Optimising the Energy Efficiency of Small Ferries

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ABSTRACT

In order to reach the goals for CO_2 reduction and energy efficiency it is important to improve the efficiency of the maritime sector. This study explores the possibilities of improving the efficiency of the harbour stays of small ferries. Operational activities for three different ferry routes are mapped out and three important areas for improvement are identified: Time savings, Time utilisation and Leadership. The implications of these themes and their dependencies on each other are discussed. In order to improve energy efficiency, time in harbour must be minimised and the time saved used instead to increase passage time. To achieve this, a more dynamic timetable is needed. Time savings and time utilisation are closely related to leadership and how this is performed. Lastly, it is identified that education and training of personnel and leaders is important for enabling development of the three identified themes.

1. INTRODUCTION

Energy efficiency has been a major concern in the maritime industry in recent decades. This is partly due to the economic aspect, but regulations and concerns about the environment are also playing an increasingly important role. Discrepancies in international goals for CO_2 reduction and the forecast for emissions from the shipping sector underline the urgent need for solutions to reduce emissions from shipping. Several studies have been conducted on energy efficiency in ships. These studies can be divided into technical solutions and operational practices, see, for example, the study by DNV GL [1] and work of Banks [2]. The present study falls into the second category, as it focuses on operational practices in smaller ferries during harbour stays.

There are a large number of ferries worldwide. Ferries play an essential role in transporting people, cargo and vehicles across waters on fixed routes with regular schedules. The size of these vessels can range from smaller boats transporting passengers across a river to larger seagoing vessels carrying passengers, cars and trucks. Interferry [3], an organisation representing the ferry industry worldwide, estimates that the ferry industry is similar in size to the airline industry, transporting approximately 2.1 billion passengers each year, indicating a vast potential if even small improvements are implemented.

Small ferries have unique operating patterns that do not correspond to the patterns of other vessel types. They usually have short sea passages and therefore spend a relatively large proportion of their time moored in harbour. This is in contrast to other vessels such as container ships, tankers or bulk carriers, which spend most of their time at sea. If the harbour stays could be shortened for ferries this could have a significant impact on energy efficiency. The most obvious effect is that a shorter harbour stay would lead to more time for passage and manoeuvre. More time for passage allows for a decrease in speed and thus lower fuel consumption and lower emissions. A study performed by Eriksen et al. [4] shows that a significant amount of energy can be saved by prolonging the passage time of a passenger ferry by just a few minutes.

This paper explores the harbour stay with the aim of mapping factors important to reducing the energy consumption of the entire ferry operation. The harbour stay is defined as the period between the ferry touching the dockside and staying still until leaving the dockside again. The time spent in harbour and how it is spent is important. Less time used for the necessary activities during the harbour stay will result in time available for other tasks, which must be utilised to increase efficiency. If the time between arrival and departure is fixed, this available time becomes a waiting time and will be unproductive. This calls for a closer look into the harbour stay and its structure as a whole, taking into account timetables, work activities and management.

The present paper is structured as follows: in Section 2, the methods used, and the data collected and used is described. Section 3 lists the findings, which are discussed in Section 4. Finally, Section 5 presents the conclusions.

2. METHODS AND DATA

A qualitative method approach has been used to explore the factors that influence the effectiveness of the harbour stay of smaller ferries. The qualitative method is suitable for exploring this since the harbour stay is a complex operation which needs to be understood in order to determine and explain important factors and their relations.

The data used for the present study was compiled on board three ferries sailing in Danish inland waters. Data was collected through a combination of interviews and observations during field trips. The ferries operate specific routes with fixed timetables and frequent consecutive arrivals and departures. The operation characteristics, i.e. traffic volume and size of the three ferries, are large, medium and small in order to provide the broadest view possible with the limited sample size. A list of relevant data regarding the selected ferry routes is provided in Table 1.

Table 1 - Ferry route characteristics.

