



# Pathways to reduction and efficient handling of food waste on passenger ships: from Baltic Sea perspective

Magda Wilewska-Bien<sup>1</sup>  · Lena Granhag<sup>1</sup> · Karin Andersson<sup>1</sup>

Received: 8 December 2017 / Accepted: 4 June 2018 / Published online: 18 June 2018  
© The Author(s) 2018

## Abstract

Food waste generation has received increasing attention in recent years. In this paper, we investigate the availability of information regarding food waste management on-board ships and describe how this information is communicated by companies operating passenger ships in the Baltic Sea. Furthermore, we summarize the aspects that influence efficient management of waste and identify pathways for food waste reduction on-board ships. The main three findings from this study are: (I) the information on waste handling at companies' websites was to a large extent lacking. Food waste was mentioned in 22% of investigated ferry ship operator cases and in 32% of cruise ship operator cases. (II) In the interviews with environmental managers from two passenger ship companies, various aspects of food waste handling on-board ships were identified, which could be further grouped into technical, economic, management, legal and social categories. We suggest that the aspects of waste handling presented in this paper can serve as a framework for detection of the challenges and possibilities for different actors including shipping companies, ports and waste management agents. (III) The pathways towards efficient food waste handling may differ for individual ships, as it depends on vessel age, type of equipment and route schedules. The effort should be put in separating food waste from the rest of waste streams as it enables a clearer picture of the waste produced, increases the handling alternatives and may provide technological and economic benefits. Transparency and communication between the waste handling actors is the key in finding tailor-made solutions for treatment of ship-generated waste.

**Keywords** Food waste · Passenger ships · Baltic Sea · Waste reduction

---

✉ Lena Granhag  
lena.granhag@chalmers.se

Magda Wilewska-Bien  
m.j.bien@outlook.com

Karin Andersson  
karin.andersson@chalmers.se

<sup>1</sup> Department of Mechanics and Maritime Sciences, Chalmers University of Technology, 412 96 Gothenburg, Sweden

## 1 Introduction

Waterways play an important role in transportation. The world's cargo and passenger ships are constantly getting bigger. The cruise shipping industry has been evolving considerably during the last decades with increasing number of tourists that sightsee and relax on-board (Sun et al. 2011). The most recent data claim a global travel of about 23 million cruise passengers in 2015 (CLIA 2016a). Passenger ships, as do other residential entities, generate waste as a result of daily activities and operations. Food waste is a substantial single waste stream as up to 3.5 kg of waste per day can be generated by a passenger on a cruise ship (HPTI, cited in EMSA 2017).

Food waste is a global problem, and it is estimated that about one-third (1.3 billion tonnes/year) of food produced is wasted or lost (FAO 2011). The handling of food waste is a multi-criteria problem (Babalola 2015; Angelo et al. 2017), where the environmental aspects are the driving forces for regulations although there are many more criteria for achieving sustainable solutions. Recent findings show that there are more energy and phosphorus savings to achieve when food waste is prevented compared to recycling of food waste (Hamilton et al. 2015). Therefore, reduction of food waste should, when possible, be prioritized and implemented along entire food chain. The prevention of food waste is being actively discussed in the international literature (Schneider 2013). In hospitality sector, food waste reduction practices include offering various portion sizes at different prices, placing information to the customers in buffet-type restaurants, removing trays and letting the customers carry the food on plates only, replacing all-you-can-eat option by pay-by-weight option and finally passing food on to charitable organizations (Filho and Kovaleva 2015). Some of this may also be of relevance to shipping, but there are also conditions that are specific to ships and shipping.

Current regulations for ships allow sea-disposal of ground food waste, also in the sensitive areas as the Baltic Sea, when the ship is moving not closer than 12 nautical miles (NM) to land (IMO 2011a). A distance of 12 NM to land is also required for sewage (toilet wastewater also called black water) discharge while for discharge of grey water (wastewater from showers, laundry and ships kitchen) there are no limitations in international regulations (IMO 2011b). How the waste is kept on-board can vary from case to case. Sometimes separating the wastes on-board is not strictly based on the regulation but results from practical management as keeping apart soft food waste from the mixture of hard food waste and packaging (EMSA 2017). It also occurs that the waste streams are mixed on-board and food waste is stored in grey water/sewage tank (EMSA 2017). In such cases, the regulation states that mixture should be handled as it is composed of the component that has the strictest rules concerning sea-discharge (IMO 2012).

Since food waste is regarded biodegradable and non-harmful, any limiting of sea-disposal will not score points in the ship environmental performance standards (CSI 2016). It is instead for each shipping company to decide how far beyond the minimum requirements to go. In case of the Baltic Sea, the cruise shipping industry voluntarily committed to be more restrictive than current law in terms of discharging sewage and grey water; however, no commitment was stated regarding discharge of food waste (CLIA 2016b). The alternative to sea-discharge is port reception of waste, and ports in the European Union are obliged to collect food waste from the visiting ships. The collection and further treatment onshore depends on whether ships previously called ports outside EU, as in such cases food waste is considered category 1 animal by-products (may transmit diseases) and must be incinerated (European Commission 2009). On the

other hand, food waste having EU origin can be used for biogas production onshore or for other purposes usually applied for land-based waste.

