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The cost of repatriating ill seafarers: A micro-costing approach

Danish title:

Omkostninger ved repatriation af syge søfarende: En mikroomkostnings undersøgelse

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Preface

This thesis has been written as the final part of the master program in Public Health at the University of Southern Denmark.

I would like to give a special thanks to my primary supervisor senior researcher at the Centre of Maritime Health and Society (CMSS), Despena Andrioti, for inspiration to the thesis subject, the main methods and always being available during the writing process. I would further like thank my co-supervisor medical doctor and senior researcher, Olaf Chresten Jensen (CMSS), for his engagement and valuable knowledge regarding the medical diseases of merchant seafarers. Likewise, I would like to thank my other co-supervisor post.doc, Lulu Hjarnø (CMSS), for providing the data from the databases of the Danish Maritime Authority and Radio Medical Denmark and for the help to make the final adjustments.

ABSTRACT

Introduction: Seafarers are an essential workforce for the global economy and around 1.5 million people are employed as seafarers. Seafarers suffer from a worse health state than the general population, and the remote nature of their workplace makes seafarers an especially vulnerable workforce. Seafarers are protected by international regulations stating that the employers must pay all expenses in relation to repatriation of ill seafarers. The objective of this report is to estimate the costs of repatriation based on four case diagnoses.

Methods: For each of the four case vignettes, the costs of repatriation were estimated applying a micro-costing local approach with an employer perspective. The four case vignettes are: I) Acute myocardial infarction (AMI), II) Malignant hypertension, III) Appendicitis and IV) Malaria. Direct cost data were derived from records at the Danish Maritime Authority and Radio Medical Denmark. Indirect costs include the costs of the loss of productivity, the costs of recruiting and training new personnel, which was estimated using the friction cost approach.

Results: The average total costs of repatriation for the four case vignettes were; AMI (98,823 EUR), Malignant hypertension (47,597 EUR), Appendicitis (58,639 EUR) and Malaria (23,792 EUR). The variations in the average total costs of repatriations were due to large variations in the average direct costs which ranged between 9,560 euro in the malaria case and 77,255 in the AMI case.

Conclusion: Repatriating an ill seafarer is a costly operation from the employer's point view and employers have a financial interest in promoting the health of seafarers by introducing or further strengthen cost-effective prevention programs and hereby reducing the number of repatriations.

Resumé

Introduktion: Søfarende er en essentiel arbejdsstyrke for den globale økonomi med mere end 1.5 millioner ansatte. Søfarende lider under et dårligere helbred sammenlignet med den generelle befolkning og har ofte dårlig adgang til sundhedsvæsenets ydelser, hvilket gør denne arbejdsstyrke særligt sårbar. Sømænd er beskyttet af internationale konventioner, hvilket betyder at alle udgifter i forbindelse med medicinsk behandling og repatriation påfalder arbejdsgiveren. Formålet med denne opgave var et estimere omkostningerne ved repatriation ved fire diagnoser.

Metode: For hver af de fire diagnoser blev omkostningerne til repatriation udregnet ved mikro omkostningsberegning med et arbejdsgiverperspektiv. De fire diagnoser var: I) Akut myokardie infarkt (AMI), II) Malignt hypertension, III) Blindtarmsbetændelse og IV) Malaria. Data for de direkte omkostninger blev udtrukket fra Søfartsstyrelsen og Radio Medical Danmarks databaser. De indirekte omkostninger inkluderede omkostningerne ved mindsket produktivitet, rekruttering og træning af en ny sømand, hvilket blev estimeret med friktionsmetoden.

Resultater: De gennemsnitlige samlede omkostninger for repatriation for de fire diagnoser AMI, malignt hypertension, blindtarmsbetændelse og malaria var; 98823, 47597, 58639 og 23792 euro. Variationerne i de gennemsnitlige totale omkostninger skyldes store variationer i de gennemsnitlige direkte omkostninger ved repatriation, som varierede mellem 9560 euro for malaria og 77255 euro for AMI.

Conclusion: Repatriation af en syg søfarende er en omkostningsfuld aktivitet set med et arbejdsgiverperspektiv, og arbejdsgivere har dermed en finansiel interesse i at fremme søfarendes helbred ved at implementere eller styrke eksisterende omkostnings effektive programmer og dermed reducere antallet af repatriationer.

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1. **Introduction**

The working life of a seafarer is somewhat untraditional since seafarers are both living and working at their workplace for several months. This poses challenges in regards to occupational medicine and it implies that the employer should not only be concerned with the health and safety of employees during the working hours, but this should also be extended to the leisure hours not spent working. Seafarers are especially vulnerable to diseases and injuries, because they live on the ship and are often cut off from the regular world with no or very limited access to proper health care. Current data suggests that seafarers suffer from a poorer health than the regular population (1–3). The vulnerability of seafarers makes their health and wellbeing a concern and priority in a public health point of view, and international regulations are set in place to secure equal quality of care as on shore (4,5). Seafarers are an essential global workforce with around 1.5 million people working day and night within the maritime sector (6), securing transportation of more than 90 percent of the goods in the world (7,8).

According to both Danish and International laws, merchant seafarers are required to hold a medical certificate, which holds a validity of maximum two years in order to reduce risks to other crew members, safe operation of the vessel and to safeguard the seafarers personal health and safety (9). These certificates are issued by approved maritime doctors (10–12). Even though a healthy-worker effect could be expected due to the compulsory medical checks every second year, seafarers remain a more vulnerable workforce with a poorer health state than the general population (1–3). This calls for more preventive measures and better training of maritime doctors in regards to awareness of the health challenges at the workplace at sea, and thus to accommodate the health needs of merchant seafarers. Today, most merchant vessels are required to have an officer trained in first aid in charge of medical care, response procedures and the medical chest containing a vast variety of medicines. The officer in charge of medical care can distribute medicine, but in case of doubt or complex matters, other measures must be taken. Direct access to skilled medical professionals and regular health care is often highly limited for the majority of merchant seafarers and sometimes completely inaccessible. Contact to authorized health care personnel, such as doctors, can often only be accessed with radio or telecommunication, which has its limits.

The maritime states have, since the implementation of the Maritime Labour Convention (MLC) 2006 on the 20th August 2013, been obliged to provide Tele Medical Advisory Services (TMAS) to ships (13,14). The Danish TMAS is called 'Radio Medical' and it is a 24-hour service available to all Danish and English speaking seafarers, onboard Danish as well as foreign flagged ships. Radio Medical Denmark consists of a team of specialized doctors, which at all times can be consulted with medical issues from ships. When a seafarer turns ill onboard, the person in charge of medical care is consulted and it is up to the captain of the ship to decide on the actions that must be taken if external advice or action is needed. The captain will often consult the Radio Medical service if a seafarer is ill (15), and they will provide solid recommendations regarding when there is a need for medical evacuation and hospitalization at the nearest hospital. Further, a seafarer may be repatriated if the seafarer, after hospitalization, is found not-fit-for duty (16,17).

Repatriation of seafarers is most likely a costly operation and the costs of repatriation will, at all times, fall upon the employer (7,17). Further, it is well established in the literature that injuries and occupational diseases cause a disruption to the work environment that have consequences that affect the core business of the company by imposing a financial burden due to cost of treatment, drop in productivity, and the reduced investment opportunities (18,19). It is reasonable to assume that employers must have an interest in reducing the number of repatriations in order to limit expenses and productivity reductions.

In case of illness or injury, the seafarer is entitled to medical care. In urgent and serious matters, the seafarer will need immediate transportation to the nearest health professional. This can be done by the ship deviating from its route finding the nearest port, by helicopter evacuation from the ship or by another often smaller boat service to come pick up the seafarer (7). A seafarer may be repatriated to his or her home country or to the destination where the seafarer signed the contract and boarded the ship, if the seafarer after hospitalization is found not-fit for duty. Repatriation is not uncommon and Abaya and colleagues (2015) found that 1.7% of all deployments end with repatriation and that 10 percent of TMAS calls resulted in medical evacuation bringing the annual number of medical evacuation up to around 9,690 (7), many of which are likely to result in repatriation.

When repatriation is needed, the ship-owner must cover all expenses for the seafarer and it can likely be highly expensive. The direct expense covering includes paying for transportation from the ship to the hospital, hospital admission, medicines, transportation to the repatriation country, food and hotel stays along the way and wage during repatriation and illness (17). The evidence in regards to the costs of repatriation is highly limited with only one study providing some insights to the issue stating that the annual costs of evacuation and medical treatment for the shipping industry amounts to a total of 760 million Euro (7).

From an employer point of view, an estimate of the total costs of repatriation provides some insight to the economic magnitude of repatriation, but it is also highly relevant for the employer to know the costs of disease at a micro level, since this insight can tell the employer what the costs of each illness case are, and a cost-of-illness study can provide this information (20). A cost-of-illness study is a form of economic evaluation and can be used as a first step in cost effectiveness or cost benefit analysis. Knowing the costs of a specific disease is a useful and highly valued tool to inform decision and policy makers (21).

Economic incentives are a powerful argument, and the economic evaluation can be used as an argument for different measures that should be implemented. Knowing the costs of repatriation for seafarers can provide valuable insights for the ship-owners, who always have scarce resources available and are also always concerned with maximizing revenues (22). The cost-of-illness analysis can stand out as the first step in the economic evaluation of repatriation as the current evidence in regards to the cost of repatriation is very limited. This makes it highly relevant and urgent to investigate the cost-of-illness in order to establish reasonable arguments to promote the health and welfare of seafarers. The one published article only provides an estimate of the costs of repatriation at an aggregate level, and evidence on a micro level is completely lacking, and would be relevant to explore further. A micro level cost analysis establishes information regarding the costs of different illnesses and what the major cost drivers are, when seafarers are repatriated (23) and is likely to be beneficial for decision makers (21). In the end, they would be able to implement preventive measures and better integrated care and thereby save money on the bottom line.

Besides the economic benefits of better care and preventive measures for the seafarers, it is likely that there will be other and softer benefits included as well, such as being perceived as a good and responsible employer, which will attract and withhold a better workforce as a result. These benefits are, however, somewhat intangible.

In the European Union HealthBASKET project, a case vignette method proposed a micro costing approach to estimate the costs of treatment. This method has been applied to the vignette cases – diagnoses – in order to compare the costs of ten different treatments across nine European Union countries. The method is an episode-specific approach, which has been widely accepted (23,24). By applying this method to the case of repatriation, it makes it possible to estimate the costs of a standard repatriation case due to a specific disease or condition. This thesis will, at a micro-level, provide insight into the average total cost, which falls upon the employer when a seafarer is repatriated. The cost of repatriation is an unexplored field and detail must be paid to the costing methodology as at the moment there is no standard for doing this. It is crucial to develop a cost formula that represents the relevant costing categories, is reliable, valid, and user friendly in order to provide useful data (25).

1.1 Objective

The objective of this thesis is to estimate the costs of repatriation based on four pre-specified case vignettes, which are some of the more common causes of repatriation due to illness (8,26).

The four vignette cases are according to the World Health Organization's 2016 ICD-10 codes (27):

- IX Diseases of the circulatory system: I21 Acute myocardial infarction – A male aged 45-55
- IX Diseases of the circulatory system: I10 Malignant Hypertension – A male aged 45-55
- XI Diseases of the digestive system: K35 Acute appendicitis – Male/female aged 20-30
- I Certain infectious and parasitic diseases: B54 Malaria – Both genders, all age-groups

These case vignettes have been chosen based on advice from medical experts with extensive knowledge and experience within the field of seafarers and existing literature on the topic of repatriations (8,26).

It is clear that, even though global initiatives to implement telemedicine have been established, seafarers' health remains vulnerable and poorer compared to the general population. Knowing the costs of repatriation can be an important measure in order to reason for what health preventive measure must be implemented to ensure and promote the health of seafarers.

1.2 Research questions

In order for this thesis to answer the objective, four research questions have been made and are the following:

- How much does the evacuation and repatriation of seafarers due to illness cost?
- How can we create a formula representing the cost categories?
- What kind of parameters should be taken into consideration from the employers' point of view?
- What kind of data should be collected regularly at company level?

1.3 Delimitations

This thesis is a framework for investigating the costs of repatriation, and it is out of the scope of the thesis to investigate any effects or benefits that occur due to implementation of this health initiative. A focus was chosen to investigate the costs of repatriation due to four diseases that, with proper medical training of maritime doctors and better integrative care, should be possible to reduce the number of repatriations due to these reasons.

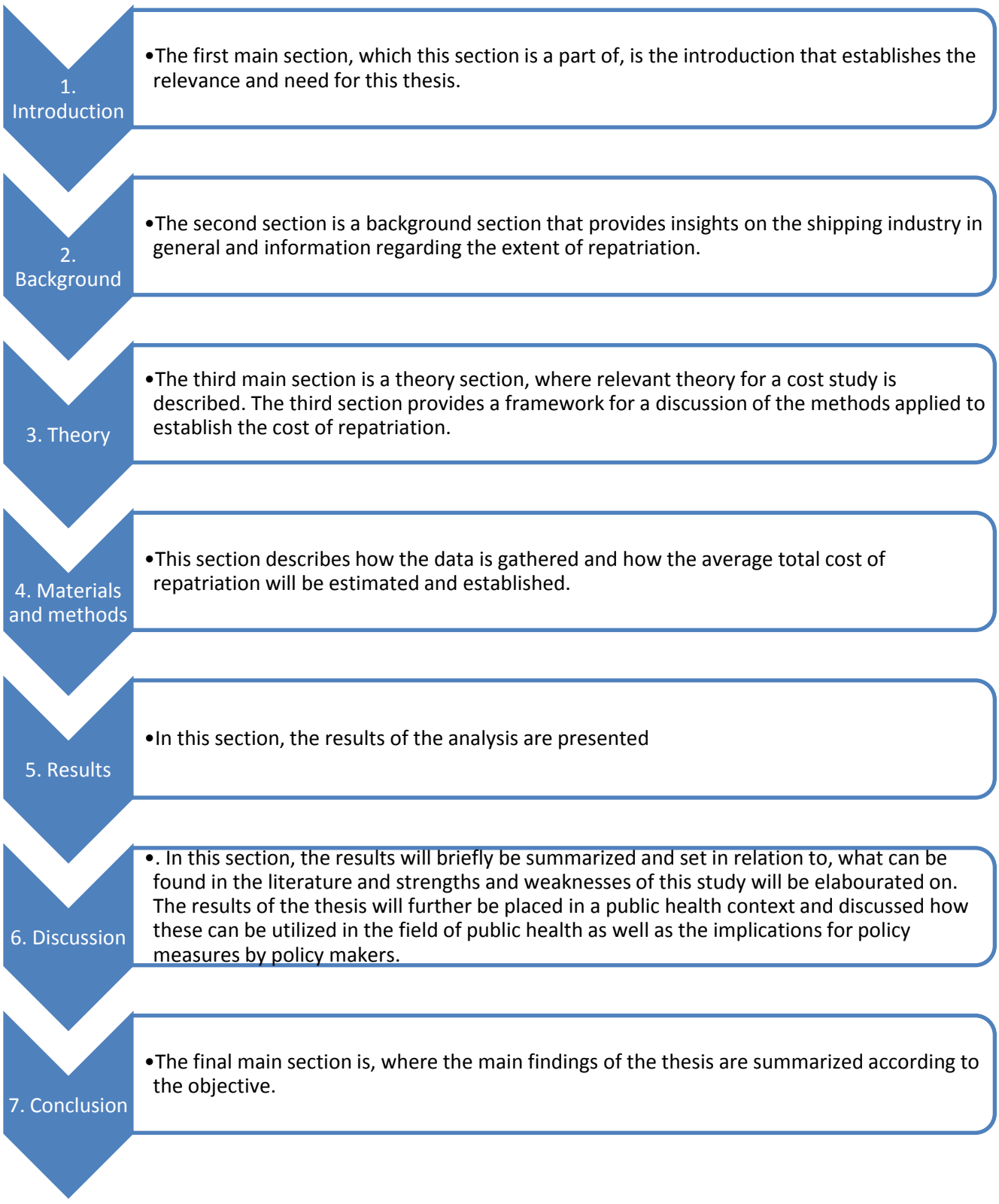
It remains highly relevant to know the costs of repatriation due to injuries and musculoskeletal disease, but within the constraints of this thesis, it is not possible to investigate further and remains to be an issue for future research.

This thesis seeks to estimate the total costs of repatriation, however, intangible costs will only be briefly mentioned, but it is beyond the scope of this thesis to provide any estimates regarding the possible spillover effects of repatriation on company image, employee engagement and motivation, which is why intangible costs will not be dealt with any further.

1.4 The structure of the assignment

This thesis consists of seven main sections. The content each section is explained in Figure 1 on the next page.

Figure 1: Structure of the assignment



1.5 Literature search

In order to gather knowledge regarding existing research within the costs of repatriating ill seafarers, a literature search was conducted with the purpose of finding existing peer reviewed literature.

1.5.1 Search Protocol

The literature search utilized the database host ProQuest searching 14 different databases; *I) ProQuest Dissertations & Thesis Global II) Australian Education Index, III) Canadian Business & Current Affairs Database, IV) ComDisDome, V) ebrary® e-books, VI) EconLit, VII) Education Database, VIII) International Bibliography of the Social Sciences (IBSS), IX) Periodicals Archive Online, X) SciTech Premium Collection, XI) Social Science Database, XII) Social Science Premium Collection, XIII) Sociological Abstracts and XIV) Worldwide Political Science Abstracts*. Besides ProQuest, the search also made use of the databases PubMed, Embase and Google Scholar. The search was conducted in the period between 5th and 13th of February, 2017. It was structured as a block search which is recognized as a proper technique to conduct literature searches (28). The search string is illustrated in the Table 1.

Table 1: Search string for literature search

Seafarer*		Repatriation		Cost* [MeSH]
OR		**OR**		**OR**
Seamen		Repatriate		Evaluation
OR		**OR**		**OR**
Mariner*	**AND**	Expatriate	**AND**	Business case
OR		**OR**		**OR**
Sailor*		Evacuate		Pricing
		OR		**OR**
		Ill health		Expenditure

As the table above shows, the search consisted of three blocks – columns – divided by the Boolean operator 'AND'. The words in the same block was divided with the Boolean operator 'OR'.

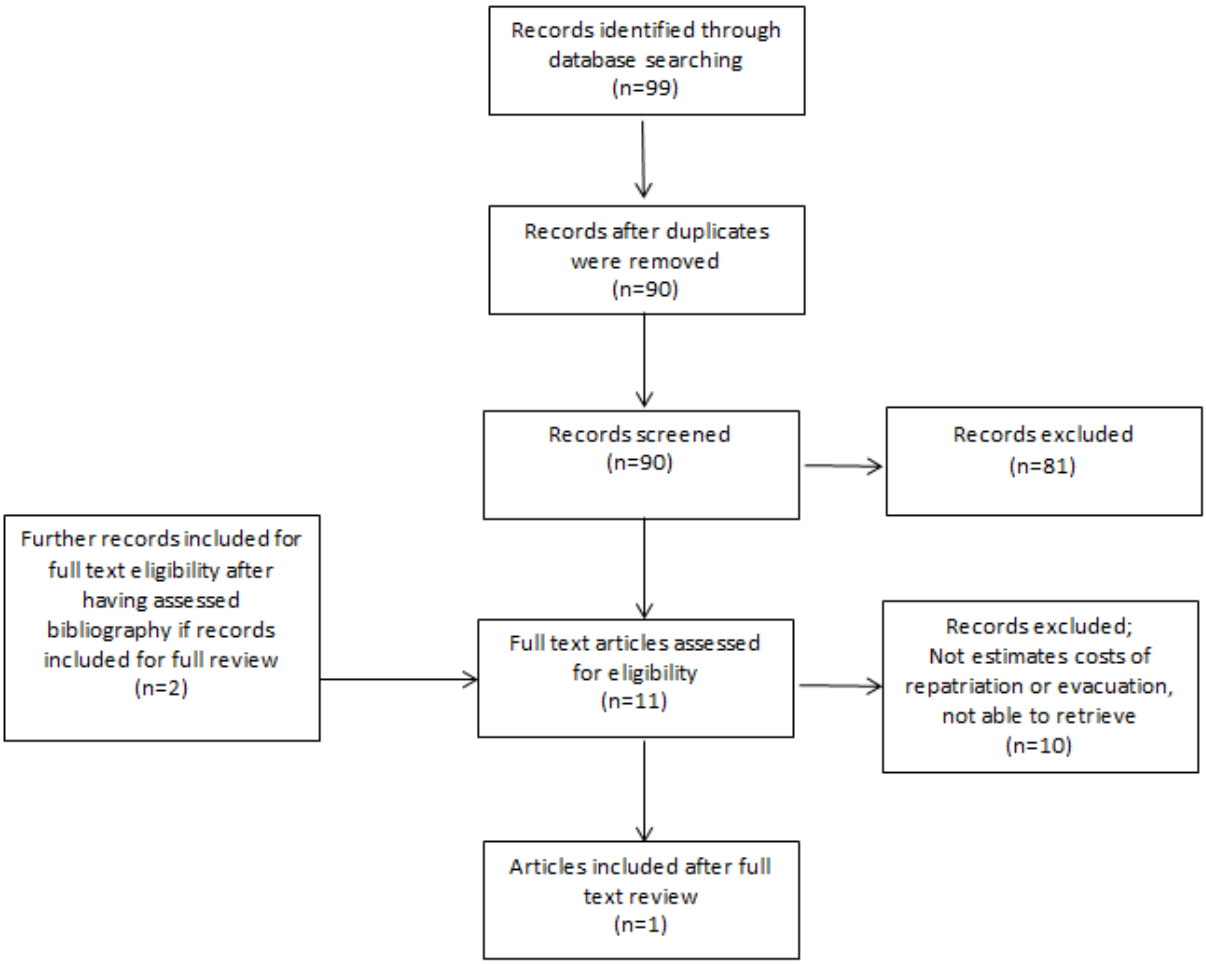
The star (*) indicates that the word is truncated (29,30). In PubMed, a search for medical subject headings terms (MeSH) in regards to costs were applied to the search, which is illustrated in the first row in the right column in Table 1.

