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WORK SHIFT SYSTEM AS A PART OF ENHANCED WORK WELFARE AND ENSURING OPERATIONAL SAFETY

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The purpose of this thesis was to study the exertion level of VTS operators in different shift working models as a part of enhancing work welfare and to ensure operational safety in all operations. Maintaining high level of alertness in long work shifts and the ability to recover from work shift changes has great role in the aspect of safety as well as in individual well-being.

Research was conducted for the operative personnel in South-Western Finland Vessel Traffic Center. The study was participated by 29 of 34 operatives and shift supervisors. Research was made by using qualitative and quantitative methods with Webropol-program and its purpose were to gather as much as possible first-hand information about the managing, recovering and periodizing of work in operators' daily living in shift work.

Research was launched to investigate how the present shift work models affect in the well-being of the operators. Research revealed that most the operators are satisfied of the present work shift models in use and in the prevailing opportunities to choose between two work shift models.

Results of the research are recorded under according subtitles.

Conclusions: contrary to the prevailing studies of the benefits in the clockwise shift rotation, the majority of operators are more willing to work in anti-clockwise winding shift rotation to maximize the recovery and social life needs in the free time.

Results of this research were taken into consideration by company to improve the well-being of employees.

Key words
Search from key word list but not linked to Finto service.

CONTENTS

LIST DEFINITIONS

AIS	Automatic Identification System
FIOH	Finnish Institution of Occupational Health
FFA	Finnish Food Authority
FMA	Finnish Maritime Authority (ceased 2009)
Fintraffic VTS	Sea Traffic Management Company
GOFREP	Gulf of Finland Reporting System
INS	Information Service
NAS	Navigation Assistance Service
SWD	Shift Work Disorder
TOS	Traffic Organisation Service
VTS	Vessel Traffic Service

1 INTRODUCTION

1.1 Background, framing and objective for this thesis

It is a universal dilemma; how to arrange work and free time in a way to satisfy both employer and employee? The objects of this this master's thesis were to investigate whether the prevailing work shift systems in the Fintraffic VTS were safe enough to ensure the operational safety and how the employees have found the balance between work time and free time, considering some of the largest influencers and issues for work well-being in shift work for personnel in different stages of life.

More and more demanding life surround us every day, even without the excessive burden of the Covid-19 virus. Social needs of families, lack of quality in free time, rush years for the parents with children, ever-increasing and constantly changing work requirements can all together make individuals more and more stressed and exhausted and when all this is added to a demanding shift work in a safety critical work where concentration is the only key to operational success, issues can arise.

The subscriber of this thesis, Fintraffic VTS, is one of the four traffic management branches of Fintraffic Oy, which controls and manages the traffic on land, in the air, on the railways, and at sea. It provides real-time traffic information that helps companies to create new traffic and smart mobility solutions for people and goods. Intelligent traffic control and management services, up-to-date, real-time traffic information, and the competence of the company's 1,100 professionals improve the safety and smoothness of traffic and help reduce emissions. Fintraffic promotes sustainable traffic. Subsidiaries and their respective areas of responsibility:

The company has done a quite extensive number of acts to ensure shift work safety. A vast service setting including occupational health, lunch, sports, culture, and commute benefits are handed equally to all personnel.

1.2 Research questions

There has been conversation of the different shift systems as long as the systems started to vary when three separate VTS centers were combined as one control center, and at the same time there was a change of the amount of personnel in the control center per time as well as a change in the being at the work site. In the past operators came to control center for the whole period of work and nowadays only few operators living further stay at the control center and operators nearby spend their time between shifts at home.

The subscriber of this thesis needs information concerning different types of relevant shift systems and for the possibility of the need to change the operative systems in order to secure safety in all operations. Shared need for the employees and employer is to get information how the different shift systems effect on individuals at work and on free time for recovery and coping. In this thesis research questions are following:

- How does the employees feel the prevailing shift system as a part of their work health?
- How has the change of shift system affected on a single employee?

The shift systems compared in this thesis are twelve hours clockwise rounding DDNN (day-day-night-night) and twelve hours anti-clockwise rounding NNDD (night-night-day-day) shifts with both following a six-day leisure period. Also, some opinions and research about longer shift circulations with twelve hours shifts arise (NNNDDD) as well as the possibility for the three-shift work with eight hours work time.

It was my goal to find the weakness and strength of prevailing shift systems and to investigate, weather any other shift system would fulfill the weaknesses. Personnel were given a questionnaire including 48 questions in which responders answered on a voluntary basis and anonymously with open and closed answers. All information gathered in this research was handled confidentially and according to good research form. Material or personal information was not handed over to anyone outside of the company. In publications, results are given in such form that individual personnel cannot be recognized.

2 CONDUCTING OF RESEARCH

2.1 Research methods in this thesis

This thesis was conducted as a hybrid of qualitative and quantitative research which often complements each other and can be used simultaneously.

In qualitative study the aim is to understand a detected target of phenomenon. Meanings for these and answer to great question of why is it so? When the quantitative research answers questions as numbers, how many or how much. Because all qualitative studies are case studies in their nature, made in the specific time, place and the cultural context of the study must be considered. In the research, reporting and reflection on the limitations of generalizations are made by understanding and reporting the differences between individuals as employees.

In general, a questionnaire is useful for researching and evaluating of experiences. Questionnaire is used when quite known things are wanted to be explained. It is a suitable method of research when it is known what kind of answers will be obtained but when the answers are based on experience of an individual. A theme questionnaire focuses on certain topics, and a typical feature is, that the interviewees have experiences of the same kind of situations. The data was collected by a large questionnaire and by targeted interviews of a small amount of individual which also show as the discretionary sample in this qualitative study and the purpose of the master´s theses was to describe and evaluate their experiences. At its best, research made by the theme questionnaire method may create a new theoretical framework through the interviewees´ experience. It is necessary and important to do research work on experiences to improve the quality of operation and safety procedures.

Source criticism of the data must also be taken into consideration. The need to answer questionnaire so that it will not affect to future by for example alterations to work shifts. As well as researcher’s own role and position, attitude towards prevailing situation, topic being common and close, these circumstances can have affected on research settings, but they will not influence results.

2.2 The Subscriber

Subscriber, Fintraffic VTS, provides Vessel Traffic Services to merchant shipping and other vessels in Finnish sea areas and in the international sea area between Sweden and Finland in the Aland Sea, where Finland has monitoring responsibility. It also maintains coastal safety radio operations. VTS Centre surveillance areas encompass coastal merchant shipping lanes, and the Saimaa deep fairway. All together there are 101 employees (2020). Fintraffic VTS operates under agreement with Finnish Transport Infrastructure.

VTS has ISO 9001:2015 certified quality control system. The quality policy sets the base for the company operation. Company acts according to international and national regulations as well as per company values and instructions. The customer and stakeholder satisfaction are key features. The core for all operation is motivated and qualified personnel.

Improving of safety in marine traffic and facilitation of the efficiency and free flow of the traffic are the main goals in operation. Preventing accidents and mitigating the potential environmental hazards are the most important issues in daily operation. The VTS operates in interminable basis all year round. Vessels receive information of safety issues, traffic situations and are given navigation assistance if needed at all hours, in English, Swedish and Finnish. (Fintraffic VTS, 2021)

Fintraffic VTS ensures foreign trade on Finnish Sea areas and the uninterrupted domestic waterborne traffic. It means yearly over 100 million tons of shipments. Also, over 20 million passengers are moving between Finland and foreign ports every year. Finland lives through maritime. Over 90 % of import and 80 % of export is transported via seaways.

In 2020 company prevented nine possible groundings, of which eight was prevented in Finnish coastal areas and one in Finnish responsibility area at international waters. (Fintraffic VTS, yearly non-conformity report)

3 VESSEL TRAFFIC SERVICES

3.1 A short history of VTS

It all begun back in 1948 in Liverpool, England with first harbor radar and when first radar surveillance system was established in 1950 in California, USA. The ability of the coastal authority to keep track of shipping traffic by radar, combined with the facility to transmit messages concerning navigation to those ships by radio, therefore constituted the first formal VTS systems.

But as VTS-operation is understood today, it got its role in 80s and 90s when technical side had developed enough. Finnish coastal areas and Saimaa was planned and started under 1995-2001. The 21st century can be held as time frame when VTS becomes more frequent and especially in the Far-East.

The value of VTS in navigation safety was first recognized by IMO in resolution A.158 (ES. IV). Recommendation on Port Advisory Systems adopted in 1968, but as technology advanced and the equipment to track and monitor shipping traffic became more sophisticated, it was clear guidelines were needed on standardizing procedures in setting up VTS. It became apparent that there was a need to clarify when a VTS might be established and to allay fears in some quarters that a VTS might impinge on the ship's master's responsibility for navigating the vessel.

As a result, in 1985, IMO adopted resolution A.578 (14) Guidelines for Vessel Traffic Services, which said that VTS was particularly appropriate in the approaches and access channels of a port and in areas having high traffic density, movements of noxious or dangerous cargoes, navigational difficulties, narrow channels, or environmental sensitivity. The Guidelines also made clear that decisions concerning effective navigation and maneuvering of the vessel remained with the ship's master. The Guidelines also highlighted the importance of pilotage in a VTS and reporting procedures for ships passing through an area where a VTS operates. (IMO, 2019)

3.2 Operational areas

The Western Finland's Sea Traffic Centre is located in Auriga Business Center at the heart of Turku. It is the working place for 34 hand-picked, and professional VTS operators (in 2019).

The sea traffic center monitors the vessel traffic in Finland's territorial waters from the Sea of Archipelago (east from Hanko) to the northernmost ports of Kemi and Tornio, as well as the South Åland Sea traffic separation scheme including the precautionary area between Finland and Sweden where the crossing passenger vessels meet the traffic, to and from the Sea- and Bay of Bothnia.

The western coast of Finland is divided into three VTS areas. The surveillance area of Archipelago VTS encompasses the Archipelago Sea, while West Coast VTS operates on the Bothnian Sea from Rauma to Vaasa and Bothnia VTS on the Finnish coast in the Bothnian Bay. Ports within the Centre's area receive some 16,000 port calls annually, and the area has a total of 2,100 kilometers of monitored fairways.

The Western Finland VTS Centre also includes Turku Radio, which is responsible for safety radio broadcasts and helps ensure distress radio communications along the Finnish coast. Together with Sweden, Finland has set up a traffic separation scheme in the Åland Sea (Åland Sea TSS). The traffic in the South Åland Sea TSS is monitored by Åland Sea Traffic. The area does not have an obligatory reporting system for vessel traffic, but vessel traffic is monitored. The vessels are notified of violations, and violations and deficiencies are reported to the flag authorities via Safety Sea Net (SSN).

During the year 2020, vessel traffic centers prevented nine vessels from running aground. Navigational assistance was given to six vessels and prevented a variety of dangerous situations by informing the vessels about them. A total of 940 reports of violations and incidents in vessel traffic were made. More than 80 % were reported inside national water areas, and the rest 20 % in international waters. (Fintraffic, 2020)

3.3 Operational Services

The services given by Fintraffic VTS in Western Finland's Sea Traffic Centre are navigation assistance (NAS), information service (INS) and traffic organization service (TOS).

An Information Service is defined as a VTS that provides essential and timely information to assist the on-board decision-making process. This means that VTS operators can inform the master of a vessel about the situation he can expect to encounter within the VTS Area but the VTS may not have the experience to advise on any specific course of action that should be taken. VTS Operator within an Information Service (INS) needs the facilities to monitor the operational situation relating to all maritime activity within the VTS area and requires facilities to communicate with vessels by VHF radio. Decision Support facilities may not be a necessary part of an Information Service, but the full recording of all activity remains essential and performance measurement should still be a desirable feature.

A Traffic Organization Service is defined as a service to provide safe and efficient movement of traffic and to identify and manage potentially dangerous traffic situations. The Traffic Organization Service provides all the services of an Information Service (INS) but may also advise, instruct, or exercise authority to direct movements. In such cases, the Traffic Organization Service is likely to be provided by fully trained operators who will use the full set of message markers in their communication with vessels within the VTS area. From a VTS system point of view, it is clear that the VTS Operator in a TOS environment needs more functionality from his VTS system that the VTS Operator in the INS environment. They will need tools that help to identify risks of collision, risks of grounding, speed monitoring tools, fairway monitoring and possible anchorage monitoring. So, there is a clear difference between the functionality required to support a TOS VTS and the functionality required to support an INS VTS.

A Navigational Assistance Service is provided in addition to an Information Service and / or a Traffic Organization Service. It is provided at the request of a vessel or is sometimes initiated by the VTS should a difficult traffic situation be developing.

3.4 The Operator

The operational watch personnel consist of maritime deck officers. When applying to the job, the lowest certification required is STCW II/1 (Deck Officer). In general, the watch personnel in Fintraffic VTS have a bachelor's degree in Maritime Management (Captain) and experience onboard ships in bridge duties. Some operators have studied master's degree in various fields on the side. This research was made for personnel in Western Finland Sea Traffic Centre, where the number of operators was 34 at the time of research.

Operators maintain real-time traffic flow picture with the help of cameras installed around the surveillance- and port areas, AIS (Automatic Identification System), radar information and reporting requirements via VHF-radio. Operators follow shipping traffic in their responsibility areas and give information amongst other things of the failures in maritime safety equipment and of the usage possibilities of the fairways in the traffic area (e.g., closed fairways due to ice or latest traffic in ice channels).

The work is on-call duty type and requires a tolerance of routine but on the other hand also the readiness to react fast and effectively to the unforeseen situations. Good simultaneous capacity, in other words ability to deal with and connect the gathered information from different sources. In addition, to carry out several tasks in real time. The Operator must be able to perceive vessel's movement and location in relation to the fairway and to the other vessels by using the situational view produced by radars and automatic identification system.