Globally, stakeholders demand environmental responsibility from international companies and the companies can respond to that demand by informing about their environmental performance. The number of companies disclosing such information is increasing, and often it is done by using Internet which is a relatively cheap, fast and easy tool (Jose and Lee 2007). Also shipping companies use websites for communication with the stakeholders.

The aim with the study is threefold;

- I. To analyse how the management of food waste is performed and communicated in comparison with sewage and grey water on the websites of the companies operating passenger ships in the Baltic Sea,
- II. To identify aspects that influence the management of food waste and
- III. To identify pathways towards food waste reduction on-board ships.

This study is focused on the Baltic Sea due to its sensitive character and designation of special area by International Maritime Organization regarding management of garbage and sewage.

## 2 Method

A *review of information* published on the websites of 27 ferry ship operators and 34 cruise ship operators active on the Baltic Sea, listed in HELCOM report (HELCOM 2015) was performed to find information about the wastes generated and the waste handling. A first quick pre-review of the information focused on the information about food waste was performed in November 2016 in order to select potential respondents for the interviews described in the paragraph below. Further the main review, performed between 22 and 29 May 2017, was to examine the websites and look for information about food waste, sewage and grey water, including also the synonyms for these terms. If no such information was found during the first step, a further investigation was performed by Google search engine using a combination of the company name and either “sewage” or “waste”. In this step, only findings that lead to the company websites were analysed and information published on external websites was excluded from the analysis.

To complement the review and to get understanding on how food waste can be managed on-board ships, *two semi-structured interviews* were performed in January and April 2017 with environmental managers from two passenger ship companies active in the Baltic Sea region. The respondents were selected based on the pre-review of the companies’ websites where the effort to reduce food waste was communicated. The interviews took approximately 1 h each and were intended to identify future solutions via answers to the following questions: (1) Why were food waste programmes started at the companies? (2) How is food waste reduction achieved? (3) What are the challenges and potentials in food waste management perceived by the shipping companies? The respondents were assured that the answers will be treated confidentially.

### 3 Results

#### 3.1 Review of the companies' websites

By reviewing the shipping companies' websites, it was found that the information about the ship-generated waste could be reached by opening subpages titled exactly or related to *environmental responsibility*, *environment*, *CSR policy*, *environmental policy*, *commitment* and *sustainability reports*. Most of the studied ferry ship operators (over 70%) do not mention food waste, sewage or grey water on their websites (Fig. 1). The term food waste, or its synonyms, is present on 22% of the websites reviewed. Seven per cent of the ferry ship operators mention "solid waste" or "waste" where, in theory, food waste could be included. Similar result to food waste has been obtained for grey water, as this term was mentioned on 22% of the reviewed websites. Sewage is mentioned slightly more often (26%) than food waste and grey water. A minor fraction of the ferry ship operators name wastewater, which can theoretically comprise sewage and grey water. A further analysis of the websites of the ferry ship operators that mentioned food waste showed that, according to the description on the websites, these wastes are delivered to shore (Fig. 2). Three ferry ship operators just describe that these wastes are disposed of ashore, whereas three operators give more details by describing that food waste is disposed of ashore in either macerated form or in untreated form. The operators that stated "waste" or "solid waste" added that the waste is delivered to shore for disposal. Disposal of sewage in port is the most common option for the analysed ferry ship lines (5 of 7 operators), followed by treatment on-board (1 of 7 operators) and a combination of either disposal of sewage ashore or treatment on-board, depending on the ship (1 of 7 operators). Similar practice is observed for grey water, with disposal ashore as the most commonly applied handling (5 of 6 operators). One operator informs that the grey water produced on-board is either delivered to shore for disposal or treated on-board. The operator that stated "wastewater" instead of specifically sewage or grey water describes that this waste is treated on-board. As mentioned above, the degree of mixing food waste in the other streams may vary for the ferry ships.

