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Tactical Planning in Tramp Shipping – a Literature Review

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Purpose: This paper discusses the current state of research on tactical planning in tramp shipping problems. The constantly changing demands in operative tramp shipping make tactical or strategical, i.e. longer-term planning, in comparison to operative planning more complex. The purpose of this paper is to describe solutions to tactical planning difficulties in tramp shipping and to point out future research directions.

Methodology: For this paper, a systematic literature review of journal articles and book chapters of the last ten years is conducted. The findings of this search are analyzed and reviewed. Thus, different planning problems and their solutions are identified.

Findings: Planning problems in tramp shipping are clearly distinct from planning problems in liner shipping as tramp shipping is subject to considerably more uncertainties. Due to the high degree of uncertainties in tramp shipping longer-term planning is challenging. Consequently, the results of research on tactical planning problems in liner shipping cannot be transferred directly to tramp shipping.

Originality: This paper provides a comprehensive overview of strategic and tactical planning in tramp shipping as presented in the literature.

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1 Introduction

Maritime transport is not only important for all sectors of the economy but also for everyday life, as more than 80 % of world merchandise trade by volume is transported by vessel. It is expected that the global seaborne trade is continuing to grow by 3.4 % annually until 2024. Although most people think of containerized trade when hearing of maritime transport, main bulks (iron ore, grain, coal, bauxite/alumina and phosphate), other dry cargo and tanker trade (crude oil, refined petroleum products, gas and chemicals) account for more than three quarters of the goods transported annually measured in ton-miles (United Nations Conference on Trade and Development, 2020). Most goods in these segments are transported by vessels operating in tramp shipping.

Usually a distinction is made between three different modes of shipping: liner, tramp and industrial shipping. In liner shipping, vessels sail on fixed routes according to a schedule. In tramp shipping, vessels follow the cargo, which consists of contract and optional spot cargo, with the objective of maximizing profit. In industrial shipping, the company that owns the cargo also operates the vessels and thus tries to minimize the transportation costs (Christiansen, et al., 2013). Tramp shipping is characterized by a high degree of uncertainty, as tramp owners or, in some cases, industrial owners seek to improve their operating business through short-term, one-off orders (spot cargoes). Volatile freight rates and fluctuating crude oil prices increase the uncertainties and complicate long-term or medium-term planning in tramp shipping. Especially, in the dry bulk shipping market, which is close to a perfect competition market, freight rates and charter rates are highly volatile (Clarkson Research Studies, 2004). Thus, planning in tramp

shipping differs clearly from planning in liner shipping. Due to the high degree of uncertainties in tramp shipping long-term and mid-term planning is challenging.

The aim of this paper is to provide a literature review of tactical planning problems in tramp shipping and how these problems can be distinguished in terms of content or timeframe between strategic or operational problems. Typically, strategic, tactical or operational problems are distinguished according to their planning horizon. As in Bektaş (2017), this is often defined as long-term, medium-term or short-term for strategic, tactical and operational. This information is rather vague and the understanding of short-term and long-term is strongly dependent on the industry. In regards to tramp shipping, the assessment of the duration of a planning horizon in the long or short term can also differ depending on the shipping company's orientation towards deep sea shipping or short sea shipping, as the duration of a voyage in deep sea operation is considerably longer than in short sea operation.

The remainder of this paper is structured as follows: Section 2 gives a brief overview about existing literature reviews in the optimization of maritime transportation. In Section 3 the research methodology is explained, Section 4 presents the results of this literature review, and Section 5 draws a conclusion and presents further research possibilities.

2 Existing Literature Reviews

Christiansen, Fagerholt and Ronen (2004) presented a literature review on ship routing and scheduling for the years 1991-2001. Ten years later Christiansen, et al. (2013) have published a follow-up literature review for the years 2002-2011. The literature reviewed is classified according to shipping mode: industrial, tramp and liner. Although a distinction between strategic and tactical is made, tactical and operational problems are treated as one. The authors define problems around fleet composition or fleet size and mix as strategic issues and routing and scheduling problems as tactical or operational issues.

