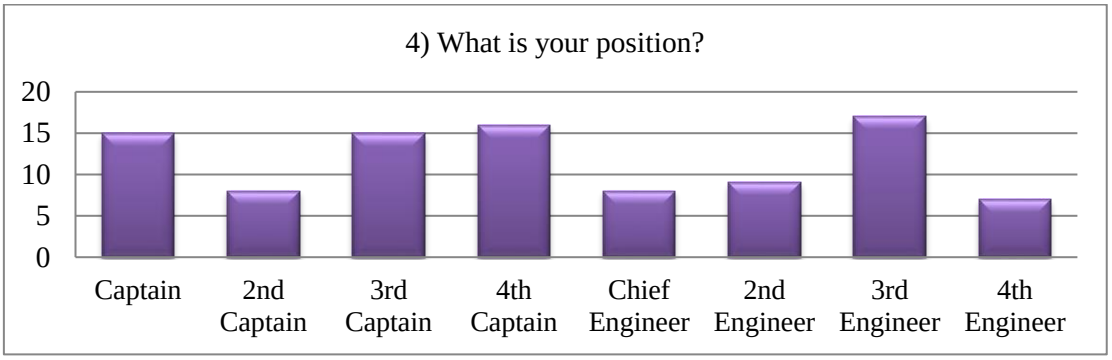

Figure 3.4 Job positions of respondents

3.3 Ship Types and Flag States

The classification rules change as the type of the ship changes. These class rules can change some design parameters such as room size, isolation, etc. It can also change the psychology, likes and expectations of people working on a dangerous ship, and the person may feel the need to feel safe. According to the results, a large majority of the respondents are working in chemical tankers. According Figure 3.5, a large majority of the respondents are working in chemical tankers.

Flag states can impose some constraints, such as carbon emissions, and these constraints can affect the design of the ship, indirectly the design of the cabin. The majority of the seafarers who participated in the survey are working on a ship which carries a flag of Turkey and Malta. Flag authorities of the ships are shown in Figure 3.6.

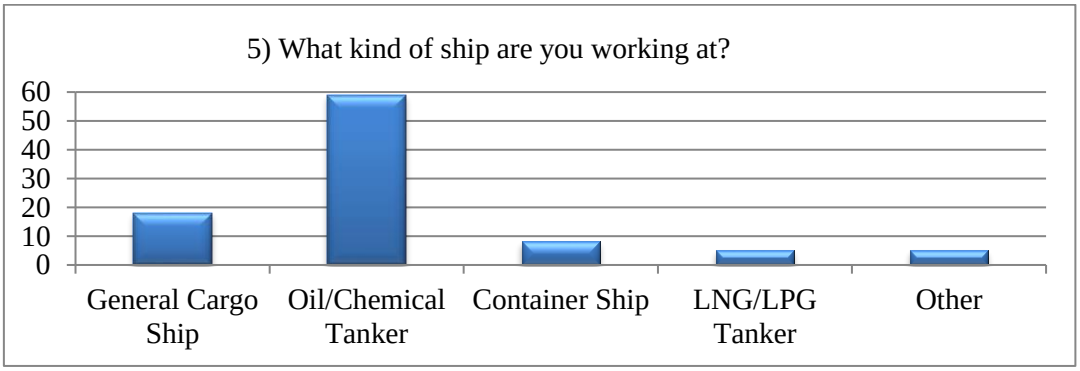

Figure 3.5 Ship types that respondents' work at

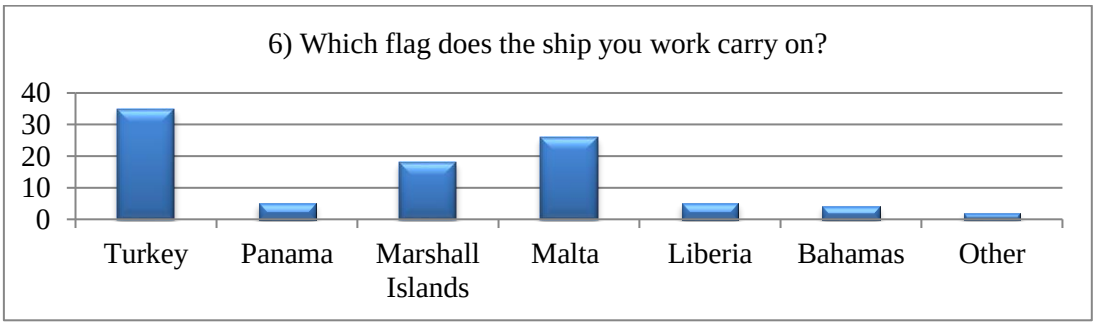

Figure 3.6 Flag authorities

3.4 Satisfaction Analysis

The seafarers' room satisfaction has a great importance to improve the design of the ship's cabin. In this question asked to find out whether they were satisfied or not, 62% of the participants stated that their rooms were not comfortable. This result shows that the ship cabin design should be developed to further satisfy the users. Figure 3.7 shows the distribution of answers.