Inclusion and exclusion criteria were established in order to help the author include the relevant records (Appendix I).

1.5.3 Literature search findings

The literature search yielded 99 results. The perception of the author was that investigations into the costs of repatriation was a relatively unexplored field, which is why records containing one of the search key words in the title or abstract were included for full text review. The records were excluded in a process, illustrated in the flowchart on the next page (Figure 2). The first step in the process was to remove any duplicates, and then records were screened based on title and abstract. If a record did not yield at least one of the search terms in the title, it was excluded. After title and abstract screening, the relevant records were chosen for full text review. The initial search yielded 90 results after removal of duplicates. After removal of records not relevant and not containing at least one of the search key words in the title or abstract, nine studies remained for full text review (8,31–38). After assessment of the bibliographies of the records included for full text review, two further records were included (7,39). One of the 11 records included for full text review had to be excluded since the report '*Injuries and Illnesses on U.S Ships*' from 1978 was no longer available from the United States National Technical Information Service (38). A record of the e-mail correspondence with the United States National Technical Information Service is attached in Appendix II. After full text review of the 10 records, only one record provided some estimates of the costs of evacuation (7). No records estimated the total costs of repatriation – neither on an aggregate level nor on a micro level. A matrix of the records found in the literature search is provided in Appendix I.

Figure 2: Literature search flowchart



The literature review revealed one relevant published article providing some estimation of the costs of repatriation. The article with the title; *Business Case for Telemedicine* by Henny and colleagues (2013) provides a business case for implementing telemedicine with a perspective of the global shipping industry. The primary concern of this article was to provide estimates of the savings that would occur to the industry if telemedicine was implemented. This differs from the objective of this thesis, which seeks to provide estimates of the costs of repatriation. Henny and colleagues (2013) do, however, provide estimates on an aggregated level on the annual costs of medical evacuations.

In their cost calculation, they have included several costs; *I) provision of Telemedicine Assistance Services, II) helicopter evacuation or deviation, III) replacing evacuated seafarers, IV) medical follow up and rehabilitation, V) returning seafarers to work*.

Findings of relevance was that hospital admissions accounted for only 2.4% of medical encounters, but 56.8% of all medical expenses, indicating that hospitalization is a major cost driver. Henny and colleagues (2013) estimated that the current annual costs of medical evacuations and treatment of the reason for evacuation was 760 million euros, which all falls upon the global shipping industry. It was then assumed that proper implementation of Telemedicine Assistance Services would reduce the annual number of medical evacuations by 20%, indicating that implementing Telemedicine Assistance Services would reduce the annual costs of medical evacuations by as much as 152 million Euro per year.

1.6 Case vignette diseases

In the following, there will be a short description of the diseases, which in which the costs of repatriation are to be established.

Acute myocardial infarction (AMI): Is an acute and life-threatening coronary heart disease. It is generally accepted that the medical term AMI describes the necrosis of the heart musculature resulting from a sudden reduction in coronary blood flow. Without sufficient blood flow and oxygen, the heart muscle tissue undergoes irreversible necrosis within three to six hours (40).

Malignant hypertension: Is a life-threatening manifestation of hypertension, which is often caused by poorly managed hypertension. Is characterized by a rapid increase in blood pressure causing it to be extremely high – above 180 mmHg/120mmHg. Malignant hypertension can cause organ damage and the associated symptoms are; severe headache, chest pain and difficulty breathing. High blood pressure is often the cause of malignant hypertension and can be caused by missing dosages of anti-hypertension drugs and the treatment is also anti-hypertension drugs often at a hospital (41,42).

Appendicitis: Appendicitis is an acute inflammation of the piece bowel called the appendix (43). In cases of appendicitis, it is usually surgically removed with a procedure called appendectomy (44).

Malaria: Is a fever disease with flu like symptoms, which in worst instance can be deadly. Mosquitos infect people with malaria. In areas with the malaria mosquito people should avoid mosquito bites with for instance nets, which are an effective way to prevent bites. Further preventive medicine can be used (45,46).

2. Background

In this section, relevant background information is described in detail regarding the two topics; *I) the shipping industry and II) the HealthBASKET project* for which the case vignette approach was invented.

2.1 The shipping industry

Seafarers and maritime transportation are an essential and cost-effective way to move goods around the globe. Seafarers are crucial to the global economy since more than 90% of all mass goods are moved by ship. The maritime industry is a continuously growing global industry, which connects countries, markets, businesses and people. The maritime industry globally employs around 1.5 million seafarers, mainly coming from the Philippines, China, Indonesia, Russia, India and Ukraine (6,26,47,48).

The maritime industry is continuously growing and, in 2015, the estimated world seaborne trade volumes surpassed 10 billion tons for the first time and the world fleet grew by 3.5% (6). Maritime transportation is the backbone of globalization and enables international trade at a large scale by providing goods at very competitive prices across the globe and the industry is, each day, responsible for bringing goods to consumers around the globe (6). The United Nations recognizes the importance of transportation in the 2030 Sustainable Development Goals, and acknowledges that transportation in general is a factor for the realization of the eight goals and 11 targets in the Sustainable Development Goals (49).

2.2 The shipping industry and the role of Protection and Indemnity insurance

This section provides the reader with general knowledge in regards to the shipping industry. It outlines how shipping companies are hired to do certain tasks, and how this is done by the use of charterers. The section further elaborates on the most common agreements in terms of compensation if a cargo is delayed, and also the shipping companies' use of protection and indemnity (P&I) insurance – most commonly referred to as P&I clubs. When ship-owners are hired to carry freight, this is often facilitated by a charterer. The purpose of the charterer is to make sure that the cargo gets to the clients, and for this, the charterer hires the ship-owner.

The charterer and the ship-owner form a contract for when the cargo must be delivered, at what port and the price of this service. In the contract it is also stated what fees the ship-owner must compensate to the charterer in terms of delay, and the ship has to be at the pre-specified berth at the pre-specified time in order not to be late (50,51). This implies that when ships arrive late with the cargo, which can be due to evacuation and/or repatriation of an ill seafarer, there will be a cost to the ship-owner, who must compensate the charterer because of the delay. In order to secure oneself, ship-owners form risk-pooling alliances – P&I clubs. The purpose of these clubs is risk-pooling by mutual insurance. Most P&I clubs are associated in the *International Group of Protection & Indemnity Clubs* and together the members of these clubs provide liability cover for approximately 90% of all goods transported on the world oceans (52). A P&I club is an independent non-profit organization who serves mainly ship-owners by risk-pooling and mutual insurance. Each member of a P&I club pays an annual contribution in order to be insured in terms of third party liability such as repatriation, war and oil pollution. If the annual contributions cover the annual expenses of the club, then no further contribution must be made, but if there is a deficit, then the premium is increased the following year (52). When repatriation occurs, the ship-owners are reimbursed for the repatriation costs by the P&I club, and repatriation and charterer loss reimbursement is likely to entail an increase in premium the following year (53). The payment structure of the P&I clubs falls in the end on the ship-owners who pay all the costs that are reimbursed by the P&I clubs.

The above-mentioned describes why the health of seafarers must be protected, and why it is important for the ship-owners to know the costs of repatriation, as in the end, it is the industry, who pays the total costs of repatriation (17).

2.2.1 The Danish Maritime Authority

The Danish Maritime Authority (DMA) is the highest authority within the shipping industry in Denmark. The overall purpose of DMA is to create the basis for safety and growth within the Danish maritime sector (54). In the case of a seafarer turning ill and needing repatriation, it is the DMA who reimburses the costs of repatriation to the Danish ship-owner. In this case, it will not be the P&I clubs, as described above.

This indicates that, in Denmark, the costs of medical repatriation and what this entails are covered by the state with DMA as the government body, who manages this process of reimbursing the ship owners. However, the ship-owners must pay an annual fee to be part of this agreement with DMA (55,56). The annual fee is based on the expenses the year before, which indicates that, in this case, it is also a risk-sharing agreement between the ship-owners and DMA with the role of the P&I club.

For this thesis, DMA is the data provider. The cost data reimbursed to the ship-owners for the different case vignettes is based on what is on file at DMA archives.

2.3 Seafarer's right for health care and repatriation

In this section, the current International and Danish laws in regards to seafarers' right to health care and repatriation will be elaborated on. Seafarers' right for health care and repatriation provided the basis for the objective and perspective of the cost analysis, and it outlines why it is relevant to take the perspective of the employer.

International regulations defined in the International Labour Organization's Maritime Labour Convention (MLC) 2006 – also known as '*the Seafarer's Bill of Rights*' – states that seafarers have the right to be repatriated for several different reasons, including injury or disease (17). MLC 2006 states that a seafarer off-shore must enjoy the same quality of care as citizens on shore and, therefore, repatriation is sometimes unavoidable in order to provide the necessary care. This section focuses on the seafarer's right for repatriation in case of illness.

In the case of disease, a seafarer has the right to be repatriated with the full costs of repatriation and treatment held by the employer, and it is in direct violation with the latest regulation defined in the MLC 2006 to charge the seafarer in the case of repatriation. In order for the employer to minimally fulfill his financial commitment to the seafarer, the travel from the ship to the agreed upon repatriation destination, accommodation and food from when the seafarer leaves the ship until he/she reaches the repatriation destination, wages, transportation of the seafarer's personal luggage, medical treatment until the seafarer is found fit for travel, must be paid by the employer. The country for which the seafarer is repatriated to, must be agreed upon beforehand and, most often, it should be a country for which the seafarer has a relation to (17).

For seafarers employed on Danish ships, the DMA covers the medical treatment expenses for up to 18 weeks and this timeframe can in special circumstances be extended (55). The employer must, besides medical expenses, cover the sickness benefits to the seafarer, which depends on seafarer's nationality and agreements made with the different Unions, but for the first 30 days of sickness, the sickness benefits must equal the normal salary (57,58). DMA reimburses the sickness benefits as well as the other costs of repatriation for up to 18 weeks and in special cases, more than 18 weeks. The maximum weekly amount of sickness benefits that DMA reimburses is, in 2017, 552 euro[1] – 4,245 DKK (57,59).

2.4 The Maritime Labour Convention 2006

The Maritime Labour Convention (MLC) 2006 states the current regulations in regards to seafarer requirements, working conditions and salary. MLC 2006 came into force on the 20th August 2013, exactly 12 months after the 30th country had signed it (14). The MLC 2006 was, from 20th August 2013, a binding international law for the first 30 countries that signed the MLC 2006, including Denmark, which had to change seven laws in order to comply with MLC 2006 (60,61). The purpose of the MLC 2006 was to create a single instrument capturing all up-to-date standards of existing maritime labour conventions and recommendations. The MLC 2006 applies to all seafarers and all ships – both publicly and privately owned – however, it does not apply to warships and naval auxiliaries. The primary objective was to promote decent working conditions and, keeping in mind that since the shipping industry is global, seafarers' rights and health needs protection. This is primarily due to the fact that by the global nature of seafarers' workplace, exemptions can be made from national labour laws (5,11) and, therefore, international regulations needed to be set in place to protect the welfare of seafarers. The convention consists of three parts; *I) the Articles, II) the Regulations and III) the Code*. In short, the articles and regulations set the core rights for seafarers and the basic principles and obligations for members. The code contains details of the implementation of the regulations and is comprised of both mandatory standards and non-mandatory guidelines (11).

MLC 2006 states that in order for a person to be qualified as a seaman, this person has to be at least 16 years of age and special working conditions are required to seafarers' under the age of 18.

[1] DMA reimburses a weekly maximum of 4,245 DKK equaling to 552 EUR using the current exchange rate of 1 DKK=0.13 EUR from the European Central Bank.

All seafarers are also required to hold a valid medical certificate. This certificate must be issued by a maritime doctor, which follows the international standards set out by the International Labour Organization, stating the minimal requirements to the health of seafarers (11,12). However, these certificates can vary in their content, detail and degree of personal medical information (7). The medical certificates must be renewed every second year, and seafarers below the age of 18 must have their medical certificate renewed every year (10,11). Even though seafarers are required to go through periodic and pre-employment medical examination, the current system does not seem to be in balance, since seafarers are more prone to suffer early mortality and chronic diseases than the general population (2). This aspect of the health of seafarers is to be elaborated on in section 2.5.

Besides having a proper age and medical examination, seafarers must also have the right training and skillset in order to be employed on a ship, and if they do not have the proper skills, it is a violation against the MLC 2006. The salaries of seafarers are often negotiated between the employer and trade unions, and wages are dependent on these negotiations and the seafarers country of origin; however, the International Labour Organization set minimum recommended wages (11,62). An overview of the recommended minimum wages is provided in Appendix III. Seafarer wages does, therefore, not only differ according to the area of responsibility – e.g. whether being a deck worker, an officer or a cook – but the wage also differs according to the seafarer's country of origin.

2.5 Health Status of Seafarers

The health of seafarers remains to be a public health interest since they are a vulnerable workforce (2,3). Seafarers both live and work at the ship, and occupational health should be a key activity and concern of every employer in the shipping industry. From a health promotion point of view, there should be several possibilities to promote the health of seafarers while being on the ship, since they are both working and living there. From the occupational health point of view, it is probably difficult to distinguish between when a seafarer is at work and when the seafarer is off work, and one can argue that the employer has a responsibility towards the seafarer all the time while the seafarer is onboard the ship. However, seafarers continue to have a poorer health status than the general population (2,3).

Some health risks which pose a risk at shore might pose an even bigger risk at sea – such as overweight and fatigue. The evidence in regards to the negative health risks of overweight are well established in the scientific literature (63–67), and it can be assumed that this risk remain at sea. However, obese seafarers might also be at increased risk of not only illnesses, but also injuries at sea. In a Danish study with 1379 seafarers, 66% of them were overweight or obese, compared to 44% in the Danish general population (68,69). Seafarers are on almost all health parameters an exposed group, and their overall health remains to be poorer than the general population (2). Compared to the general population, they have increased risk of musculoskeletal diseases, cardiovascular diseases, mental health diseases, early death and suicide. Published research concludes that the seafarer occupation is correlated with adverse health outcomes (2,26,31,70–81).

One Danish review of register based studies reviewed the health status of Danish seafarers in the period 1970 to 2005 and found that, in the whole period, the mortality rates among seafarers were significantly higher than of the general working population. The highest mortality was found in the engine and deck crew. Officers had a lower mortality than crew members; however, officers' mortality rates remained significantly higher than the general population. The study stated that especially the 20-34 year olds were at particular risk of mortality (2). This high risk group of death indicates that early mortality among seafarers are a reason for many life years lost, compared to if it were an older generation of seafarers, who were at particular risk of occupational mortality. Mortality among the Danish seafarers was especially caused by accidents, cirrhosis of the liver, ischemic heart disease, lung cancer and suicide (2). Similar trends are seen in seafarers from other nations (3). The deaths caused by diseases, are all diseases, which in daily language are termed as lifestyle diseases – meaning they are related to the way the person lives and behaves. This implies that these diseases, to a large degree, are unnecessary and can be prevented by proper health promotion efforts. The risk of these diseases increases with poor diet, lack of exercise, excessive alcohol intake and smoking (82,83). However, diseases such as cardiovascular diseases and ischemic heart disease are related to the lifestyle factors such as exercising and smoking habits, but they are also related to the working conditions. Seafarers face a difficult work environment with long working hours, shifting working hours and an increased risk of fatigue (78,79,84).

These are all risk factors that the seafarers face at work, making the employers responsibility in terms of occupational health highly urgent and relevant to promote. In total, in all non-traumatic sudden deaths, cardiovascular diseases account for between 55% and 71% of all natural causes of seafarer mortality (75). As seafarers are assigned to regular physical fitness evaluations, some healthy worker effect must be expected in this workforce (85), which further indicates that there is a need for general health promotion in the seafarer population.

It is important that the health of seafarers is maintained and monitored closely, since access to health care at sea is limited (13). At most merchant vessels, there is no doctor available and medical treatment relies on a medically trained officer and on tele-medical advice provided by, for instance, Radio Medical Denmark. The direct health care provision at sea is therefore often related to the experience of the medical officer and the availability of medicine onboard the ship. If it is a Danish ship the required training of the medical officer has a duration of 10 days, which indicates that the training is highly basic and superficial, and in other countries this training is even shorter and more basic than the one provided in Denmark (13,16,86).

2.6 Repatriation

In the following, the magnitude and risk factors for repatriation will be elaborated on, but first the concept of repatriation must be established. Repatriation is a process where the seafarer is returned to the home country or an agreed upon destination. The International Labour Organization's Maritime Labour Convention 2006 is the current guideline in regards to repatriation of seafarers, of which the ship-owners are obliged to comply with no matter the origin of the employing organization. The Maritime Labour Convention guideline on repatriation from 2006 states that seafarers can be entitled to repatriation for several different reasons, one of them being in the case of illness or injury (17).

Repatriation is the process of transporting the seafarer to from his or her workplace – the ship – to his or her home country in the case of illness, injury or other reasons stated in the MLC (17).

Published research in regards to repatriation is not extensive; however, some studies are present and provide detailed insights on merchant seafarer repatriation (8,26,39).

Abaya and colleagues (2015) utilize data from different Filipino manning agencies, which is the nation in the world with most citizens employed as seafarers, and approximately 400,000 from the Philippines were in 2014 employed as seafarers. Abaya and colleagues (2015) gathered data on repatriation from a five year period – January 2010 to December 2014 – from the manning agencies, and in this period data were gathered on 388,963 seafarers. Within the cohort of 388,963 seafarers being deployed, a total of 6,759 medical repatriations were noted. This equals that 1.7% of all deployments on a ship ends with repatriation. Injuries were found to be the most common cause of medical repatriation, accounting for 21.45% of all repatriations. Musculoskeletal disorders were the second most frequent reason of repatriation with approximately 19% of all cases. Gastrointestinal, genitourinary, cardiovascular, dermatological and infectious diseases accounted for respectively 17%, 9%, 8%, 6% and 4% of all repatriations. For gastrointestinal problems, it was appendicitis, acid peptic disease including ulcers and hernia which accounted for half of the repatriated cases (26).

Lefkowitz and colleagues (2015) utilized data over a four-year period from Future Care Inc., which is a company that manages a telemedicine database with data on health of seafarers globally and provides telemedicine services. The data consisted of 2,764 illness and 1,157 injury cases totaling of 3921. Of these 3921 cases, 61 (1.6%) resulted in repatriation. This figure of 1.6 percent of telemedicine contacts resulting in repatriation is fairly low compared to Abaya and colleagues' (2015) results, where it was 1.73% of all deployments that ended with repatriation. Henny and colleagues (2013) have, in their business case for telemedicine, assumed that 10% of all calls handled by the telemedical service results in repatriation. This figure is higher than the one found by Lefkowitz and colleagues (2015), but is probably more in line with the findings of Abaya and colleagues (2015). Based on the assumption of 10% of all tele medical consultations resulting in medical evacuation, Henny and colleagues (2013) estimated the annual number of medical evacuations to be 9690.

An older Polish study found comparable results to Abaya and colleagues (2015). The study utilized five years of data from Polish seafarers employed on ships owned by Polish Ocean Lines. Within the five-year period from 1985-1989, a total of 354 Polish seafarers were medically repatriated. That equals 16.9 cases per 1000 men per year employed at Polish Ocean Lines.

They found that 287 repatriation cases were due to serious illness – most frequently acute myocardial infarction – and 67 were attributed to serious injuries. The study stratified repatriation by age and found that most seafarers repatriated were below 41 years of age – 153 repatriated in this age group (39).

2.7 The HealthBASKET project and the case vignette approach

The HealthBASKET project is a European Union (EU) project, which is a cost comparison of different health care services across nine EU member countries. The project was initiated in 2004 and ended three years later in 2007. The purpose of the project was to provide insights to decision makers in order to make informed decisions. Before the HealthBASKET project, there was no standard of how comparison between health care services in different countries should be made, when wanting to assess the costs on a micro level. Before this assessment, the cost comparisons of health care services were at an aggregated macro level, such as percentage of gross domestic product. The case vignette approach was established in order to be able to make comparisons of the same service between countries. Ten case vignettes were established of 10 different disease classifications. The project sought to provide detailed information on the 10 episode specific cases in the nine EU member states; *I) Denmark, II) England, III) France, IV) Germany, V) Hungary, VI) Italy, VII) The Netherlands, VIII) Poland and IX) Spain* and the costs associated with these services related to the specific treatment cases (87).

The case vignette is an innovative and novel approach developed to explore resource use and costs. The methodology was developed due to a lack of an accepted scientific methodology to assess costs of health care services. A case vignette describes the typical patient in regards to diagnosis, age, gender and possible comorbidity. The approach is a retrospective micro costing approach to estimating the cost of a specific illness case. As a costing exercise, the approach starts with defining a problem, the objectives and perspectives, the time horizon and, secondly, provides a description of the service (24). After the service has been described, the included cost categories must be established in several steps that contains; I) identification of used resources, II) measurement of the resources in their natural units, III) attaching monetary values to the resources used and IV) considering issues such as cost of capital and taxation.

The case vignette approach is an episode specific approach – similar to a case study – where a vignette is designed based on a typical patient, and then a patient is found which matches the criteria for the vignette, and the data for this patient are then found based on what is included in the vignette such as; an age interval, gender and comorbidity. For the approach, it should be stated what sources of cost data are to be used (24).

3. Theory

This section elaborates on relevant theory regarding health economics and cost studies. The first section serves as an introduction to the theory of health economics, and the remaining is regarding the framework for a cost study and how to estimate costs. The theory should lay the foundation for the discussion regarding the methods of this thesis.