According to job advertisement the operator is expected to be able to work independently, to have good social skills and be willing to develop in work. Operator is expected to have good written skills in Finnish or Swedish and a satisfactory oral competence in secondary language. In English, general language examination level four is required. It is preferred that the operator has experience onboard as officer, as well as a master's degree and good IT-skills. (Oikotie, 2019)

VTS Operator (V-103/1: VTS Operator Training) courses are held after recruitment, when necessary, either in England or in Finland (Aboa Mare). Education consists of three sections: Operator Training Course, On-the-Job Training and Professional in-service training (fairway training, simulator training and language training). VTS Operator must comply with regulations in "Law for Vessel Traffic Systems" to have an appropriate certificate from Traficom (Finnish Transport and Communications Agency), including independent language skill testing. In addition, the candidate must pass health inspection with permission for night work, drug testing and security clearance made by SUPO (Finnish Security and Intelligence Service). (Liikenne- ja viestintäministeriö, 2005)

VTS operator must be able to stand the time when "nothing or less happens". All recruited operators go through a large-scale testing of mental ability to function under pressure and a test of low activation before sudden changes in on hand situation. Throughout the history, from the times of Finnish Maritime Administration (1917-2009) turnover of employees in VTS has been very small, almost all recruitments are based on retirement. Within the last five years, the middle age of employees has been decreasing because of new recruits have been younger. Overall, the employees are very experienced. More than 50% of the employees have been working as VTS Operators over 11 years.

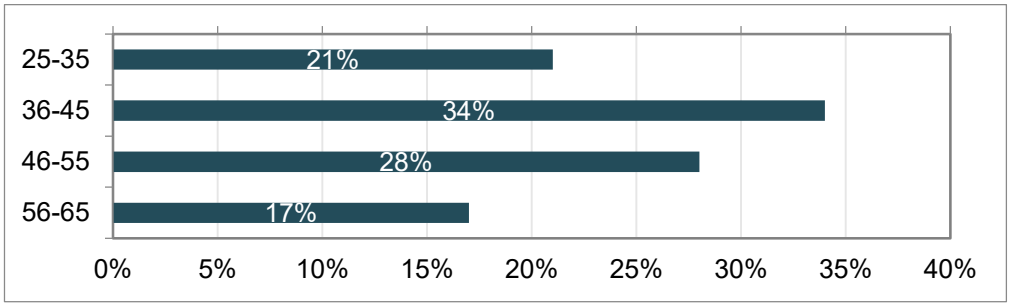

Figure 1 The age distribution of the employees

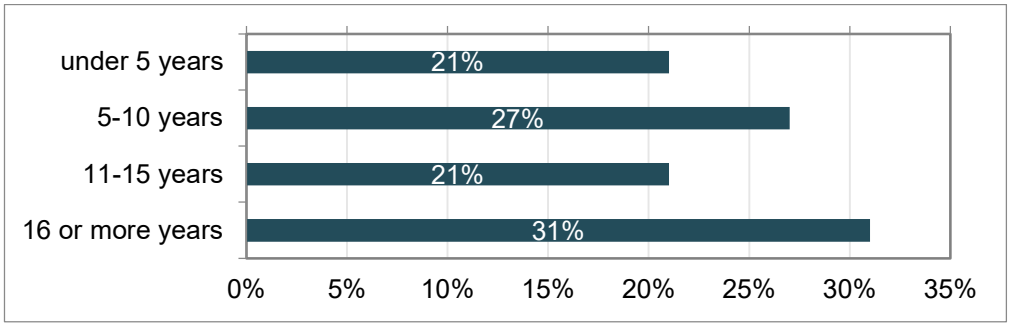

Figure 2 The work experience of employees in years

4 OCCUPATIONAL HEALTH

4.1 Legislation

According to section 4 of the Occupational Health Care Act (1383/2001), the employer must arrange occupational health care at his own expense in order to prevent and combat health hazards and inconveniences caused by work and working conditions. Occupational health care must be organized and significantly broader than the need for work, work organization, personnel, significant workplace, and their changes, as provided by law. Occupational health care is defined by law as governing occupational health care and its operation, and its scope is bound by the Occupational Safety and Health Act. Occupational health care services must be provided equally to all employees and the services must be free of charge.

The activities of occupational health care include conducting health inspections, e.g., initial inspections and periodic inspections. As explained in the previous paragraph, the law obliges the employer to arrange regular health examinations for employees if the work involves a special risk of illness or health requirements. The aim of the health inspection is to prevent occupational diseases and other work-related diseases and symptoms. Occupational health care must monitor the survival of each employee at work and support its progress. In connection with health inspections, information should be provided on possible hazards at work and how to prevent them. The health check should be used as early as possible to detect signs of adverse exposure or other adverse health effects. If there is a risk of illness at work, the primary goal of the health examination should be the employee prevention of work-related health damage.

According to the subsection 13§, an employee may not, without a justified reason, refuse to participate in the health examination referred to in this Act, which is necessary for the placement or duration of the work. Section 2 of the Government Decree on health inspections in work causing a special risk of illness (1485/2001) provides that night work is one of the factors requiring health inspections. (Finlex, Työterveyshuoltolaki, 2001)

4.2 Inspections for shift work

4.2.1 Preliminary inspection

The initial inspection should be carried out before the employee starts work if there is a special risk of illness at work, or otherwise no later than one month after starting work. If the hazards of the work have been similar in the previous work, it is not necessary to carry out an initial inspection. However, information from previous health examinations must be submitted to the occupational health service. The initial inspection of a shift worker is similar to the initial inspection normally in occupational health care, i.e., it seeks to determine whether an employee has an illness or exposure that puts him or her at risk for his or her health from the planned work. The assessment of the health status of the shift worker may be included as part of the initial inspection or subsequent periodic inspections.

4.2.2 Periodical inspections

The health status of shift workers, and especially night shift workers is monitored by health inspections. Medical examinations should be performed regularly if the health hazards related to shift work are significant or if there are problems with the employee's ability to work. The health effects of shift work are individual and sometimes difficult to predict, so it is recommended that a health check be performed during the first year of work.

The opportunity to follow a healthy lifestyle is related to work, as working hours and working time opportunities vary according to workplace conditions and work arrangements. Motivating the shift worker for a healthy lifestyle is one of the key tasks of occupational health care. It is important to provide information and different approaches on the ways in which the employee can contribute to the prevention and reduction of work-related harm. This includes finding a suitable sleep rhythm, exercise, good sleep hygiene, a suitable eating rhythm and nutrition, and various psychosocial adjustment measures.

Of the unhealthy lifestyles, smoking seems to be most clearly associated with shift work. According to several studies, being overweight and gaining weight is more common in shift work than in day shifts. Experimental studies have found that accumulating sleep deprivation increases sugar and fat hunger. (Hakola H. H., 2007)

Health examinations may be less frequent for shift workers aged 25-45, while more frequent health examinations are recommended for older people due to the interaction between aging and shift work. For example, sleep problems begin to become more common in people over the age of 40, and studies have found that the risk of coronary heart disease in people over the age of 50 increases more in shift work than in day work. In certain tasks where night work is performed regularly, the employment placement inspection should be performed as part of the jobseeker's aptitude test. This should be the case, for example, for fire and rescue missions and public transport missions. This is justified because the flawless ability of the employee to function is essential in safety-critical occupations. Night work in particular has a strong detrimental effect on staying awake and alert. If an applicant for night work is diagnosed with a disease that significantly affects the state of alertness, this should be considered in the assessment of suitability. (Sampsa Puttonen, 2010)

4.3 Operator performance

Finnish workers are absent from work with a median of 5-7 days a year. One day off work cost employer about 350 €. (OP, 2020) According to questionnaire VTS operators over 60 % has been absent less than the median and in experience, the operators have high limit of not coming to work.

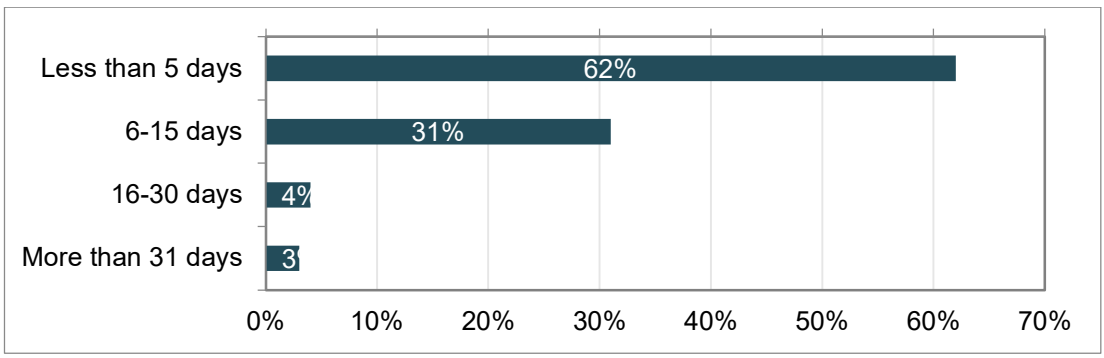

Figure 3 Sick leave days in 2018

4.4 Covid-19 and operational work

The coronavirus disease broke up in the end of 2019, starting from Wuhan, China. Three weeks later, the first patients in Finland were discovered among tourists in Northern Lapland. First, nobody realized what this will mean to the society, then already in February 2020 employers started to draw employees from job sites to their homes to remote work. There was a fear among the people and no information available. The disease started to spread wider and faster, it was also discovered that the disease was inflecting through air and can be infected among people with no symptoms.

Operators in vessel traffic services cannot work remotely from home. Vacations were cut partly, either by the need of the employer or because the employees did not want to have them. Normal life, as seen before was over for a time. When working in safety critical line of business, which is highly controlled by different laws and degrees, it is almost impossible to get more work power if something unseen happens in short period of time. It takes months, to educate a new operator to work independently in vessel traffic service, with all the selection steps and testing, as well as clearances and adjusting the work schemes with the on-job-training operators.

The employer was forced to start weekly meetings to control and to inform employees of on-going state of the arrangement to prevent the virus from spreading within the operational workforce. All visitors were firstly banned from operational spaces and a little later all visits were cancelled. Disinfection was used in operational spaces and operators started to use masks at shift changes and when left the sector desk for general spaces. All workers with respiratory problems were banned from work until negative test results. Stress was seen to arise within the operational workforce and the employer started with the help of occupational health company to give mental guidance and support with varying channels.

In March 2021, the use of masks was extended for all worktime and places, throughout the worktime, with strict regulations for eating and drinking in between. In April 2021, air purifiers were installed in operational spaces to ensure that possible particles of the

virus were killed. In May 2021, the planning of the exiting Covid-19 restrictions stage by stage were launched.

5 SHIFT WORK ERGONOMY

5.1 Legislation for arranging shift work and periodical working hours

The characteristics of working hours are becoming increasingly flexible in all Nordic countries. Every fifth employee, mostly in lower socioeconomic groups, are also working in shifts. Working hours are related to health, work-life balance, and welfare, but they are also associated with socioeconomic differences; timing of work is socially constructed and gendered. (Eurofound, 2015)

Regular work time can be arranged in a way, that it is 120 hours within 3 weeks' time frame. And to make it suitable for arranging, or to refrain inappropriate work shifts, regular working time can be arranged so, that two three weeks' period in a row can include maximum of 240 work hours. Regular work time can never be over 128 hours within one three weeks' period, or 88 hours in two weeks' time within the period. Periodical working hours are acceptable for example safety-, guarding-, monitoring- and traffic management work, in which also vessel traffic services inhere in. (Finlex, Law of work time, 2019)

Regular working hours may be arranged as shift work, where shifts must change constantly. Shifts are considered to change evenly when shifts are on top of each other for maximum of one hour, or apart from each other for one hour. Night work can be arranged for regular working hours in shift work. Employer must give information from the regular night work if the work safety officials request it. In periodical work time, or in continuous shift work, employee can have according to work scheme, five shifts in a row, in which 3 hours is located between 23:00 and 06:00, after that the employee must be given 24 hours solid rest time. Above mentioned shifts can be added

two more in a row if the employee approves them separately. (Finlex, Law of work time, 2019)

Worktime bank is integration system for leisure and worktime, in which earned leisure days, or money-based benefits are altered to leisure time and can be saved or combined. Employee has a right to use saved leisure time of two weeks within calendar year. (Finlex, Law of work time, 2019)

According to Europe Work Conditions Survey in 2015 the beginnings and endings of work shifts changed more as timing of shifts which made it more unregular than in Europe. Shift work was more common in Finland, but night working was as common as in Europe. Long, over 10 hours workdays where more common in Finland than in Europe. (Eurofound, 2015)

Employer in responsible for the workplace safety and health. This demands that the employer is aware of the disadvantages and all the elements of danger. In addition, the employer must take care that the employees have enough knowledge and information to carry out their work safely. Employees must follow the rules and regulations given by the employer and need to take care of the safety of themselves and their co-workers at work. (Finlex, Työturvallisuuslaki, 2002)

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Finnish Institute of Occupational Health has written guidance for the ergonomics of shift work. Shiftwork ergonomic stands for shift alignment in a way which has a supportive effort on employees' well-being. In Working Hours Restriction Act and in Collective Labor Agreement there are protective regulations for employee concerning daily, twenty-four-hours, and weekly resting times. Nightshift has been stated to strain employee physically and mentally more than morning and evening shifts. Also, the amount of consecutive work shifts, and the sequencing can affect to work well-being.

Shift working provides the employee advantages depending on the life situations, inter alia as in increasing free time and additional compensation. Changes in sleep and sleep-wake cycle may affect detrimentally to the social relationships. Irregular work puts more load to the body and sets a lot of challenges to take care of oneself and others around. Working while the body is in sleep mode also makes more stress and is demanding for health (FIOH, 2016)

5.2 Work shift planning

The minimum quantity of operators in every watch at Western Finland's Sea Traffic Center is four operators plus a shift supervisor. There must also be competent operator for every sector of the sea traffic area. In Fintraffic VTS work shifts are planned for six weeks periods. The next period must be locked seven days before its starting date, and after this time, the working time of individual operator can be changed only with the permission of the employee. In case of sudden absence of shift supervisor, and no other shift supervisor available, the head of Sea Traffic Centre will control the operation on-scene and extra operator will be called on duty.