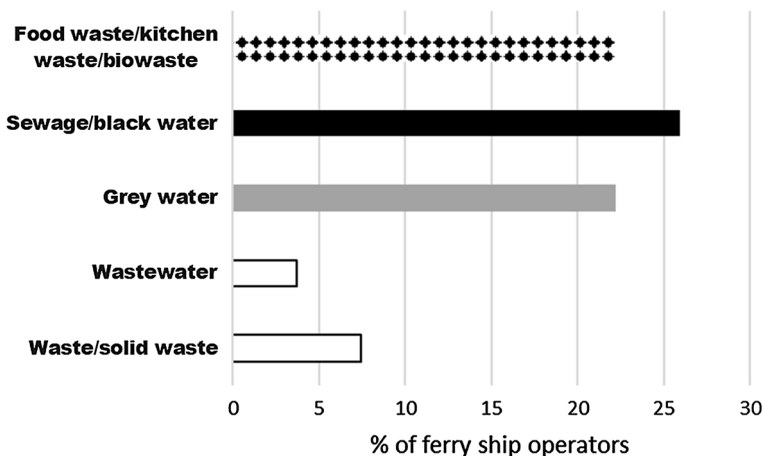


Fig. 1 Percentage of ferry ships operators stating "food waste", "sewage" and "grey water" on the websites

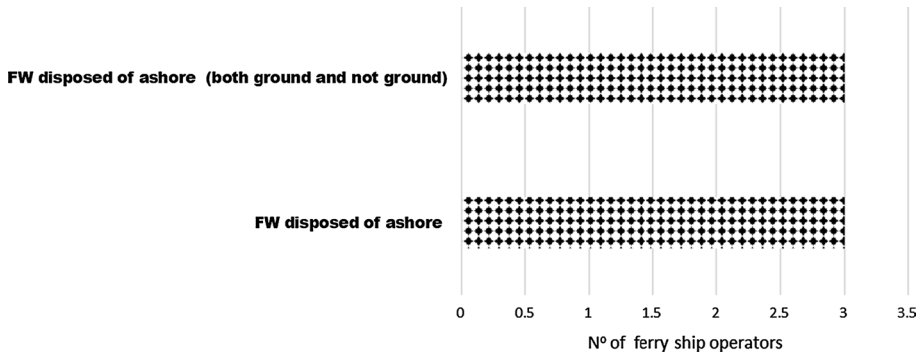


Fig. 2 Handling of food waste described by ferry ship operators

The cruise ship operators mention food waste more often, compared to the ferry ship operators. The term food waste has been found on 32% of the websites of the cruise ship operators, and additionally on 21% of the websites “solid waste” has been found (Fig. 3). Sewage has been found on 44% cruise websites, whereas grey water is stated by 38% of analysed cruise ship operators. Additionally, one cruise ship company states wastewater on the website. A further analysis showed that in the group of 11 cruise ship operators that mention food waste on the websites, more than half state sea-discharge as handling option for food waste (Fig. 4), either as the only handling or in combination with disposal ashore or incineration. Incineration is mentioned also in combination with shore disposal (2 operators) or alone as the only alternative (1 operator). The remaining cruise ship operator describes that food waste is dehydrated and compacted, but no information on how and where the compacted waste is disposed off further. Cruise operators that stated waste or solid waste were analysed as a separate group. Out of seven operators in total, four do not provide further information about the handling on the website and three operators inform that either the wastes are not discharged overboard or that the wastes are disposed of ashore. Regarding sewage, the on-board treatment is the common practice by the cruise

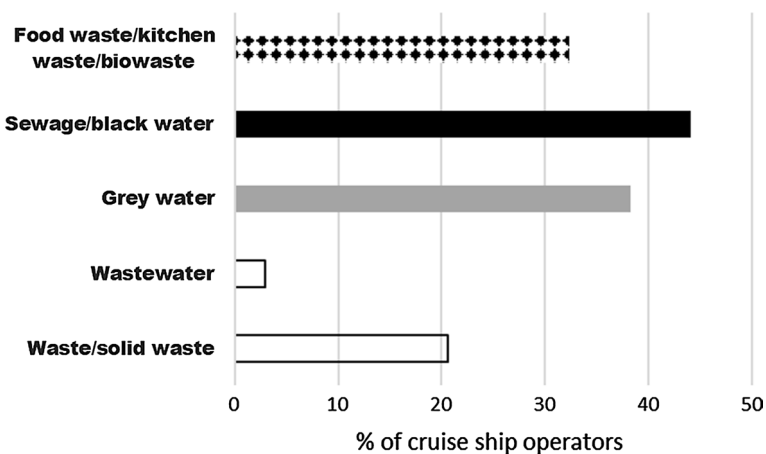
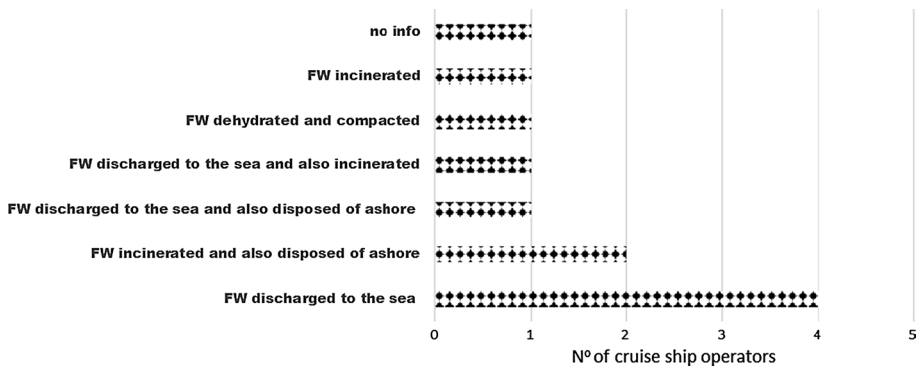