3.1 Health economics and the economic evaluation framework

The field of health economics is a subpart of economics. The field of economics is concerned with behavior, and economists are, therefore, primarily concerned with choices and decisions, which is a part of the normative decisions theory. Economists assume that decision making is a rational process (88), since the individual or the decision maker, at all times, is concerned with maximizing utility or get the most effect for money. Health economics is mainly concerned with maximizing utility or effect for money. Like in all businesses, it is good to have as much outcome with as little input as possible – a high return on investment. Health economic evaluations are primarily based on welfare economics and are concerned with the welfare of the society as a whole. As a consequence, welfare economists argue that health economic evaluation should always consider the societal perspective and, therefore, include all societal costs. More narrow perspectives, such as the health provider perspective, could lead to maximizing the benefits within the limited budget, but may not lead to maximizing utility for the society as a whole (89).

Within health economics, health and health care are perceived as economic goods important to individuals as well as the society (90). A main assumption in the field of economics is that resources are scarce, but there are no known bounds on the quantity of goods and services desired, which implies that choices must be made in regards to the production of goods – the issue is known as the problem of *scarcity of resources* (91). By assuming that health care is an economic good, choices must be made in regards to the quantity produced, the different services provided, how to produce the health care, how it is paid, by whom and how it is distributed. These are important questions that decision makers commit themselves to make, and decision makers are bound to make priorities within health care provision. Health is a fundamental good that is important to all people in the society, and the choices regarding the production and distribution of health care are often emotionally laden and of high political interest (90).

The nature of scarce resources implies that there is a tradeoff between choosing one thing and not choosing another, which is captured in the notion *opportunity costs*. Opportunity costs can best be explained as; when a choice is made by a consumer, then the value that the consumer would have received from the next best choice is the opportunity cost of the choice that was not made (92).
Health as an economic good differs from traditional goods in the way that it can be produced in different institutional settings, and is not only produced in the health care system. Health can be produced and increased by individuals, households and the structure of society (4,93,94). Health is a traditional good in the way that people are willing to pay for it – hereby implied improvements in health – and a scarce resource, meaning that people want more than, what is available. However, a major difference between health and regular goods is that health cannot be traded because of its intrinsic nature. Health is not either a manageable commodity and it is not possible to trade episodes of sickness (90). It can be argued that health care in itself should not be perceived as an economic good, since it is not the health care service in itself that accommodates utility for the consumer, but it is the outcome – improvements in health – which the service produces, that the consumer of the service is interested in and willing to pay for. Health care services are often associated with pain and agony, and can actually cause a disutility in the short term; however, people accept these often unpleasant treatments in order to increase their stock of health (93). Health care differs from traditional goods and commodities in more ways than the utility since health care is often based on a need for health care rather than a want for health care. It can, however, be argued that newer forms of health care services – cosmetic operations – are mainly based on a want rather than need, so both wants and needs exists within health care as well. Further, for the need-based health care services, the consumer is not aware beforehand when and what health care service is actually needed (90). This makes a big difference to other need-based commodities like food and water, which we by ourselves know our need for. It is for most people not possible to know beforehand when a health care service is needed and further consumers are not aware of what they need, or how much they need. They rely on the health care professional to tell them, which implies that there is imperfect information within health care. In many countries, health care services are fully subsidized – meaning that the patient is not obliged to pay at the time of treatment – and then the demand for the service is increased compared to if the patient should pay at the time of treatment (90).

3.2 Costs

In this section and the following, the framework for a costing analysis is elaborated on. The purpose is to describe the general theory and recommended applications for a cost analysis, which provides the foundation for the methods of this thesis and are to be discussed in section 6 of this thesis – the discussion section.

It is important to establish the term cost in order to describe a cost analysis. Cost is defined as the amount of expenditure incurred or attributable to a particular good or activity representing its value – for the case of this thesis, the costs are attributable to repatriation both directly and indirectly. Cost is, therefore, something that has occurred since it relates to past activities (87). The term cost can be divided into many subcategories of costs and, for the purpose of this thesis, it is important to establish what is meant by total costs, direct costs and indirect costs.

Total costs are the addition of all direct, indirect and intangible costs (25). The concept of direct costs and indirect costs are further to be elaborated on in section 3.3 and 3.4.

Intangible costs are costs that cannot be captured, such as possible spillover effects of repatriation on company image, employee engagement and motivation (20,25). These are even more difficult to quantify and measure. However, as stated in section 1.3, it is out of the scope of this thesis to provide any estimates of the intangible costs related to repatriation.

3.2.1 Framework for a cost analysis

In 1967, Dorothy Rice provided an early framework for a health economic evaluation. It was a framework for cost-of-illness studies, where she emphasized that in order to estimate the total costs of a disease, the following cost categories should be considered; *I) The direct costs of the disease in terms of medical treatment, hospitalization, etc., II) The indirect costs in terms of productivity loss and III) The intangible costs in terms of patients' and relatives' loss of quality of life, pain and concerns*. Rice further argued on the usefulness of cost-of-illness studies in the policy arena, on the ground that a cost analysis could provide insights into where resources should be focused in order to reduce the burden of particular cost-intensive illnesses (20). Her work should be seen as a framework for cost-of-illness studies in the sense that she provided a structured methodology to this type of study.

Her work has helped to secure some homogeneity in the methods of cost-of-illness studies, which is crucial in order to compare different studies and draw in the validity of the results (95). This section elaborates on the work by Dorothy Rice and sequential health economists, and provides a framework for a methodologically sound cost-of-illness study.

A cost-of-illness study – or a cost analysis – is an economic analysis of the costs of a specific disease or condition. The primary purpose of an economic analysis/evaluation is to provide inputs to decision makers regarding prioritization and optimization of resource use, and decision makers often need monetary terms in order to do that (21,22,96,97). Full-scale economic evaluations are supposed to make comparisons between alternatives, for instance another treatment or no actions taken (status quo), since it establishes reasonable ground for rational decision making, in which a costing analysis is one side of that equation. The main priority for a cost analysis is to identify, measure and value the costs related to a specific service or condition (22).
Costs can be defined in different ways, and the outlay of a costing exercise depends on the definition of costs. Economists and accountants have different cost concepts, where accountants are concerned with measuring the costs for financial and reporting purposes and accounting costs of a health care service is encompassing the direct and indirect costs (87).
From an economist perspective, the real costs are the costs that occur to the society and, therefore, costs in this perspective will be defined by the opportunity costs, and the benefits that could have been obtained by choosing the next best alternative. This implies that economists are concerned with alternatives and measuring costs for decision making (87).

The difference between the costs included from the two perspectives usually occurs when costs are implicit, such as the costs of informal care, which could be relevant for the economist to include, but the accountant would not include these costs, because it is out of the scope of their theory. In general, there are two costing methods; *I) The economic evaluation method, which is based on marginal analysis of costs and outputs and II) cost analysis based on average unit cost assessment which is an accounting method* (87). For a cost study, it should be explicitly stated what the perspective and objective of the study is.

A cost study usually follows five overall steps; *I) Portray the objectives of the costing exercise, II) Detailed description of the service(s) for costing, III) Identification and classification of resource items and units of resources utilized, IV) Measuring resource consumption in natural units and V) Placing a monetary value on the resource units* (87).

3.2.1.1 Portraying the objectives

The first step of portraying the objectives is to define the scope of the exercise. This provides the overall information for the perspective of the study, which is crucial in order to decide what costs are relevant to include and the time horizon for the costs to be included (87). In a costing exercise, different types of costs will occur. In order to specify what costs need to be included in the analysis, it is important to specify the viewpoint of the analysis e.g. the society, the healthcare sector or the firm. When estimating costs, it is always important that the costing methodology is the same, and especially when comparing cost studies (22).

3.2.1.2 Description of the services

The second step is to define the health services that should be included. Health services can be defined by the cost of a particular service based on the respective tariffs in a given country e.g. visit to the general practitioner, the Diagnostic Related Group (DRG) reimbursement (87). There are basically three methods in use for measuring the costs; *I) The top-down approach, II) the bottom-up approach and III) the local approach*. The top-down approach uses aggregated data to provide a cost estimate and portrays the burden of a disease to the society. The bottom-up approach also utilizes aggregated data, but these data should be more specific than the top-down approach. The bottom-up approach should take into account the industry sector, the company size, the age of the repatriated worker and maybe also the rank of the worker. The bottom-up approach should, therefore, yield more detailed and accurate estimates of the costs. The local approach is characterized by acknowledging that there can be differences in the costs of a service in different cases. The approach involves an assessment of the costs more directly by company (19). The local approach can be characterized as a micro-costing approach, where each component of resource use is measured. This method is the most accurate, but also the most time consuming (22). As stated in section 2.2.1, the Danish Maritime Authority (DMA) reimburses ship-owners for the costs of medical treatment and sickness benefits that occur due to illness.

To use the data on a case-to-case basis from DMA would be a good example of the local approach. In this second step, the population of interest should also be described, meaning that it should be explicitly stated if it is a particular gender and age group of interest (87).

3.2.1.3 Identification and classification of resource items

The third step is the identification and classification of resource items. It is in this step that resource utilization should be quantified (22). A detailed flowchart of the treatment process can be a helpful way to identify resource consumption. It is in this step that both treatment related costs and other indirect costs must be identified (87).

3.2.1.4 Measuring resource consumption

The fourth step is to measure the resources that were identified in the third step. Here the resource items must be measured, and it should be established how to measure them, which depends on the objective. A micro-costing approach requires a detailed approach to resource measurement and can be a difficult and time consuming exercise. Measuring the resources using aggregated data is often a more pragmatic approach than micro-costing, since these types of data are readily available at country level. However, some reliability and validity is sacrificed using this method. It should also be considered whether data collection is to be collected retrospectively or prospectively. A prospectively analysis often has a higher validity than a retrospective one and it is possible to capture the resource items more accurately; however, a prospective costing analysis is often time and resource consuming. A special attention should be made to accurately measure items that are considered to be cost drivers, since they are likely to form the largest components of the total costs (87). When applying a micro-costing approach, it can sometimes be necessary to allow a mixed approach for resource measurement, where some costs are measured using a micro-costing approach and other costs are measured on an aggregate level using, for instance, the average costs. This approach should be utilized where micro-costing would be too expensive, variations in costs between cases are assumed to be low, or measuring the exact micro costs is not feasible nor possible (87).

3.2.1.5 Valuing resource units

The fifth and final step is to attach a monetary value to each unit of resources that were utilized. This is mainly done in five different ways; *I) Direct measurement of costs, II) Using cost accounting methods, III) Using standard unit costs, IV) Use of fees, charges or market prices and V) Estimates based on the literature and experts opinions* (87). The chosen method to attach monetary values to the utilized resources again depends on the objective and perspective of the analysis, and there is no consensus in the guidelines in this regard. It should, therefore, be explicitly stated why and which approach that has been chosen.

It is never possible to fully capture all costs and some assumptions will have to be made in regards to some of the costs. These assumptions come with a higher degree of uncertainty and it is important that assumptions are explicitly stated (87).

3.3 Direct costs

Direct costs are the costs that can be directly linked to the use of a particular program, resource or service (87). Direct costs are the visible component in the repatriation case, which are easily linked to the repatriation and fairly easy to establish as well (19). In the case of repatriation, direct costs are the costs of evacuation with helicopter, boat or by deviation of the vessel, further transportation costs such as ambulance from the harbor to the hospital, hospital admission fees, and the cost of medical treatment and rehabilitation and compensation to the affected seafarer. The following section *3.2.1* elaborates further on the concept of costs and how these should be identified and measured. In the method section of this thesis, it is elaborated on, how the cost inputs for the results of this thesis were identified and measured.

3.4 Indirect costs

In a costing exercise, indirect costs need to be considered in order to capture the full picture of the costs surrounding the illness in scope, often referred to as loss of productivity. This next section outlines the theory behind calculating and valuing indirect costs.

Indirect cost is an aspect of total costs important to elaborate on and the term indirect cost refers to non-directly allocable costs.

These costs can be called a hidden or invisible component to the total costs and the indirect costs are often more difficult to quantify and measure and are often underestimated by the employer mainly because they are not considered as cost, no data are available (19). In the case of repatriation, the indirect costs cover increase in insurance premiums, delays and penalties, overtime payments, productivity losses and the costs of recruiting a new seafarer (53,87). Indirect costs are the costs not directly related to the disease and the treatment of the disease. In the case of repatriation, the indirect costs are not directly related to the repatriation and medical treatment of the merchant seafarer. The indirect costs are entailed by the disease and, in the literature, indirect costs are often used interchangeably with productivity costs. Indirect costs can be valued in several ways depending on the perspective of the economic evaluation (22,98–100). Productivity costs are defined as: "*Costs associated with production loss and replacement costs due to illness, disease and death of productive persons, both paid and unpaid"* (101). This indicates that these costs are related to being less productive due to health problems, but indirect costs also represent the costs that occur when recruiting and training a new employee to take over the job of the employee turning ill, delays and penalties paid to the charterer and insurance premiums. Further indirect costs can be overtime payment, losses and time spent managing the repatriation case, and these costs are all held by the employer. These data are often not captured since managers generally do not consider these as costs related to the illness and, therefore, the costs of illness and accidents are often underestimated (19). Many repatriation cases or accidents could entail that a certain company is not perceived as an attractable worksite and morale and motivation could drop. Delays due to repatriation could entail that charterers next time hire another company. This would also entail a cost to the company; however, these costs are often intangible. It is important to bear in mind that these intangible costs could be quite substantial, but since intangible costs are out of the scope of this thesis, they will not be elaborated on further.

3.4.1 The Costs of Lost Productivity

When estimating the productivity costs, there are two aspects to consider, the first being the time that a person is away from the job – absenteeism, which leads to a loss of productivity or costs related to paying for instance overtime, and the second is the time a person spends at work, but not working with optimal efficiency due to illness – presenteeism (99).

Productivity loss can occur in the context of both paid and unpaid work; however, it is not expected that any of the merchant seafarers do unpaid work when onboard the ship – at least not any work where the productivity is of value to the employer, which is why loss of productivity in regards to unpaid work is omitted from this section. It is in regards to paid work that absenteeism is of interest (98–100). Presenteeism would also be of interest from the employer perspective if the scope of the study was to estimate the costs of a particular disease; however, in regards to the cost of repatriation, presenteeism is not a relevant cost category to consider since the repatriated seafarers are no longer working. Therefore the relevant estimates of productivity costs are the costs that are related to absenteeism, which in the case of repatriation would be sickness benefits, production decrease and overtime payments. There is no universal standard for estimating productivity costs, but the human capital and the friction approach are mentioned in the literature as being the two most utilized methodologies for valuing the productivity loss (98–100).

3.4.2 The Human Capital Approach

The human capital approach values the whole aspect of a person's life. This implies that a disease or injury entails that a person's productivity or time on the labour market is reduced. The human capital approach then seeks to put a value on this time forgone on the labour market, often using the market wage rate. The approach seeks to put a monetary value on all the benefits that are forgone if a person's time or productivity on the labour market is reduced due to illness or injury, and it should be measured as the total value for the entire period – the rest of that person's life.

The human capital approach is criticized for being too comprehensive by overestimating the true costs since it does not take into account that there is unemployment, and oftentimes an ill worker would be replaced by a healthy unemployed worker (99). Not all the costs estimated with the human capital approach would be paid by the employer, but some of the costs would fall upon the society and the human capital approach is of value when an economic evaluation is applying a societal perspective (19,98–100). The second approach to estimating the costs of productivity losses is the friction approach.

3.4.3 The Friction Approach

The friction approach differs from the human capital approach in the way that it is only concerned with the costs in the period for when a worker turns ill to when a suitable replacement is hired and trained – the friction period (102). The friction approach is, therefore, only concerned with the costs that occur within a limited timeframe. The period for when the productivity costs occur is less than with the human capital approach. This implies that, in the case of merchant seafarers, the friction period is from when the seafarer is turning sick up until the seafarer is declared fit for duty and can return to the ship or when a suitable replacement has been found and trained and sickness benefits are no longer paid to the repatriated seafarer. According to the friction method, when a replacement is found and hired, the marginal costs are costs that should be included as friction costs (25). Besides the costs of the loss of productivity in the friction period, there are costs associated with hiring and training new personnel and these costs are also a part of the indirect costs (98–100). The friction method applies the market wage rate as the proxy for the value of the production loss (100). This is in accordance with the theoretical approach to estimate the value of lost production, since the market value is supposed to reflect the marginal revenue product, and productivity losses equaling one person should equal this person's wage. However, many studies utilize an elasticity of 0.8, because the elasticity between manual labour time versus manual labour productivity has been found to be between 0.6 and 0.9. This indicates that a reduction in labour time causes a less than proportional reduction in productivity (102).

The overall argument in favor of the friction approach is that when someone is away from work, the productivity only drops for a limited time until a replacement is hired and trained accordingly.

In the literature, no consensus is reached regarding whether either of the two approaches is the most appropriate, and Krol and Brouwer (2014) mention this as the reason to why productivity costs are often ignored in economic evaluations.

The conclusion in regards to costs of lost productivity must be to include them in the analysis if it makes sense and the utilized approach – Human capital or Friction – depends on the objective of the costing exercise.

4. Methods and materials

This section describes the methods and materials that were applied and utilized in order to answer the research questions. The purpose of this section is to provide the reader with detailed information in regards to how the results were derived for maximum transparency.

The aim of this study was to investigate the total costs of repatriation for the four case vignettes by estimating the direct and indirect costs. To estimate the direct cost of repatriation, a local approach was used based on data from DMA (19) and to estimate the indirect costs a mixed approach was used, which is further elaborated on in section 4.4.4.

The first step to estimate the cost of repatriation was to establish the four case vignettes. Thereafter, a formula was created with the purpose of detailing all the costs that should be included in order to estimate the average total costs of repatriation.

4.1 Case Vignettes

The four case vignettes utilized for this study were derived based on inputs from medical professionals with extensive knowledge within the field of merchant seafarers, and from latest epidemiological research describing the reasons for repatriation (8,26). The four vignette cases were designed by classifying them according to the World Health Organization's 2016 ICD-10 codes (27) and age and gender were outlined for some of the diagnoses, which are presented in the pre-specified case vignettes below:

- IX Diseases of the circulatory system: I21 Acute myocardial infarction – A male aged 45-55
- IX Diseases of the circulatory system: I10 Malignant Hypertension – A male aged 45-55
- XI Diseases of the digestive system: K35 Acute appendicitis – Male/female aged 20-30
- I Certain infectious and parasitic diseases: B54 Malaria – Both genders, all age-groups

4.2 Identifying the cases

This section elaborates on how the cases were identified. The primary data source for cost information was the Danish Maritime Authority (DMA), as it reimburses the ship-owners costs of repatriation and keeps a detailed record of the reimbursements made in the last five years. However, the DMA only keeps paper archives of all the reimbursement cases, making it highly difficult and time consuming to identify the relevant cases to fit the case vignettes.

The identification of the cases to fit the case vignettes were instead derived from Radio Medical Denmark records, which contains information on the date of the call, the expected diagnosis, personal identification number, gender of the seafarer and whether a helicopter emergency medical service or deviation was used to get the seafarer from the ship to shore. With the help of the supervisors, the relevant four cases were identified. For each case vignette, one case from Radio Medical Denmark was found and utilized in the costing exercise.

The identified cases were derived from the period of 2011 to 2013, which is why the total costs of the repatriation cases were transformed into 2013 prices using the Danish consumer price index (103).

4.3 Establishing cost categories and measuring costs

This study followed the framework for a costing study described in the theory section 3.2.1, where it was described – based on recommendations from Mogyorosy and Smith (2005) – that a costing exercise follows these predefined steps; *I) Portray the objectives of the costing exercise, II) Detailed description of the service(s) for costing, III) Identification and classification of resource items and units of resources utilized, IV) Measuring resource consumption in natural units and V) Placing a monetary value on the resource units* (87).

4.3.1 Objectives and perspective of the costing exercise

The objective of this cost study was to retrospectively estimate the costs of repatriation for the four case vignettes outlined in section 4.1 with an employer perspective. The aim was to estimate the average total costs of repatriation for each of the four case vignettes.

The timeframe can vary from case to case since illness duration cannot be expected to be similar across cases, but it will be no longer than 18 weeks since this is the maximum time that is reimbursed by DMA, unless special circumstances prolongs this timeframe (55,104), and in that case, it will be explicitly stated in the results part, both the reason for extension and the costs that occurs in the extension period. As the repatriation costs remain to be established, a methodology to do so had to be developed to assess the economic burden of repatriating ill seafarers. As explained in the theory section, several methods to estimate the cost of illness exists, however they remain to be applied to the maritime field.

The next section outlines the cost formula that was developed to assess the economic burden of repatriation. The formula seeks to ease the understanding of which variables should be included in a cost estimation of the total costs of repatriation.

4.3.2 Establishing a cost formula

A cost formula was established with the purpose of leveling out the relevant costing categories that should be captured in order to fully assess the average total costs of repatriation.

The objective of this thesis was to estimate the total cost of repatriation (C_{Total}), which is comprised of the direct costs (C_{Direct}) and the indirect costs ($C_{Indirect}$) (20). The total costs are therefore illustrated by: $C_{Total} = C_{Direct} + C_{Indirect}$

As stated in section 3.2, the direct costs of repatriation are related to helicopter evacuation or deviation, further transportation costs such as ambulance and airplane to repatriation country, hospitalization, medication, rehabilitation and sickness benefits, which can be expressed in the formula (53):

$C_{Direct} = C_{Transport} + C_{Treatment} + C_{Compensation}$

The indirect costs are expressed as: $C_{Indirect} = C_{production\ loss} + C_{recruit} + C_{overtime} + C_{insurance\ premium} + C_{manage}$

$C_{production\ loss}$ are the costs resulting from a slowdown in production.

$C_{recruit}$ are the costs of hiring an additional worker to replace to repatriated seafarer.