Zak (2010) provides a comprehensive overview about computer based decision support systems for a range of different modes of transportation. The author concludes that the definition of the planning horizon is highly dependent on the industry, as, for example, the lifespan of vessels is considerably longer than the lifespan of trucks. Furthermore, there are comparably few computer-based decision support systems for the shipping sector.

Lun, Cheng and Lai (2010) discuss business strategies in shipping, in addition to chapters about intermodal transportation and port management, and give an overview of the shipping and logistics industry. The concept of strategy is divided into three categories: corporate strategy (what kind of business), business strategy (how to compete in the chosen business), and functional strategy (how to support the business strategy). As the authors' main focus is on liner shipping, tactical problems and / or tramp shipping is barely discussed.

The most recent literature review on optimization in maritime transportation is on linear programming in liner shipping as well as in tramp and industrial shipping (Pradana and Noche, 2019). Other optimization approaches are not considered in the literature review. The authors define strategical planning problems as "mostly about the optimal fleet size", while tactical planning "involves constructing a set of routes which [is] known as ship routing and scheduling" and the operational planning "focus[es] on the cargo routing problem" (Pradana and Noche, 2019, p. 1). Although tramp shipping is different from liner shipping, the authors do not distinguish between liner and tramp shipping in the literature classification in terms of strategic and tactical.

Tactical planning in tramp shipping has not yet been covered independently in any literature review / educational book. To understand tactical planning in tramp shipping and how it differs from strategic planning and operational planning, a structured literature review is conducted.

3 Research Methodology

3.1 Literature Search

A structured literature search is carried out using search terms. The following limitations apply: the literature must be published in English in a referred journal or edited volumes. Therefore so-called grey literature, conference proceedings and theses are excluded. The databases *Scopus, ScienceDirect, Web of Science* and *IEEE Explore* were searched for literature between 2000 and March 2020 using the search string in Figure 1 for all databases.

When choosing the search key words, a focus was placed on tactical and strategic, as well as planning problems in tramp shipping. As tramp shipping is often not referred to as such, bulk, which can refer to dry bulk (e.g. iron ore, coal ...) or liquid bulk (e.g. crude oil), was included in the search string. In the past it was found that dry bulk is also written as "drybulk", so this term was added as a search key word.

The continuous improvement of the computing power in the last years enables the solution of optimization problems that were unthinkable until recently. Therefore, the literature of the last ten years is examined. Using the above described key words a total of 957 publications published since 2000 until the end of 2019 is identified. After reading the titles 123 publications remain. Many publications found either refer to bulk power electrical systems, power grids or design and construction of bulk carriers or tankers. These research fields are not related to the problem investigated here. The amount of publications is further reduced to 68 publications by reading the

abstracts and eliminating conference publications. After removing duplicate publications, 48 publications remain. Of these, 9 more, which are older than ten years, are dropped.

Figure 2 shows the number of publications over the publication year. No clear trend can be identified here, although it can be noted that the number of publications tends to increase with a more recent year of publication.

The 39 publications examined were published in 26 different journals or volumes. *Transportation Research Part E: Logistics and Transportation Review* is the most frequently occurring journal with 15.4 % of the publications followed by *Maritime Policy & Management* with 7.7 % of the examined publications.

tactical		tramp		shipping
OR		OR		OR
strategic	AND	bulk	AND	ship
OR		OR		OR
planning		drybulk		market

Figure 1: Search keywords used for the structured literature search

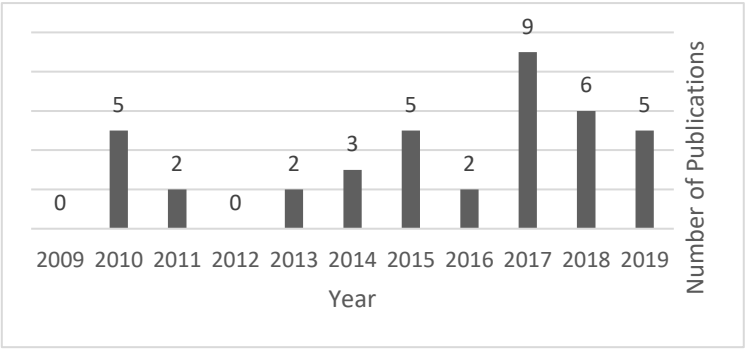


Figure 2: Number of publications per year

3.2 Classification Scheme

The planning horizon is often not clearly defined or is not attributed to the categories strategic, tactical or operational. At the same time, it can also be seen that the planning horizons differ from one specific problem to another. To answer the question how tactical planning in tramp shipping is defined in research and how it differs from strategic or operational planning, the following five classification criteria were examined in the found literature:

(1) Shipping mode: tramp, industrial or liner or the whole supply chain in one of the shipping modes

(2) Planning horizon: strategic, tactical or operational (as defined in the respective publications)

(3) Vessel type: bulk carrier, tanker or other (Container vessel, Ro/Ro vessel)

(4) Intended audience of the publication: ship owners or shipping companies, shippers, authorities and policy makers, investors, researchers, and port or terminal operators

(5) Voyage distance: short see shipping or deep sea shipping

The first classification criterion is the shipping mode (*tramp, industrial, liner*). The shipping mode has a considerable influence on decision making and planning problems. There are usually no spot cargoes, spontaneous orders which are accepted to prevent idle times of vessels, in liner shipping. Since spot cargoes are short-term in comparison to contract cargoes, planning is conducted with more uncertainty if spot cargoes are part of the business model. In industrial shipping, there are only a few spot cargoes, whereas in tramp shipping spot cargoes are an integral part of the operational concept. The publications are also analyzed to check whether they really address a problem in tramp shipping or whether it is a problem in industrial or liner shipping. Publications that define the planning problem as one in liner shipping, assume fixed timetables or focus solely on container shipping were identified as liner shipping. Some publications address the whole supply chain in one of the shipping modes. These publications are categorized as *supply chain*.

The second classification parameter is the planning horizon, which can be *strategic, tactical, operational* or a combination of these types. The literature was not classified according to a general definition of the planning horizon, but according to the definition in the publication. This is due to the fact that the general definitions of planning horizons are quite vague.

The third classification parameter considered is the type of vessel. In this publication a distinction is made between *bulk carriers* for dry bulk and

general cargo, *tankers* for liquid bulk and *other vessels*. In this publication vessel types that are not usually operated in tramp shipping, such as container vessels or Ro/Ro vessels, are referred to as other vessels.

The fourth parameter is the target audience of the publications. It is investigated to whom the research is directed, who can benefit from the results. In many cases, in the conclusion it is described who can benefit from the research presented or the solutions in a publication are specifically developed for a real-world problem. The following categories were identified: *ship owners or shipping companies, shippers, authorities and policy makers, investors, researchers, and port or terminal operators*. This classification parameter is based on the idea that publications dealing with real planning problems from practice could have a different definition of planning horizons than publications that develop scientific methods or conduct fundamental research.

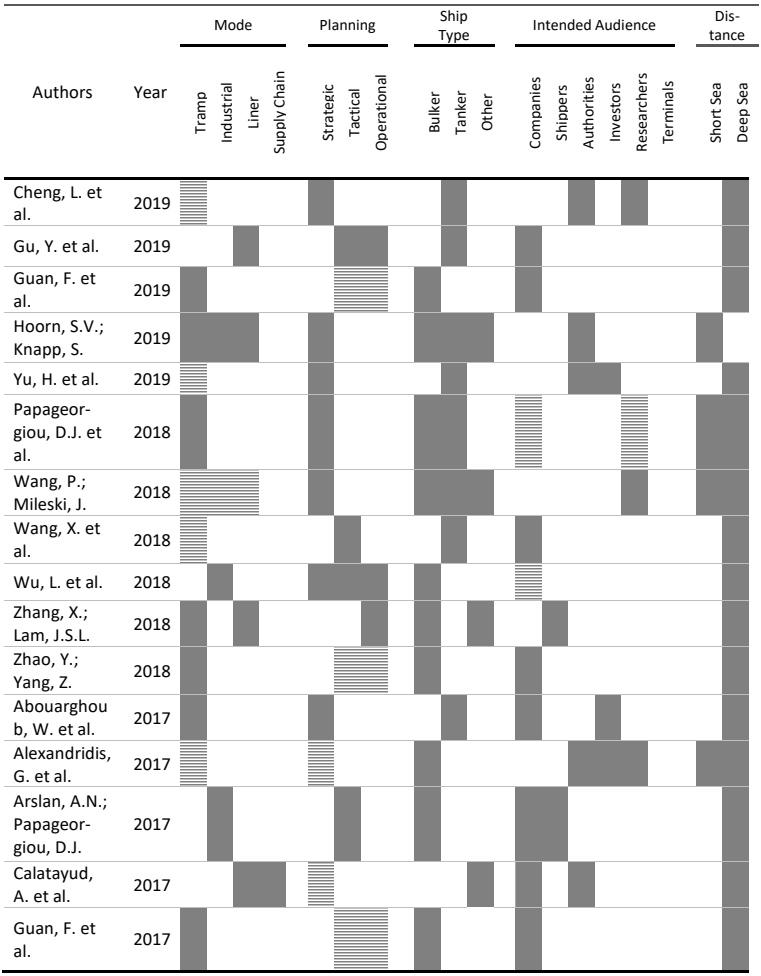
The fifth classification parameter examined is distance, i.e. whether the vessels operate in *deep sea shipping* or *short sea shipping*. Although many of the decision support models or optimization models found can be applied to both deep sea and short sea problems, the duration of the voyage can influence the definition of the planning horizon.