Fig. 3 Cruise ships operators stating “food waste”, “sewage” and “grey water” on the websites



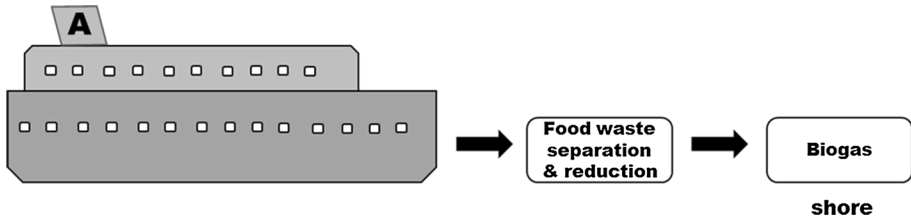
**Fig. 4** Handling of food waste described by cruise ship operators

ship operators, either for the whole sewage generated (9 of 15 operators) or for a fraction of the generated sewage (6 of 15 operators). In the latter group, the fraction of sewage which is not treated on-board, is disposed of ashore (4 of 15 operators) or either disposed of ashore or discharged legally to the sea without treatment (2 of 15 operators). Grey water is handled in various ways on-board cruise ships as described by 13 operators. Five operators stated that grey water, either the entire volume or parts of it, is treated on-board, however, with no information provided on how the remaining part of grey water is handled. One additional operator applies a combination of treatment on-board and disposal ashore. Two operators discharge grey water to the sea without treatment, and five operators mention that this water is handled in a combination of sea-discharge and shore disposal and/or treatment on-board. The only operator that stated “wastewater” did not provide more information, and therefore, the handling is unknown.

### 3.2 Interviews

The work concerning food waste reduction was described by the environmental managers at the passenger ship companies (company A and company B). Both companies started food waste projects about the same time, three years before the interview.

*Company A* is one of the major ferry companies operating in the Baltic Sea, offering freight and passenger transport. The company operates ships also outside the Baltic Sea. Currently, at the company the effort is put on separation of the food waste from other wastes and on waste reduction. In some cases, food waste is collected separately and disposed of ashore for biogas production (Fig. 5). Food waste is offloaded without any pre-treatment on-board except for one vessel where galley comminuters are installed. In that case, food waste is ground on-board to a slurry, transferred to a separate holding tank and, at the port, the slurry is collected by a tank truck and transported to a biogas plant. The food waste reduction programme has been implemented in the truck drivers’ restaurants and in buffet-type restaurants. Both initiatives to start food waste reduction programme and to start separating food waste from other wastes were taken by the company with motivation to lower the food costs and amount of food waste generated. At the company A, the generation of food waste is estimated at 0.25 kg/person a day. Currently, food waste numbers are gathered as monthly waste generation per ship and the numbers vary between high and low season and thus generation per passenger may be difficult to evaluate.



**Fig. 5** Company A strives to reduce food waste. The generated food waste is collected separately and disposed of ashore for biogas production

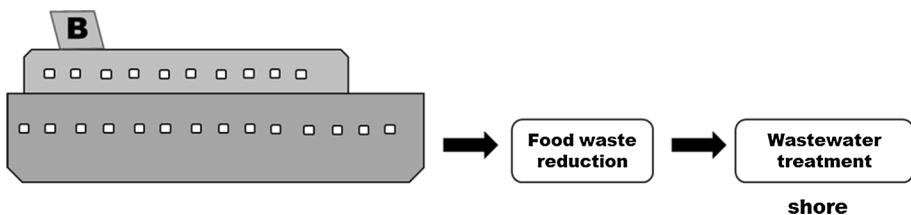
*Company B* runs a day cruise all year around on the Baltic Sea on a passenger vessel with capacity of about 2000 passengers. The work to reduce the generation of food waste has been implemented in the buffet-type restaurant. Currently, food waste is ground on-board and pumped into the grey water tank (Fig. 6). While in port, the mixture of food waste, grey water and black water is pumped to the sewer system onshore. The main motivation to reduce food waste was twofold: (1) the company realized that too much food has been thrown away and (2) the sewer system on land is at risk of deterioration due to formation of hydrogen sulphide ( $H_2S$ ) caused by offloading the mixture of food waste and waste water. An installation of the separated food waste system is being considered by the company in a long-term plan. Meanwhile, food waste reduction actions are introduced to lower the load of food waste in the grey water tank. By implementing improved routines in the galley and in the serving area, a 30% food waste reduction has been achieved. A current estimate for the generation of food waste is at 0.3 kg/person a day. The total amounts of generated waste vary between the seasons, which is mostly related to the varying number of passengers.