$C_{overtime}$ are the costs related to paying overtime to other seafarers in order to avoid a slowdown in production.

$C_{insurance\ premium}$ are the costs related to an increase in insurance premium either to the P&I club or to the DMA or both, which occurs after having the costs related to repatriation reimbursed.

C_{manage} are the costs related to managing the repatriation case e.g. that the master of the vessel must spend time compiling the receipts and claiming reimbursement (25).

This formula for the costing exercise is flexible enough to accommodate the data from DMA. For some cases, detailed inputs from DMA are available based on the receipts sent to DMA from the employer for reimbursement and, in other cases, the data only fits within the pre-specified categories.

If the data were more detailed than what was needed in order to fit the data into the categories, a detailed cost explanation was compiled in the appendix, and it was stated in the result section for each case vignette, if more detailed data was available. In other cases, only the overall data reimbursed by DMA was available and, in these cases, it will be a total amount spent on the categories e.g. hospital, medication and transportation, but it will not be more detailed than that.

4.4.3 Identification and classification of resource items and units of resources utilized

In the third step, a detailed description of the resource utilization of each of the four case vignettes were created and the resource utilization for each case vignette was measured using the local approach (19,25). Where it was not possible to utilize the local approach, aggregated data based on assumptions from Henny and colleagues (2013) had to be used. Each case was presented with the costs included in the different cost categories in the cost formula, which illustrates the resource consumption for both direct costs and indirect costs based on the data from DMA and Radio Medical Denmark. Indirect costs, such as insurance premiums, costs related to managing the repatriation case, and replacement costs are not captured in the data from DMA and assumptions in this regard had to be made.

4.4.4 Measuring resource units and placing a monetary value on the resource units

The fourth and final step of this cost exercise was to measure resource units and place a monetary value on the consumption. It is described in the two following sections how this was done for the direct costs and the indirect costs estimation.

4.4.4.1 Direct costs

For this exercise, the data for estimating the direct costs was provided by DMA records for reimbursement claims and were estimated using a local approach. In order to get reimbursement, the shipping companies must provide the DMA with detailed information on the costs related to treatment, transport and sickness benefits of the repatriated seafarer, hereby, the local approach (25). These costs will be based on fees and charges from hospitals, transportation services, pharmacies, general practitioners and sickness benefits. The costs were all provided in Danish Kroner (DKK) as this was the currency reimbursed to the shipping companies.

This was exchanged to euro (EUR) with current exchange rate from the European Central Bank (105). As the costs occurred in different time periods 2011 to 2013, the total cost estimates were all transformed into 2013 prices using the Danish retail price index derived from Statistics Denmark (103). The cost transformation formula and currency exchange rates are provided in Appendix VI.

In most cases, DMA or Radio Medical Denmark had a record of whether the seafarer was evacuated by rerouting the ship, by helicopter, by boat or just set ashore at the coming harbor. The costs of these activities are often not on file, which is why these estimates had to be based on the existing published literature stating that helicopter rescue at sea costs on average 25,000 euro per evacuation and that the average merchant vessel consumes 100 tons of fuel per day at a cost of 525 euro per ton (7). In the data from conversations with Radio Medical Denmark, it can be stated the estimated time for rerouting in the specific case. If a specific time estimate was in the case, then this time estimate was used to estimate the cost of rerouting based on an hourly fuel consumption of 100/24 = 4.2 tons of fuel per hour at a cost of 525 euro per ton. If nothing was stated in the data, then the average rerouting estimate of 1.5 days was utilized (7). Henny and colleagues' (2013) assumption regarding the cost of fuel of 525 euro per ton is in accordance with the prices today – 17th April 2017 (106). The repatriated seafarer was entitled to sickness benefits, which were included as a part of the direct costs. The sickness benefits were reimbursed by DMA and the length of sickness benefits was available in the data from DMA. During the first month of sick leave, the seafarer was entitled to his or her normal wage (57). The normal wage can be on the records of DMA, but is often not the case. If the normal wage was not on file, this estimate was based on assumptions according to data from Marine Insight (107).

4.4.4.2 Indirect costs

For estimation of the indirect costs less information were available. In order to estimate the indirect costs, the friction method was applied. The data from DMA provides information on the duration of sickness benefits paid to the repatriated seafarer. This time period was then the friction period as this is the period for when productivity losses, additional expenses to sickness benefits and recruitment of a new seafarer could occur.

If information on sickness benefits was lacking in the data from DMA, it was assumed that the friction period lasted 18 weeks, which was the maximum duration that sickness benefits were covered by the DMA (57).

It was assumed that fellow seafarers worked overtime in the period between when the seafarer turns ill and a new merchant seafarer was recruited in order to avoid a production loss, which entails that there was no production loss. At some point, a medical decision was made in regards to whether or not the seafarer could be found fit-for-duty. This decision is on file at the DMA and the period for when overtime occurred was the period between the seafarer turning ill and the decision regarding fit-for-duty was made. Since these are all repatriation cases, the seafarer would, in all cases, be found not-fit-for-duty and the seafarer therefore had to be replaced. It was assumed that the recruitment process in all cases is straightforward and takes two days. This indicates that fellow seafarers had to work overtime in the period between the seafarer turning ill and the medical decision of not-fit-for-duty, plus an additional two days allowing for the new recruited employee to reach the ship. The cost of overtime was based on the wage of the repatriated seafarer (107) by assuming that the wage was based on a 200 hour work month. The daily overtime was assumed to be 8 hours.

The replacement of the seafarer has some costs, which in this case was assumed to be a two-month salary paid up-front. The salary of the newly recruited seafarer was based on the salary of the repatriated seafarer since it was assumed that the newly recruited seafarer had the same country of origin and skill level as the repatriated seafarer and, therefore, no further training was needed. The newly recruited seafarer had to be transported from country of origin to the port, where he or she had to board the vessel, which was assumed to have a cost of 1500 euro (53).

In the case of repatriation, the master of the ship spends time establishing contact with Radio Medical and also claims reimbursement to DMA. It was assumed that each contact to both Radio Medical and DMA had a cost of 100 euro for the time spent by the master of the ship. The number of contacts was accessible with the data from DMA and Radio Medical. If no data were available, it was assumed that there were five contacts at a total value of 500 euro.

There was no data available of how much an insurance premium would increase based on a repatriation case, but for the sake of this thesis, it was assumed that the premium increase was 10% of the costs reimbursed by DMA and the P&I club. No information was provided anywhere regarding charterer loss penalties and these costs were not included in the estimation of the average total costs of repatriation.

The provided numbers above are summoned up in the table below.

Table 2: Summary of cost estimates and assumptions

Category	Description	Estimate EUR
Direct costs	Average cost per hour of ship diversion (100 ton/24*525 EUR)	2,200 per hour of diversion
Direct costs	Average costs per helicopter mission (assumption)	25,000 (7)
Direct costs	Seafarer wage in the first month of absence	Based on Marine Insight data (107)
Indirect costs	Overtime for fellow seafarers 8 hours per day spent working overtime	Based on salary of repatriated seafarer assuming a 200 hour work month
Indirect costs	Replacement costs (1 flight ticket to the vessel)	1,500 (53)
Indirect costs	Replacement costs (Up front salary to new seafarer two month)	Same monthly salary as repatriated seafarer (107)
Indirect costs	Insurance premium increase (7)	10 % of reimbursed costs (Assumed based on Henny et al. 2013 stating that insurance increases)
Indirect costs	Master of the ship managing the case (assumption)	100 Euro per contact with DMA and Radio Medical

4.4.5 Sensitivity Analysis

A sensitivity analysis was carried out in order to investigate the robustness of the cost categories. The sensitivity analysis addressed the uncertainties regarding the cost estimates and assumptions (22). The sensitivity analysis was carried out with a base case scenario – the costs explained in Table 3 – and an optimistic and pessimistic scenario. The reimbursed costs by DMA were not prone to the sensitivity analysis and were the same in the optimistic, base and pessimistic case scenarios, since no uncertainty surrounded these estimates.

The results of the sensitivity analysis were shown in a tornado diagram, which shows the impact of the different cost scenarios for that particular variable on the percentage of total costs for the case vignette. The purpose of the tornado diagram is to illustrate the impact of the uncertainties surrounding some of the cost variables (108).

4.4.5.1 Optimistic scenario

For the optimistic scenario, cost assumptions were decreased. In regards to rerouting the vessel, it was assumed that the average vessel consumes 50 tons of fuel per 24-hour period instead of 100 ton. The costs of helicopter evacuation was decreased to 9,200 euro, which was found to be in the middle cost per patient transport within land-based helicopter emergency services (109,110). The wage of the seafarer was decreased to the minimal wage from International Transportation of Workers' Federation (ITWF) and the costs of recruiting a new seafarer were decreased by applying the minimal wage from ITWF (62). For the replacement costs, a lower cost for the transportation of the newly recruited seafarer was applied – 500 euro. In terms of overtime, the minimal hourly wage plus overtime rate of 25% from ITWF was applied (62), and the cost per captain contact with DMA and Radio Medical was assumed to come at a cost of 50 euro per contact. In the base case, it was assumed that there would be an insurance premium increase of 10% of the total reimbursed costs. In the optimistic case scenario, it was assumed that there was no insurance premium increase.

The table below sums up the assumptions for the optimistic case scenario.

Table 3: Summary of cost inputs for the sensitivity analysis optimistic case scenario

Category	Description	Estimate EUR
Direct costs	Average cost per ship diversion per hour (50 tons of fuel/24*525 EUR	1,100 per hour of deviation
Direct costs	Average costs per helicopter mission (assumption)	9,200
Direct costs	Seafarer wage in the first month of absence	Based on ITWF minimal wage according to rank (62)
Indirect costs	Overtime	Based on minimal hourly overtime rate and rank of seafarer (62)
Indirect costs	Replacement costs (Transportation)	500
Indirect costs	Replacement costs (Two month salary up front)	Similar to repatriated seafarer
Indirect costs	Insurance premium increase	None
Indirect costs	Master of the ship managing the case	50 Euro per contact with DMA and Radio Medical

4.4.5.2 Pessimistic scenario

In the pessimistic scenario, the cost assumptions were increased and the assumptions and cost estimates are shown in Table 4. For the wage of the seafarer, data from Payscale.com was used with the 90th percentile as the proxy for monthly wage of the seafarer also taking into account the rank (111).

Table 4: Summary of cost inputs for the sensitivity analysis pessimistic case scenario

Category	Description	Estimate EUR
Direct costs	Average cost per ship diversion per hour (150 ton of fuel/24*525 EUR)	3,300 per hour
Direct costs	Average costs per helicopter mission	37,500
Direct costs	Seafarer wage in the first month of absence	Based on 90th percentile salary in data from PayScale Inc. based on rank (111)
Indirect costs	Overtime	Based on salary of repatriated seafarer provided by PayScale inc. assuming a 200 hour work month
Indirect costs	Replacement costs (transportation)	5,000
Indirect costs	Replacement costs (Two month salary up front)	Similar to repatriated seafarer
Indirect costs	Insurance premium increase	20 % of reimbursed costs
Indirect costs	Master of the ship managing the case	200 euro per contact with DMA and Radio Medical

To sum up, the table below provides an overview of the three scenarios. All numbers are provided in euro.

Table 5: Summary of cost inputs for the base case scenario and the sensitivity analysis

Category	Description	Optimistic Assumption/Estimate	Base case Assumption/Estimate	Pessimistic Assumption/Estimate
Direct costs	Average cost per ship diversion	1,100 per hour of diversion	2,200 per hour of diversion	3,300 per hour of diversion
Direct costs	Average costs per helicopter mission (assumption)	9,200	25,000	37,500
Direct costs	Seafarer wage in the first month of absence	Based on ITWF minimal wage (62)	Based on Marine Insight data (107)	Based on data from PayScale Inc. (111)
Indirect costs	Overtime per ten day period	Based on salary of repatriated seafarer provided by **ITFW** assuming a 200 hour work month	Based on salary of repatriated seafarer provided by **Marine Insight** assuming a 200 hour work month	Based on salary of repatriated seafarer provided by **PayScale inc.** assuming a 200 hour work month
Indirect costs	Replacement costs (transportation)	500	1,500	5,000
Indirect costs	Replacement costs (salary)	Two month salary up front similar to repatriated seafarer		
Indirect costs	Insurance premium increase	None	10 % of reimbursed costs	20 % of reimbursed costs
Indirect costs	Master of the ship managing the case	50 Euro per contact with DMA and Radio Medical	100 Euro per contact with DMA and Radio Medical	200 Euro per contact with DMA and Radio Medical

5. Results

This section is the fifth main section of this thesis, and it outlines the results from the cost analysis for the four case vignettes.

5.1 IX Diseases of the circulatory system: I21 Acute myocardial infarction – A male aged 45-55

On 23rd October 2011, the captain of the vessel contacted Radio Medical Denmark. A Filipino seafarer aged 52 working as chief cook experienced light pain in the chest. The seafarer was known to have hypertension, but had run out of medication the week before. A storm was in the area and medical evacuation with helicopter was considered impossible. The seafarer was treated by the ships medical officer with some light painkillers, diuretic and anti-hypertension drugs. On the 24th, the pain in the chest had worsened and the seafarer was also experiencing pain in both arms. Radio Medical Denmark advised to evacuate the seafarer immediately by helicopter, which was now possible. The seafarer was evacuated by helicopter to the port of Bergen, where he was transported by car to a hospital. The seafarer was diagnosed with an acute myocardial infarction (AMI) and had a percutaneous coronary intervention (PCI), also known as angioplasty (112). The seafarer was hospitalized for 12 days until 5th November 2011, where the seafarer was found not-fit-for-duty and had to be transported back to the Philippines. At the Philippines, the seafarer received further medical attention and was hospitalized; however, the data from the Danish Maritime Authority (DMA) does not outline the specifics regarding the treatment that he received at the Philippines – only the reimbursed expenses. The seafarer received more than 18 weeks of treatment; however, DMA only reimbursed within the 18-week period. The shipping company did not get reimbursement for medical expenses of 300 euro since they occurred after week 18. These expenses are not included in the average total cost of this repatriation case either.

DMA reimbursed sickness benefits for the full 18 weeks. Falck Agency assisted with transportation of the seafarer and immigration issues and for this service they received a fee. It is assumed that the fellow seafarers had to cover for the sick cook. As the ill cook was hospitalized in Norway for 12 days, it was assumed that the fellow seafarers worked overtime in the 12 days and then the cook was found not-fit-for-duty and a replacement was found within two days. This meant that fellow seafarers worked overtime for a total of 14 days. The newly recruited seafarer was hired at the same monthly wage as the repatriated cook, which was assumed to be 4230 Euro (107).

With the data from DMA and Radio Medical, it is pointed out that it was the master of the ship who provided the immediate care of the seafarer and he had three contacts with Radio Medical and made three reimbursement claims to DMA. So in total, the master of the ship had six contacts with Radio Medical and DMA and five contacts with the seafarer at an assumed cost of 100 Euro per contact, totaling 1100 Euro for the time the master of the ship spent of the case.

The table below illustrates the costs inputs of this repatriation case. For a more detailed table see Appendix V.

Table 6: Summary of costs – Case vignette no. 1 AMI

Cost category	Cost description	Total EUR	Percentage of total costs
Direct	Compensation (sickness benefits and first month salary)	5,856	6.1%
Direct	Helicopter evacuation and transportation	25,306	26.4%
Direct	Hospitalization and medicine	42,816	44.7%
Direct	Other: Falck agency fee to assist seafarer	876	0.9%
Indirect	Insurance premium increase (10% of all costs reimbursed by P&I club or DMA)	7,485	7.8%
Indirect	Overtime for fellow seafarers (8 hours*14 days at an hourly rate of 21 euro)	2,352	2.5%
Indirect	Replacement (salary to new seafarer up-front 2 months and transportation)	9,960	10.4%
Indirect	Master's time of managing the case	1,100	1.1%
	Total costs 2011 value	95,752	
	Total costs 2013 value: $\frac{95{,}752*6{,}821}{6{,}609}$	**98,823**	

The table below illustrates the sum of indirect, direct and total costs.

Table 7: Summary of average indirect, direct and total costs – Case vignette no. 1 AMI

	Total EUR (2011)	**Total EUR (2013)**	**Percentage of total costs**
Sum of direct costs	74,854	**77,255**	**78 %**
Sum of indirect costs	20,897	**21,567**	**22%**
Total costs	95,752	**98,823**	**100%**

As shown by the estimates, the average total cost of this repatriation case with the seafarer turning ill with AMI resulted in total costs of 95,752 euros. The average total costs of 95,752 euro in 2011 was transformed into 2013 value, which meant that the average total costs of repatriation for case vignette number one was 98,823 euros. In this case, the average direct costs of repatriation were the main cost driver compared to indirect costs – 78% vs. 22% respectively. The biggest single cost driver was the hospital and medicine costs that amounted to 42,816 euro – 44.7% of total costs. In the data from DMA, medicine and hospital costs were divided into two categories; medicine costs were 99 euro and hospital costs in Norway were 14,750 euro, and in the Philippines these were 27,968 euro (Appendix V). Medicine, therefore, only accounted for 0.1% of the average total costs which is extremely low for treating an AMI, but most likely pharmaceuticals were included in the hospital cost. However, the data do not specify this. Helicopter evacuation and transportation on shore was the second largest cost driver, which accounted for 26.4% of the total costs. In this cost category, the costs of helicopter evacuation of 25,000 euro and transportation in Norway of 306 euro are included, which is pointed out in the detailed cost description in Appendix V.

In the data from DMA, no further reimbursement for transportation was given to the shipping company; however, reimbursement was given to Falck Agency. The reimbursed services concerned assistance to the seafarer from the Hospital to Bergen Airport. The reimbursed agency fee was 876 euro. No reimbursement was granted for the transportation to the Philippines and the costs of this trip were not specified in the data. No assumptions were made in this regard, and the transportation costs from Norway to the Philippines of the repatriated seafarer were not included in the average total costs of this repatriation case.

Further, there were some expenses that were not covered by reimbursement by the DMA. These are also pointed out in the detailed description (Appendix V) and amounted to 604 euro. These 604 euro are not part of the total average costs of 98,823 euro.

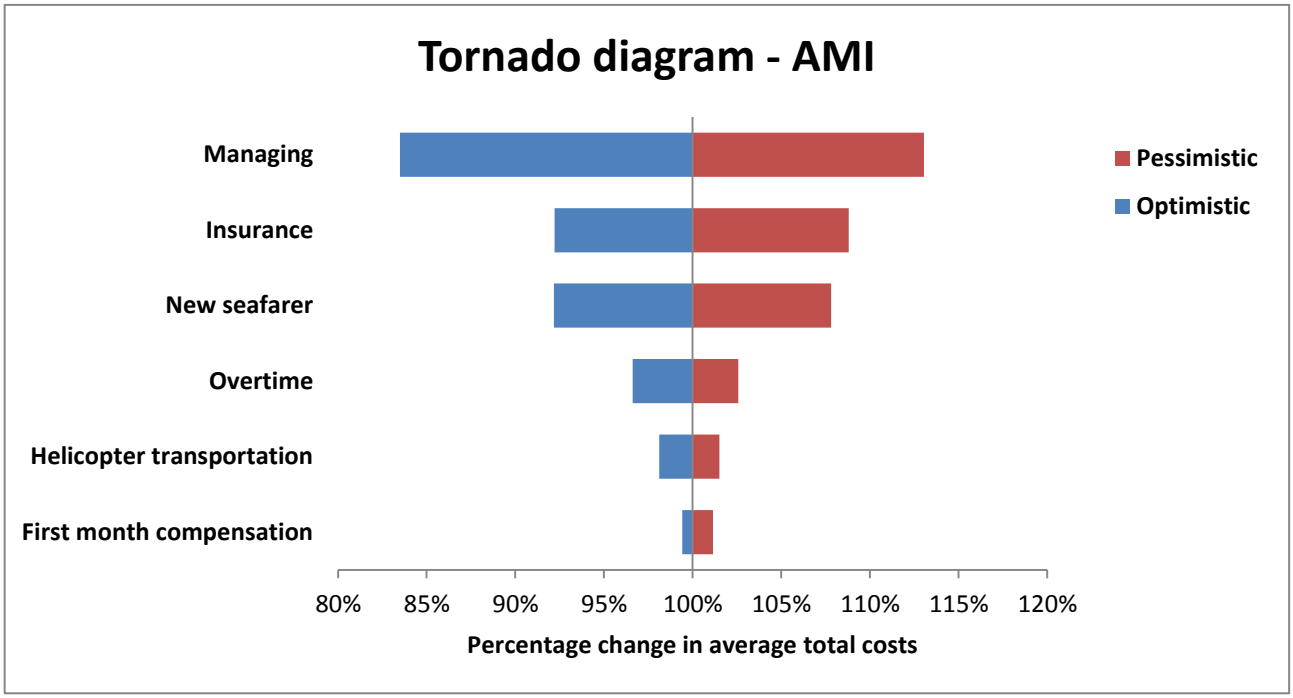
A sensitivity analysis was carried through in order to address the uncertainties surrounding the cost estimates that are based on assumptions; *replacement, master's time, insurance premium increase, helicopter transportation, overtime for fellow seafarers*. The cost inputs for the optimistic and pessimistic case scenario are provided in Table 8. The cost inputs provided directly from DMA are not prone to the sensitivity analysis and will be the same in the base case, optimistic case and pessimistic case scenarios. Table 8 on the next page illustrates the cost inputs for the sensitivity analysis.