Alterations, to general work shifts calculated for the next calendar year, can appear from other operator's annual leaves either in operators own work shift system or in the opposite work shift system, simulator training, fairway training or any other education compulsory demanded by employer. Generally, only one operator in the shift can be on the annual leave at the time. Usually, the annual leaves are arranged with the shift supervisor according to cyclic order and the possible additional leaves with work shift planner based on date of request and the opportunity to fulfil the shift with an extra operator.

Also, changing of the shifts between operators is possible, with the permission from both shift supervisors, and without compromising the operational safety, and taking care of rest hours between shifts with the possible day/night alterations.

Like recommended in FIOH 2020 recommendations, *"Working hours, health, well-being and participation in working life creating new working time models and solutions for Nordic countries*" employees have the power to adjust and be part of the

planning of work time (FIOH, 2015-2020). This is important for employees' work well-being as well as it is vital for the life control outside of work when planning life ahead with family or pursuit.

5.2.1 Managing shift work

According to FIOH guidance book for shift workers, the most important shift work related health risks are:

- the disturbance of circadian rhythm,
- conducting sleeplessness and daytime tiredness,
- interference of family life and free time,
- degradation of work quality due to tiredness,
- increasing risk for accidents, and
- coronary artery disease and adult-onset diabetes.

To diminish risks and lighten the management of shift work every employee must test many different options and share the information and guidance with other people working in shifts. It is possible to effect on the management by light and sleeping rhythms. By exposing to light and to sleep at the right time shift worker can adjust biological watch synchronising the circadian rhythm. (TTL, 2017)

5.3 Working models in different operating centres

Internationally it is common that operators in monitoring type of work have always wanted to work in longer shifts. The greater the work shift time, the greater the free time. Long periods of leave often increase the motivation to cope with long shifts.

Also, the fact that most operators in the field of e.g., vessel traffic services have worked onboard commercial ships and have got the base for working longer times away from home. Different working models mixed in the centers also mix the crews internally within the shifts which is good counterbalance for forming of coteries. The forming of coteries is a one fundamental problem in shift work and can be an issue in operational safety too.

5.3.1 Western Finland's Sea Traffic Centre

Western Finland's VTS Centre was established in Turku 2012 when four decentralized traffic sectors were combined. Archipelago VTS and Turku Radio were previously located in Pärnäinen (Parainen), West Coast VTS in Mäntyluoto (Pori). Before these centers where combined in Turku, the Bothnia VTS was operated by Finnish Coast Guard and with the resolution from Finnish Transport and Communication ministry in 2011 this traffic sector with all its services was transferred from Finnish CG to Finnish Transport Agency. This decision was made because it was seen that more wide-ranging services was needed to ensure traffic flow and safety in tight coastal fairways. The need for these necessities came from clients using the services. (LiVi, 2011)

When these two centers where combined and more employees where recruited, there was a need to harmonize work shift arrangements. Archipelago VTS together with Turku Radio had operated with shift system 3-3-9 (three nightshifts – three dayshifts – nine days off duty). Whereas West Coast VTS had run by 4-6-4-6 (4 nights – 6 days off – 4 days – 6 days off duty). The 3-3-9 shift working system was well-liked within the operators in AVTS and Turku Radio back in Pärnäinen for many reasons, for example more free time after work period (able to travel for a week without the need of vacation), time together with the employees also between work shifts for sports and hanging out (location was remote from homes), and the food supply line was arranged by employer.

When the VTS center was relocated in Turku, the employer was reluctant to continue this work shift model in a fear of increasing absence rates. The decision was to take the work shift system from West Coast VTS the 4-6-4-6 into use. But it was noticed in early stages that four-night shifts in a row was too hard for operators and a small testing group of operators started to use the backward winding shift model consisting of 2-2-6 work shift pattern (night-night-day-day-six off duty). After the testing period, it was found that this working model was easier to manage for the employees and was taken into use for them all.

There are two different working models in active use at this moment, which are fast forward winding (FFW) and backward winding (BW) models. Currently there are 25 operators working in with the backward winding model and five operators in regular fast forward winding model. Rest of the employees are somewhere in the middle, making both models, in irregular rotation. Some operators are also working partly in Saimaa VTS Centre and one employee has worktime divided between office hours and operative work.

In 2018 five employees started to use fast forward winding work model because increasing difficulties with sleeping, alertness, health or combining family life with the shift work. Also, because there has been more information available for shift workers to understand the consequences of shift work hazards and the multiple ways of coping with them to have the energy to go on throughout the working age and the fact that the pension age is raising all the time in the society.

According to the survey 21 % of the operators felt that DDNN-shift is the best for them and none of those who changed work shift system has shifted back for the anti-clockwise rotation.

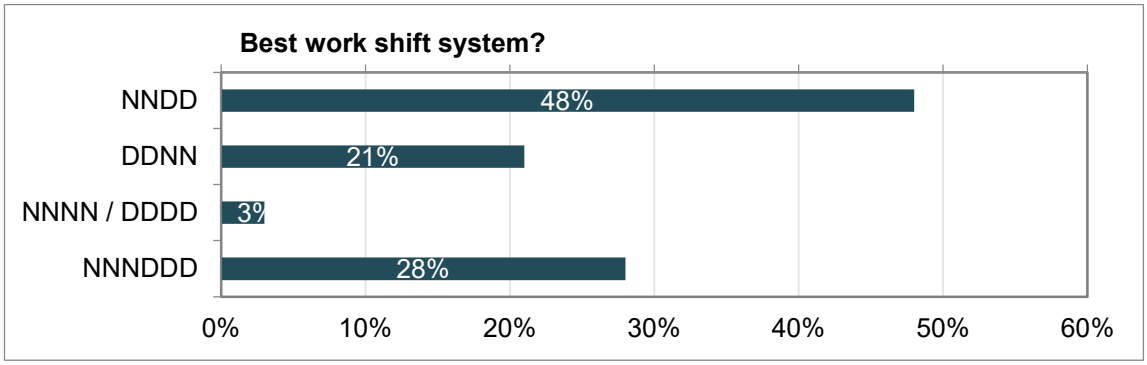

Figure 4. The best work shift system

5.3.2 Gulf of Finland Sea Traffic Centre

The traffic central is located in Sörnäinen, Helsinki, and it is responsible for three VTS sectors from Hanko along the coastline to the Eastern border of Finland. In addition, the Helsinki Traffic, operating and monitoring the Finnish side in the Gulf of Finland Reporting System (GOFREP) between Finland and Estonia is situated in the center.

There are four sectors overwatched, Helsinki VTS 1& 2, Kotka VTS, and Hanko VTS combined with GOFREP. Operators are responsible for the same sector throughout the whole watch excluding the Helsinki VTS 1 & 2, where the operators change inn between because of the unevenly divided traffic density. In the center, the watch manning consists of five operators and one shift supervisor

In the beginning of Helsinki VTS at the end of 1990's the employees operated in three-shift-system with 8-hours work time, consisting of four morning shifts – one day off-four evening shifts – one day off – four nightshifts – seven days off. But it was detected that it was too hard for maintaining alertness and recovering from the shiftwork. This was also because the Port of Helsinki had three-shift-system and half of the employees came to work for the VTS from the Port of Helsinki.

In 2005, 4-6-4-6 work shift system was launched with 12-hours work time (4 nights – 6 off – 4 days – 6 days off), and most operators still work within this system. And in 2015, a possibility to work in 2-2-6 fast forward winding shift system was launched and 10 operators are working in this shift system on permanent basis.

The operators work in shifts starting at 09:30/21:30 and ending 22:00/10:00 due to overlapping. Starting times have been selected according to the rush hours in the previous location of the center in Katajanokka. Nowadays the center operates in Sörnäinen, in joint spaces with Finnish Border Guard.

5.3.3 Saimaa Water Traffic Centre

Saimaa VTS has developed with major steps in last few years. The quality of service for the traffic, enhanced equipment for monitoring and the level of cooperation with all local stake holders has increased the value of operation. The change of employees has changed the character as well. New recruits and cross-qualified operators have the same level of acknowledge for maritime education as the operators in coastal centers.

The work shift planning is more challenging in Saimaa VTS, because nearly all, except two employees, live in remote cities and only come to work on-site. Also, all except one, operators are working permanently in some other coastal traffic center throughout the year for maintaining the competence and this must be taken into consideration by the work planner. Required hours for the sector competences in the main and secondary center must meet with the varying vacations needs and training hours.

When all operators were living near the center, work scheme was DD-OFF-NN. So, operators had one more day free between the change from dayshifts to nightshifts to recover. This system was changed when operators from remote cities came to work in the centers, and DD-NN system was launched in order to cut the time to spend away from home.

In the beginning of 2021, Saimaa VTS started to test 2-2-6 shift system in anti-clockwise rotation, this testing period was reasoned with the remote location of traffic center and easier organization of work schedules. After testing period of six weeks, the anti-clockwise system was taken into use with the decision of the head of the center. All employees were able to reason their own opinion and their stand before the decision was made. Employees feel that it is easier to adapt normal circadian rhythm after work period. Also, that work travelling is easier and will take less time from free time because there is no need to travel to work site a day before the work starts.

Comparing the traffic safety in work travel, after dayshifts it will increase compared to driving after nightshift. The farthest operators come to the center from Turku, 400 kilometers away. Public transport usage is recommended because of the long distances

but the usage of public transport is sometimes difficult because of the 24/7 service range at work. Also, the living in other city usually requires travelling in the city and although Lappeenranta is a small city, it is spread in vast area, so the use of own car is commonly felt easier than using public transport.

5.3.4 Carnival Maritime - Fleet Operations Centers (FOC)

The world's largest leisure travel company, Carnival Maritime, launched a breakthrough technology, in 2017, to monitor its fleet and ship operations on real time basis from Fleet Operation Centers (FOCs). The operational center staff monitors all aspects of navigational safety, weather, and energy management. FOC's are located in Seattle, Hamburg, and Miami. There are over 100 ships included under monitoring (2017).

The advanced system captures thousands of data points for 28 distinct parameters for navigational safety from each ship, and it only focuses on the strategic areas to optimize safety, efficiency, and overall fleet performance. There is a capability to see real-time radar visuals, stability conditions, automation, along with GPS location, routing, ship conditions and weather data. Also, the fuel and energy usage, emissions levels, water, and waste management are monitored. (Maritime, 2017)

The Carnival Maritime Fleet Operations Center operates seven days a week, 24 hours a day. The shift plan is unusual: four day shifts from 08:00 through 20:00 and then four days off, then three-night shifts from 20:00 to 08:00 and another four days off. The staff has specifically requested the 12-hour shifts and this very particular rhythm. Operators come from different countries, e.g., Germany, Poland, Italy, and England. The FOC Hamburg employs 15 experienced mariners, including three women; the required qualifications are nautical training and at least three years' active service at sea, ideally on a cruise ship.

5.4 Research of fast forward vs. backward winding shift work

A human cannot shift its own inner clock according to work shifts because physiological synchronism occurs for the most part according to light changes. Rotation of work shift clockwise, in other words first day shifts then nightshifts, is better for all of those who are suffering of sleeping problems because it is always easier to change rhythm forward than backward. After nightshifts there should always be at least two days off and the period of night-day should be avoided. (Joki, 2010)

Clockwise rotation is generally related to a more positive health effects (Knauth and Hornberger 2003), but employees often prefer anti-clockwise rotation, because of the extra day off (Knauth 2001). Fast forward winding shift work has been confirmed to cause less fatigue and degrade less the quality of sleep than in backward winding shift work. However, the positive effects of clockwise rotation are also questioned (Fletcher and Dawson 2001, Åkerstedt 2003, Spencer et al. 2006).

In a Finnish research by Hakola and Härmä, 2001 *"Evaluation of a fast forward rotating shift schedule in the steel industry with a special focus on ageing and sleep"* for 16 men with middle age of 42 were investigated before and one year after changing from backward winding to forward winding shift work. Questionnaire revealed that the quality and quantity of sleep and the vitality were worse during the dayshift in comparison to evening and nights shifts. After the change in work shifts, subjective sleeping problems decreased, and the alertness increased in the morning shifts especially within older employees. When investigated with actigraphy, older workers sleep efficiency and waking up in middle of the sleep diminished. (Hakola T, 2001) Same matters were researched in following research; *"Effects on health of a change from a delaying to an advancing shift system"* by Barton, Folkard, Smith in 1994 and results were the same. In this study employees reported their symptoms 2 months before and six months after the shift change. (Barton J, 1995)

In controlled intervention study made in Finland the health of air technicians was studied in fast forward and in regular backward winding shift work. According to the study fast forward winding shift work increased especially the length of the sleeping period after night shifts and the alertness and performance during nightshift within the

older operators. Alertness also increased in the off-duty time after night shifts and sleeping problems decreased in all shifts. New system affected positively in both young and ageing operators sleeping, alertness and well-being. (Härmä M, 2006)

When questioned from operators, given answers were predictable. In NNDD-shift the lack of sleep after nightshifts has already diminished into normal during the dayshifts. This is a good rhythm for the employer but in practice it means that the employee is recovering at work time and not in the free time which is usually destined for it.

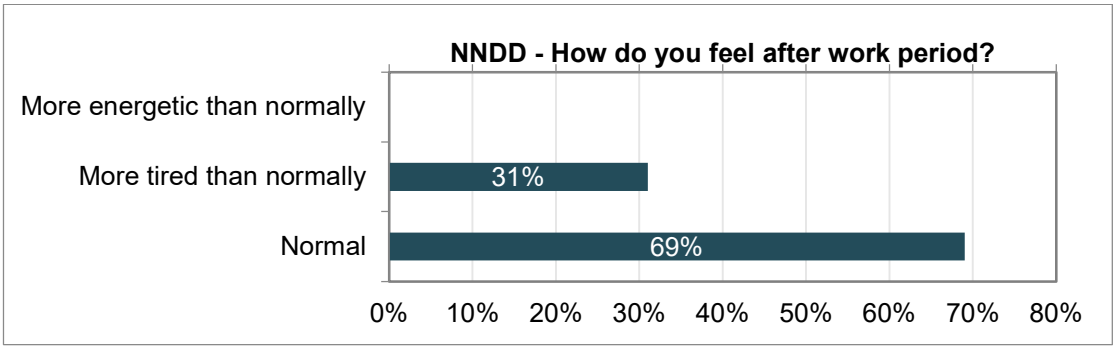

Figure 5 Energy level after NNDD-shifts

Almost 70 % of operators feel normal and only 30 % feel more tired than in free time. The amount of tiredness reveals in the question among the operators in clockwise work shift, after DDNN-shifts operators feel more tired because of the night shifts take about 48 hours of recovery time. Dayshifts, if they are not exceptionally high in work load do not increase the tiredness.