Operational characteristics	**Timetable harbour/passage**	**Length overall (m)**	**Capacity (cars)**	**Max PAX Summer/winter**
Large volume, main traffic lane	15 min/45 min	142	364	1140/1140
Medium volume, regional traffic lane	15 min/75 min	49.9	42	395/250

Small volume, local island traffic lane	5/0 min/30 min	35	14	98/60

On board each of the ferries, a person involved in the unloading and loading activities was selected for interview. Three interviews were made. The respondents were all officers, and both engine and deck officers were represented. The views and opinions of other crew members, as well as other observations, were recorded in separate field notes. Written notes made during the interview by the interviewer himself and two observers documented the interviews. In all interviews, the interviewer and the observers were the same researchers. The setting: two interviews were performed on board the ferry on which the officer worked, one interview was conducted in a conference room ashore. All interviews were performed in the Danish language and all involved persons were native Danish speakers. The interviews all followed the same interview guide.

The interview guide was compiled based on the experience of the researchers who have all been professionally involved in ferry operation. A workshop was performed in which the knowledge and experience gathered was used to identify activities necessary for a generic harbour stay. The following activities were identified: mooring, unloading, loading, and let go. During some harbour stays, it is also necessary to arrange tasks such as crew change, bunkering and loading of provisions. Five topics for questions were identified:

1. Harbour stay - necessary activities and their duration;
2. Timetable;
3. Optimisation, ideas already implemented and ideas for the future;
4. Cooperation and team spirit;
5. Systematic planning.

The first topic covers which activities are done and how much time these take. The second topic clarifies to which degree the timetable corresponds with the time required for necessary activities. This is especially interesting if unproductive periods, i.e. waiting or delays, occur regularly. The third topic deals with initiatives already taken to improve energy efficiency and future ideas. The fourth topic explores how the people involved in the harbour stay cooperate and if team spirit is a factor. The fifth and final topic addresses booking and planning procedures, in particular if systematic planning is based on bookings or other information.

3. FINDINGS

The field notes were coded using inductive coding, as described by Frankfort-Nachmias et al. [5], i.e. extracting the codes from the collected data. In doing so, 33 codes were identified. Table 2 shows a list of the codes extracted from interview and field notes for all three ferry routes explored in this study. The codes were categorised and subsequently grouped into three thematic areas, namely “time savings”, “time utilisation”, and “leadership”. The first two themes, time savings and time utilisation, are similar to each other in the sense that they deal with concrete processes. The third theme “leadership” is of a different nature to the first two. Leadership acts as a catalyst for the two other. This means that leadership affects both time savings and time utilisation.

Table 2. Codes, categories and themes – findings.

Code	Category	Theme
Load meeting	Planning	Time savings
Booking plan available		
Sufficient personnel	Manning	
Flexible personnel		
Skilled personnel		
Teamwork		
Clear and open communication channels	Communication	
Passenger conflicts	Management of events	
Ambulance transport		
Sick passengers		
Bicycles		
Last minute passengers		
Sorting post		
Change resistance	Challenges	
Lack of knowledge of complete operation		
On-time arrival/on-time departure	Timetable paradigms	Time utilisation
On-time arrival/flexible departure		
Flexible arrival/on-time departure		
Flexible arrival/flexible departure		
Waiting for train/bus	Infrastructure dependencies	
Need to arrive before train/bus departure		
Skip trip	Timetable flexibility	
Extra trip		
Harbour stay long enough for full load	Timetable coherency	
Harbour stay longer than full load		
Passage time long enough to catch up		
Focus on efficiency	Visible leadership	Leadership
Team spirit		
New ideas encouraged		
Facilitate communication	Structural leadership	
Facilitate change		
Knowledge sharing		
Staff meetings		

4. DISCUSSION

The aim of the present study was to explore the harbour stay with the intention of mapping factors important for reducing the energy consumption of the entire route operation. This was achieved by investigating the harbour stay in its entirety, taking into account work activities, timetables, leadership, and management. From interviews and observations on board three different vessels, 33 codes were identified and subsequently categorised and grouped into three main thematic areas, namely Time savings, Time utilisation, and Leadership. Time savings and time utilisation are inter-related. Time savings are of no consequence if time utilisation is impossible, likewise time utilisation is impossible if time is not available or no waiting time is present to be utilised. Leadership influences both time savings and time utilisation because it acts as a catalyst or a barrier for improvement in these areas.