Table 8: Summary of sensitivity analysis cost assumptions – Case vignette no. 1 AMI

Cost category	Description	Optimistic Assumption/Estimate (EUR)	Pessimistic Assumption/Estimate (EUR)
Direct	Cost of helicopter mission	9,200	37,500
Direct	Seafarer wage in the first month of absence	1,000 (62)	6,700 (113)
Indirect	Overtime in 14 day period per ten day period	5 euro per hour for 112 hours = 560	34 euro per hour for 112 hours = 3,800
Indirect	Replacement costs	2,500 (2,000 in up-front salary and 500 for transportation)	18,400 (13,400 in up-front salary and 5,000 for transportation)
Indirect	Insurance premium increase	None	20% of reimbursed costs
Indirect	Master of the ship managing the case	50 Euro per contact with DMA and Radio Medical	200 Euro per contact with DMA and Radio Medical

The figure below is a tornado diagram, which portrays the uncertainties in the cost estimates and their impact on the average total costs of this repatriation case vignette. Appendix V provides a similar tornado diagram, with absolute values instead of relative impact.

Figure 3: Tornado diagram illustrating the sensitivity analysis – Case vignette no. 1 AMI



The pillars in blue and red on the tornado diagram illustrate the impact that this cost category has on the total costs for the two sensitivity scenarios. The place on the x-axis, where the two pillars meet is the base case scenario, which in this case had a total cost of 98,823 euro or 100 percent of average total costs. The blue pillar illustrates the optimistic case in which the total costs of repatriation decreases, and the red illustrates the pessimistic case, where the total costs increases. In this case, where the repatriated seafarer had an AMI, the sensitivity analysis addressed the uncertainties regarding the cost categories that were not reimbursed by DMA – primarily the indirect costs and helicopter evacuation. The tornado diagram illustrates that helicopter evacuation costs, replacement costs and insurance premiums are the three major cost drivers surrounded by some uncertainty that could have an impact on the total costs.

The first month compensation to the affected seafarer has some impact on total costs. The overtime category and cost of managing the case only has minor impact on total costs in the optimistic and pessimistic case scenario.

5.2 IX Diseases of the circulatory system: I10 Malignant Hypertension – A male aged 45-55

On 6th April 2013, Radio Medical Denmark was contacted regarding a male Filipino 2nd engineer at age 50 who had turned ill. The seafarer was presented with eye pain, which had occurred during working at a computer in the morning and he was later experiencing a left side headache. The blood pressure was measured to 235mmHg/124mmHg, but no further action was taken on this day. This is a very high blood pressure, where a normal blood pressure should be in the interval 100-140 mHg/60-90 mmHg (114). The next day, contact with Radio Medical Denmark was established again, since the pain in the head and eye was more severe. The seafarer received medicine according to advice from Radio Medical and it was decided that the seafarer should seek a doctor, when the ship was planned to reach its destination at April 10th – three days later. On 8th April, the seafarer was vomiting and complaining of chest pain and was treated with further medicine from the ship's medicine chest based on recommendations from Radio Medical. Radio Medical gave the seafarer a preliminary diagnosis of malignant hypertension, however a suspicion of a more severe diagnosis such as myocardial infarction was present and had to be investigated further. An agreement between Radio Medical and the master of the ship was made that the ship should reroute to port in order to get the seafarer to medical treatment. In the papers from Radio Medical, it is stated that the ship had to deviate from its course to the port of Shanghai, which lasted six hours. The seafarer then received medical attention and was found not-fit-for-duty. DMA reimbursed hospital expenses at a cost of 332 Euro and transportation to the Philippines at a cost of 296 Euro. No further costs were reimbursed by DMA. Since the hospital costs were very low, it was assumed that the seafarer was discharged from the hospital the same day, but as he was found not-fit-for duty, a new seafarer was recruited. Based on this information, it was assumed that fellow seafarers had to work overtime for a total of three days, which based on the salary of a second engineer would equal an hourly wage of 40 euro (107).

Since data on sickness benefits are lacking from DMA records, it was assumed that the repatriated seafarer was ill for the whole period of 18 weeks with monthly sickness benefits of 1006 Euro (62). It was assumed that as a second engineer, the normal wage was 8000 Euro (107). From April 6th to the 8th the master of the ship had five contacts with Radio Medical and two reimbursement claims to DMA, totaling a cost for the master of the ships time of 700 euro. The costs provided by the reimbursements and the assumptions are provided in the table below. The cost of deviation is based on the stated six hours.

Table 9: Summary of costs – Case vignette no. 2 Malignant hypertension

Cost category	Description	Total EUR	Percentage of average total costs
Direct	Deviation for six hours at an hourly fuel consumption cost of 2200 euro	13,200	27.7%
Direct	Hospitalization	332	0.7%
Direct	Transportation to home country and accommodation	296	0.6%
Direct	Sickness benefits (first month of salary 8000 euro and 18 weeks of sickness benefits 4024 euro)	12,024	25.3%
Indirect	Insurance premium increase (10% of all costs reimbursed by P&I club or DMA)	2,585	5.4%
indirect	Replacement (salary to new seafarer for two month 16,000 euro and transportation 1,500 euro)	17,500	36.8%
Indirect	Overtime for fellow seafarers (8 hours*3 days*40 euro per hour)	960	2.0%
Indirect	Masters time of managing the case	700	1.5%
	Total costs 2013 value	**47,597**	

In this case, the seafarer had malignant hypertension; however, he was evacuated from the boat to shore, because of suspicion of acute myocardial infarction. As only 332 euro was reimbursed by the DMA stated as hospital costs, it must be assumed that myocardial infarction was not the diagnosis, as much more treatment would have been needed – see case vignette number 1. It is not further outlined in the data from DMA, what the hospital costs covered. It is, therefore, not possible to conclude further on the treatment the seafarer received, but it accounted for 0.7 percent of the average total costs of 47,597 euro for this repatriation case. Having a rank as a second engineer implied that this seafarer had a high monthly wage, which is also shown in the sickness benefits and the up-front payment to the newly recruited seafarer, which amounted to 28,024 euros. This was 58.9% of the total costs of this repatriation case. In this case, the major cost drivers were the costs of the new seafarer and sickness benefits and compensation.

The rerouting costs amounted to 13,200 euro and was also a major cost driver contributing with 27.7% of the total costs. This estimate of six hours only takes into account the time duration into the port. It does not take into consideration that further deviation time might occurred since the ship might had to sail the other way again.

A more detailed cost description is provided in Appendix VI. The table below illustrates that in this repatriation case the direct and indirect costs each contributed to nearly half of the total costs (54% vs. 46%).

Table 10: Summary of indirect, direct and total costs – Case vignette no. 2 Malignant hypertension

	Total 2013 EUR	**Percentage of total costs**
Sum of direct costs	25,852	54%
Sum of indirect costs	21,745	46%
Total costs	**47,597**	100%

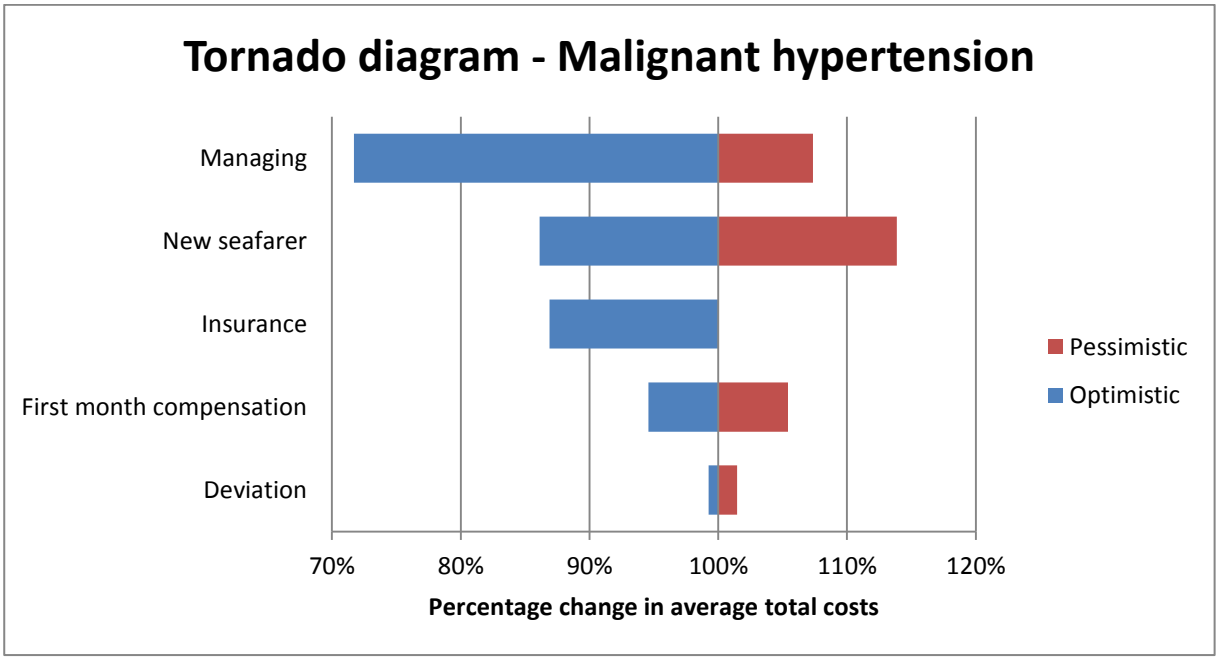
A sensitivity analysis was carried out for the pessimistic and optimistic case scenarios. The table below illustrates the cost inputs used for the sensitivity analysis for the seafarer with malignant hypertension.

Table 11: Summary of sensitivity analysis cost assumptions – Case vignette no. 2 Malignant hypertension

Cost category	Description	Optimistic Assumption/Estimate (EUR)	Pessimistic Assumption/Estimate (EUR)
Direct	Rerouting costs	6,600 (based on fuel consumption of 50 ton per 24 hour – with a reroute time of 6 hours)	19,800 (based on fuel consumption of 150 ton per 24 hour – with a reroute time of 6 hours)
Direct	Seafarer wage in the first month of absence	1,766 (62)	8,000 (115)
Indirect	Overtime per ten day period	144 (based on hourly overtime rate of 6 euro for a 2nd engineer (62)	960 (based on an hourly overtime rate of 40 euro (115)
Indirect	Replacement costs	4,032 (based on transportation of 500 euro and two month salary of 1766 euro per month)	21,000 (based on transportation of 5,000 euro and monthly wage 8,000 euro)
Indirect	Insurance premium increase	No increase	5,170 (20 % of reimbursed costs)
Indirect	Master of the ship managing the case	350 (50 Euro per contact with DMA and Radio Medical and a total of 7 contacts)	1,400 (200 Euro per contact with DMA and Radio Medical and a total of 7 contacts)

The tornado diagram on the next page illustrates (Figure 4) the relative impact that the changes proposed in Table 11 incur on the average total costs of this repatriation case vignette. As shown, the new seafarer costs had a big impact in the optimistic case mainly driven by a smaller monthly wage (8,000 euro vs. 1,766 euro). In the pessimistic case, the salary was not changed, and the change here was that the transportation costs of the new seafarer was increased (1,500 euro vs. 5,000 euro), which is the cause of the increase in total costs for the replacement costs in the pessimistic case scenario. It is the same scenario with the first month of compensation to the repatriated seafarer, which was 8,000 euro in both the base case and pessimistic case scenario, which is why it has no impact on total costs in pessimistic case scenario. The reason for this was that the 90th percentile salary of engineers from PayScale inc. (115) did provide the same estimate as the average one provided by Marine Insights (107). In the base case, it was lowered and it had some impact on total costs as illustrated by the tornado diagram below. Changes in the costs of deviation had a big impact on total costs, where a 50% decrease in fuel costs decreased the average total costs of repatriation with 14 percent from 47,597 euro to 41,000 euro and an increase meant that the total costs increased to 54,200 euro. The size of the insurance premium increase did have some impact on the total costs of repatriation – five percent in both the optimistic and pessimistic case scenario, and implies that insurance premium increase was not a major cost driver. The cost of the captain's time spent managing the case had only very little impact on the costs of repatriation as illustrated by figure 4.

Figure 4: Tornado diagram illustrating the sensitivity analysis – Case vignette no. 2 Malignant hypertension



5.3 XI Diseases of the digestive system: K35 Acute appendicitis

On 6th February 2011, Radio Medical provided medical advice in regards to a female Filipino seafarer aged 25 working as a second cook, who experienced severe abdominal pain. The seafarer had for some days experienced light stomach pain, which she thought was due to her period. On February 6th, the pain had become so severe that the master of the ship contacted Radio Medical Denmark. The master of the ship and the doctor from Radio Medical Denmark agreed that the ship had to reroute to the port of Malaga for emergency evacuation of the seafarer. The deviation time was estimated to be 12 hours. The patient was operated acutely for appendicitis. After surgery, the patient was found not-fit-for-duty. It is assumed that the seafarer was not hospitalized for more than one day, as this is the standard of care when having appendicitis surgery (116). It is, therefore, assumed that fellow seafarers only had to work overtime for a total of three days.

The seafarer was repatriated to the Philippines, where she attended a clinic for laboratory tests and to see a doctor. She was found fit-for-duty again on 29th March 2011, since 28th March 2011 was the last day that reimbursement for sickness benefits was made indicating that the friction period for this case vignette was 7.5 weeks. The table below provides an overview of the costs for this repatriation case.

Table 12: Summary of costs – Case vignette no. 3 Appendicitis

Cost category	Cost category/despription	Total EUR	Percentage of total costs
Direct	Deviation for 12 hours (Fuel consumption is 100 tons per 24 hour at a cost of 525 per ton)	26,400	46.5%
Direct	Hospitalization and medication	10,076	17.7%
Direct	Transportation	554	1.0%
DIrect	Sickness benefits and first month of compensation (4230 in first month salary 514 in sickness benefits for 7.5 weeks) (107)	4,744	8.4%
Indirect	Insurance premium increase (10 % of costs reimbursed)	4,177	7.4%
Indirect	Overtime fellow seafarers for 3 days (21 euro per hour * 3 days * 8 hours per day) days	504	0.9%
Indirect	Replacement (2 months up-front salary to new seafarer and transportation)	9,960	17.5%
Indirect	Managing the case	400	0.7%
	Total costs 2011 value	56,816	100.0%
	Total costs 2013 value $\frac{56{,}816*6{,}821}{6{,}609}$	**58,639**	

Table 12 shows that the average total costs of repatriation due to appendicitis were 58,639 euros. A more detailed cost overview is provided in Appendix VII.

The single biggest cost category was the cost of rerouting the ship for 12 hours, which had a cost of 26,400 euro – 46.5% of the total costs of this repatriation case vignette. In the data from Radio Medical, it is stated that the ship had to reroute for 12 hours to get to the port of Malaga and this estimate has been applied to derive the estimate. It is not considered in the estimate that there might have been additional rerouting time and therefore fuel consumption, when the ship had to get back on its original route.

The surgery and hospitalization accounted for 17.7 percent of the average total costs. Transportation, managing the case and overtime of fellow seafarers were small cost categories, as illustrated in Table 12 and combined made up 2.8 percent of total costs.

The table below shows that the direct costs in this repatriation case were the largest cost category (74%). Most of these costs were attributable to the fuel consumption costs of rerouting the ship, which accounted for 63% of the average direct costs.

Table 13: Summary of average direct, indirect and total costs – Case vignette no. 3 Appendicitis

	Total EUR 2011	**Total EUR 2013**	**Percentage of total costs**
Sum of direct costs	41,774	43,114	74%
Sum of indirect costs	15,041	15,523	26%
Total	56,816	**58,639**	**100%**

The table below illustrates the cost estimates – based on assumptions – which were utilized for the sensitivity analysis.

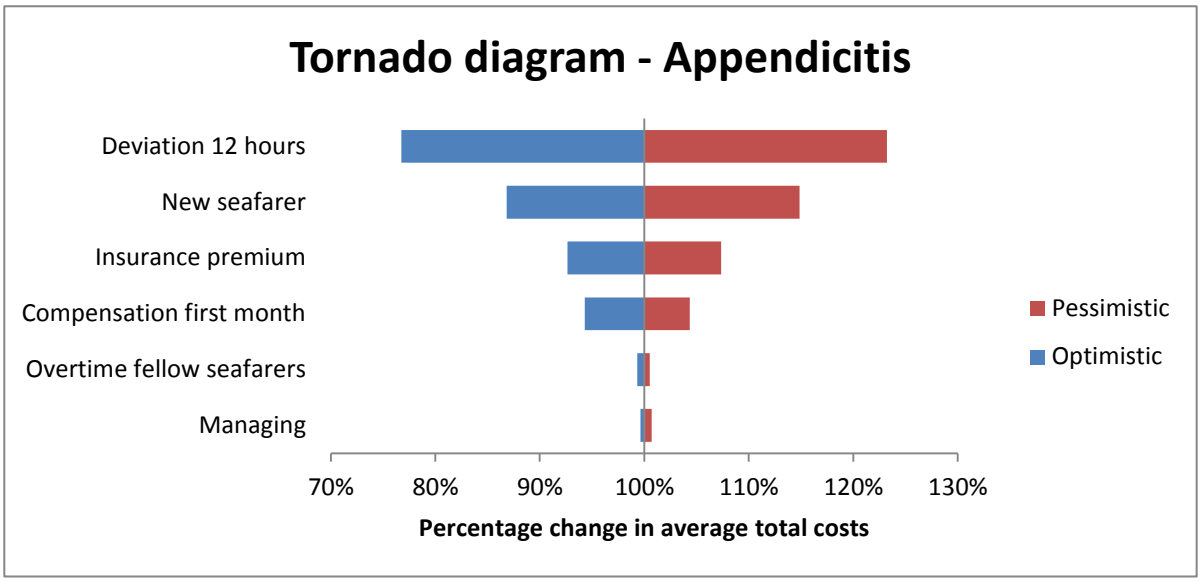
Table 14: Summary of sensitivity analysis cost assumptions – Case vignette no. 3 Appendicitis

Cost category	Cost description	Optimistic	Base	Pessimistic
Direct	Deviation for 12 hours (Fuel consumption is 100 tons per 24 hour at a cost of 525 per ton)	13,128	26,256	39,384
DIrect	Sickness benefits and first month of compensation	1,000 (62)	4,230	6,700 (113)
Indirect	Insurance premium increase (0%, 10 % or 20% of costs reimbursed)	None	4,162	6,244
Indirect	Overtime fellow seafarers for 3 days	120	504	804
Indirect	Replacement - 2 months up-front salary (62,111) and transport	2,500	9,960	18,400
Indirect	Managing	200	400	800

The tornado diagram in Figure 5 portrays the uncertainties of the assumptions in regards to the indirect costs and the direct costs categories; deviation and the compensation in the first month of sickness and is a result on the total costs of the optimistic and pessimistic case scenario, where the inputs are provided in the table above. The tornado diagram illustrates that changes in the deviation cost had an impact of 23 percent – in both the optimistic case and the pessimistic case scenario. Changes in fuel consumption of 50 percent could increase or decrease the average total costs of repatriation for this case with 23 percent. Costs associated with the newly recruited seafarer also had a high impact on the total costs and the deviation and new seafarer costs were

the two primary cost drivers. The categories managing and overtime have minor impact on the total costs since changes for each variable impacted average total costs with one percent.

Figure 5: Tornado diagram illustrating the sensitivity analysis – Case vignette no. 3 Appendicitis



5.4 I Certain infectious and parasitic diseases: B54 Malaria

On January 29th 2011, a 26-year-old Indian 2nd officer was evacuated from the ship to the port of Norfolk Virginia after a rapid malaria test had shown a positive result. The seafarer was transported to Norfolk General Emergency Department for further diagnosing and treatment. A boat service was utilized to get the seafarer from the vessel to shore. The patient was initiated on malaria treatment and discharged from the hospital the following day – January 30th. The seafarer was found not-fit-for-duty and had to be repatriated back to India. On February 1st, the seafarer was flown from Norfolk to Miami and then from Miami to London, where on February 2nd he flew to Mumbai, India. In India, he received further medical examinations – laboratory tests, chest x-ray and electrocardiography.

The recruitment process was initiated when the seafarer was found not-fit-for-duty. He was at the hospital for one night – two working days lost – and the recruitment was assumed to last two days, so the fellow seafarers had to work overtime for a total of four days. The Indian seafarer received sickness benefits in the period from January 30th to April 6th 2011, which is the friction period. In this repatriation case, no assumptions had to be made regarding the salary since the monthly salary of the repatriated seafarer was outlined and was 4371 euro.

The table below provides an overview of the repatriation costs. A more detailed cost overview is provided in Appendix VIII.

Table 15: Summary of costs – Case vignette no. 4 Malaria

Cost category	Cost category/description	Total EUR	Percentage of total costs
Direct	Transportation from ship to shore	1,093	4.7%
Direct	Sickness benefits (period 30JAN2011 to 6APR2011) and first month salary	5,927	25.7%
Direct	Transportation to home country and accommodation	713	3.1%
Direct	Treatment	1,530	6.6%
Indirect	Insurance premium increase (10% of costs reimbursed)	926	4.0%
indirect	Overtime fellow seafarers (4 days of 8 hours á 22 euro per hour)	704	3.1%
Indirect	New seafarer: salary and transportation	11,460	49.7%
Indirect	Managing	700	3.0%
	Total costs 2011 value	23,053	100.0%
	Total costs 2013 value $\frac{23{,}053 * 6{,}821}{6{,}609}$	**23,792**	

As illustrated by the table above, the total average costs of this repatriation case was 23,792 euros. The transportation cost from the vessel to shore was, in this case, 4.7 percent of the total costs.

The seafarer was evacuated by boat using a launch service. The main cost driver in this repatriation case was the costs associated with a newly recruited seafarer, which amounted to nearly half of the total costs – 49.7%. The secondary cost driver was the compensation and sickness benefits paid to the repatriated seafarer, which amounted to 25.7 percent of total costs.

The treatment costs were 1,530 euro, which covered treatment in the emergency department in Norfolk, Virginia, examination at a general practitioner clinic in Mumbai, India and medicine. The treatment costs amounted to 6.6 percent of the total costs of this repatriation case. The received data from DMA revealed that the master of the ship had one contact with Radio Medical Denmark and six contacts with DMA at an assumed cost of 700 euros for these seven encounters.