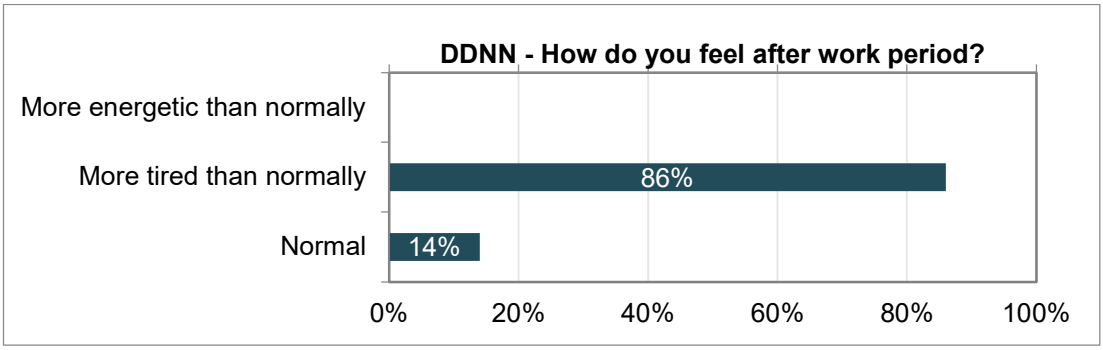

Figure 6 Energy level after DDNN-shifts

It is clear without saying, if employee judges the amount of tiredness after waking up from second night shift, that the tiredness is in higher level than operator evaluating the same tiredness after sleeping throughout the night in right circadian rhythm.

5.5 Length of shifts

It has been studied by the FIOH (Finnish Institute of Occupational Health) in 2016 that 12 hours shifts are preferable for employees and employers than eight hours shifts. Employees sleep better, feel better and recover better. Also, the work satisfaction is better in longer shift because of the long off duty time. In some earlier studies (Son 2009, Sallinen and Kecklund 2010) it has been discovered that long working hours increase the amount of fatigue while working.

Bad psychological well-being appears as weakness, tiredness, stress, overstraining and weakening ability to concentrate (Perkiö-Mäkelä, 2006). According to different studies the performance weakens in in 12-hour shifts and this does not happen in 8-hour shifts. In long shifts, tiredness affects the ability to receive, to handle, and to produce information. The weakening of psychological performance affects to the ability to observe, which is high risk factor in many safety critical work duties. (Hakola T. H., 2007)

Contrary to expectations in the FIOH research responders felt less or same amount of fatigue than in eight hours shift. There are multiple reasons stated for this result, firstly 12 hours shift fast forward winding shift (only two-night shifts in-a-row) minimizes the delay of the 24-hour-period and after that optimizes the recovery for the normal day rhythm during the days off duty.

Secondly, responders in 12 hours shift more often took nap before night duty compared to eight hours shift workers. Short, efficient naps taken before and during the night shift significantly improve the alertness during the nightshift. (Härmä 1989, Sallinen 1998).

In FIOH research employer's perspective was also taken into consideration and found that control of problems was enhanced because the workers had more time to investigate and make up solutions for problems at hand than in shorter eight hours shift. Workers also felt preferable not to leave unsolved problems for the next shift workers. Employers interviewed thought that this matter reflects on decreasing amount

of loss and as a smaller safety risk. According to employers interviewed in the research substitutive workers were harder to find in 12 hours shift inferior to eight hours shift because it was not possible for the worker to stay overtime after own shift. (FIOH, 2016)

5.6 Starting times of shifts

A Finnish study has found that only a third of workers feel that their personal ability to sleep at certain times match the times they need to wake up to get to work. The study found that there is a personal circadian rhythm for everyone and that is in-born. Chronotypes, as the researchers call them, are an individual's ability to sleep at particular times of the day. Schedules for early morning alarms do not suit everyone as well as being up in late evening hours. According to the study, schedules should always be made for people depending on their personal chronotype, but usually the society is generally arranged for morning people. (Alexandra Lahtinen, 2021)

Around 12-14 % of people in the country were found to be more alert during the hours of the evening. That is small amount of people, but it can be that this 12-14% is the majority of workers in a selected working place, because people from the same education background and same working cultures (e.g., ships) have already selected their education according to the work they are going to do in the future.

Starting the morning shift late, for instance, at 07.00 hours instead of 06.00 hours reduces sleeping problems, because the natural sleep rhythm is less disturbed. (Knauth and Hornberger 2003).

In this VTS center, the work starts officially at 8:00 in the morning but usually all operators are on scene by 07:45. Timing is the same in the evening, work starts at 20:00 and new shift is on scene by 19:45. Then there is official overlapping time of 30 min to go through all important events and possible incidents as well as the prevailing traffic situation, and if there are some specialties coming within the next shift or days.

When starting times for shifts were questioned from employees, following answers were given. There is a quite amount of variation but as many investigations tell, starting very early (06:00-06:30) in the morning is not also in the comfort zone for operators. Five operators answered “other”, written answers 40 % at 10:00, 40 % at 09:00, and 20 % answered “present time is good”.

The differences may be explained by the differences in family life stages and circadian rhythms. 51 % of operators would like to change the shift start earlier than at 08:00, this is something to consider for the employer too.

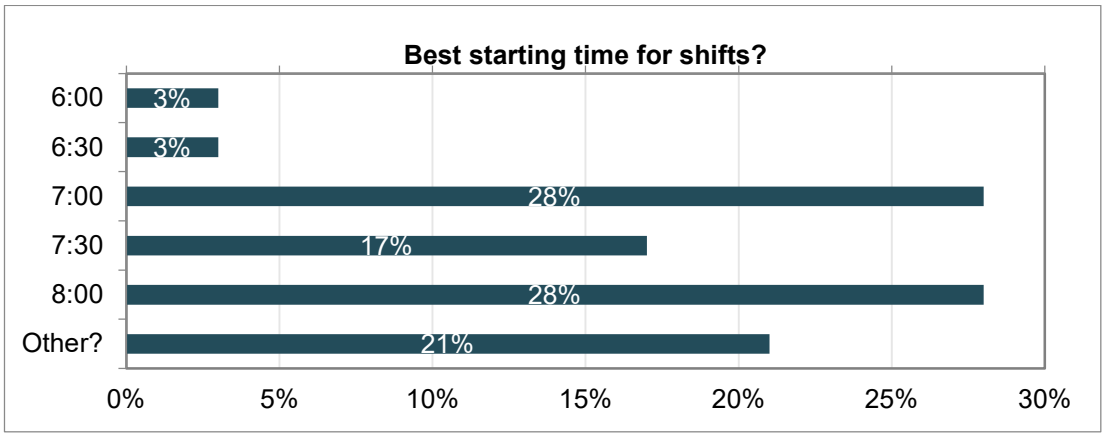

Figure 7 Starting times questionnaire

6 SAFETY IN OPERATION

6.1 Maintaining the alertness and quality of work in long shifts

The most common concerns in 12-hour work shifts are that the employees will not get enough sleep, which will reduce alertness, and could lead to problems with safety and productivity. In a line of work, like vessel traffic services, where work performance is crucial, accidents at work can affect indirectly to thousands of people onboard ships.

According to a pilot study *"Assessment of a new dynamic light regimen in a nuclear power control room without windows on quickly rotating shift workers"* it was revealed that it seems that appropriate dynamic light in rooms without windows during the dark Nordic season may promote alertness, sleep, and better adaptation to quickly rotating shift work. The study was conducted during winter with reduced opportunities of daylight exposure during work, after night work, or before morning work. Results from the wake/sleep diary showed the new light treatment increased alertness during the 2nd night shift. Time of waking was delayed in the light condition after the 3rd night shift but the amount of wake time during the sleep span increased after the 2nd night shift also showing a tendency to affect sleep efficiency. (Arne Lowden, 2012)

When operators were questioned about the tiredness in watch, the results state that over half (55 %) feel some kind of tiredness during the long watch. At the same time 45 % do not feel any tiredness. These results often vary with different conditions as well as at work and off work. Some operators feel tiredness throughout free time and worktime but have adjusted their living so, that it affects as little as possible.

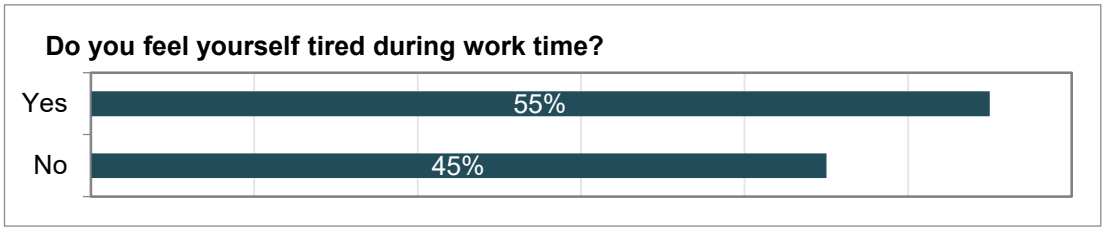

Figure 8 Operator tiredness during work time

There is a variety of different kind of motioning equipment available in the operational space. According to questionnaire standing is the most commonly used way to fight the tiredness and keep the alertness level up. The walking mill has not received any users because of the poor variety of different speed stages and too short walking space.

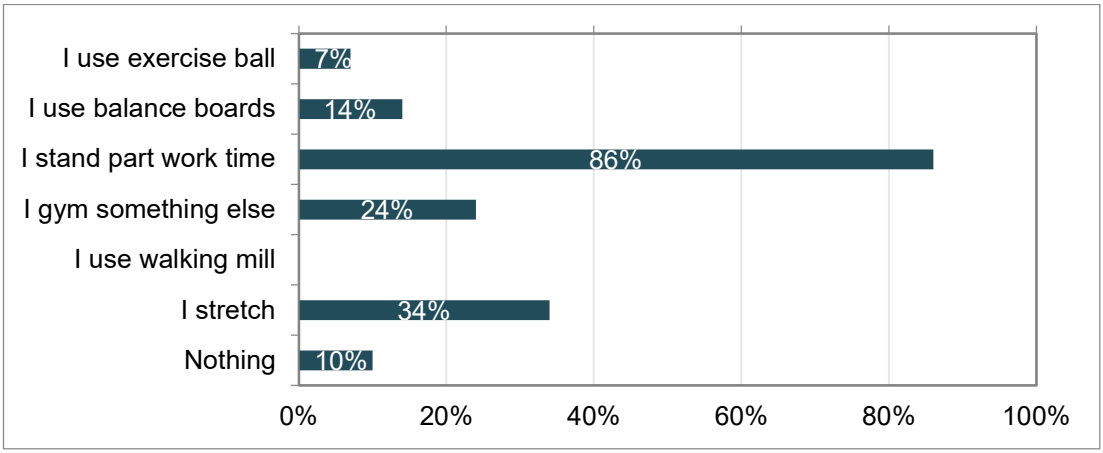

Figure 9 The use of motioning equipment to fight tiredness and to increase alertness

Here were some open answers from operators on how to keep alertness through the watch:

- Drinking coffee,
- switching work postures,
- eating regularly little by little,
- gymnastics on worksite,
- using balance board and stretching,
- socializing,
- using bright light lamp,
- focusing on work duties and
- sleeping before worktime.

Operators have a possibility to take refreshment time for themselves if the current traffic situation and all other operative matters allow during the day and night shifts. This time the sector in hand will be covered by the shift supervisor or extra operator in the shift. Operators are not allowed to leave the premises so many use their refreshment time walking around the building or going to the gym in the building basement. Operators must be ready to be summoned back to the operational space immediately if situation requires so.

6.2 Disturbing factors in focus-orientated work

6.2.1 Differences in solitude level

Majority of operators are used to work independently, in their own peace. There are possibilities to discuss between operators during the watch even though the working space is quite big for five operators. Every operator has about 5-meter curved desk space facing walls and large active screens that demonstrate the sea area monitored. In the latest questionnaire made for operators by employer (Pulssi, 2020) some workers found the volume in conversations between operators distracting from the very focus-orientated work.

In the control room, distances between operators may come long when the sectors are permanently aligned, and the visual contact must be kept to the monitors in the sector. This problem varies highly between different shifts, some shifts are quiet, and some are talkative.

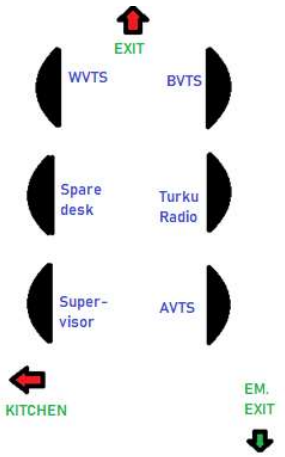

Figure 10 Desk arrangement in VTS Operating Center

6.2.2 Communicational noise

Radio communication through VHF and the usage of loudspeakers in operational desk or in the ceiling in the hall type space is causing problems for keeping concentration in own sector.

The guidelines agreed together state, that unnecessary noise production via loudspeakers is prohibited and all operators should use headphones supplied by the employer. Also, the headphones should be used for the sake of clear radio communication and decreased amount of background noise with ships. The usage of table microphones is terminated in this Sea Traffic Center for this reason too.

Some operators feel that the prohibition of the use of loudspeakers affects in operational safety, because then the traffic on the sector will be monitored only by the operator on-duty and is not overheard by another operators. If operator has a need to leave the sector for a short session, another operator or shift supervisor will listen and follow the traffic in the meantime.