It is worth noting that the specific codes identified are all related to operational or leadership practices and not technical limitations. This indicates that the equipment available is sufficient from the operator's perspective. It also implies that an improvement in efficiency is possible by changing the operational practices, and does not solely depend on technical solutions, as also found by Banks [2].

Developing better operational practices will largely depend on the factors represented by the codes identified. The code "Skilled personnel" covers knowledge of logistics and how well skills are employed during loading and discharging. Knowledge of logistics can be acquired through education and training. The codes in the category "Management of events" cover interaction with passengers, and how smooth operations and skilled handling of unforeseen challenges can avoid loss of time. These skills can be acquired through courses in communication, and conflict and crisis management.

An important factor is the ability of the individuals involved in the operation to understand the team tasks. This will induce back-up behaviour and flexibility. It also allows all personnel involved to prioritise the most important tasks in case of a shortage of personnel. An example of this was an observation made of the captain counting passengers coming on board, thus relieving the rating at the gangway. The rating was then free to assist the officer on deck with stowing cars during a busy period. Another example from an interview was a description of a case where no-one had been assigned to operate the suspended deck; an engineer, who was not normally a part of the loading team, stepped in and assisted. Examples such as these were coded under "Flexible personnel".

It was observed in the interviews that leadership plays an important role when trying to improve efficiency. The leader must initiate and enable the task of improving energy efficiency and continuously ensure that the focus remains on this issue. Studies show that when energy efficiency awareness is raised, this alone can lead to practices that are more effective, as found by Jensen et al [6]. Awareness is a skill that can be trained, as indicated by Rasmussen et al [7] and Jensen et al. [6], and the leaders should therefore support and arrange training. Studies show that a change in operational practices can lead to a significant increase in efficiency with little or no investment in technical equipment [2]. The findings in the present paper also show that "team spirit" is important, and that a working environment which allows for suggesting and testing alternative practices leads to better cooperation and engaged personnel. The leader is responsible for creating a work environment where ideas for improvement are welcomed. An example of this was described in one of the interviews where the leader rewarded ideas

with small tokens of appreciation and, in case ideas failed, practiced leniency so as not to discourage new ideas, which, according to the interview respondent, worked well.

Changing the timetables was mentioned in all interviews as a central piece of the puzzle. Many possibilities were discussed in all interviews, which strongly indicate the need for looking into the timetables with an open mind, and this might call for a new definition of punctuality. Johnson and Styhre [8] also suggest flexibility in arriving time as a means of allowing for longer passage time. One attempt at making the timetable flexible has already been conducted on a ferry serving two small islands. On the timetable, a harbour stay is allocated zero minutes. This is a way of allowing for a dynamic timetable since this harbour is only called on when passengers are requesting transportation. The timetable allows for either a slightly faster passage or later arrival at next the harbour to compensate for the harbour stay when needed. Another example is a route where the ferry is allowed to depart before the official departure time if no more passengers are in sight. This utilises what, under normal circumstances, would be waiting time and converts it to passage time. Changing the timetables might seem a simple solution but in practice it can be very difficult since many stakeholders are involved.

The ferry routes explored in this paper present a noticeable difference in how much optimisation of the harbour stay has already been implemented. However, during all interviews, ideas emerged that could potentially improve efficiency. This indicates that there is a potential to increase the efficiency of all three routes by changing operational practices.

The wide varieties in ferry operations makes it difficult to transfer specific findings between ferry routes. However, the three themes identified could be used as a guide to improve the efficiency of other ferry routes. The specific codes identified in this paper could serve as an example of what may be considered in order to improve efficiency. It is, however, quite clear that each individual route will need to perform its own analysis to identify specific points to improve.

5. CONCLUSION

This paper has discussed several factors important for increasing the energy efficiency of ferry routes by shortening harbour stays. Three key themes were identified: Time savings, Time utilisation, and Leadership. These themes were discussed and examples given, and it was found that many of the underlying factors can be addressed with training or courses. This is true for both leaders and directly involved personnel.

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