4 Literature Classification and Research Findings

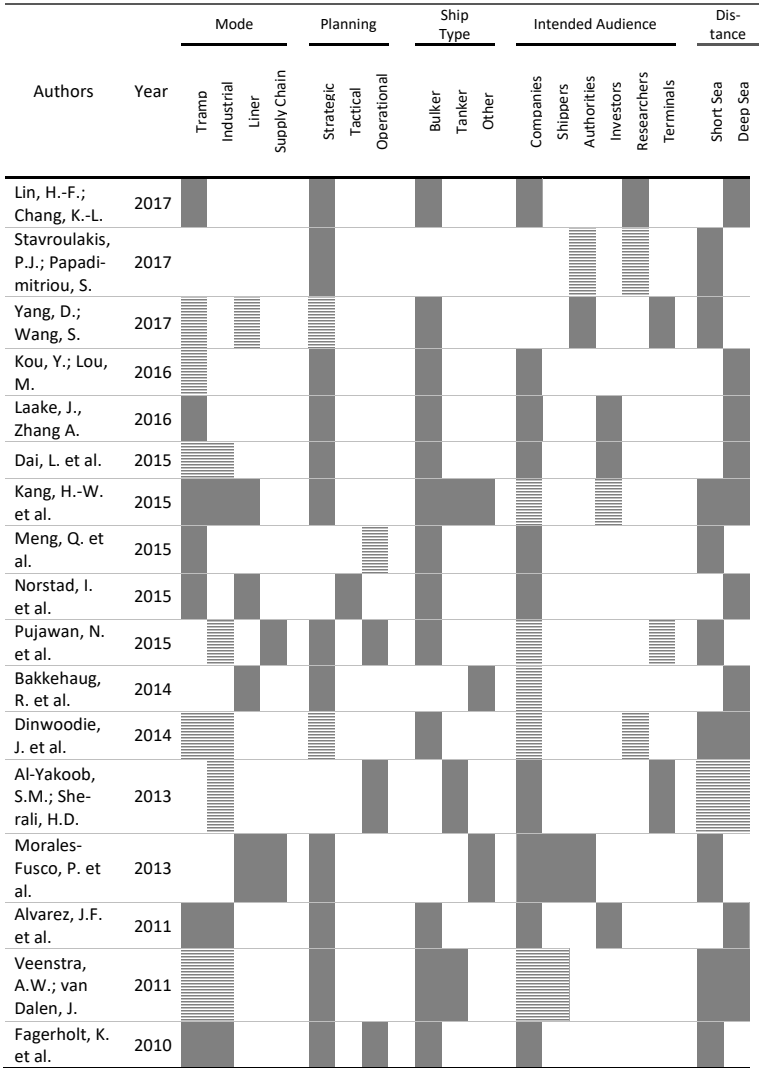
The literature classification is based on five classification parameters, which are evaluated in the following. A total of 39 publications were examined, of which 4 are literature reviews or educational books (Lun, Cheng and Lai, 2010; Zak, 2010; Sahebi, Nickel and Ashayeri, 2014; Bektaş, 2017) and therefore not categorized, as they may fulfill all classification parameters without defining them or implementing different parameters in a model. Table 1 shows the investigated publications and the classification parameters. A filled field means that this parameter applies to the publication, a dashed field means that this parameter was not explicitly defined in the publication, but the publication can be assigned to this classification parameter. Literature reviews and educational books are omitted in Table 1.