As the table below illustrates, the average direct costs made up 40% of the average total costs and the average indirect costs made up 60% indicating that, in this repatriation case, the indirect costs of repatriation were the main cost drivers.

Table 16: Summary of direct, indirect and total average costs of case vignette no. 4 Malaria

	Total EUR 2011	**Total EUR 2013**	**Percentage of total costs**
Sum of direct costs	9,263	9,560	40%
Sum of indirect costs	13,790	14,232	60%
Total	23,053	**23,792**	100%

The sensitivity analysis was carried out for the assumed cost estimated surrounded by uncertainty. The wage and sickness benefits were not prone to sensitivity analysis in this case as in the other case vignettes, as the data from DMA contained more detailed information in this regard and there was no uncertainty in regards to these estimates. The costs of the new seafarer remain prone to the sensitivity analysis as it is not certain that a new seafarer would have equal salary as the repatriated seafarer.

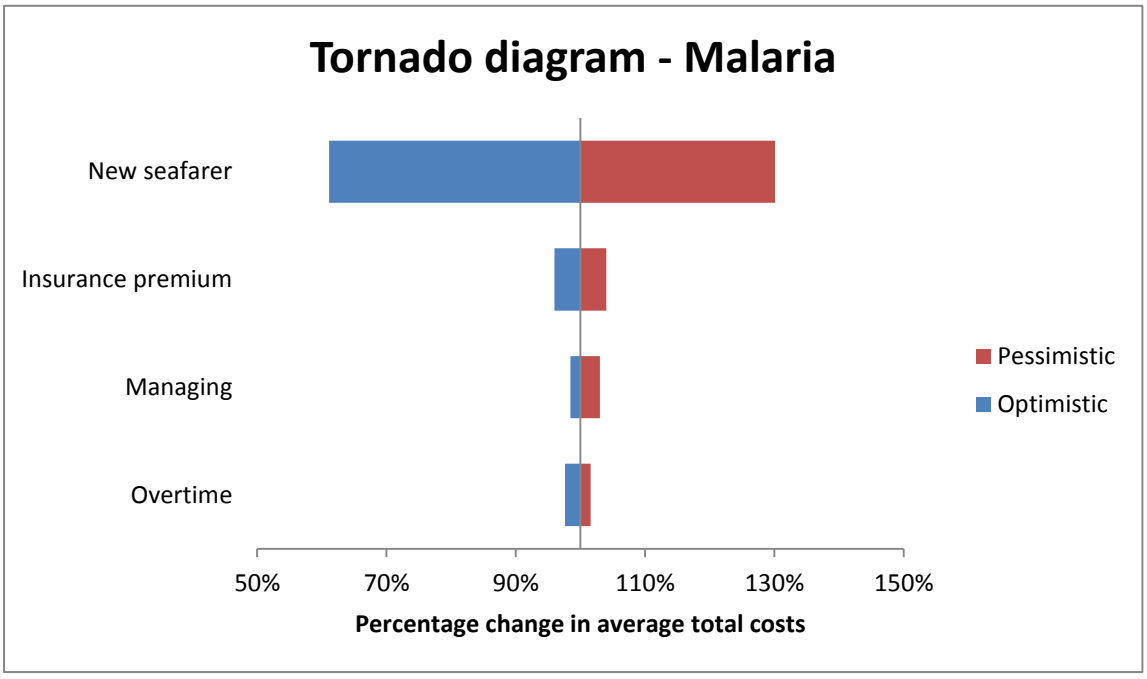
The cost inputs for the sensitivity analysis are provided in the table below.

Table 17: Summary of sensitivity analysis cost assumptions – Case vignette no. 4 Malaria

	Sensitivity Analysis			
Cost category	**Cost description**	**Optimistic**	**Base**	**Pessimistic**
Indirect	Insurance premium increase (0%, 10 %, 20% of costs reimbursed)	0	926	1853
Indirect	Overtime fellow seafarers for 4 days	160	704	1072
Indirect	New seafarer: salary and transportation	2500	11460	18400
Indirect	Managing	350	700	1400

The sensitivity analysis is illustrated in the tornado diagram below (Figure 6).

Figure 6: Tornado diagram illustrating the sensitivity analysis – Case vignette no. 4 Malaria



The tornado diagram illustrated in Figure 6 addresses the uncertainties in the total average cost estimate of this repatriation case of 23,792 euro. The data from DMA were comprehensive and, in this repatriation case, assumptions were only necessary to estimate the costs of; managing, recruiting and transporting a new seafarer, overtime of fellow seafarers and the insurance premium increase. As illustrated by Figure 6, a major impact on the average total costs was the costs of recruiting the new seafarer. In the base case, it was assumed that the new seafarer was recruited at an equal salary to the repatriated seafarer, but if the newly recruited seafarer received the minimal wage according to ITWF, then the impact would be that the average total costs of this repatriation case was reduced to 61 percent of the total costs in the base case. In the pessimistic case scenario, it was only the new seafarer costs that had a major impact on the average total costs of repatriation. In the pessimistic case scenario for the new seafarer, the total costs of repatriation were increased with 30 percent. The other variables managing, overtime and insurance premium had in the two scenarios prone to sensitivity analysis only minor impact on total costs – less than five percent.

6. Discussion

The sixth part of this thesis is the discussion section. In this section, the main findings from the previous sections are presented and discussed upon.

6.1 Summary of main findings

Based on the material from the Danish Maritime Authority (DMA) and Radio Medical Denmark, the average total costs of four case vignettes were estimated. The data yielded large variations in the average total costs of repatriation, where the costs ranged between 23,792 and 98,823 euros. This large gap in the cost of repatriation indicates a great heterogeneity in repatriation cases, where the least expensive repatriation case amounted to only a quarter of the average total costs of the most expensive repatriation case.

The most expensive repatriation case was case vignette number one, where the repatriated seafarer was suffering from the cardiovascular disease acute myocardial infarction (AMI), which has been pointed out as a common cause of repatriation (8). The average total costs of AMI amounted to nearly 99,000 euros in the 18-week friction period.

In case vignette number one, the employer had some additional costs, which in this case were not reimbursed by the DMA, because some of the costs occurred after the 18-week period and some costs were simply not accepted for reimbursement. The non-reimbursed costs amounted to 604 euro. The data from DMA revealed no cost record of transporting the affected seafarer from Norway to the Philippines, but the data included a receipt for transportation to the airport in Bergen. The estimate of 99,000 euro is, therefore, likely to be an underestimate of the financial burden held by the employer in this repatriation case. For this repatriation case, the direct costs accounted for 78 percent of the total costs.

In case vignette number two, where the seafarer was repatriated with the cardiovascular disease malignant hypertension and with a suspicion of an AMI, the average total costs amounted to nearly 48,000 euro. In this repatriation case, the seafarer was examined at the hospital after the ship had to reroute to the port of Shanghai in China. The hospital expenses were limited to 332 euro.

The data from DMA did not specify what these hospital expenses covered; however, it can be assumed that no comprehensive treatment was initiated at these costs and, therefore, the seafarer was most likely not suffering from an AMI. In this case, the compensation, sickness benefits and replacement costs accounted for 59 percent of the average total costs and the rerouting costs for 28 percent. Almost all costs (87%) were attributed to paying salary to the ill seafarer, transporting him to shore and replacing him after he was found not-fit-for-duty.

In case vignette number three, a female seafarer was repatriated due to appendicitis. The average total costs of this repatriation case vignette were close to 59,000 euros. In this instance, the seafarer had to have surgery and the treatment costs amounted to 18 percent of the total costs. The main cost driver in this repatriation case was the rerouting of the vessel for 12 hours to get the seafarer to shore. This had an estimated cost of more than 26,000 euro and accounted for 47 percent of the average total costs of this repatriation case. In this fuel consumption estimate, it was not considered that the vessel might had to sail for 12 hours to get back to its original route. The average direct costs accounted for 74 percent of the average total costs.

The fourth repatriation case was a malaria case. This is the only case where the seafarer was evacuated from the vessel to shore by boat. This had a low cost – 1093 euro – compared to helicopter evacuation, which had an estimated cost of 25,000 euro per evacuation or rerouting of the ship, which had an estimated fuel consumption cost of 2,200 euro per hour of rerouting. The malaria case vignette had an average total cost of nearly 24,000 euro and was the least expensive of the four case vignettes. The main cost drivers were costs related to replacing the repatriated seafarer, the new seafarer (50%), and paying sickness benefits of compensation to the repatriated seafarer (26%).

The variations in indirect costs between the cases were mainly due to differences in the salary of the seafarers. The average indirect costs varied between 14,000 euro in the malaria case and almost 22,000 euro in the malignant hypertension case vignette.
The variation indicates that average indirect cost proportions ranges between 22 and 60 percent in the case vignettes. Indirect costs remain to be a substantial cost driver and outline the importance of estimating indirect costs, when estimating the total cost of repatriation.

The great heterogeneity in the average total costs of repatriation was driven by large variation in the average direct costs. These differences in the direct costs were mainly due to large differences in; *I) the costs of getting the seafarer from the vessel to shore and II) differences in treatment costs.*

Transportation of the seafarer from the merchant vessel to shore – either by rerouting the vessel or helicopter – was shown to be a cost-intensive operation ranging between 13,000 and 26,000 per operation. Transportation by boat launch service was the least expensive option and had a cost of 1,093 euro. It is possible that this option is not feasible in many cases of repatriation due to the merchant vessel being too far away from shore and weather conditions.

In the data from Radio Medical Denmark, the estimated rerouting time was provided, when the vessels deviated from their course to get the seafarer to shore, as in case vignette number two and three. This estimate was applied to calculate the fuel costs of rerouting; however, it is likely that this estimate does not represent the entire time that the ship had to reroute since the ship possibly had to sail in the other direction after having set the ill seafarer ashore. If the ship had to sail for the same amount of time in the opposite direction, rerouting costs could have amounted to as much as nearly 53,000 euro in fuel consumption costs. The sensitivity analyses indicated that changes in deviation in the two scenarios had a high impact on the total costs of repatriation, which implies that rerouting the ship from its course to get the seafarer to shore is a major cost driver.

The heterogeneity in the costs of treatment for the four case vignettes were great, where the least expensive treatment amounted to 332 euro to treat malignant hypertension up to nearly 43,000 euro paid to treatment of acute myocardial infarction.

6.2 Discussion of the findings of this thesis in relation to existing literature

To set this thesis' results in a context of previous findings on the costs of repatriation of seafarers is somewhat difficult, since research within the field is sparse, which further speaks of the relevance and meaningfulness of the results provided by this project. Limited published literature is available and the most utilized in this regard is a business case for telemedicine (7).

In the business case, it was estimated that the annual number of repatriations amounts to nearly 10,000 with an annual estimated cost of 760 million euro (7). The results of this thesis found that the costs per repatriation case ranged between 24,000 and 99,000 euro, and by the basis of these results, the annual costs of repatriation for 10,000 repatriation cases is somewhere between 240 million and 1 billion euros. The least expensive case vignette in this thesis had an average total cost of 24,000, with only minimal costs of health services provided to the seafarer and evacuation by boat. It is not likely that this case vignette is representative of the average repatriated seafarer, as it must be expected that in many cases of ill seafarers, more health services and more expensive evacuation are needed. The case vignettes for malignant hypertension and malaria do point out that repatriation of an ill seafarer is a highly cost intensive operation from the employer's point of view, even if limited health care services are needed. In these two cases, the cost of treatment accounted for 0.7 and 6.6 percent of the average total costs of repatriation.

A model for estimating repatriation costs was presented with a case study at the International Maritime Health Association conference in Manilla, where the estimated repatriation costs for a seafarer with an acute myocardial infarction (AMI) was 181,000 dollars (53) equaling to 170,000 euro implying that the costs of a single repatriation case can be even more expensive than the results found in this thesis.

In the European Union HealthBASKET project, the case vignette approach was developed and utilized in order to estimate the costs of AMI treatment in the nine included countries. In France, The Netherlands and Italy, a percutaneous coronary intervention (PCI) was the standard of care intervention to treat AMI, with costs ranging between 3,720 and 9,374 euros (117). In case vignette number one, the seafarer had an AMI and the corresponding treatment was PCI. In this case, the cost of the first treatment in Norway was 14,750 euro, which is somewhat higher than the highest estimated number from the HealthBASKET project (117). Preferably, a case vignette should have no co-morbidity (24); however, this was not possible to control for in the data from DMA as it was not stated whether or not the seafarer suffered from co-morbidity and this could be the reason of the higher costs of treatment or cross country differences in treatment costs. The seafarer needed further treatment at the Philippines, which increased the hospitalization costs with 28,000 euro, making the treatment of this case vignette much more expensive than the average cost of treatment for AMI estimated in the HealthBASKET project (117).

Other studies looking into the costs and effects of AMI treatment, utilizing other methods than the case vignette approach, have found that the average cost of hospitalization and treatment for AMI ranges between 5,434 and 7,770 euros (118,119).

The HealthBASKET project also looked into the costs of treatment for appendicitis (24) and found that the mean total costs per case vignette across the included countries were 1,601 euro. Spain had a very low cost of treating appendicitis at a mean of 594 euro (120). This estimate is very low compared to the treatment costs for case vignette number three of 10,076 euro, where the female seafarer received treatment in Malaga, Spain for appendicitis. A published cost-effectiveness analysis from the United States found that the average operative management costs for an appendectomy were 11,480 euros (121). This estimate is higher than the cost of treatment for the appendectomy in case vignette number three, which was to be expected since the United States have the most expensive health care system in the developed world (122). Published data from Italy estimating the costs of appendectomy by applying a prospective costing method following a randomized controlled trial found that the average costs per treatment varied between 2282 and 2337 euro (123).

The HealthBASKET project used diagnostic related group (DRG) tariffs in the participating countries (24,124). These are highly associated with the socioeconomic status, the type of health system and reimbursement methods in a given country. This implies that in the case of seafarers – international employees not covered by any health system – market prices are used for the health services provided to them. This raises the question of how prices for the same diagnosis differentiate in different countries around the globe, where seafarers may need health services.

The costs of treatments for the repatriated seafarers were, in general, higher than the costs of the same treatment found in the published literature for standard cases of the same illness as the seafarer was suffering from (117–120,123). Except when comparing the costs of the treatment for appendectomy in the United States, in which case the cost of the average treatment was higher than the cost of treatment in the appendicitis case vignette (121).

6.2.1 Discussion of cost assumptions

Any model is always a simplification of the reality (125), and since the available data did not cover all aspects of the model, assumptions had to be made. To estimate the average total costs of repatriation for the four case vignettes, several assumptions had to be made in order to fully capture the average total costs of each repatriation case.

In this thesis, the fuel costs for rerouting the ship was in the interval of 13,000 to 26,000 euro. That is a much smaller estimate than the one derived from the literature of 78,000 euro (7). This is due to the fact that Henny and colleagues (2013), in their calculations, used an assumption stating that the annual average rerouting time was 1.5 days. This assumption was not necessary to use in this thesis, as it was stated in the material from Radio Medical Denmark how many hours the ship had to reroute to reach port. This time estimate was used for the cost of rerouting in this thesis. In the two cases, the duration of rerouting was 6 hours and 12 hours, which is much less than the assumed 1.5 days. In this thesis, it was assumed that the average vessel consumes 100 tons of fuel per 24 hour period, which is an estimate provided by Henny and colleagues (2013). This estimate of 100 tons per day was provided as an estimate of the average merchant vessels fuel consumption (7). The fuel costs of a ship is mostly a function between ship size and cruise speed (126). Notteboom and Cariou (2009) states that most merchant vessels will have a cruise speed between 21 and 25 knots and, depending on the size of the vessel, the daily fuel consumption will be between 78 tons for a 2500 twenty-foot equivalence unit (TEU) sized vessel and up to 367 tons for a 11,600 TEU sized vessel. Their numbers are provided based on a sample of 2,259 vessels (127). Assuming that this sample is an accurate picture of the distribution of vessels according to size, then it is possible to calculate a weighted average for the daily fuel consumption (appendix IX). Based on Notteboom and Cariou (2009) and their sample of vessels, the daily fuel consumption was 135 tons for the average vessel. This estimate is somewhat closer to the estimate used in the sensitivity analysis for the pessimistic case, where the daily fuel consumption was assumed to be 150 tons. Clearly there will be huge variations in the daily fuel consumption, when a vessel must reroute to get a seafarer to shore since vessel size varies. In the cost estimates and sensitivity analysis, it was shown, that rerouting of the vessel was a major cost driver, when this occurred. When wanting to know the true costs of a repatriation case, attention should be paid to at least the size of the vessel since this has a huge impact on rerouting costs.

Further, it is likely that by using the estimates provided in the records from Radio Medical, the fuel costs of rerouting are undervalued since the estimates do not account for that the vessel had to sail in an opposite direction after having rerouted to get the seafarer to shore – possibly for the same amount of time as the rerouting to shore. By assuming that time was spent sailing in the opposite direction, the cost of rerouting would have been considerably higher.

In this thesis, it was assumed that there was no production loss in the friction period, it was covered by overtime of fellow seafarers in the period from the seafarer turning ill until the decision not-fit-for-duty was made, plus an additional two days for recruitment of a new seafarer. The cost of overtime for the fellow seafarers was based on an assumption that fellow seafarers working overtime were paid an hourly wage corresponding to the assumed hourly wage of the repatriated seafarer, and no overtime fee was added to the calculation. The cost of overtime was, in all cases, a minor cost driver with only little impact on the average total costs.

The cost of helicopter evacuation at sea was estimated to be 25,000 euros per intervention. The estimate was based on consensus between relevant stakeholders within the field at a conference in Manilla (7). Helicopter evacuation at sea has some similarities with remote area helicopter emergency services. Cost studies investigating the cost per mission for remote area helicopter services found that the cost of each mission varied between 6,600 and 13,500 euros (109,110). These estimates show that there are large variations in the cost per helicopter evacuation. The same is likely to be the case for helicopter evacuations at sea, which is why the estimate of 25,000 euro must be perceived as an average estimate. The remote area helicopter service estimates are somewhat lower than the estimate of helicopter evacuation at sea. It is likely that the distance of the ship to shore can be the root cause of increased cost of sea based helicopter missions. The cost estimate for helicopter evacuation was, due to the uncertainties surrounding the estimate, prone to sensitivity analysis. This was done in order to look into the effect of changes in the estimate on the average total cost of repatriation. For the optimistic case, the estimate of 6,600 euro was used, since this was the lowest cost estimate from the literature regarding remote area helicopter emergency services. As the literature did not provide any estimates above the 25,000 euro estimate, the pessimistic case estimate of 37,500 euros was based on an assumption.

The sensitivity analysis yielded that changes to the cost of helicopter evacuation had a big impact on the average total cost of repatriation. In the case vignette number 1, the cost of helicopter evacuation attributed for 26 percent of the total costs of the repatriation case in the base case scenario. As the current literature does not provide any studies investigating the costs per helicopter evacuation at sea, the estimate of 25,000 euro provided by Henny and colleagues (2013) must be considered as the best available estimate.

In case vignette number 1-3, assumptions had to be made in regards to the salary of the seafarer. It was assumed that the repatriated seafarer and recruited had the same wage. The salary of the seafarer can be a major cost driver and have a high impact on the total costs of repatriation, especially shown in case vignette of malignant hypertension, where compensation and sickness benefits to the repatriated seafarer and the costs of recruiting a new seafarer accounted for more than half (57.1%) of the total costs of this repatriation case. Companies clearly have on record the salary of the seafarer and it would ease future use of DMA database records if this number were provided when claiming reimbursement from DMA, as is the situation in the malaria case vignette.

This thesis did not estimate any costs in terms of charterer loss penalties, which could imply that estimates of repatriation found in this thesis are conservative estimates of the true total costs.

Henny and colleagues (2013) provided an estimate of the indirect costs of 60,000 euro. This estimate covered the average replacement and onshore costs in the case of repatriation. Hereby implied that hospital costs are also included in this estimate, which is why that this estimate was not directly transferred as the cost of replacement in this thesis, as it was likely to overestimate the cost of replacement.

No immediate conclusions can be drawn to why treatment of repatriated seafarers was more costly compared to the treatment costs derived from the HealthBASKET project, and other published sources of data and why sea-based helicopter evacuation is more costly than land based. There is no clear explanation for these increased expenditures, but the treatment costs of the case vignettes illustrates a clear picture, that seafarers evacuated from sea to shore for treatment requires more expensive treatment than the standard case vignette (23,24). This may be attributed to the different charges of services to seafarers compared to the population of a given country, which is more or less covered by the health system of this country.

This thesis has found a wide possible cost-span for the cost of repatriation and as charterer loss penalties, which would incur in the case of delay, are not included in this analysis. The estimate is likely to also undervalue the true total costs of repatriation, which could be as high as 1 billion euro annually. This clearly speaks as a powerful argument for implementing preventive measures to prevent repatriation and improve the general health status of the seafarer population. This thesis found that repatriation of ill seafarers is highly cost-intensive, even though the costs of treating the illness were minimal.

Not only does the health of seafarers remain to be vulnerable, the treatment of their illnesses are likewise more expensive than treatment of their on shore counterparts, and then comes additional expenses of transportation, evacuation, compensations and replacement, which have a major impact on the total costs of repatriation, which is in accordance with already published findings (7). The high financial burden of repatriation calls for cost-effective preventive measures in order to promote the health of seafarers, reduce the annual number of repatriation and hereby result in cost savings to the employers. In order to provide more valid and accurate estimates of the financial burden of repatriation, the companies should consider to routinely collect and make available more data at a company level – especially in regards to the wage of the seafarer, which is already on file and any penalties paid due to delays caused by an ill seafarer. This would provide better estimates of repatriation, when applying the local approach to estimate the cost of repatriation.