6.2.3 VHF- link coverages

This disturbance is highly exhausting for operative work in some sectors. Radio bulletins from other countries using the same channels and frequencies can by either overheard or just disturbing the VHF-links with carrier waves. One good example is in the Riga Rescue Radio located in Latvia, over 400 kilometers away from Turku, transmitting their sea warnings and daily bulletins in the same channel where Archipelago VTS operates. Sometimes the links can be occupied for 15 minutes and there is nothing that the operator can do about it. Then it is possible to try to tell the ships that there is interference, and some traffic announcements and information has to be done by calling with phone.

The farthest VHF-discussions heard are from the Dover Coastguard operating the traffic in the Dover Strait between England and France, 1600 kilometers away from Turku.

Sometimes, when ship officers are not familiar with the equipment used in VTS, there may be caps in the communication where the operator is discussing with a ship in the other side of the sector with another VHF-link and another ship calls at the same in other part of the sector. It can be that the operator can or cannot hear the calling, depending on the location, ship equipment, weather, and the link the operator has put to active for discussion.

Operator is able the rewind all conversations and callings through the radio system used but still the recordings are made on the most active link and some callings can be unheard. That is why the ship must call the operator again and only with answerback from the operator the ship can trust that the message has gone through. This is called "close loop"-communication and is really important to be understood on ships too. Operators are guided to answer the ship by repeating the message and to use message markers to keep the communication clear and fluent. With close loop communication misunderstandings can be decreased and operational safety increase.

6.2.4 Ventilation and air-condition

The general ventilation in control room is controlled by the complex. There is also ventilation equipment affecting only to control room, but the local operation is not commonly used. The ventilation stage differs depending on the usage capacity of the whole building where the control room is only one small piece, the amount of people in the building and for example from usage of large-scale mechanized catering establishment. At weekends or in nighttime the ventilation formulates draft that affects to some sectors more than others. There has already been changes within workplaces to eliminate draft, but the changes require more information of property ventilation.

Due to Covid-19 virus spread the work safety organization recommended the company to supply air purifiers to the operational space to avoid to the last the need to use masks in operational work. In April 2021, four air purifiers were supplied to the operational space which have been said to decrease sick leaves because of more particles purified from the air, enhanced ambient air improving the mindsight and performance. Every

air purifier unit creates approximately 55 dB light humming sound driven on full power (capacity of 400m^3/h purified air). (Genano, 2021)

6.2.5 Uneven workload

Already back in the 2005 it was researched by Finnish Maritime Authorities, that uneven workload is a problem for VTS operators. Description of one operator when questioned what a busy work shift is, the answer stated "*the one where you can't cook coffee, eat or take a trip to toilet*" which emphasizes the seriousness of the situation. This type of situation cannot be held as acceptable relative to work well-being, because if work shifts like this occur for many days it can be that the rates of sick leaves start to arise.

20 years after the operators still feel the workload differently. Some state that the most intense moments are the most motivating and the other feel them the most stressful. At the same time, if the work shift has been very demanding, operators feel the success rewarding even if they feel tired after the work shift.

Also, the quiet times can be felt as situations in where the work motivation can be decreased. Definitions of which situations are pressing vary between operators. The experience on same kind of situation can differ a lot because of the procedures used, equipment used and at hand, or the skills accomplished by experience. Also, worth considering is the differences in the daily mood affecting every human being.

As in all work the workload experience is always subjective and relative to the situation in hand. In these times when it feels that the index of the work changes all the time and there are more and more people and different stakeholders to look out for, many operators feel that the basic work is jeopardized. In total, the stress level is defined also by the fact that the operator must make the boundaries to her/himself, defining what quality of service is given to each ship and when to interfere to the passage of each ship.

Also, there are more and more duties outside the working time taking away the free time and/or cutting it into pieces which makes it harder to recover from work. At the time of Covid-19, the online meetings have arisen multiple times compared to time before the disease. It has become more than normality that operator has some work outside the work shifts.

According to the research made in the 2005, some of the results are still the same when the factors for increasing workload are questioned. Some problems have been fixed in fifteen years. Below is stated some findings from the old research and if they have been fixed and how.

- ✓ Overlapping work → fixed with new high-tech equipment and software, where all info is at sight at once.
- ✓ Work of which the relevance is unknown (statistics) → statistic is nowadays mostly taken from the data gathered by automatic means. Special super-monitoring sequences are held about twice a year with different themes which increase the amount of reporting work for the operator.
- ✓ Phone calls, especially the ones not applicable for VTS → number of phone calls has reduced because the Pilot Order Centre handles their own traffic normally, VTS only assists if ship has difficulties e.g. with phone equipment at open sea.
- ✓ Equipment failures and disturbances → equipment is updated and has a high standard; some problems arise time to time, but normal operation is failure free.
- ✓ Issues, which demand more time or follow-up during watch → rogue ships, foreign ships, ships with pilot exemptions and using all loopholes available are still a normality in daily operation.
- ✓ Embarkment / disembarkment of pilot → even with the high-tech equipment at hand, all specialties require the undivided concentration of the operator.
- ✓ Liner traffic schedules → easier to follow with the use of equipment
- ✓ fairway crossings → simulation has made the life easier for the operator, as well as the possibility to route vessels one by one to use different fairways in crossings and for that reason the quality of service has increased significantly.
- ✓ Ships not using AIS (Automatic Identification System) → governmental vessels and small tugs doing towages still hold this tick up high on the statistics.

- ✓ language problems → English as working language has decreased workload.
- ✓ VHF-disturbances → Still going strong. Especially Riga Rescue Radio.
- ✓ Quantity of traffic – monitoring area size → some sectors are difficult to handle with large size and a vast number of ships, shift supervisor can assist in need.
- ✓ Winter navigation → IB Net software has decreased the workload significantly.

Also, it was both researched and experienced at work that short increases are not a problem for the operator. Firstly, because of the redundancy in the system e.g., ships can and are obligated to listen also to each other and all the traffic information given in the area and they can discuss without the participation of VTS operator.

Secondly, it was brought up that operator can and must even in critical phase control all excessive issues and move them until further if needed. The situation is of course more susceptibility to risk if the amount of operationally monitored situations grow as well as in the opposite situations where the traffic situation is in good phase and there will be no new traffic for a while. Upkeeping of the situational awareness is felt important and when something critical happens in the traffic the concept of time can be affected, just as in normal life situations (e.g., accidents).

In the quiet phase of traffic, the operator will fill their time with self-picked ways. At the same time, the concentration must be kept in monitors but for example eating is commonly done in the quiet phases. There are many duties for operator in addition with the main duty, monitoring. Some additional duties can distract the operator whole, and the work can be directed in incorrect matters. This includes, for example that stakeholder's do not understand that the service has different levels of quality based on the traffic in the area. When the quantity in operators serving the area does not change according to the traffic situation, the difference comes from the quality. This problem seldomly shows out to the client because the traffic situations are foreseen and delt provocatively if possible. The situational awareness is not done in a minute, so if there is another operator to share the workload, it takes time and effort to change systems for another sector and this means that the whole traffic center must adapt in the new situation.

Therefore the equipment for working must be top of the line, as well as the work shifts safe for all employees. So that the tiredness overall with changing situations in the center will not affect even more to the quality of service given.

6.3 Life control

Definition of" life control" is interesting for its contradiction and paradoxality. Fast conclusion could be that life is controllable. In other case, life is full of uncertainty and unpredictable happenings. Uncontrollability is a global question, because of the fast changes in the environment are felt to be over threatening, the powerlessness starts to increase. In pluralistic societies, human felts more and more exteriority.

Control is the feeling that you can have on impact to your own actions and environment. Divided generally in three sections, controlling of mind (emotions, fears), body (sports, physical exercise, eating, controlled substances) and social relations. The control can be seen in relation with the inner world (feelings, self-esteem, ability, dependency) and outer environment (possibility to influence in work, studies). The key component for life control is coping (means to survive) and to find real, suitable action methods for situations.

Being a human, in different stages of life, means that there is specific amount of energy to share for all the things in the life. Working age is defined in Finland to be from 15 to 74 years. In this time frame many situations in life have a habit change and influence life control.

Combining work and other life is important thing because it affects both in work life and society as well as in induvial and family's overall well-being. Operators have multiple roles outside workplace. In addition to family member, there are relationship roles, free time roles, and possible roles in studying and roles in different organizations. Unbalance between these roles affect health and performance in and outside of the work. (Suomala, 2007)

According to the research for operators, it was found that 55 % of employees have small or teenager children, and 38 % of them are facing the "rush years" where

combining and balancing the life and time between family and work is very tricky. At the same time when the work can be psychologically demanding, employees must have strict control on themselves, to be able to balance with work and family, more often when there are different schedules especially shift work families or sole guardian families. 45 % of employees have no children or children have reached adulthood, nowadays it is not so obvious that Finnish young people move away from their childhood home when reaching the official age of adulthood but stay at home until the age of 21,8 years (Europe average 26,2 years). This means, that even larger number of employees are controlled by the family longer.

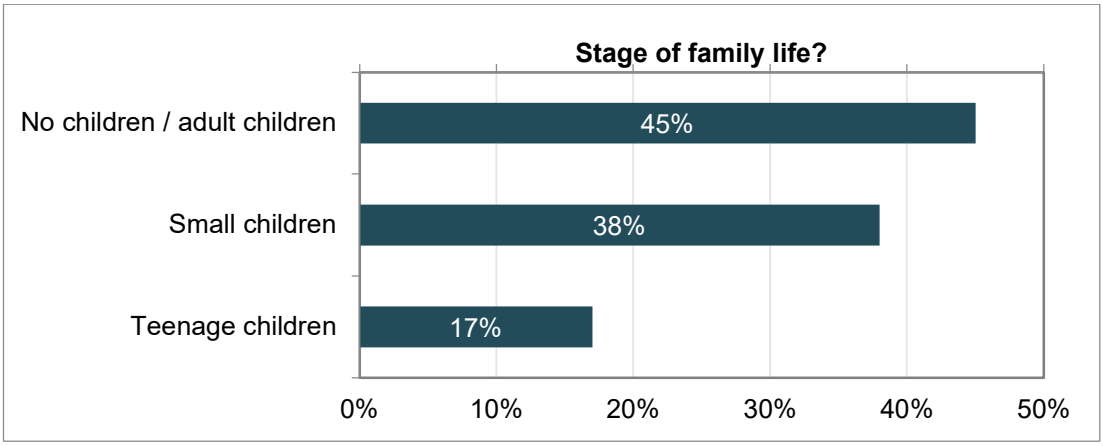

Figure 11 Family life stages of operators

The reality today is not the same as it was 20 years ago. People change, habits change, and work has changed. The stage of family life is not all in all. Nowadays more and more, adults take time for themselves and have hobbies more than ever before. Hobbies take time and increasing amount of time from the free time. Many adults without children or when children have grown to teenagers have taken their own hobbies into new levels, e.g., competing in some sports. So, it cannot be generally calculated, that people with children have less time to recover from work.

6.4 Fitness

According to activity recommendation, to achieve the health benefits of training, adults should do weekly: (UKK-institute, 2019)

- medium cardiovascular load training, at least 2 h 30 min or
- hard cardiovascular load training at least 1 h 15 min and
- training to maintain muscle and motion control, at least 2 times.

When questioned of their weekly activities, operators gave answers that are well above the baseline for the majority of Finns, where roughly only 30 % is moving within the recommended. Employees were also satisfied (median 4,0/5,0) with the employer's contribution to support active life.

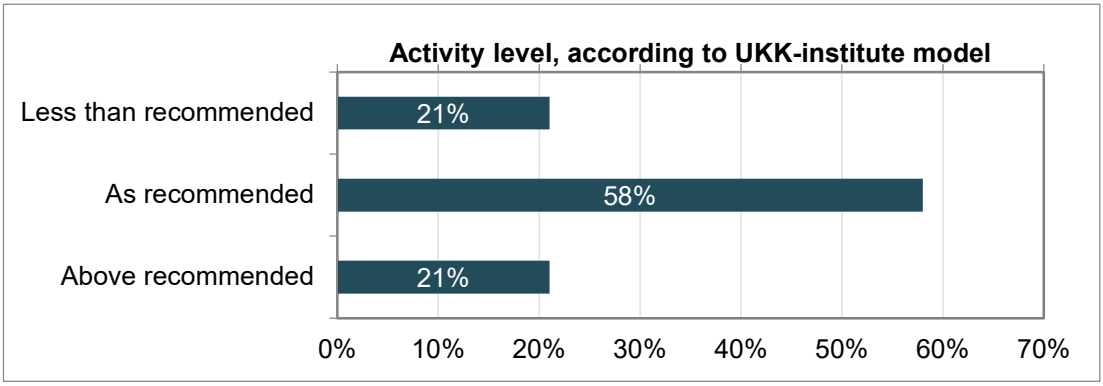

Figure 12 Operators' activity level, according to UKK-institute recommendation

According to the questionnaire, 11 % of operators walk or cycle to work. The median length of work travel is between 6-30 kilometers. Open answers stated that there is a will among the operators to have support in cycling to work. As little thing it is, a personal key to the cycle storage would make a difference in choosing the way of travel to work.

It was discovered through the questionnaire that operators would like to have more common sporting days with different themes, also with other companies and stakeholders involved. Sponsor money for participating in events, personal trainer services, and the return of massage subsidy.

6.5 Nutrition

Eating healthy is very important for everybody. It is crucially important for the shift worker. Lack of energy consumption has been studied to be one of the main issues for shift workers overweight. In addition, there are anomalies in the choosing of food and how the food is eaten. Especially night workers consume more snacks, candies, sugar powered drinks and alcohol than office hour workers. With decreased sleeping quantity, there is a connection for eating few vegetables. Being awake at night and sleeping less than recommended is straight in connection with the need to eat. It is a good idea for the shift worker to strive for 3–5-hour meal intervals. The diet of a shift worker is based on general nutritional recommendations. At night, light meals should be preferred and the main meal should be eaten before 1 p.m. It is a good idea to reduce coffee drinking towards the end of the night shift. The shift worker should pay special attention to the adequate intake of vegetables and dietary fiber, the quality of snacks and the sugar and fat content of the food. Anticipation and menu and snack planning are helpful in implementing a full-fledged and health-promoting diet. The plate model helps to put together a proper balanced meal. Filling half of the plate by vegetables, ¼ with carbohydrates (like potato, pasta, rice) and the final quarter with protein (meat, fish, chicken).