### 3.2.1 A multi-criteria analysis of food waste management

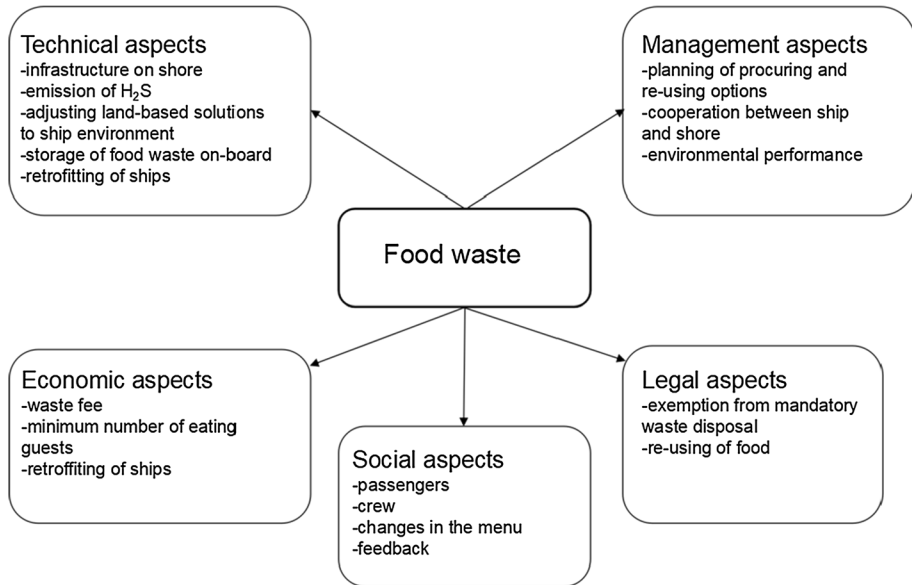
The respondents described what kind of food waste management practices are currently being applied at their companies and also shared their views on the challenges and opportunities in food waste management. As any practice of waste management is built around a number of criteria including technical characteristics, economic aspects or legal compliance, the aspects raised in the interviews were thus sorted under the headings, as follows (Fig. 7).

Under the technical aspects following points have been identified:

*Infrastructure onshore* Available infrastructure for waste handling in ports can greatly differ, what relates to the land infrastructure. One of the respondents from company A



**Fig. 6** Company B strives to reduce food waste. The generated food waste is stored in grey water tank and disposed of ashore into the sewer system



**Fig. 7** The aspects of the ship-generated food waste management

mentioned in the interview that the differences between regions can influence how food waste from ships is handled further onshore. Sweden has been given as an example of a country where the waste management is generally advanced and includes options adjusted specifically for handling of food waste. In other regions, similar possibilities onshore may not be present to the same extent and food waste from ships is usually disposed of together with combustible waste or discharged to the sea on international waters.

*Emission of undesirable compounds and deterioration of infrastructure onshore* Unwanted compounds can potentially be formed during biodegradation of organic waste. Problems with H<sub>2</sub>S generation and the deterioration of the sewer system on land were raised in the case of company B. Under anaerobic conditions, hydrogen sulphide is formed in the mixture of sewage, grey water and food waste, which corrodes the sewer pipes. After alarming information from the port, the company began the analysis and trials to lower levels of H<sub>2</sub>S in the waste streams. The conclusion was that only separating food waste from the rest of the wastewater would make a significant difference. Since a separate system was not in place on-board, a food waste reduction project was implemented as an intermediate solution.

*Adjusting the land-based solutions to ship environment* Waste collection practices may differ onshore and on-board. This issue was raised in the interview with respondent from company A. In case of this company, it has been learned that the solutions on how food waste should be collected on-board and transferred further to shore should not be applied based only on the land-based experience. An efficient solution should be adapted accordingly to the ship environment and the fact that ship is affected by the water movements.

*Storing food waste on-board* The interviews revealed that there are several difficulties connected to storing of organic waste on ships. Both respondents claim that food waste separation from other wastes can be a challenge because storing of food waste on-board is associated, especially during longer travels, with hygienic problems, dirty bins, unpleasant



smell and even with insects and rats. It is also necessary to cool down the stored waste, which is associated with additional consumption of energy. The space on-board for the storage of waste is limited, which is a further challenge.

*Retrofitting of ships* A separate food waste system on-board is a favourable solution. In the interview with respondent from Company B, however, a technical challenge when retrofitting existing ships with a separate food waste system was mentioned. Installing such system in the ship's structure on-board is difficult mainly due to limited available space. The installation process is easier in case of newly build vessels as such system is included already in the design stage.

Under the economic aspects, following points have been identified:

*Waste fee* One of the business expenses of the companies is a fee to dispose of generated wastes. Information provided during the interview showed that the waste collector processing waste from the company A charges lower fee when food waste is separated compared to the fee for the mixed combustible waste. The difference in the fees is motivated by high demand for food waste for the biogas production. An optimal solution for shipping companies in general, suggested by respondent from company B, would be the possibility to sell the separated food waste to operators of biogas plants.