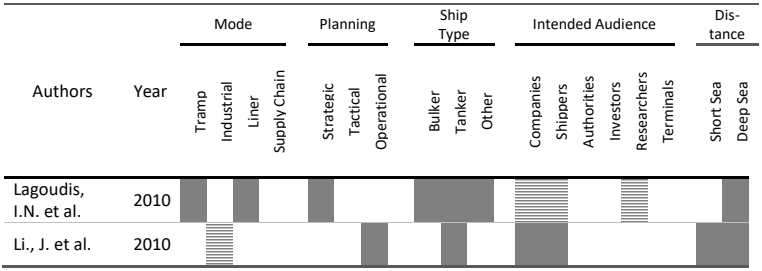
In the following the individual classification parameters: shipping mode, planning horizon, vessel type, intended audience, and voyage distance are evaluated and analyzed. The found results for each classification parameter are discussed.

Table 1: Classification table of investigated literature, continued on next page



Authors	Year	Mode				Planning			Ship Type			Intended Audience						Distance	
		Tramp	Industrial	Liner	Supply Chain	Strategic	Tactical	Operational	Bulker	Tanker	Other	Companies	Shippers	Authorities	Investors	Researchers	Terminals	Short Sea	Deep Sea
Cheng, L. et al.	2019	▒				■			■					■		■			■
Gu, Y. et al.	2019			■			■		■			■							■
Guan, F. et al.	2019	■					▒		■			■							■
Hoorn, S.V.; Knapp, S.	2019	■	■			■			■	■				■				■	
Yu, H. et al.	2019	▒				■				■				■	■				■
Papageorgiou, D.J. et al.	2018	■				■			■	■		▒				■		■	■
Wang, P.; Mileski, J.	2018	▒	▒			■			■	■						■		■	■
Wang, X. et al.	2018	▒					■			■		■							■
Wu, L. et al.	2018		■			■	■		■			▒							■
Zhang, X.; Lam, J.S.L.	2018	■		■			■		■		■		■						■
Zhao, Y.; Yang, Z.	2018	■					▒		■			■							■
Abouarghoub, W. et al.	2017	■				■				■		■			■				■
Alexandridis, G. et al.	2017	▒				▒			■					■	■	■			■
Arslan, A.N.; Papageorgiou, D.J.	2017		■				■		■			■							■
Calatayud, A. et al.	2017			■		▒					■	■		■					■
Guan, F. et al.	2017	■					▒		■			■							■


Mode
Planning
Ship Type
Intended Audience
Dis-tance
Authors
Year
Tramp
Industrial
Liner
Supply Chain
Strategic
Tactical
Operational
Bulker
Tanker
Other
Companies
Shippers
Authorities
Investors
Researchers
Terminals
Short Sea
Deep Sea
Lin, H.-F.; Chang, K.-L. 2017
Stavroulakis, P.J.; Papadi-mitriou, S. 2017
Yang, D.; Wang, S. 2017
Kou, Y.; Lou, M. 2016
Laake, J., Zhang A. 2016
Dai, L. et al. 2015
Kang, H.-W. et al. 2015
Meng, Q. et al. 2015
Norstad, I. et al. 2015
Pujawan, N. et al. 2015
Bakkehaug, R. et al. 2014
Dinwoodie, J. et al. 2014
Al-Yakoob, S.M.; She-rali, H.D. 2013
Morales-Fusco, P. et al. 2013
Alvarez, J.F. et al. 2011
Veenstra, A.W.; van Dalen, J. 2011
Fagerholt, K. et al. 2010



4.1 Operational Mode

Most of the publications deal with planning problems in tramp shipping, which can be expected with the chosen search terms. Surprisingly, almost as many publications deal with tramp shipping and liner shipping (4 publications) at the same time as with tramp shipping and industrial shipping (5 publications). Although the shipping modes tramp and industrial are resemble each other and clearly distinguish from liner shipping. A detailed distribution of publications by shipping mode is shown in Figure 3. The intersecting circles show the overlaps of the individual classification parameters, thus publications which can be assigned to two or more operational modes. The intersections are highlighted in a darker shade.