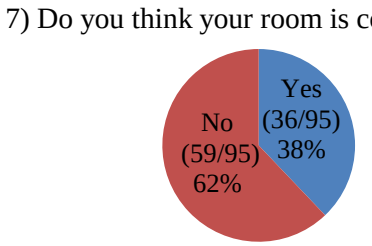

Figure 3.7 Seafarers' satisfaction from ship's cabin

3.5 Accommodation Area Sufficiency

This question was asked to find out the effect of the room space adequacy which affects the amount of comfort Seafarers have in the room. Opinions of respondents for sufficiency of their rooms' area are shown in Figure 3.8. As a result of this question, it was found out that the seafarers found the room areas to be inadequate.

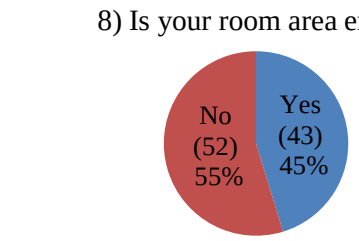

Figure 3.8 Room area sufficiency analysis

3.6 Disturbing Factors

There are 4 main factors that disturb the people in the ship's cabin. These are noise, vibration, indoor climate and lighting. When designing the ship cabin these four factors must be taken into consideration, but it is important to make a decision as to which of these is more important. According to the survey results, disturbing factors can be sorted respectively vibration, noise, indoor climate and lighting. Figure 3.9 shows the comparison of disturbing factors.

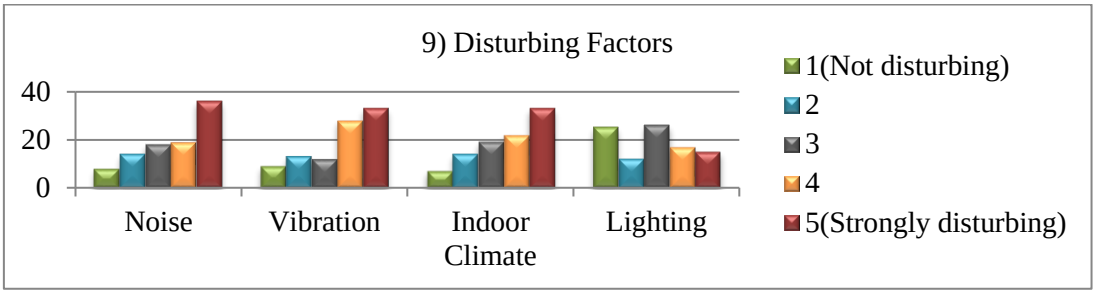

Figure 3.9 Comparison of disturbing factors

3.7 Effect of Color Selection on Design

Color has an impact on human psychology. Designers usually use cold colors such as blue, green, purple for relaxations room which calms people, while hot colors such as yellow, red and orange are used in daily areas to move people more. But the color choices of people working on board may be different. The four rooms designed to find which color is better are recreated with the same light and the same furniture and only the color of the furniture and walls in the room has been changed. And the color preferences of the people working on ship were learned by asking the respondents who they would feel more comfortable in which room. Green, blue, red and black concept rooms are show in Figure 3.10, Figure 3.11, Figure 3.12, Figure 3.13 respectively and Figure 3.14 shows the preferred amounts of room.

Figure 3.10 Green concept room

Figure 3.11 Blue concept room

Figure 3.12 Red concept room

Figure 3.13 Black concept room

10) Which room is more comfortable for you?

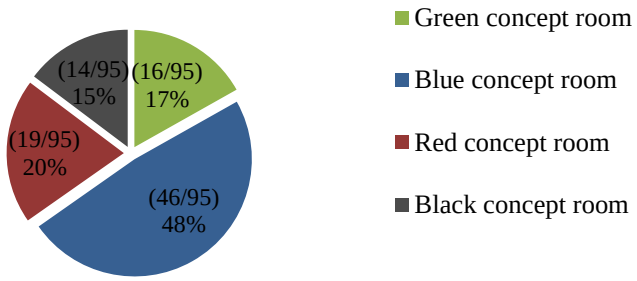

Figure 3.14 Preferred amounts of rooms

According to the results of this question, the vast majority of seafarers chose the blue concept room. The other rooms were chosen at almost the same amount. It is evident that blue color tones are more attractive where they feel more comfortable and peaceful.

3.8 The Effect of Furniture Settlement and Lighting

Each item in the room has a reflection amount. When the room is being designed, positioning the furniture in different places changes this reflection. Also, the location of the furniture in the room may vary depending on the liking and comfort of the person. To find out how to make better design, three different rooms were created with the same objects and the same colors, only by changing the locations of the objects in the room and the participants were asked which room to select. Figure 3.15, Figure 3.16 and Figure 3.17 show the room with 3 differently positioned furniture and Figure 3.18 shows the preferred amounts of these rooms by participants.