*Minimum number of eating guests at the buffet-type restaurant* Number of eating guests at the buffet restaurant is important for economic reasons. An example was given by the respondent from company A where in the early stage of the project a minimum number of eating guests has been estimated when offering the buffet was profitable. If the number is not reached, the buffet is not offered and the guests are asked to choose another restaurant that sells portion meals instead. Having the rule of minimum number of eating guests helps to avoid the generation of food waste at serving.

*Retrofitting of ship* As provided by the respondent from company B the installation of separate food waste system is not only challenging from the technical perspective but there exists an additional economic aspect. The retrofitting work needs investment from the shipping company. There is also loss of income for the company during the time of retrofit as the ship is not operating.

Under the management aspects following points have been identified:

*Planning of procuring of food and reusing options* Planning how much food to prepare and repurposing of leftovers leads to food waste reduction. As provided in the interviews, the initial stage of the project at company A included reviewing of the purchasing procedures, planning of procurement of food ingredients and working with reusing of food in those cases when it is appropriate. In the case of company B, the reduction of food waste is performed at different stages including purchasing of provisions, preparing the meal and serving. The former stage is especially challenging as the number of passengers vary between cruises.

*Cooperation between "the ship and the shore"* As maritime traffic operates between shore and sea most of the operations require collaboration of personnel from both sides. The respondent from company A pointed out that the cooperation between the ship crew and the municipality is important in the matter of offloading ship-generated wastes. Communication between all actors is needed to achieve a sustainable, functional management of waste. A recommendation from the respondent to make the overall process more efficient is to increase the engagement of the waste entrepreneurs. One idea to achieve that could be by formulating the waste reception agreement that obliges entrepreneurs to provide service in guiding and suggesting options for the utilization of waste from ships. Another input to make the overall process more efficient is to clearly communicate the responsible person for waste reduction issues in ports.

*Environmental performance* Companies can commit to responsible care for environment by setting the reduction of food waste as an environmental target. The interviewed companies currently do not use food waste numbers as targets or goals in their environmental work. It has been motivated by the fact that the projects have been quite recently implemented and the respondents do not want to set unrealistic numbers. However, it is not excluded that quantitative targets for that waste will be set in the future.

Under the legal aspects, following points have been identified:

*Exemption from the mandatory waste disposal* Whether shipping company is obliged to dispose waste in every port of call or in some specific ports can have an impact on the further waste handling onshore. This was revealed during the interviews that being granted the exemption from the mandatory waste disposal, company A could, according to the company needs, make agreements with the waste entrepreneurs and plan where the waste (including food waste) is disposed of.

*Reusing the food* One alternative to reduce volume of food waste is to reuse food. In the interviews the respondents explained that in the buffet-type restaurants on-board care is taken to limit food served at once. Due to the hygienic regulations, any remaining food from the buffet cannot be returned to the kitchen and be served again but instead it must be thrown away. A possible exception from that rule, however, is to serve the remaining food to the crew, and it is sometimes practiced at company B. Company A also considers the possibilities to reuse some food ingredients if it is along with the regulations.

Under the social aspects, following points have been identified:

*Passengers* The behaviour of passengers during the meals has an impact on the amount of food waste. Some examples mentioned by the respondents from companies A and B are as follows. It has been realized, in case of company B, that the buffet-type restaurant is the main source of food waste. Therefore, this restaurant was re-organized according to procedures and processes aimed to reduce waste that included introduction of smaller portions at the buffet table, use of smaller plates and improving the “flow” of eating guests. The latter has been motivated by an observation that long queues at the buffet have negative effect on the eating guests as they tend to take larger portions of food to avoid getting in the long line again. Company A decided to introduce an additional person who serves meat and other protein-rich food to the eating guests in the buffet-type restaurant. Earlier, the guests were taking this type of food by themselves which resulted often in big portions on the plates and consequently in waste. Additionally, a written information has been placed in the restaurant aimed to make eating guests aware of food waste. The guests are asked to take smaller portions but several times.

*Changes in the menu* Differentiation of menu can be an element of the food waste reduction project. An example given by company B was an initiated cooperation with a popular restaurant onshore that resulted in introduction of vegetarian menu on-board.

*Crew* An engagement of the crew in the food waste reduction is crucial. In the interview, the respondent from company B said that the crew has been prepared through a 6-month training provided by an external firm, with aim to raise awareness of the waste generation and to introduce new practices aiming at reduction of wasted food.

*Feedback from the crew and passengers* The progress of the food waste reduction projects can be reviewed by collecting feedback from the crew and passengers. None of the interviewed companies has performed systematic surveys among passengers and crew to get feedback on the company’s approach to waste reduction. However, according to the respondent from company B, engagement and positive response from the crew to the project has been noticed.