6.2.1 Data collection at a company level

The indirect costs attributed to the total costs with a proportion between 22 and 60 percent. This finding is small compared to estimates from the National Safety Council of Canada, which state that indirect costs are three to ten times higher than the direct costs of a work related injury or disease (19). Evacuation costs are a direct cost accounting for a large proportion of the direct costs found in the case vignettes, this expenditure would not be there in land-based illnesses on the workplace and can be a part of the explanation in the differences in indirect costs between the findings of this thesis and the estimates from the National Safety Council.

However, the findings of this thesis and the estimates from the National Safety Council of Canada emphasize the need to monitor the indirect costs as these remain to be a large proportion of the total costs of repatriation. For this thesis, assumptions were made in regards to the indirect costs, since they are not in the data from the DMA.

The theoretical framework stated that, in order to produce a robust cost analysis, special attention should be made in regards to properly estimate the major cost drivers (87). The major cost drivers for repatriation were transport from vessel to shore either by helicopter or deviation, treatment, compensation and sickness benefits, recruitment of the new seafarer and insurance premium increase. These were the five major cost drivers in the case of repatriation. Sickness benefits and treatment costs were reimbursed and are in the DMA records, which is why these estimates are fairly valid. But the salary of the seafarers, transportation from sea to shore and insurance premium increase are all based on published literature and assumptions. The companies should seek to collect this data, as much of it is probably already on file such as insurance premium increase and salary of the repatriated and recruited seafarers. The difficult part about an insurance premium increase can be to relate it to a particular incident if more than one insurance claim has been filed. For the companies, it would be interesting to know these costs of repatriation, especially in regards to helicopter evacuation, deviation and charterer loss. This could help the employer model the most cost effective way of evacuating the seafarer from the vessel to shore in regards to whether helicopter evacuation is the cheapest option or deviation in each case. With the basis of the findings in this thesis, and the malaria case vignette, it is evident that if evacuation by boat is an option, then this is by far the least expensive option from the employer perspective.
Knowing the size of the ship in case of deviation could help provide better estimates of deviation costs by applying the average fuel consumption according to the size of the ship. In this thesis, charterer loss penalties have not been considered, but they should if they can be attributed to delays due to repatriation. Since these costs are not captured in this thesis, but however can be attributable to repatriation, efforts should be made at a company level to capture these costs, whenever they occur due to repatriation. The charterer loss penalty should be of such a size, that it has an impact on the total costs of repatriation since the efforts to collect these data at a company level should be worthwhile.

Spending valuable administration time at the company level to record small cost estimates, which does not have a real impact on the total costs, is probably not worthwhile the time spent. Changes in the costs of the time spent managing the case by the master of the ship was illustrated in the sensitivity analysis to only have a very little impact on the total costs of repatriation. Therefore, assumptions in regards to the costs of the master's time spent managing the case is in order, since accurate estimates of the actual time and costs would not have any real impact on the total costs of repatriation. However, it has a cumulative impact on the productivity of the master by increasing his time spent in completing forms and communications with the administration in the shipping company and the Telemedicine Assistance Services.

The records at DMA are a great way to estimate the direct cost of repatriation, except the costs of getting the seafarer from the vessel to shore, but as already mentioned, attention at a company level should be paid to estimate the indirect costs as these contribute often more than the direct costs to the total costs of repatriation.

6.3 Economic benefits of health promotion initiatives

With the results of this thesis, it has been established that there is a big financial burden when repatriation of a seafarer is needed. This thesis does not state what should be done next; however, these high financial costs of repatriation form a powerful argument in the favor of health promotion initiatives at the merchant vessels, in order to promote the health of seafarers and reduce the financial burden of repatriation on employers. Employers should seek to implement or strengthen existing cost-effective prevention programs.

In other sectors, the cost-benefits of health promotion efforts at the workplace have had a positive return on investment (128,129). It can be argued, that this would also be the case of health promotion efforts in the seafarer population, since they have a poorer health state than the general population (2,3,26,31,70–81), and that there should be a greater potential for health improvements compared to the general population. Health benefits among seafarers are likely, as in other sectors, to produce positive financial numbers for the employers (128,129), which must at all times be in the interest of the employer; however, the seafarer occupation has shown to be a difficult to reach target group, when trying to implement health promotion initiatives in a workplace setting (130).

6.4 Considerations regarding the methods of this thesis

Currently, very little research has been made looking into the costs of repatriation and only one published business case provides some insights into the aggregated financial burden of repatriation of seafarers (7). Before this thesis, no research had looked into the costs of repatriation at a micro-level. In this section, the methods used to establish the cost of repatriation in this thesis will be discussed upon.

This costing exercise had the perspective of the employer, which is not in accordance with the recommendations in the framework. The theoretical framework states that the societal perspective should be applied in order to know the true value of a disease (87). Knowing all the societal costs of ill seafarers would be beneficial in order to establish the entire burden of repatriation. However, due to the global nature of seafaring, it is difficult to attribute these societal costs. In such cases, the cost of disease mainly burdens the employer, and this approach is scientifically accepted provided that the objective is clearly stated (22).

Furthermore, it makes sense to apply the employer perspective since employers hold a big proportion of the financial burden – at least in the first 18 weeks – and also when wanting to establish arguments for health promotion efforts and better integrated care in a workplace setting.
The employer perspective is the proper perspective for this cost analysis since the employers should know their financial burden of repatriation, when the employer is to make informed decisions regarding the health and welfare of their employees and possible initiatives to promote this.

This study applied a retrospectively micro-costing approach to estimate the financial burden of repatriation. Costs were mostly measured by a local approach using company level data (19). In some instances, such as the helicopter evacuation and deviation costs were not possible to estimate by the local approach and estimates were then derived at an aggregated level based on published literature (7).

It would have been preferred if the exact costs of the helicopter mission or deviation had been known; however, there was no available data of this, which is why the local approach was not feasible for these exact estimates. As the local approach is even more specific than a bottom-up approach (19), and as both the costing categories and cost resources for this thesis were identified at the local level, this implies that the cost estimates have a high degree of accuracy (131).

The retrospective nature of the costing exercise gives reason for an uncertainty of some of the cost estimates. A time and motion study would be the preferred study design for a micro-costing study (131), since this would allow to follow the patient prospectively and measure the time spent and resources used very precisely. However, this was not possible within the constraints of this thesis. The source of the direct cost collection was the DMA, which should provide a fairly valid estimate of the direct costs incurred to the employer. However, the case vignettes illustrated that some services were not reimbursed by the DMA either, because it was after week 18, or because this particular item was not something covered in the reimbursement agreement – such as a mobile phone in case vignette number one. Also, in case vignette number one, there was information on the seafarer getting transportation to the airport, but there were no reimbursements made for an airplane ticket; however, the employer must have had some costs associated with the transportation of the seafarer from Norway to the Philippines. This implies that simply utilizing the data from DMA as a proxy for the costs incurred to the employer is not entirely accurate, but no better data source was available for this study. It would have produced a slightly higher average total costs estimate of case vignette number one. If these non-reimbursed costs were included in the calculation, it would not have changed the average total costs of this repatriation case by a major amount. The data source from DMA is perceived as a fairly valid source and definitely the best available option for assessing cost data for repatriation retrospectively.

This study utilized data from a real-life source and not a clinical setting, which in theory would provide a good external validity, but the internal validity could be compromised since it is likely that data collection is not obsolete. Since most costs were collected utilizing the local approach, and it can safely be assumed that it is in the interest of the employer to get as many of their costs reimbursed as possible, then the internal validity of this study is high as well.

The external validity is, however, somewhat compromised by only having one case in each case vignette, since a small sample size has a greater level of uncertainty (132).

In order to estimate the productivity losses that occurred due to repatriation, the friction approach was utilized. Two methods to estimate productivity losses were explained in the literature – *the friction approach and the human capital approach*. The human capital approach values the whole aspect of a person's life and is often criticized for placing too big a value on the productivity losses that occur (19,98–100). When estimating the costs of repatriation from an employer point of view, it is reasonable to apply the friction approach, since in that way it is only the costs that incur on the employer which are considered (25).

It has been argued in previous work that indirect costs should not be included, since that tends to favor men and women of the working age, which would not exactly increase equity within healthcare spending. Equity is one of the primary concerns within public health, and that could be a reason not to include indirect costs in the analysis in terms of loss of productivity (133). For this study, it was relevant to incorporate calculations of loss of productivity since the perspective of the study was the employer, who pays overtime to the fellow seafarers in order to have the job of the ill seafarer done. The employer is not concerned with people not working, and there will be no equity questions in that regard if preventive measures were to be implemented. Multiplier effects have not been considered in this study. It is, however, relevant to know the multiplier effects from repatriation on productivity as these costs could bear a significant cost burden and have a large impact on the overall productivity costs (134). In a recently conducted systematic review of assessing the practical use of the friction approach, it was found that no studies had attempted to estimate multiplier effects (135). It is likely that the estimating the multiplier effects are associated with too large uncertainties in retrospective analyses and, therefore, it is not incorporated in the analyses since it would be based solely on assumptions. In order to have proper estimates for multiplier effects, there should be estimates of the overall productivity before the disease occurred, and then it should be measured again after the disease. However, it is likely that there will be more than one disease case at a workplace, which further makes the estimates unsure.

It was beyond the scope of this study to estimate the intangible costs, which is also a mentioned critique in many cost-of-illness studies (133). It is of high relevance to make considerations in regards to the intangible costs, when the perspective is the employer. Especially delays due to repatriation could imply significant financial losses to the employer in terms of lost future income and a damaged company image. It is relevant to have in mind that these losses could probably be much higher than the actual direct and indirect costs of each repatriation case vignette, but also very difficult to establish and to attribute to the repatriation.

It was assumed, by applying the case vignette methodology to estimate the costs of repatriation at a micro-level, that each case vignette represented a typical patient with that disease (24). This implies that no co-morbidity should be present. It was not possible to derive from the data whether any co-morbidity was present. But since the seafarers were all working and prone to mandatory health checks, it is reasonable to assume, that for the working seafarer population, a healthy worker effect is present (136) and that the seafarers, therefore, did not suffer from co-morbidity.

One case for each case vignette is not representative for the entire population, since there will be uncertainties associated with having only one repatriated seafarer for each case vignette. Large individual differences could occur between the seafarers and also large variations in the cost of treatment and repatriation would be present. A major part of this thesis was to establish the cost formula, and by having established a cost formula that has proven to work in order to estimate the costs of repatriation and having established four case vignettes, future work should seek to test these estimates by applying the same methodology on the same case vignettes, and including more seafarers in each case vignette.

The internal validity of this study must be considered high and the estimates very close to the true costs of repatriation for each of the four case vignettes. Due to low numbers of cases in each case vignette, the external validity of this study can with reason be questioned.

7. Conclusion

This thesis was a first attempt to map the relevant financial burden to the employer due to employee sickness on board merchant vessels. The objective was to establish a cost formula and estimate the costs of repatriation of ill seafarers based on four case vignettes; *I) acute myocardial infarction, II) malignant hypertension, III) acute appendicitis and IV) malaria.*

The thesis should be perceived as a framework for investigating the average total costs of repatriation by establishing case vignettes and utilizing a micro-costing approach. The findings were, that from an employer's point of view, each case of repatriation were highly cost intensive. For the employers, the annual financial burden of evacuation and repatriation could yield costs of 1 billion euro. The results showed large variations in the average total costs of repatriation among the four case vignettes ranging from nearly 24,000 euro for the least expensive repatriation case – *malaria* – to almost 99,000 euro for the most expensive – *acute myocardial infarction* – indicating that repatriations are highly heterogeneous.

In order to estimate the total costs of each case vignette a costing formula was established. The formula contained the relevant direct and indirect cost categories, when seafarers are repatriated. A local approach was used to estimate the costs at a company level and this thesis proved the approach feasible to estimate the total costs of repatriation with an employer perspective.

Several cost categories contributed considerably to driving the costs up. Especially the cost of evacuation from ship to shore was a major single cost driver, when the merchant vessel had to reroute or the seafarer was evacuated by helicopter, and accounted for at least 25 percent of the total costs in the repatriation case vignettes.

Treatment costs, sickness benefits and the cost of replacing the repatriated seafarer were substantial cost drivers for the total costs of repatriation from the employer's point of view.

There were large variations in the proportions of direct and indirect costs between the case vignettes, but it was established that indirect costs are an important estimate from the employer's point of view, and a major cost driver for the total costs of repatriation.

These indirect costs are not reimbursed, and they all fall directly upon the employer. In order to estimate the total costs of repatriation, it would be beneficial if these cost data were collected regularly at the company level.

Employers have a financial interest in promoting the health of seafarers by introducing or strengthening cost-effective prevention and health promotion programs, and hereby reducing the number of repatriations, as each single repatriation of an ill seafarer is a heavy financial burden to the employer.

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9. Appendix

Appendix I: Litterature search

Inclusion and exclusion criteria

In order to be included in the review the study had to be written in English, Danish or Norwegian. For a record to be included for full text review at least one of the search terms had to be present in the title or abstract. In Google Scholar an additional criterion was put in the search stating the search terms should be present in the title otherwise the results would yield too much 'noise' in terms of irrelevant records and it would not be possible within the timeframe of the study to look into all these results. If the extra criterion was not applied the search would have yielded more than 19.000 results. A snowball technique was used by hand searching the bibliographies in order to gather further information on the topic (137). The study had to provide estimastes for the costs of repatriating or evacuating ill seafarers based on pre-specified criteria for a cost analysis, cost-effectiveness/-utility or cost-benefit evaluation. The pre-specified criteria are outlined in the table below. These criteria are derived from similar research within the field of estimating the costs of helicopter emergency service (109).

Table 18: Definitions for four types of economic studies derived from Taylor (2010).

Type of article	Definition
Cost analysis/ cost-of-illness	The study provides an estimate of the costs in relation to a pre-specified condition or performance. An economic evaluation in which only the costs are evaluated.
Cost-effectiveness/-utility	An economic evaluation comparing the costs and outcomes of alternative interventions. Patient outcomes are measured and compared in terms of quality adjusted life years (QALYs) or another patient relevant outcome such as mortality.
Cost-benefit	An economic evaluation where the costs and benefits are valued in monetary terms.

The perception of the author was that investigations into the costs of repatriation was a relatively unexplored field which is why records containing one of the search key words in the title or abstract was included for full text review. Removal of studies were done as a process where the first step was to remove duplicates, the second step was to exclude studies based on title and abstract screening and the last step was to exclude studies after full text review.

Literature review matrix

The table is divided into two parts in order for the content to fit the pages.

Author	Title	Year	Included after full text review	Reason for in-/exclusion	Introduction
Lefkowitz R.Y., Slade M.D., Redlich C.A.	Risk factors for merchant seafarer repatriation due to injury or illness at sea.	2015	No	Does not include measures of the cost of repatriation besides Henny et al.'s number.	Seafarers are an essential workforce, and their health is vulnerable. When a seafarer is repatriated he or she is returned to their home country, and all the costs fall on the employer. Seafaerer medical conditions is estimated to cost more than 760 MEUR annually, where repatriation is one of the major cost drivers.
Idnani N.	Varicella among seafarers: a case study on testing and vaccination as a cost-effective method of prevention.	2010	No	No estimates of the cost of repatriation	When people are living closely they are more prone to infections and vira, and the thread of exposure if an outbreak on s ship is great.
Matheson et al.	The health of fishermen in the catching sector of the fishing industry: a gap analysis.	2001	No	No estimates of the cost of repatriation, nor cost of disease	The fishing industry is a large industry especially in the UK. Seafarers are an exposed population group and more often suffers from a higher degree of morbidity and mortality than the general population.

Rosik et al.	Can general cardiovascular risk evaluation facilitate the assessment of fitness for work and contribute to the reduction of cardiovascular incidents among seamen and fishermen? Article for discussion	2006	No	No estimates of the cost of repatriation, article for discussion only	Evidence suggests that the prevalence of cardiovascular diseases among fishermen is high, and that CVD results in repatriation.
Nielsen et al.	Deaths due to disease of seafarers on board Singapore ships	2000	No	No estimates of costs of repatriation or evacuation	Seafarers are exposed to various occupational hazards due to the nature of their work and do not have immediate access to health care facilities. This study aims to explain the circumstances of natural death records in Singapore.
Tomaszunas & Mrozinsky	Diseases and injuries in Polish seafarers repatriated from ships	1990	No	Provides no estimates on the costs of evacuation or repatriation	Seriously ill or injured seafarers might need repatriation to the homecountry for further medical treatment.
Zewallos et al.,	Outcomes of seafarer work fitness qualifications in the Netherlands	2014	No	No estimates for the cost of repatriation	The requirements for the Netherlands seafarers medical qualification (SMQ) is based on international guidelines. The purpose of the SMQ is to ensure that the person is fit for the job as seafarer and in order to avoid operational costs such as repatriation.
Wadsworth et al.	Patterns of fatigue among seafarers during a tour on duty	2006	No	No estimates for the cost of repatriation	Work related fatigue is associated with sickness absence and physical health problems.

Henny et al.	The business case for telemedicine	2013	Yes	Includes estimates on the costs of repatriation on an aggregate level	The shipping community and flag states are now required to implement telemedicine (2012).
	Injuries and Illnesses on U.S Ships	1978	No	Not included since it was not possible to retrieve the report	NA
Lucero-Prisno et al.	Mainstreaming health in maritime education and training	2005	No	No estimates for the cost of repatriation, it is a discussion article	Diseases, injuries and death among seafarers remain to be a serious problem

Author	**Objective**	**Method**	**Results**	**Conclusion**
Lefkowitz R.Y., Slade M.D., Redlich C.A.	The objective was to describe repatriation patterns due to ilness or injury	Utilized data from a telemedical database. Fishcer exact test was used to test for associations between categorical variables and a t-test was used compare means. Logistic regression models were used to find the odds for repatriation adjusted for different variables.	The included populationen totaled 3921 seafarer cases of injury or illness at sea. Repatriation were more often due til ilness than injury (62,3% vs. 37,7). Indian seafarers are more often repatriated from the ships compared to Filipino seafarers. 1,6% of all telemedical consultations results in repatriation. Gastrointestinal was the most signicant due to illness.	Gastrointestinal illness os the most common reason for repatriation. 1,6% of all telmedicul tantion.
Idnani N.	To investigate the cost effectiveness of varicella vaccination	121 Indian seafarers employed on cruise ships. A blood sample was drawn from each participant. Vaccination was given to them the lowest bloodcount. Vaccination was given	16,5% were administered the vaccine. The total costs of providing the vaccine and testing all crewmembers is a litte above 7000 USD. No estimates have been given on the savings.	Only the costs, but not the effects are accounted for. However the authors state that if an outbreak of varicella on a ship is loose it would cost a lot more than 7000 USD. The testing and vaccination is recommended

		to them without antigenes.		as a pre/employement medical examination for indian seafarers.
Matheson et al.	A review exploring the evidence in regards to morbidity and mortality of seamen and fishermen in particular.	Litterature review	In general fishermen suffer from a worse health, an increased mortality and also have more risk factors present than other populations.	There are often limits in the desing of the studies assessing fishermens health, and the health of fishermen should remain to be a priority.
Rosik et al.	I)Forecasting CVD incidence in a seafarer, II) assessing of fitness for work on ships, III) working out principles of primary prevention in the maritime environment, either individual or collective for persons with a high general CVD risk	No clear method as it is an article for discussion	Seafarers are more likely to suffer from CVD and stroke than the general population, and because it happens at sea they are isolated from the health care system, and this further increases the risk of a CVD to be fatal.	I) The general cardiovascular death risk assessment is the health and life risk indicator relatively simple and easy to be applied in the occupational group of seamen and fishermen, II) It seems that the application of such an assessment during the periodic medical examinations of seafarers should result in medical, economic and social benefits, III) It is worthwhile to compare the results of examinations and decisions made when issuing health certificates before and after the application of the cardiovascular death risk assessment
Nielsen et al.	The objective was to cover natural deaths registered by the Singapore Mercantile Marine Office.	Records of natural deaths from the period 1986-95 were analyzed.	373 deaths was identified of which 69 were due to disease based on a total of 140,361 seafarer-years over the ten year period. Heart related diseases accounted for 45 deaths (62.2%)	The study is biased towards sudden deaths as death of repatriated seafarers are not included. Only death onboard and there is therefore and underreporting of death cases.

Tomaszunas & Mrozinsky	The objective of the study was to assess which injuries and diseases that requires repatriation of the seafarer.	All medical repatriations were retrieved from Polish Ocean Lines in the period 1st jan. 1985 to 31 st december 1989. The age, occupation onboard and reason of repatriation were noted and also how the patient travelled home.	In the five year period there were 16.87 cases per 1000 men year and the total number of repatriations during the period were 354. 111 of them below the age of 40. 287 cases were due to disease and 67 due to injuries.	Serious disease occured four times more frequently than serious injury. AMI was the most frequent reason to repatriation.
Zewallos et al.,	To determine the proportion of seafarers failing to pass the SMQ in the Netherlands during 2012, to analyse the outcomes of the SMQ according to the qualification, age, duties and requirements of additional evaluations and to describe the reasons for considering a seafarer unfit for duty.	Retrospective database study utilizing data from seafarers SMQ. The SMQ's were carried out by physicians specifically appointed.	Only 0.6% of SMQ's results finding the seafarer unfit for duty,, whcih is similar to British reports. Cardiovascular conditions was the major reason to being found unfit for duty.	Only 0.6% of SMQ's results finding the seafarer unfit for duty, whcih is similar to British reports. Cardiovascular conditions was the major reason to being found unfit for duty.
Wadsworth et al.	To describe the day to day fatigue of seafarers on duty	Diaries were used to measure the self reported amount of fatigue among seafarers both during a tour and when on leave. The two main outcomes were the fatigue rating based on when waking up and going to bed rated on a VAS.	Seafarers experience an increased amount of fatigue when on tour. And results suggests that when on duty the seafarer is also sleep deprived.	Many factors contribute to fatigue such as; night work, sleep quality, and other environmental and occupational factors.