According to questionnaire, operators are on expert level also in eating habits. In contrary to surveys done for shift workers, VTS operators eat well according to Finnish Food Authority (FFA) described plate model, and do not change their habits on eating when at work. Good nutritional choices also help with shift workers' common problem with stomach issues.

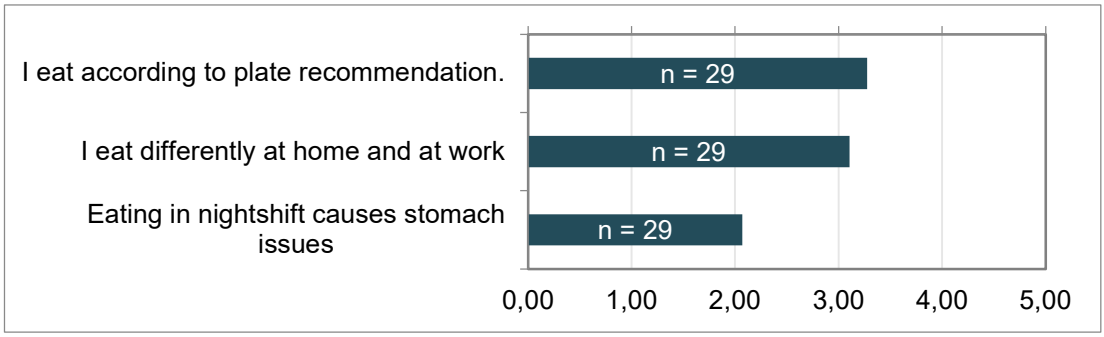

Figure 13 Eating habits and health

7 SLEEP

Brain activity is at its lowest stage while sleeping and the repair of cell damages is most efficient. According to studies brain cleans itself from metabolic waste material and toxins by shrinking brain cells and letting the brain-spinal cord fluids to reach deeper into cell openings which flushes away even more waste material. This cleaning prevents inflammatory diseases and maintains resistance to diseases.

Sleep has multiple tasks for example physical and psychological resting, strength recovery, cell repair, brain energy reserves fill up and their metabolism normalizes. In sleep stage brain resolves problems and emotions subconsciously, prevents stress behavior and deletes unnecessary information.

Sleeping helps the memory, memorizing and learning. In sleep stage cognitive functional ability recovers and memory functions strengthen. Old saying “Sleep is the best medicine” still stands today. According to research made in Germany 2019, where white blood T-cells were studied (those that have a critical effect to the body’s immune response) was observed that the amount of prostaglandin and adrenalin drops when sleeping. Researchers compared T-cells from healthy workers, one group of staying awake all night and the other group who went sleeping normally. Sleeping group had considerable higher level of a certain protein activation compared to subjects awake. T-cells attack their target by gluing integrins in affected cells and killing it, what is less known is which are the signals that dampen the ability for T-cell to attach to the hostile cell. Their research has shown that sleep is one of the most potential matter to strengthen the T-cell activity which influence high prevalence of sleep disorders and other illnesses as depression, stress, aging and shift work.

According to a FIOH study in 2018 the majority of Finns sleep well or fairy well, even though temporary sleeping disorders seem to have become more commonplace, the research results are positive considering the multitude of connections between sleep and general health. (Kaprio, 2018)

7.1 Sleeping patterns

It is very important for a shift worker to take care for healthy living. Having a strong base, created with good choices in life, help shift workers to be more resistant to everyday fluctuations. Every shift needs its own attention, its own rhythm. Enough sleep is individual yet according to studies the typical amount of necessary sleep for a grown-up is from seven to nine hours.

Differences in day rhythms between people are vast and it is mainly because of genetic differences. Highly genetic characteristic is morning-evening-type people. Morning-type of people have earlier day rhythm, and they wake up earlier and go to sleep earlier. Evening-type of people have more sleeplessness than morning-type people, and they suffer more with daytime insomnia too. Their sleep-awake rhythm is more unstable, and they need more sleep than morning-type people. Morning type behavior increases along with the aging process. (Härmä M., 2004)

Modern digital technology can assist in studying your own sleeping patterns. When monitoring sleeping digitally, it can be observed if the time used for sleeping is slipping into too short. Sleeping data can help make better decisions throughout the day, because it can be seen in sleeping data how for example different type, amount, and intensity training affect to sleeping as well as different nutritional choices. Activity trackers, smartwatches and rings follow sleeping by movement and pulse. When laying down still, equipment registers sleeping and when moving it observes being awake. Smart electronics tell the time of falling into asleep, waking up time, the quality and quantity of different sleeping stages (rem, deep, shallow, interruptions). Some equipment gathers vast amount of data and give feedback on sleeping and advice to make sleeping and sleep preparing better.

The WOW research has given support in between the exposure to night shift work and several acute and chronic conditions such as the increased risk of fatigue and insomnia, occupational injuries as well as short and long sickness absence and disability pensions. They found mixed results regarding the association between night shift work and breast cancer, mortality and dementia, and no support for an association between night shift work and prostate cancer. (Mikko Härmä, 2020)

7.2 Shift rotation change survey

To understand the sleeping pattern of an individual shift worker in different shift systems with the help of modern digital technology, piece of research was made with the material gathered from Polar® smartwatch. For background information, subject is in mid-forties, no children, competitive athlete. To keep the findings more accurate, material was gathered during the same season, because the amount of light has a great relevance when living in areas with less sun.

First study period was from January 2020 to April 2020 when the subject of study was working in NNDD-shift system. Sleeping rhythm is seen in Pic. 13. Days off the work and nights between dayshifts are between 23:00 and 06:30, are giving sleep for approximately 7,5 hours. When looking closely for the sleeping during the nightshifts, the amount of sleep is significantly lower from 09:00 to 13:00, giving sleep for approximately 4 hours.

Empty lines on the paragraphs state that the amount of sleep has been less than four hours on that day and the smartwatch refuses to calculate resting time as sleep if so. At the period chosen for this study, the subjective had 19 nightshifts of which according to data only 7 gathered data for sleeping. The reality is that after second nightshift the rhythm must be changed to get sleep in the evening and according to the questionnaire given to all operators, it was seen that the amount of sleep is usually restricted after second night to approximately 3-6 hours (Pic 23).

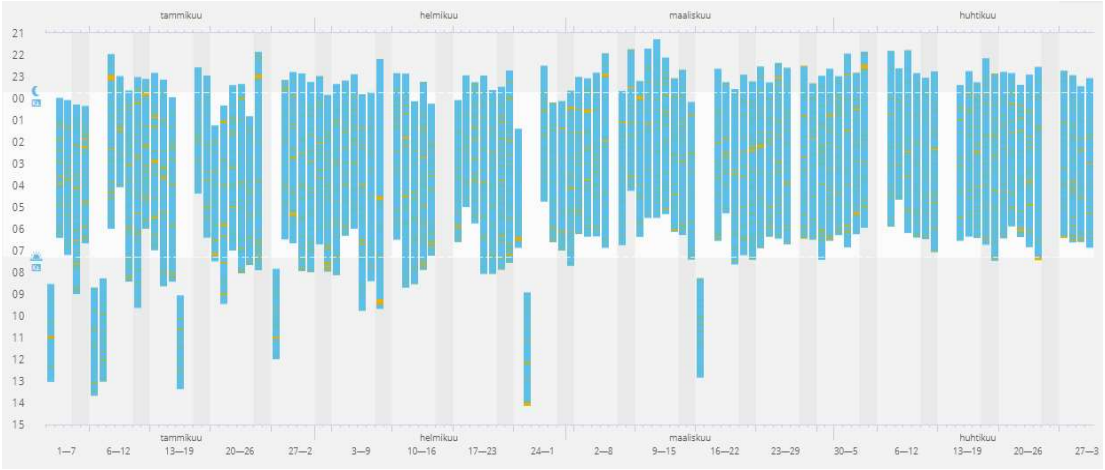

Figure 14 Sleeping rhythm: 1-4/2020 – shift rotation NNDD

Subject of research experiences the strain demanding but recovery under off days is adequate to start another 4 days working period without sleep deprivation. Combining sleep rhythm and cardiovascular system load is showing that the area of variation in training is strong (Pic 14.) Red lines indicate training impulse (a method for quantifying aerobic training load), light blue wave for the tolerance and lilac for the exertion.

As in many sports, also in triathlon, the competitive season for athletes in the north is usually the summer, and the training loads start to increase in springtime. The change between long low range training changes to more exhausting training depending on the season goals. Also, when training changes from in- to outside, the quantities have a habit to rise if not tracked properly.

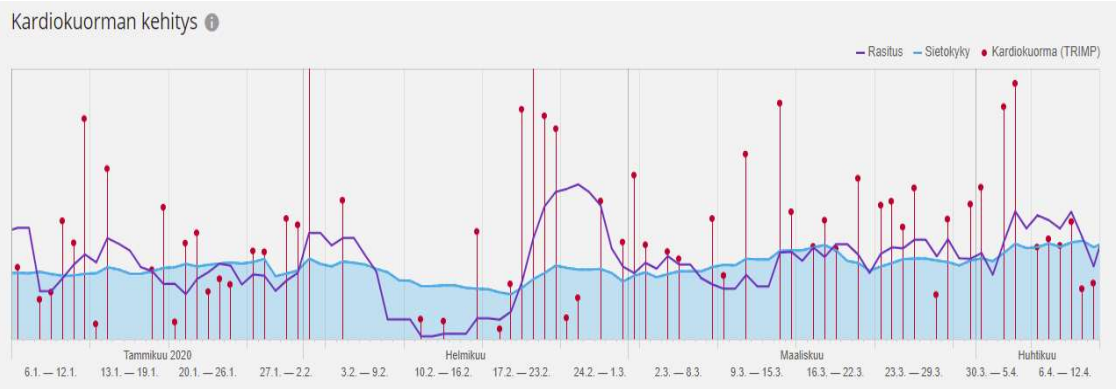

Figure 15 Cardiovascular system loads: 01-04/2020. 104 exercises (118 hours).

Subject of research changed to DDNN-shift system on a permanent basis in December 2020, in order to have more energy throughout the working period. Subject had tested the DDNN- system in varying occasions throughout summer and autumn in two different traffic centers.

Same number of nightshifts between January 2021 and April 2021 as researched in 2020. 7 nightshifts with gathered data, same as in NNDD-system (Fig. 14). Days off and dayshifts show a good amount of sleep in the nighttime within the sleeping scale from 23:00 to 07:00. Sleeping after first nightshift usually is more than 4 hours and after second nightshift less than 4 hours.

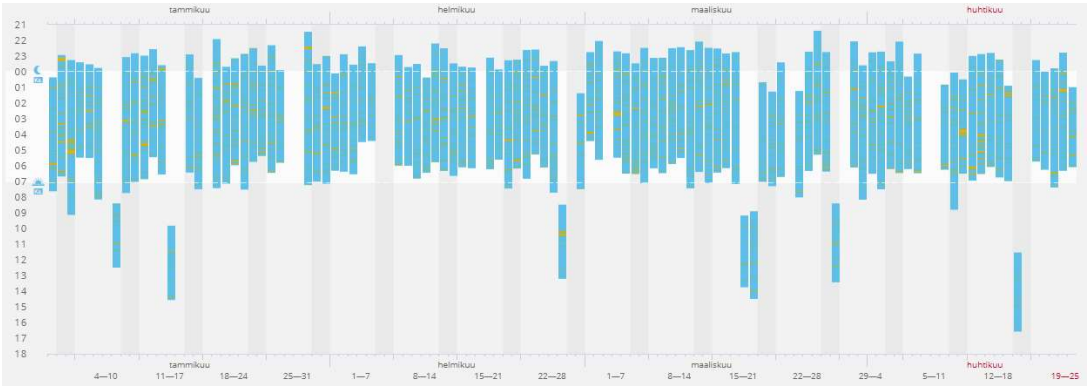

Figure 16 Sleeping rhythm 01-04 /2021 – shift rotation DDNN

The considerable difference can be seen in the change in cardiovascular systems loads. The subject experiences less fatigue through the researched period. The upward trend with the consistent tolerance and exertion, together with no high or low peaks in the graph, clearly state that the well-being in life combining work and sports has develop for better.

The quantity of training has risen from 118 hours to 179 in (61 hours) in the same period which is a significant change and in numbers stands for the training time of one month extra in given period in comparison of the year 2020.

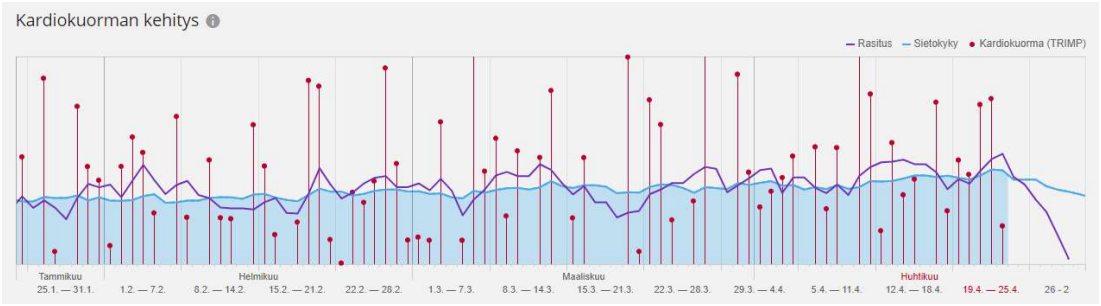

Figure 17 Cardiovascular system loads 01-04 /2021. 136 exercises (179 hours).