## 4 Discussion

In this study, mapping of information published on the websites showed that the minority of the passenger ship operators inform about food waste management practices. It has been noted that cruise ship operators provide more information about the waste management compared to the ferry ship operators. Additionally, many cruise ship operators apply more than one alternative to handle the same type of wastes, which is visible especially for food waste and grey water. This can result from the fact that the operator has many ships operating in different regions governed by local regulations and also from the fact that ships have varying equipment on-board.

Food waste is, according to the information published, always delivered to shore by the ferry companies. There are some cases when food waste is disposed of in the sewer system onshore together with the wastewater from ferry ships, which seems to be relevant for older vessels. In case of cruise companies, it is quite common to discharge food waste to the sea. Other options to handle cruise food waste include shore disposal and incineration. Sewage and its handling is described on the websites of ferry and cruise ship operators more often than handling of other waste streams. This can be related to the ongoing public discussion on handling of ship sewage and also to recently revised MARPOL Annex IV that will limit sea-discharge of sewage. It should be noted that this study relies on published information from the companies' websites. There might be shipping companies that have specific waste management programs but do not use their websites to disclose such information; hence, they are not included in the study.

Disclosing information about the waste disposal is not mandatory by law but is a decision of a single shipping company and its environmental management system. This step does not require considerable work load but can give numerous benefits to the company including passenger participation in the waste management system. Food waste, sewage and grey water can be of interest to the passengers as these wastes directly relate to the presence of people on-board and are also well known from the household environment. Therefore, waste volumes can be possibly lowered with the help of passengers and their behaviour on-board.

More light on the aspects that influence management of food waste on-board was put during the interviews with the environmental managers. The information about food waste practices given by the respondents was analysed and sorted under technical, economic, management, social and legal aspects. It can be concluded that an important step towards more effective management is the separation of food waste from other waste streams. This enables to measure generated waste, monitor the amounts and provides recycle possibilities. Both respondents agree that storing of food waste on-board is troublesome due to hygienic reasons and limited space. On existing ships, the retrofitting of the waste system is challenging due to technical and economic reasons identified in the interviews. A significant technical aspect that has also impact on the infrastructure onshore is associated with practice to mix food waste with wastewater on-board. To limit deterioration problems in sewer system onshore, an effective food waste reduction should be applied to constantly lower the organic load of the wastewater mixture and, in the long run, a separate food waste system should be installed. The separated food waste can be processed further onshore. It has been noticed that there is demand for food waste to produce biogas on land; however, biogas infrastructure is developed to different degrees in the region, and therefore, the demand is concentrated at some locations.

The examples given by the companies interviewed in this study show multiple approaches to reduce food waste generation. In both cases, the efforts were focused on buffet-type restaurants. The solutions used were created by considering mainly management, social and economic aspects, whereas legal aspects (reusing of food) were mentioned as an obstacle. The pathways towards reduction of wastes start at planning and purchase phase and continue through implementing improved routines in the galley and in the serving area. The latter is associated much with social aspects as the companies could impact the eating guests and their behaviour which in turn resulted in lower amount of waste.

In this study, due to the limited number of interviewed respondents, it is not possible to draw clear conclusions regarding the whole shipping sector. Nevertheless, the findings are still of interest, as they give insight into challenges and possibilities that companies face in their every-day work with management of waste. They can serve as a base to build a hypothesis to be tested further on a larger group of respondents. Can the findings and solutions from interviews be used by other shipping companies operating in the region in the meanwhile? In general, yes, although there are some limitations. Due to EU regulations, only food waste from ships operating in the EU may be used as biogas substrate, which makes this possibility unavailable for international cruise ships. From the general point of view, it should be also considered that even if the energy from food waste is recovered in the biogas process, a focus should be put on systematic reduction of generated food waste instead of creating a solution that relies entirely on the delivery of food waste.

There is a possibility to observe how food waste reduction is performed onshore to make an effort to implement some of the used solutions on-board. Several opportunities for food waste reduction in the hospitality sector can be found in the literature but they should be analysed whether they suit the maritime environment. Some of them can simply be applied directly on-board, such as placing information for the eating guests in the buffet-type restaurants as was practiced by one respondent in the study. On the other hand, some land-based solutions for example donating food to the charitable organizations cannot be applied to entire shipping sector as there are health regulations prohibiting such solutions from ships engaged in the international transport.

There might be multiple factors which impact the management of wastes in the ferry sector and in cruise sector. One of them is route schedule as ferry ships operate on a regular schedule during the whole year, whereas cruise ships visit the Baltic Sea region less often. The frequent schedule between the countries in the region enables tighter cooperation between actors onshore and on ship, which in turn helps in solving the waste issues. In order to get accurate picture of food waste management in the region also other perspectives have to be included, as for example government policies.