Of the identified publications, only 3 address the entire supply chain, two of them with a focus on liner shipping. No publication considers a supply chain in tramp shipping. This could be due to the fact that spot cargoes in tramp shipping make it more difficult to plan and optimize supply chains, in particular if irregular shipments are involved.

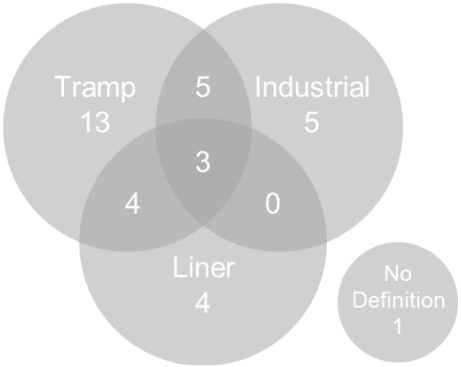


Figure 3: Evaluation of the publications by shipping mode

4.2 Planning Horizon

In Figure 4 the number of publications categorized according to the three different planning horizons: strategical (long-term), tactical (medium-term), and operational (short-term) is shown. The amount of publications that can be assigned to more than one planning horizon is listed in the darker, overlapping areas in Figure 4. The evaluation according to the classification parameter planning horizon in Figure 4 shows that no publication combine strategic and tactical planning at the same time, but there are two publications that combine strategic and operational planning. Pujawan, et

al. (2015) present methods to combine the operational problem shipment planning with the strategic decision of storage capacity planning. In their simulation model the authors use the example of a cement company, that operates its own ships (categorized as industrial shipping) as well as its own storages (categorized as supply chain). The second publication combining operational and strategic decisions is by Fagerholt, et al. (2010). Fagerholt, et al. (2010) investigate two strategic problems: acceptance or rejection of long-term transport contracts and determination of an optimal fleet (fleet size and mix problem). The authors combine these strategical planning problems by implementing a simulation framework around an optimization based approach for short term routing and scheduling.

Figure 4: Evaluation on the publications by planning horizon

As already noted in the existing literature reviews, tactical planning horizons are often considered together with operational ones, or there is no clear distinction between these planning horizons. In this review 5 publications address tactical and operational planning horizons together.

Only 3 publications identify a solely tactical problem, these are briefly described in the following. Wang, Fagerholt and Wallace (2018) describe their investigated problem as a tactical fleet composition problem in which charter decisions are investigated. The authors use a planning horizon of one year and based on their problem description the shipping mode in the publication is categorized as tramp shipping. Arslan and Papageorgiou (2017) investigate a fleet sizing and deployment problem in industrial bulk shipping. The authors aim it to determine the amount of charter vessels and the respective charter duration. They describe their problem as a tactical planning problem with a planning horizon from six months up to three years divided in time periods of three or six months. Norstad, et al. (2015) define the fleet deployment problem as a tactical planning problem, as the aim is to find a fleet schedule for the next few months. The authors investigated a company that operates in both liner and tramp shipping, as its business model is a mix of both shipping modes. In summary, the tactical planning horizon can be described as a few months to years, depending on the investigated problem or company under consideration.