Henny et al.	To provide a business case for telemedicine on board ships and vessels.	Financial numbers have been derived from consensus at the International Maritime Health Association's conference in 2013. Estimation of both direct and indirect costs of medical evuacuation or deviation and treatment.	Direct costs: TMAS (telemedicine); cost of handling one phone call is between 200 and 260 EUR. 10 % of calls results in an evacuation or rerouting. With an estimated total costs of 760 million EUR annually and the possibility to save approx 20% = 152 millio EUR if implementing TMAS	Implementing TMAS can save the industry up to 152 million EUR annually on medical evacuation costs. Besides that there are other more softer benefits included with implementing TMAS such as being perceived as a good employer.
	NA	NA	NA	NA
Lucero-Prisno et al.	To discuss methodologies and approaches on mainstreaming maritime health education and training	NA	NA	NA

Appendix II: E-mail correspondence with United States National Technical Information Service

Fra: NTIS Info [mailto:info@ntis.gov]
Sendt: 6. marts 2017 15:59
Til: Bente Krogh Hansen
Emne: RE: report

Dear Bente Krogh Hansen

Thank you for contacting the National Technical Information Service

The report PB292656 Title: Injuries and Illnesses on U.S. Ships this report is No Longer available from NTIS.

Please Note: NTIS is No Longer printing Paper copies. NTIS does not loan out documents. Reports that are available and have been digitized will be available in a free pdf format from the NTRL Open File. If reports that are on the NTRL site and does not show pdf format available NTIS will not have this report. The above report has not been digitized.

Please Note: Digital on Demand is No Longer available effective October 1, 2016. NTIS is searching for a solution to reinstate this option.

Thank you

Carol Varney
Customer Contact Representative
National Technical Information Service
U.S. Department of Commerce
info@ntis.gov or direct cvarney@ntis.gov
P: 800-553-6847 or direct 703-605-6019
F: 703-605-6900
www.ntis.gov

Appendix III: IFT ILO Minimum Wage Scale

- **The scale is using joint ITF/ISF Interpretation of the ILO Recommended Minimum Wage for an AB - extrapolated on basis of ITF Standard Agreement Differentials**
- **Rates are applicable from 1st January 2016**

Rank	**Basic pay** US$	**Daily wage** US$	**Leave pay**** US$	**Leave pay for public hols***** US$	**Total** US$	**Hourly O/T Rate** US$	**hrs OT 104*** US$	**Total inc. US$** **US$**
Master	2069	69,0	172,38	99,45	2340	*12,43*	1293	3.633
Chief Eng.	1880	62,7	156,67	90,39	2127	*11,30*	1175	3.302
Chief Off.	1335	44,5	111,29	64,20	1511	*8,03*	835	2.346
1st Eng.	1335	44,5	111,29	64,20	1511	*8,03*	835	2.346
2nd Eng.	1070	35,7	89,13	51,42	1210	*6,43*	668	1.879
2nd Off.	1070	35,7	89,13	51,42	1210	*6,43*	668	1.879
3rd Eng.	1031	34,4	85,91	49,56	1166	*6,20*	644	1.811
3rd Off.	1031	34,4	85,91	49,56	1166	*6,20*	644	1.811
RO	1070	35,7	89,13	51,42	1210	*6,43*	668	1.879
Elec Eng.	1070	35,7	89,13	51,42	1210	*6,43*	668	1.879
Ch. St/Cook	1070	35,7	89,13	51,42	1210	*6,43*	668	1.879
Bosun	686	22,9	57,15	32,97	776	*4,12*	429	1.205
Pumpman #	686	22,9	57,15	32,97	776	*4,12*	429	1.205
AB	**614**	**20,5**	**51,17**	**29,52**	**695**	***3,69***	**384**	**1.078**
AB	614	20,5	51,17	29,52	695	*3,69*	384	1.078
AB	614	20,5	51,17	29,52	695	*3,69*	384	1.078
ERR	614	20,5	51,17	29,52	695	*3,69*	384	1.078
ERR	614	20,5	51,17	29,52	695	*3,69*	384	1.078

ERR	614	20,5	51,17	29,52	695	*3,69*	384	1.078
ERR(Jnr)	457	15,2	38,07	21,96	517	*2,75*	286	802
OS	457	15,2	38,07	21,96	517	*2,75*	286	802
Stew	523	17,4	43,59	25,15	592	*3,14*	327	919
Stew	523	17,4	43,59	25,15	592	*3,14*	327	919

* Overtime is calculated at 1.25 the normal hourly rate based on a 48 hour working week and a maximum working week of 72 hours (ref: MLC A2.3.5(a) and B2.2.2) hence 104 hrs OT.

** Leave is 2.5 days per month at a rate of 1/30 the monthly basic wage (MLC A2.4)

*** Work performed on public holidays should be compensated at the overtime rate, although it should generally not be counted within the maximum hours of overtime which can be performed under MLC B2.2.2

Manning is for illustrative purposes only i.e. 23 (12 ratings) i.e. ITF Manning Scale No. 5 for vessels over 20,000 GT. The pumpman only applies to tankers.

Appendix IV: Cost transformation formula and currency exchange rate

The formula for the cost transformation was:

$$\frac{Cost * new\ index\ (2013)}{old\ index\ (2011)} = Cost\ transformed\ to\ 2013\ value$$

The index in 2011 and 2013 was 6,609 and 6,821 (138).

The table below provides an overview of the currency exchange rate used to exchange costs into euro (105).

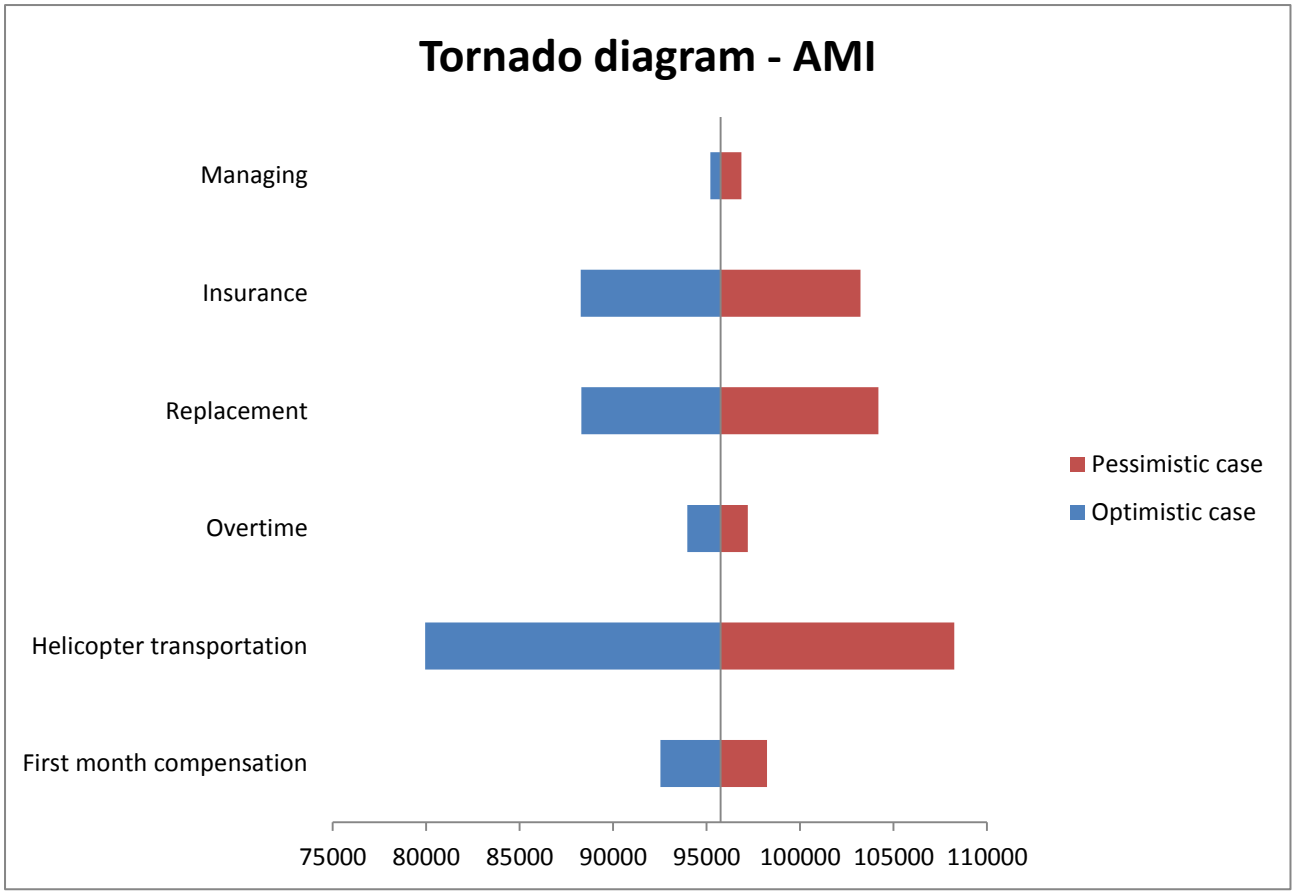
Currency	Exchange rate to EUR
Australian Dollars	0.71
United States Dollars	0.94
Danish Kroner	0.13

Appendix V: Detailed cost description AMI – Case vignette no. 1

A detailed description of the costs related to the case vignette no. 1 – Acute myocardial infarction – is provided in the table below, and the figure below is a tornado diagram illustrating the sensitivity analysis and the absolute impact on the average total costs of repatriation.

Cost category	Cost description	Units consumed	Unit cost EUR	Total EUR
Direct	Seafarer compensation 474 EUR per month (24-10-11/26-02-12)	1	1,626	1,626
Direct	Seafarer compensation for the first month of absence	1	4,230	4,230
Direct	Helicopter transportation	1	25,000	25,000
Direct	Hospitalization Philippines	1	27,968	27,968
Direct	Hospitalization Norway	1	14,750	14,750
Direct	Medicine	1	99	99
Direct	Transportation (Norway)	1	306	306
Direct	Falck Agency fee to assist seafarer	1	876	876
Indirect	Insurance premium increase (10% of all costs reimbursed by P&I club or DMA)	0,1	74,854	7,485
Indirect	Overtime for fellow seafarers (8 hours*14 days at an hourly rate of 21 euro)	112	21	2,352
Indirect	Replacement (Salary to new seafarer 2 months up-front)	2	4,230	8,460
Indirect	Replacement (Transportation of newly recruited seafarer)	1	1,500	1,500
Indirect	Masters time of managing the case	11	100	1,100
	Total costs 2011 value			**95,752**

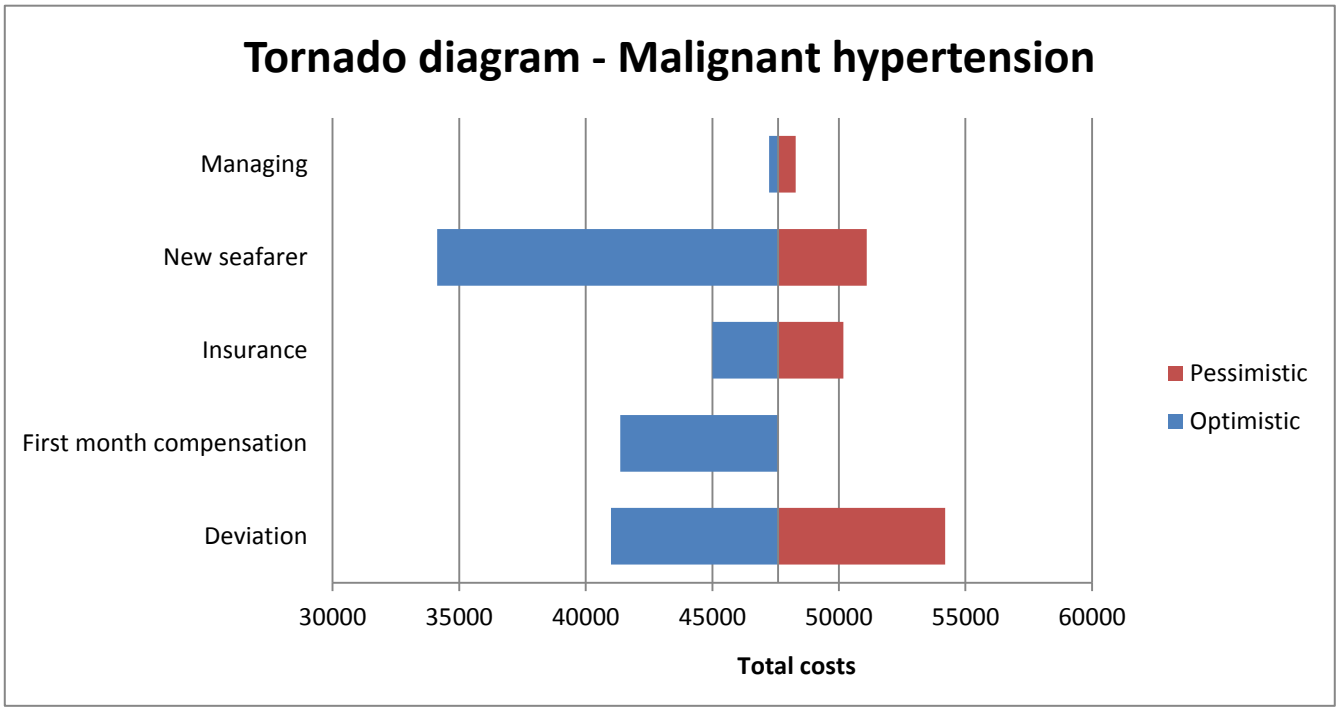
	Total costs 2013 value $\frac{95,752*6,821}{6,609}$	**98,823**
Non-reimbursed costs	Recieved cash, IKT, telephone, medical costs after week 18, assistance at the hospital	**604**



Appendix VI: Detailed cost description – case vignette no. 2 Malignant hypertension

In the table below a more detailed description of the cost estimates and calculations is provided and the tornado diagram illustrates the absolute impact of the sensitivity analysis on the average total costs of repatriation.

Cost category	Cost despription	Units consumed	Unit cost EUR	Total EUR	Percentage of total costs
Direct	Deviation for six hours	6	2,200	13,200	27.7%
Direct	Hospitalization	1	332	332	0.7%
Direct	Transportation to home country and accomodation	1	296	296	0.6%
Direct	Sickness benefits (assumption)	4	1,006	4,024	8.5%
Direct	Compensation in the first month of sickness absence	1	8,000	8,000	16.8%
Indirect	Insurance premium increase (10% of all costs reimbursed by P&I club or DMA)	0,1	25,852	2,585	5.4%
indirect	Replacement (transportation)	1	1,500	1,500	3.2%
Indirect	Overtime for fellow seafarers 8 hours*3 days at an hourly rate of 40 euro	24	40	960	2.0%
Indirect	Replacement (salary to new seafarer for two months)	2	8,000	16,000	33.6%
Indirect	Masters time of managing the case	7	100	700	1.5%
	Total costs 2011			**47,597**	

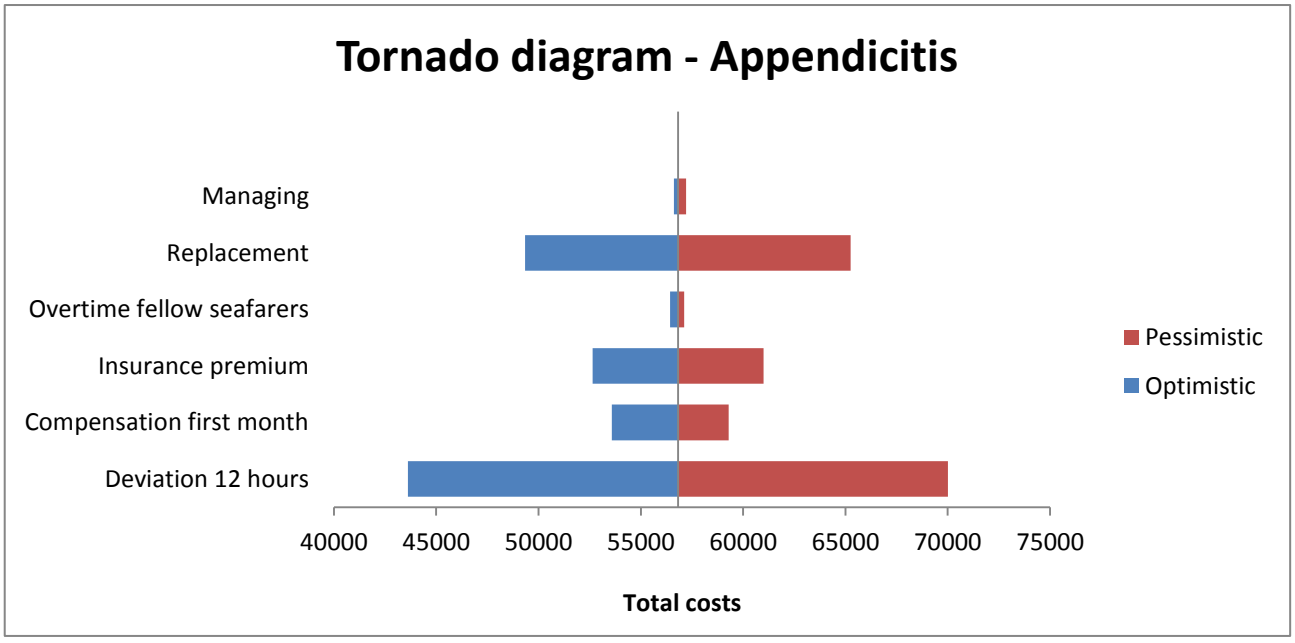

Tornado diagram - Malignant hypertension
Managing
New seafarer
Insurance
First month compensation
Deviation
30000
35000
40000
45000
50000
55000
60000
Total costs
Pessimistic
Optimistic

Appendix VII: Detailed cost overview of the case vignette no. 3 – Appendicitis

In the table below a more detailed description of the cost estimates and calculations is provided and the tornado diagram illustrates the absolute impact of the sensitivity analysis on the average total costs of repatriation.

Cost category	Cost category/despription	Units consumed	Unit cost EUR	Total EUR	Percentage of total costs
Direct	Deviation for 12 hours	12	2200	26400	46,5%
Direct	Hospitalization, lab work	1	206	206	0,4%
Direct	Sickness benefits (period 07-02-11/28-03-11)	1	514	514	0,9%
Direct	Hospitalization - stay	1	450	450	0,8%
Direct	Hospitalization - stay	5	390	1950	3,4%
Direct	Hospital - blood analysis	2	200	400	0,7%
Direct	Hospital - attending a doctor	1	200	200	0,4%
Direct	Hospital - x-ray abdomen	1	100	100	0,2%
Direct	Hospital - x-ray tecnician	1	50	50	0,1%
Direct	Hospital - Nursing	1	70	70	0,1%
Direct	Hospital - Preop examination	1	275	275	0,5%
Direct	Hospital - Operation tax	1	750	750	1,3%
Direct	Hospital - Recovery room	1	185	185	0,3%
Direct	Medication during surgery	1	1000	1000	1,8%
Direct	Medication delivery	5	250	1250	2,2%
Direct	Hospital - fee to the surgeon	1	1200	1200	2,1%
Direct	Hospital - fee to the anaesthesiologist	1	1300	1300	2,3%
Direct	Hospital - Nursing	5	100	500	0,9%
Direct	Hospital - Lab work	1	190	190	0,3%
Direct	Transportation to home country and	1	554	554	1,0%

	accomodation				
Direct	Compensation for first month of absence	1	4230	4230	7,4%
Indirect	Insurance premium increase (10% of costs reimbursed)	0,1	41774	4177	7,4%
indirect	Overtime fellow seafarers	24	21	504	0,9%
Indirect	Replacement	1	9960	9960	17,5%
Indirect	Managing	4	100	400	0,7%
	Total costs 2011 value			56,816	
	Total costs 2013 value $\frac{56,816*6,821}{6,609}$			**58,639**	



Appendix VIII: Detailed cost overview of the case vignette no. 4 – Malaria

Cost category	Cost category/despription	Units consumed	Unit cost EUR	Total EUR	Percentage of total costs
Direct	Transportation from ship to shore	1	1,093	1,093	4.7%
Direct	Sickness benefits (period 30JAN2011 to 6APR2011)	1	1,556	1,556	6.7%
Direct	Salary first month	1	4,371	4,371	19.0%
Direct	Transportation to home country	1	574	574	2.5%
Direct	Hospital India	1	103	103	0.4%
Direct	Medication India	1	21	21	0.1%
Direct	Hospital US	1	1,406	1,406	6.1%
Direct	Food and accomodation	1	139	139	0.6%
Indirect	Insurance premium increase (10% of costs reimbursed)	0.1	9,263	926	4.0%
indirect	Overtime fellow seafarers (4 days of 8 hours á 22 euro per hour)	32	22	704	3.1%
Indirect	Salary new seafarer (2 months up front)	1	9,960	9,960	43.2%
Indirect	Transport new seafarer	1	1,500	1,500	6.5%
Indirect	Managing	7	100	700	3.0%
	Total costs 2011 value			23,053	
	Total costs 2013 value $\frac{23{,}053*6{,}821}{6{,}609}$			**23,792**	

Appendix IX: Calculations for the average fuel consumption of a merchant vessel derived from numbers provided by Notteboom and Cariou (2009).

Vessel mean size (TEU)	Daily consumption (ton)	Number of vessels	Average daily fuel consumption (ton)
2530	78,1	764	**135**
3432	106,4	350	
4385	136,4	469	
5491	171,3	285	
6505	203,4	146	
7372	230	60	
8293	260	122	
937	292	46	
11660	367	17	