## 5 Conclusions

The aim of the study was to analyse how the management of food waste is performed and communicated on the websites of the companies operating passenger ships in the Baltic Sea. Currently, it is a challenge to see the big picture on how food waste is handled by passenger ships operating in the Baltic Sea as most of companies do not make this information available online. The further goal was to identify aspects that influence management of food wastes on-board ships. Using the information gathered at the interviews, these can be further grouped into technical, economic, legal, social and management character. Both respondents agree that separation of food waste from other wastes is favourable. However,

as the findings shown, the separation can be a challenge on existing ships that require retrofitting. Finally, by analysing the studied cases, shipping companies can choose the buffet-type restaurants as a starting point for food waste reduction programmes. Further steps can be adjusted according to the individual ships and their unique characteristics. The findings from the interviews can be used in the further research to build a hypothesis to be tested on a larger group of respondents from the passenger ship sector.

A suggested sustainable solution for the ship-generated food waste in the region is based on three pillars: on-board food waste should

- (1) be separated from other waste streams,
- (2) should be measured and
- (3) constantly reduced.

The study was focused on shipping in the Baltic Sea region; however, the findings can be translated to other regions and encourage more intensive work with ship-generated wastes.

**Acknowledgements** The project was funded by BalticSea2020 and the BONUS project Sustainable Shipping and Environment of the Baltic Sea region (SHEBA).

**Open Access** This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

## References

- Angelo, A. C. M., Saraiva, A. B., Clímaco, J. C. N., Infante, C. E., & Valle, R. (2017). Life Cycle Assessment and Multi-criteria Decision Analysis: Selection of a strategy for domestic food waste management in Rio de Janeiro. *Journal of Cleaner Production*, 143(Supplement C), 744–756, doi:<https://doi.org/10.1016/j.jclepro.2016.12.049>.
- Babalola, M. A. (2015). A multi-criteria decision analysis of waste treatment options for food and biodegradable waste management in Japan. *Environments*, 2(4), 471.
- CLIA (2016a). State of the Cruise Industry Outlook 2017. Cruise Lines International Association Ltd.
- CLIA (2016b). Waste Management. <http://www.cruising.org/about-the-industry/regulatory/industry-policies/environmental-protection/waste-management>. Accessed 2016-11-1.
- CSI. (2016). Clean Shipping Index. Real-time, quantified insight into the environmental performance of ship. <http://www.cleanshippingindex.com/>. Accessed 12 June 2016.
- EMSA. (2017). The Management of Ship-Generated Waste On-board Ships. EMSA/OP/02/2016.
- European Commission. (2009). Regulation (EC) No 1069/2009 of The European Parliament and of The Council of 21 October 2009 laying down health rules concerning animal by-products not intended for human consumption and repealing Regulation (EC) No 1774/2002. Official Journal of the European Communities.
- FAO (2011). Global food losses and food waste—Extent, causes and prevention. Rome.
- Filho, W. L., & Kovaleva, M. (2015). *Food waste and sustainable food waste management in the Baltic Sea Region (Environmental Science)*. Cham: Springer International Publishing Switzerland.
- Hamilton, H. A., Peverill, M. S., Müller, D. B., & Brattebø, H. (2015). Assessment of food waste prevention and recycling strategies using a multilayer systems approach. *Environmental Science and Technology*, 49(24), 13937–13945. <https://doi.org/10.1021/acs.est.5b03781>.
- HELCOM (2015). Baltic Sea Sewage Port Reception Facilities. HELCOM Overview 2014. Revised Second Edition. Helsinki, Finland.

- IMO (2011a). Resolution MEPC. 201(62). Adopted on 15 July 2011. Revised MARPOL Annex V, Regulations for the prevention of pollution by garbage from ships. International Maritime Organisation, Marine Environment Protection Committee.
- IMO (2011b). Resolution MEPC.200(62), Amendments To The Annex Of The Protocol Of 1978 Relating To The International Convention For The Prevention Of Pollution From Ships, 1973, Special Area Provisions and the Designation of the Baltic Sea as a Special Area under MARPOL Annex IV, Adopted on 15 July 2011. International Maritime Organisation, Marine Environment Protection Committee.
- IMO (2012). Resolution MEPC. 219(63)2012. Adopted on 2 March 2012. Guidelines for the implementation of MARPOL Annex V. International Maritime Organization, Marine Environment Protection Committee.
- Jose, A., & Lee, S.-M. (2007). Environmental reporting of global corporations: A content analysis based on website disclosures. *Journal of Business Ethics*, 72(4), 307–321. <https://doi.org/10.1007/s10551-006-9172-8>.
- Schneider, F. (2013). Review of food waste prevention on an international level. *Waste and Resource Management*, 166(WR4), 187–203. <https://doi.org/10.1680/warm.13.00016>.
- Sun, X., Jiao, Y., & Tian, P. (2011). Marketing research and revenue optimization for the cruise industry: A concise review. *International Journal of Hospitality Management*, 30(3), 746–755. <https://doi.org/10.1016/j.ijhm.2010.11.007>.