7.3 Dayshifts

According to studies in shifts starting in the morning its crucial to concentrate to ensure early bedtime. The biggest challenges are usually involved in sleeping, the lack of sleeping quantity is usually because of the late bedtime. It is advised that sleep should be given its value, evenings should be quietened down by avoiding the use of phones, tablets, computers, and television because of the blue light at least one hour before going to bed. Blue light reminds daylight in its wavelength and exposure for it in the evening time might affect in the production of sleep hormone melatonin, hampering to fall asleep, and diminishes the quality of sleep. To help the body to wake up early the bright light therapy lamp can be used or exposure to daylight instantly after waking up.

According to research, operators sleep within the FIOH recommendations before the first dayshift (of two) in both shift systems. There is a slightly greater amount of sleep in DDNN-system, this can be a result of normal sleeping pattern before of the start of the first dayshift, when in NNDD-system the first dayshift is after two nightshifts and a rhythm change.

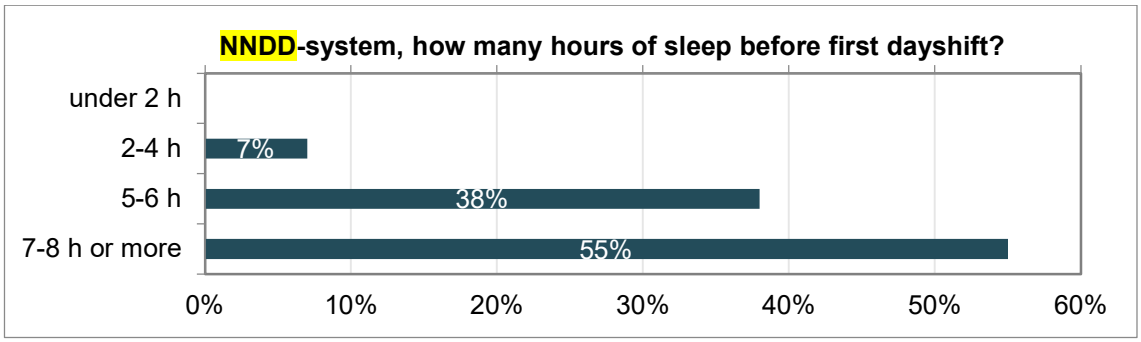

Figure 18 NNDD-system, how many hours of sleep before first dayshift?

Operators have a varying sleeping patterns before the first dayshift, which can be a result of different sleeping pattern after second nightshift and the need of changing the rhythm.

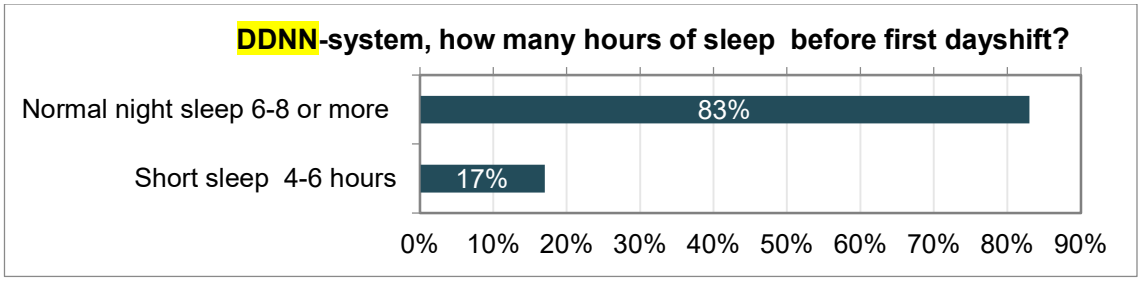

Figure 19 DDNN-system, how many hours of sleep before first dayshift?

This question reveals clearly that the work period is started usually with good night sleep and the change can be understood with the regional variation of operators living places (those who live further, have to leave to work sooner). After the second dayshift the pattern seems quite same as before first dayshift. The majority of operators sleep more than six hours. Operators in the DDNN- system sleep even longer. Operators can sleep and recover sufficiently after nightshifts in NNDD- shift system.

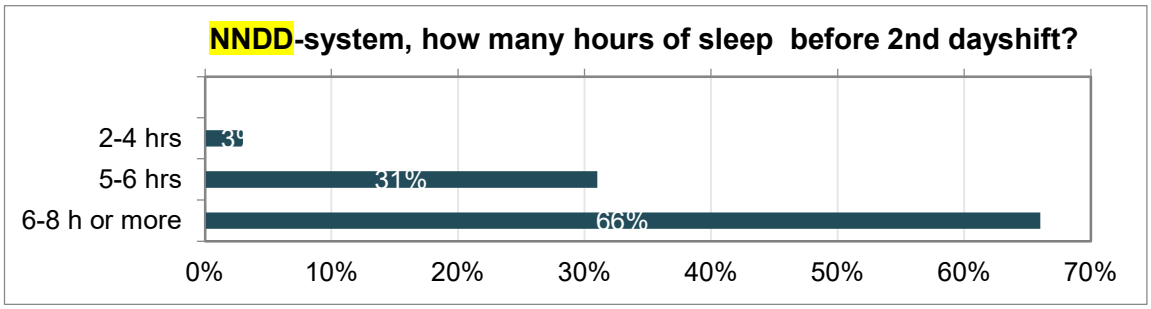

Figure 20 Sleeping pattern before 2nd dayshift in NNDD-shift system.

In the DDNN-shift system operators sleep well between the dayshifts. This is normal because the circadian rhythm is not changing, and the body does not need to adapt for any sleep time changes.

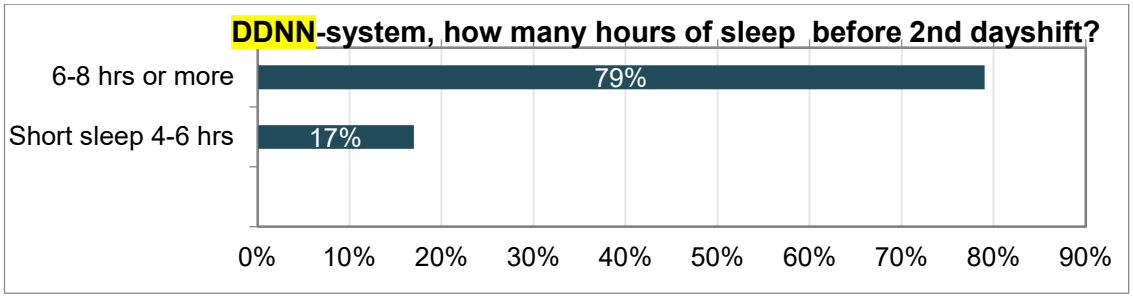

Figure 21 Sleeping pattern before 2nd dayshift in DDNN-shift system.

7.4 Nightshifts

According to the questionnaire for operators there was quite vast deviation on how they prepared themselves into nightshifts. This is the part which defines a lot in the managing for the whole working period. How to sift the head from free time to work mode? To prepare to be awake whole night, alert and focused on a job which stipulates a lot of attention in cases and sometimes demands nothing but being present all the time, ready to act if necessary. Almost half of the operators wake up early in the morning and nap before night work starts at 20:00. According to FIOH recommendations to night workers this is a good way to prepare for nightshifts. Also, exposure to bright light in the beginning of the nightshift and avoiding bright lights (or the sun) after nightshift can have extensive influence in managing the nightshifts. There are no noteworthy differences between different the shift systems. (FIOH, 2016)

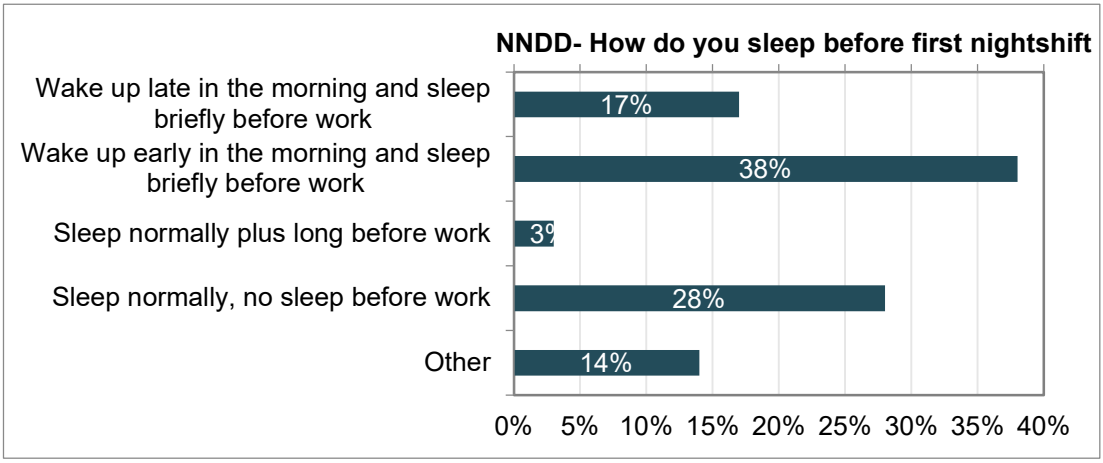

Figure 22 Sleeping before first nightshift in NNDD-shift system.

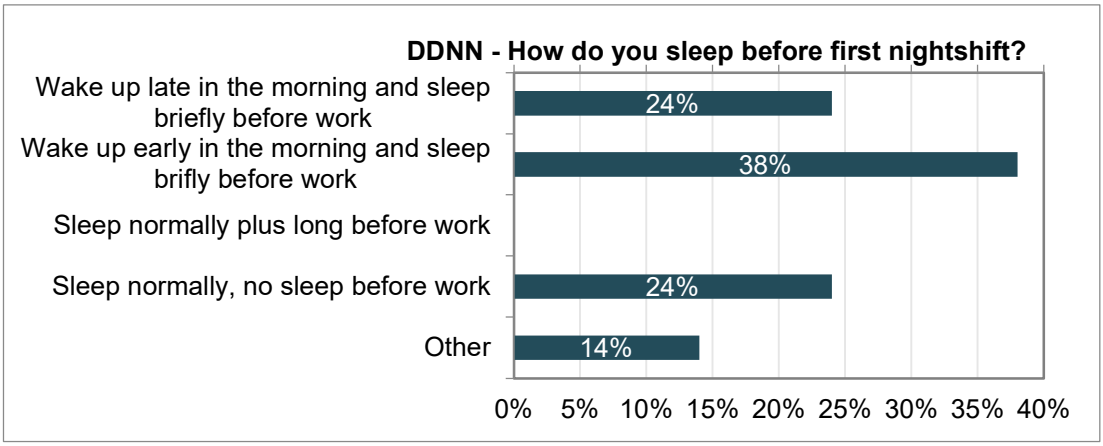

Figure 23 Sleeping before first nightshift in DDNN-shift system.

Also, when it comes to sleeping between the two nightshifts, operators tend to act according to prevailing recommendations for shift workers. Normal amount of sleep (which comes naturally) and then nap before work time starts again.

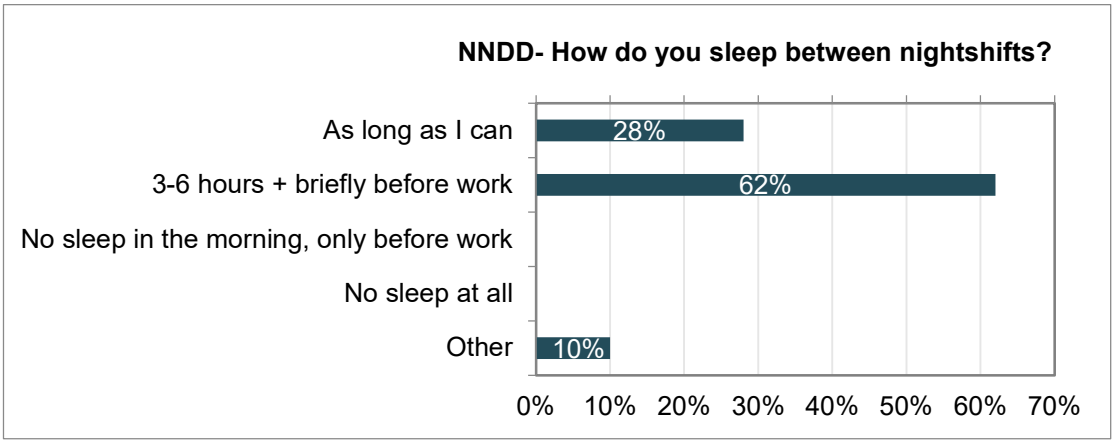

Figure 24 Sleeping pattern between two nightshifts, NNDD-system

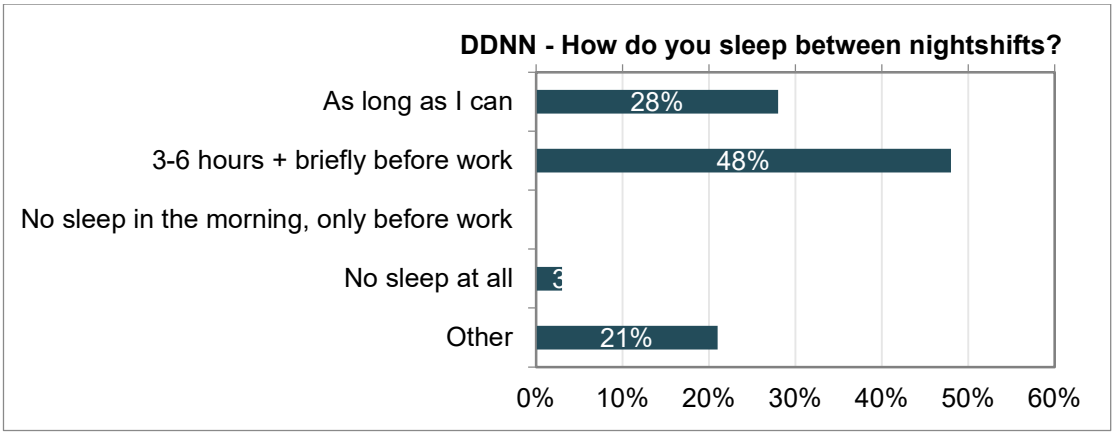

Figure 25 Sleeping pattern between two nightshifts, DDNN-system

The WOW research has given support in between the exposure to night shift work and several acute and chronic conditions such as the increased risk of fatigue and insomnia, occupational injuries, rheumatoid arthritis, type-2 diabetes, hypertension, miscarriage, and hypertension and preeclampsia during pregnancy, as well as short and long sickness absence and disability pensions. They found mixed results regarding the association between night shift work and breast cancer, mortality and dementia, and no support for an association between night shift work and prostate cancer. (Mikko Härmä, 2020)