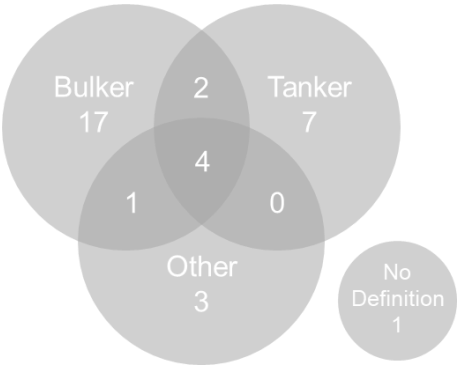


Figure 5: Evaluation of the publications by vessel type

4.3 Vessel Type

The number of publications that can be categorized in terms of vessel type is shown in Figure 5. One publication (Stavroulakis and Papadimitriou, 2017) could not be categorized according to vessel type and thus are listed in a separated circle in Figure 5. The majority of the investigated papers relate to bulk shipping and are classified as bulk carriers (Bulker in Figure 5). Publications that address bulk carriers, tankers as well as other vessels (4 publications), all indicate a strategic planning horizon. Otherwise, the overlap between the individual vessel types is small. *Publications that are categorized as other vessel types are also categorized as liner shipping. Other vessel types are mainly container vessels, which usually operate in liner shipping.*

4.4 Audience

Several indented audiences can be addressed in one paper, as shown in Table 1. 21 publications address at least two different audience groups. For 14 publications only one audience could be identified, which does not mean that the research cannot be of interest to other groups as well. The audience most frequently addressed is shipping companies with 27 publications. It is noticeable that publications aimed at investors, authorities or researchers always refer to a strategic planning horizon. While papers aimed solely at shipping companies mainly address tactical-operational (4 publications), tactical (2 publications) and operational problems (2 publications). This distribution of intended audiences may be caused by the tendency of investors and authorities to plan long-term projects and investments with a strategic character. Why researchers in particular investigate mainly long-term problems, i.e. strategic problems, is unclear. However, it can be assumed that these problems are characterized by a very high degree of uncertainty, so that solutions found might have a more theoretical character. The distribution for publications addressing shippers or ports and terminals is balanced between the planning horizons.

4.5 Voyage Distance

More than half of the papers found (20 papers) deal with planning problems in deep sea shipping. 8 publications deal with both deep sea and short sea shipping, 7 publications only refer to short sea shipping. This is also shown in Figure 6. The darker area shows the number of publications dealing with both deep sea shipping and short sea shipping.

All found publications addressing ports or terminals can be categorized as short sea problems in the respective publications. This could be due to the fact that the duration of the voyage in short sea shipping is significantly shorter than in deep sea shipping and thus the planning uncertainties caused by heavy weather, for example, are also smaller. Publications in which planning problems for both short sea and deep sea are examined, mostly consider problems at the strategic level (6 publications), only 2 publications consider both short sea and deep sea shipping at the operational level; none of the publications considers a tactical planning horizon.

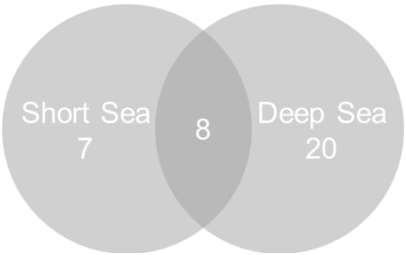


Figure 6: Evaluation of the publications by voyage distance

5 Conclusion and Outlook

A clear classification of planning problems by planning horizon in tramp shipping cannot be made. Neither is it possible to give exact time spans of long, medium and short term in order to improve this vague definition. Nevertheless, it can be stated that decisions that have an impact on several years, such as fleet size and composition, are considered strategic. Decisions that affect time periods of a few months up to about one year, such as charter-in or charter-out decisions, are considered tactical. Operational problems refer to a period of a few weeks to days.

In the literature examined, the planning horizons (strategic, tactical and operational) are often considered separately. This neglects the influence that long-term strategic decisions, for example, can have on the operative business. In particular, the link between strategic planning and operational optimization, the tactical planning horizon, is examined in less than a quarter of the literature reviewed. This may be due to the fact that tactical and operational problems are considered together or no distinction is made between planning horizons. Like prior literature reviews and publications, this one concludes that both business and research would benefit from a linked consideration of the different planning horizons in optimization and market analysis. Since decisions from the three planning horizons influence each other and cannot be strictly separated in practice, this link should also be reflected in research.

Despite the authors' thorough literature research, it cannot be guaranteed that individual sources have been overlooked, thus this literature research cannot claim to be complete. The evaluation of the individual literature sources has shown that the search string cannot cover all possible terms

used in the literature. Often tramp shipping is not described as such or the words strategic or tactical are not explicitly mentioned. Therefore this literature review would benefit from an extensive snowballing search in the future.

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