According to these results, the 1st room is preferred by the seafarers. The table in this room takes the sunshine from the left-hand rear, there are no items to feel stuffy around the bed, the furniture is positioned to make easier to move around in the room.

Figure 3.15 1st Placement of furnitures

Figure 3.16 2nd Placement of furnitures

Figure 3.17 3rd Placement of furnitures

11) Which room do you prefer?

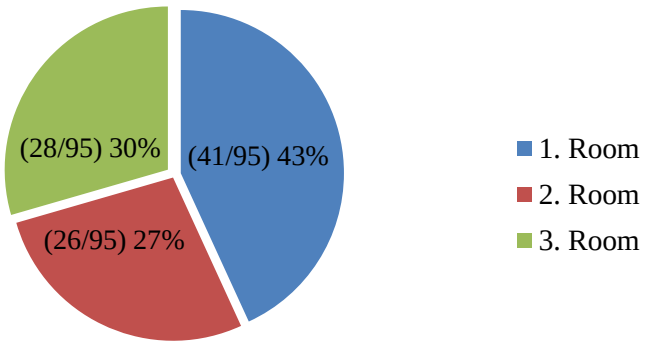

Figure 3.18 Preferred amounts of the rooms

3.9 The Importance of Ship Cabin Design

Ship design is a long and challenging design process. Usually the ship's cabin is shaped after the last design stages or even after the ship is built. But the importance of the ship's cabin should not be underestimated. In this question, if the seafarers cabins are be better and more comfortable, they were asked whether their work efficiency would increase or decrease, and according to the results, 88 out of 95 people said their work efficiency will increase. Considering that increased work efficiency would create a healthier and better working environment, the importance of improving the ships cabin design was emphasized. The amount of impact on work efficiency when participants live in a more comfortable room is shown in Figure 3.18.

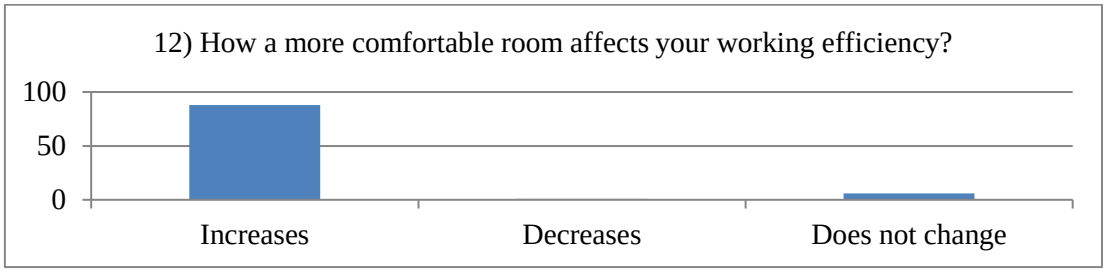

Figure 3.19 More comfartable room vs. Working Efficiency

It is very important to take into consideration the seafarers opinions in cabing or living places to develop the ship cabin design. For this reason, seafarers' respondents were asked to comment on the cabin. Some of their comments are as follows to improve the cabin design;

- Insufficient number and size of clothes locker,
- Seats and beds are very uncomfortable,
- The portholes should be a little larger,
- Ceiling color should be light color,
- The garbage cans must be stable,
- The room temperature and the amount of light must adjusted by the person himself,
- Portable opening and closing furniture must be used.

4. CONCLUSIONS

In this study, factors effecting the design of cabins or compartment in a superstructure are examined. These factors are usually neglected or not paid proper attention. ILO an Classification Societies must be followed in order to ensure better living conditions for seafarers who spend a certain part of their lives in the sea their cabin. In addition, the psychological state of seafarers living on that ship must be considered. Also a survey was carried out on seafarers to improve the design of ship's cabins.

According to the results of this survey, 62% of the respondents indicated that their rooms were not comfortable and 93% said that more comfortable rooms would increase their work efficiency. Correspondinly this, one feels well, work efficiency increases and morelikely the work accidents will be reduced. Besides, respondents were asked to choose one of the rooms designed according to 4 different color concepts (green, blue, red and black). In the result of this question, it is seen that 48% of the participants prefer to live in a blue-toned cabin. This proves that seafarers' psychology is better when blue tones are used to express calmness and comfort in their cabin.

ILO, IMO, and SOLAS rules address five major factors that affect ship cabin design. These are accommodation areas, vibration, noise, indoor climate and lighting. In this study which is based on a survey, the effects of these parameters were also investigated in some limits.

Ergonomics have been taken into account more widely on board. However, effects of noise and vibration, climate control on board, lighting, furniture and fabrics used in cabins and color must be searched. Outcomes of the research must be judged to see their impacts on crewmember's psychology. Furthermore the relation between worker phycology and work safety must be compared.

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