7.5 Shift Worker Disorder (SWD)

According to newest research of Helsinki University and Finnish institute for health and welfare, about 20 per cent of people working in shifts suffer from sleeping disorders caused by wrong shift working systems. It was found that workers with sleeping disorders do not recover fully in their off-duty days and more than 50 % can be tired throughout the free time period. The importance of understanding and recognizing the causes of insomnia were highlighted because there can always be underlying illnesses, life situations or stress at work or at home which can influence the sleeping. The study also found that people with SWSD were less relaxed before bed, took longer to fall asleep and had a lower quality of sleep than those who did not have the disorder. (Alexandra Lahtinen, 2021)

SWD is related to disturbed sleep and alertness in association with both morning and night shifts, and to shorter compensatory sleep on days off. Those vulnerable to shift work are also sensitive to other sleep-related complaints like restless legs syndrome, headache, and migraine. An intervention study in OHS showed similar sleep improvements both after cognitive behavioral therapy for insomnia and short sleep hygiene control intervention among shift workers with insomnia. The preliminary results of an intervention study indicate that strong light boosts in the beginning of night shifts promote alertness. Earlier studies show that scheduled exposure to bright light will facilitate the adaptation of the circadian rhythm. Most of the earlier studies involve simulated night work, but also a few field studies are encouraging. There is also some earlier evidence that methods are an effective way to treat SWD. (Bjorvatn B, 2020) Being alert to excessive sleepiness or insomnia in shift workers may prevent occurrences and accidents that can happen because of shift-worker disorder. Not all shift workers develop SWD. Identification of sensitivity to shift work may be facilitated by asking workers whether they find it difficult to function in the absence of consolidated sleep, prefer to be active early in the day, or have previously experienced insomnia due to sleep challenges. (Drake, 2010) Difficulties in attaining appropriate shifts in circadian phase, in response to night work, may explain why some individuals develop SWD. (Medicine, 2003)

8 CONCLUSIONS

Safety is the most essential objective in vessel traffic service. To gain the highest level in safety, operators must be able to keep alertness in high level at all times through the long night- and dayshifts. The main research questions for this thesis were to find out how the employees found the exertion of the prevailing shift system and how the change had affected on a single employee changing the shift system from anti-clockwise to clockwise shift system.

As per results given in questionnaire, 70 % of operators felt normal exertion after the end of NNDD-shift period and 30 % felt more tired than normally. In opposite shift system of DDNN 86 % of operator felt more exertion and energy level fall and only 14 % felt their condition normal. It is clear that operators have less exertion after NNDD-shift system but because the exertion level is equal in the working period, it is a known fact that the operators are more tired at work in NNDD-shift system.

Because of different life stages, different circadian rhythms, and life in all, it is crucial that the employer has the opportunity and will to offer different type of shift working systems to the operators, in order to maintain work well-being and thus the sick leave rates stay in low rate and the operators do not get overexertion from additional shifts.

51 % of operators want to change to starting time to earlier from the present 08:00 for either 07:00 or 07:30. Only 17 % want the shift to start later between 09:00 and 10:00.

The change of shift system for a single employee from NNDD to DDNN gave results in accordance with multiple researches done for the exertion level downturn when changing from counter- to clockwise shift system. Sleeping pattern was enhanced for longer time between the end of past work period until the start of the next work period, and the cardiovascular loads were increased at the same time without the exertion level to rise.

Differences between operator’s life situations, age, location, and health make shift systems fit dissimilarly, and it is important that the employer is able to offer different

shift system possibilities for operators in order to ensure work bell-being and through that the safety level in operative work increases. The employer has committed on high level for the work well-being and the employees agree it according to questionnaire.

While conducting this thesis, the opposite views, both for the research and for the need of changing the shift work system arise among the operators. Strongly within the operators with different personal opinion from the thesis writer. At the same time those, who had already changed their shift system match with the writer felt a strong need to have this discussion out in the open.

Operators in different shift systems feel they are treated unevenly, and this applies in both ways. Those who work with the majority of operators in NNDD-shift system feel that all operators should work in same system because there is uncertainty involved with every operators' work scheme due to vacations of an individual operator. At the same time those working in DDNN-shift system feel "left outside" when they do not have a permanent watch and the shift supervisor is changing three times in under one work shift period. It takes a lot more focus to keep the issues outside the operational work running, than with NNDD-worker who has the shift supervisor doing the matters for the worker.

Challenges in writing this thesis were in managing the work well-being and understanding the different situations among all operators affecting the need of some specific shift work system and separate the need of specific system from what is best according to the health of operator.

This thesis has been produced under three years' time frame. A lot has changed in between the start and end point. Operators have changed due retirements and point of views in the correct work shift system available has changed in both ways. New studies have been made about shift work systems but still there is no absolute right system for everyone.

9 CONSIDERATION

The work of VTS operator is unequally loaded. There are shifts where it feels there is no time anything extra, including eating. This type of situation cannot be considered as acceptable, and if there are many of these shifts in a row, it can influence sick leave statistics. Operators feel the change of working load differently, some feel that high workload is motivating whereas other can feel it stressful. Also, the lack of workload is heavy to bear sometimes because the alertness and motivation must be kept in high level throughout the shift.

Like all humans, operators have different days with different moods and, the differences in life stages take energy from the prevailing work. Therefore, every operator must be true to itself, listen to the body and mind to find the real balance between work and leisure time. When the employer is responsible for the employee to maintain good working conditions and safety at workplace, so does the employee have the responsibility to work with high level of motivation and without risking the employer reputation or safety in operations.

The watershed in this thesis is the result in exertion after work period, where most of the workers state, that they feel more exertion after DDNN shift system than in NNDD shift system. This is a reasonable answer to be caused by night shift recovery being handled already during dayshifts and not such as in DDNN-shift system where the recovery from the nightshifts is completed during leisure time. The question staying in the air is, is it employer or the safety of operation, which suffer from this? Leisure time is normally meant to be for recovery from the work period, not the work time. But in order to keep work well being in high level, the employer must take this risk and trust the employees to handle the exertion so, that it does not influence on the operational safety.

For future, the leadership in operational safety affecting and the general procedures for maintaining alertness in operative work should be evaluated and researched in order to get new and enhanced safety precautions for the safety critical work.

REFERENCES

Alexandra Lahtinen, A. H.-H. (2021). *Differential DNA methylation in recovery from shift work disorder.* Helsinki: THL.

Arne Lowden, T. Å. (2012). Assessment of a new dynamic light regimen in a nuclear power control room without windows on quickly rotating shiftworkers--effects on health, wakefulness, and circadian alignment: a pilot study. *Chronobiology International.* Stockholm: Stress Research Institute, Stockholm University.

Barton J, F. S. (1995). *Effects on health of a change from a delaying to an advancing shift system.* Work Stress.

Bjorvatn B, J. H. (2020). Working hours, health, wellbeing and participation in working life. Current knowledge and recommendations for health and Safety. WOW Symposium, Espoo Finland.

Devoe, D. R. (1979). *New Orleans Vessel Traffic Service Watchstander Analysis*. Retrieved from https://rosap.ntl.bts.gov/view/dot/10729

Drake, C. L. (2010). The characterization and pathology of circadian rhythm sleep disorders. Sleep Disorders and Research Center, Henry Ford Hospital, Detroit, MI, USA.

Erik S. Musiek, M. B.-E. (2018, Jan 29). Body clock disruptions occur years before memory loss in Alzheimer's. *JAMA Neurology*.

Eurofound. (2015). *European Working Conditions Survey (EWCS)*. Retrieved from https://www.eurofound.europa.eu/surveys/2020/european-working-conditions-survey-2020

Eurostat. (2019). *Main place of work and commuting time - statistics*. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Main_place_of_work_and_commuting_time_-_statistics

Finlex. (2001, 12 21). *Työterveyshuoltolaki*. Retrieved from https://finlex.fi/fi/laki/ajantasa/2001/20011383

Finlex. (2002, 08 23). *Työturvallisuuslaki*. Retrieved from https://www.finlex.fi/fi/laki/ajantasa/2002/20020738

Finlex. (2019, 07 05). *Law of work time*. Retrieved from Finlex: https://www.finlex.fi/fi/laki/alkup/2019/20190872#Pidp447355536

Finlex. (2019, Heinäkuu 05). *Työaikalaki*. Retrieved from https://www.finlex.fi/fi/laki/alkup/2019/20190872

Fintraffic. (2020). *Annual report 2020*. Retrieved from https://www.fintraffic.fi/sites/default/files/2021-03/annual_report_2020.pdf

Fintraffic VTS. (2021). Retrieved from https://www.fintraffic.fi/en/fintraffic/fintraffics-vessel-traffic-services-brief

FIOH. (2015-2020). *Working hours, health, well-being and participation in working life (WOW) – creating new working time models and solutions for Nordic countries*. Retrieved from https://www.ttl.fi/en/research-and-development-projects/wow/

FIOH. (2016). *12 tunnin vuorojärjestelmien turvallinen ja työhyvinvointia edistävä toteuttaminen.* Helsinki: Finnish Occupational Health Department.

FTA. (2005). *Alusliikenneohjaajan työn ja työympäristön kehittäminen.* Helsinki: Merenkulkulaitos. Retrieved 05 17, 2021, from https://julkaisut.vayla.fi/pdf5/mkl_2005-13_alusliikenneohjaajan_tyon.pdf

Genano. (2021). *Safer ambient air to offices*. Retrieved from https://genano.sterly.io/

Hakola T, H. M. (2001). *Evaluation of a fast forward rotating shift schedule with a special focus on ageing and sleep. .* Tokyo: J Hum Ergol.

Hakola, H. H. (2007). *TOIMIVAT JA TERVEET TYÖAJAT.* Helsinki: TTL.

Hakola, T. H. (2007). Toimivat ja terveet työajat. Helsinki: Työterveyslaitos.

Härmä M, T. H. (2006). *A controlled intervention study on the effects of a very rapidly forward rotating shift system on sleep-wakefulness and well-being among young and elderly shift workers.*

Härmä M., S. M. (2004). *Hyvä uni – hyvä työ.* Työterveyslaitos.

IMO. (2019). Retrieved from https://www.imo.org/en/OurWork/Safety/Pages/VesselTrafficServices.aspx

Joki, E. (2010). *Esimiehen käsissä työyhteisön hyvinvointi ja tulos.* PSYCON.

Journal of Obsessive-Compulsive and Related Disorders, vol 18. (2018). In C. J. M.E.Coles, *Journal of Obsessive-Compulsive and Related Disorders* (pp. 25-30). Binghamton, NY 13902-6000, USA: Department of Psychology, Binghamton University.

Kaprio, C. H. (2018). Changes in sleep quality with age–a 36-year follow-up study of Finnish working-aged adults.

Leena Salo-Gunst, Anneli Vilkko-Riihelä. (2004). *Psyyke, kertaajan opas.* Helsinki: WSOY.

Liikenne- ja viestintäministeriö. (2005). *Alusliikennepalvelulaki.* Helsinki.

LiVi. (2011, 4 26). *Alusliikennepalvelulain muutos*. Retrieved from https://mb.cision.com/Public/MigratedWpy/92454/9113544/a20b02dc868d7e62.pdf

Maritime, C. (2017, 03 13). *Global Fleet Operations Centers*. Retrieved from https://www.carnival-maritime.com/fileadmin/user_upload_carnival_maritime/Presse/NR_--_Carnival_Corp_Announces_Global_FOCs_--_FINAL_--_For_Distro_on_3.13.17.pdf

Medicine, S. o. (2003). Occupational Medicine, Vol. 53 No. 2. In T. Åkerstedt, *DOI: 10.1093/occmed/kqg046* (pp. 53: 89–94). Society of Occupational Medicine.

Mikko Härmä, K. K. (2020). *Working hours, health, well-being and.* Retrieved from CURRENT KNOWLEDGE AND RECOMMENDATIONS FOR HEALTH AND SAFETY: http://urn.fi/URN:ISBN:9789522619129

Musiek, E. S. (2018). Body clock disruptions occur years before memory loss in Alzheimer's. *JAMA Neurology.* Washington University in St. Louis.

Oikotie. (2019). Retrieved from https://tyopaikat.oikotie.fi/avoimet-tyopaikat/alusliikenneohjaaja/1392772

Perkiö-Mäkelä. (2006). Työ ja terveys.

Sallinen M, K. G. (2010). *Shift work, sleep, and sleepiness - differences between shift schedules and systems.* Scand J Work Environ Health.

Sampsa Puttonen, M. H. (2010, 01 20). Shift work and cardiovascular disease - pathways from circadian stress to morbidity. *Scandinavian Journal of Work, Environment & Health*, pp. 96-108.

Suomala, L. K. (2007). Työ ja ihminen. Kuormittuneisuus. Helsinki: THL.

Traficom. (n.d.). *Maritime Certification*. Retrieved from https://www.traficom.fi/en/transport/maritime/maritime-certificates-competency

TTL. (2017). *Hyvinvointia vuorotyöhön.* Helsinki: Työterveyslaitos.

UKK-institute. (2019, 10 21). *Adult activity recommendations*. Retrieved from https://ukkinstituutti.fi/liikkuminen/liikkumisen-suositukset/aikuisten-liikkumisen-suositus/

van Amelsvoort LG, J. N. (2004). *Direction of shift rotation among three-shift workers in relation to psychological health and work-family conflict.* Scand J Work Environ Health.

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