Conflicts Encountered with Bridge Team from the Perspective of Vessel Traffic Service Operators: A Research Within E-Navigation Concept

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The hazards that threaten marine navigation safety in the intensive routes and critical straits need to be managed effectively. To manage these risks, the concept of e-navigation has been offered to all stakeholders of marine transportation. E-navigation basically aims to organize, serve, and exchange marine information systematically. It is considered that the relations between the stakeholders may constitute significant conflicts in exchanging marine information. The main purpose of this study is to reveal the sources of conflicts and risk scores on navigation operations encountered with the bridge team from the perspective of vessel traffic services operators (VTSOs). In order to determine the sources of the conflicts, the conflict-related literature has been thoroughly reviewed, a semi-structured interview form was developed, and the VTS supervisors have been interviewed. In discovering the sources of conflicts, content analysis has been carried out from the interviews. The findings have been discussed with the relevant experts, and risk scales have been developed to evaluate the risks of conflicts. The frequency of conflicts and the results have been evaluated by the VTSOs employed at the Center of VTS in İstanbul, and risk scores have been defined. The risk scores related to the conflicts indicated on the risk matrix and e-navigation designed solutions have been compared and discussed. The findings reveal that there are certain similarities between the high-scored risks regarding communication quality and reporting systems. Although e-navigation solutions focus on improving technical issues. Conflicts caused by interpersonal, cognitive, and personal features that are not covered by e-navigation solutions have an important place among the conflict sources.

KEY WORDS
~ Vessel traffic services operator
~ Conflict
~ Bridge team
~ E-navigation

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1. INTRODUCTION

Keeping in mind that over 80% in volume and 70% in value of the world trade is carried out through marine transportation (UNCTAD, 2017), the safety of maritime traffic has great importance in terms of protecting cargoes, human life, and the environment. Increasing the number and capacity of ships to navigate on seas all over the world results in unavoidable congestion and accidents such as; collisions and groundings (Li et al., 2019; Eliopoulou et al., 2016). 42% of casualties occur in port areas, followed by 28.6% of the coastal waters, revealing the importance of regulating regional sea traffic (EMSA, 2018). In addition, Uğurlu et al. (2015) studied 379 tanker accidents to show that 90 of these accidents occurred in the open sea and 289 in the coastal area. The coastal area is described as channel (86), coastal waters (73), maneuvering area (49), port (47), and anchorage (34).

Such a regulation called Vessel Traffic Service (VTS) provided by an authority in charge of sustaining the safety of maritime traffic and protection of the environment is which should be able to respond to any risky encounter (IMO, 1997). This system provides services directly for vessels, through communication and interaction between VTS operators and Bridge Team. Bridge team members generally consist of a shipmaster, officers, helmsman, and pilot. In this study, pilots and shipmasters are included in the concept of a bridge team because, in an area where there is VTS, its operators are in communication with them.

Head of the bridge team is the shipmaster who is responsible for the safety of ship, pilot who advises the shipmaster with his local expertise, and Vessel Traffic Service Operators (VTSOs), who provide the master with any required information from the shore, to improve safety. In this cooperation, conflicts might occur due to differences in working styles, roles, perceptions, and personal and institutional concerns, as well as uncertainties in management, communication barriers, and ambitions to get power (Bruno and Lützhoft, 2009).

Involved in social studies, conflicts can be defined as "disagreements and discrepancies encountered between two or more persons or groups sourced from inconsistent aims, attitudes, and behaviors" (Koçel, 2014). Conflicts appear more frequently in work environments like maritime transportation, where the parties are dependent on one another and a great variety of stakeholders are to work together (Robbins and Judge, 2012). Although shipmasters are responsible for their ships and navigational safety, pilots who provide advisory services with their local knowledge are employed to contribute to maritime traffic safety (Cömert, 2016). Another party involved in this organization with navigation operations are the VTSOs who are employed on shore to manage all the risks to maritime traffic safety. These services provided by the above-mentioned parties are interdependent and the responsibilities of these parties are intertwined. For this reason, it is unavoidable for the parties to be in conflict with each other during the joint activities carried out to ensure the safety of maritime traffic. In this study, the aim is to identify the sources of conflicts that threaten the safety of the maritime traffic, occurring during the joint work of the shipmasters and VTSOs. In addition, the risk level of conflicts, identified as hazards, were evaluated, and solutions of the e-navigation concept were compared.

The idea of evaluating conflicts through e-navigation was first inspired by Mosier et al. (2013) by means of the Nextgen program they used and determined the conflicts encountered between Air Traffic Controller (ATC) and Air Pilot. Nextgen is a system based on the struggles to improve the capacity and technological contributions to mitigate concerns about the air traffic congestion, air pollution, and climate changes caused by the ever-increasing air transport (JPDO, 2011). The main purpose of Nextgen is to solve the problems brought about in the communication between the air pilots and ATCs through cooperation and creating a sort of situational awareness on both sides. Nextgen and e-navigation are similar in the purposes of strengthening the communication between the bridge team/ cabin crew and VTSo/ATC and increasing marine/air safety. Although there are fundamental differences between the two systems, it is widely accepted that there are similarities in terms of organization, management, and traffic control since they actually have the same goals (De Bievre, 1985; Bootsma and Polderman, 1987).

2. CONCEPTUAL FRAMEWORK

2.1. Vessel Traffic Service (VTS)

The International Maritime Organization (IMO) defines VTS as "a service implemented by a competent authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment", which is able to respond to situations experienced in maritime traffic (IMO, 1997). The VTS authority fulfills the requirements of the following services to be determined by the Administration in accordance with the regulations and recommendations of the IMO and IALA regarding vessel traffic services:

- Information Service (INS), is a service to relay such information to vessels as "the position, identity, intention and destination of vessels, maritime traffic, radio frequencies, reporting points, amendments and changes, meteorological information, maneuvers, pilot operations, status of aids to navigation, any dangers threatening the vessels and the maritime traffic" (IALA, 2016; RG, 2007).
- Traffic Organization Service (TOS) is an effective and efficient vessel traffic planning service which aims to prevent dangerous maritime traffic through operational management of the traffic and planning the vessel movements particularly when the maritime traffic is intensive (IALA, 2016).
- Navigational Assistance Service (NAS) involves providing the information in due time required for safe navigation in order to help vessels make navigational decisions and observe the effects. This service might also involve certain instructions and recommendations (IALA, 2016).

On behalf of the VTS authority, the above-mentioned services performed by the VTSo to contribute to shipmasters' making decisions (IMO, 1997). VTSOs monitor the maritime traffic from VTS Centers located on the coast. In this center, the data regarding maritime traffic are collected and turned into information through stations equipped with the required technology located at sea or land. In accordance with the data collected. VTSOs plan and manage the traffic by communicating with the ships, sharing information, monitoring the developments, giving recommendations and / or instructions

when deemed necessary. The organization of VTS also includes VTS supervisors, who are responsible for managing, coordinating, and assisting the operational activities of the VTSOs (IALA, 2016). Figure 1 covers the overall process of the VTS operations as well as the positions of the operators/supervisors, shipmasters and maritime pilots. The operators provide the necessary services to the vessels in the responsibility area of the VTS, while the master and/or pilot passing through this area contacts the operators in order to receive the necessary services and provide the necessary information to the local authority.

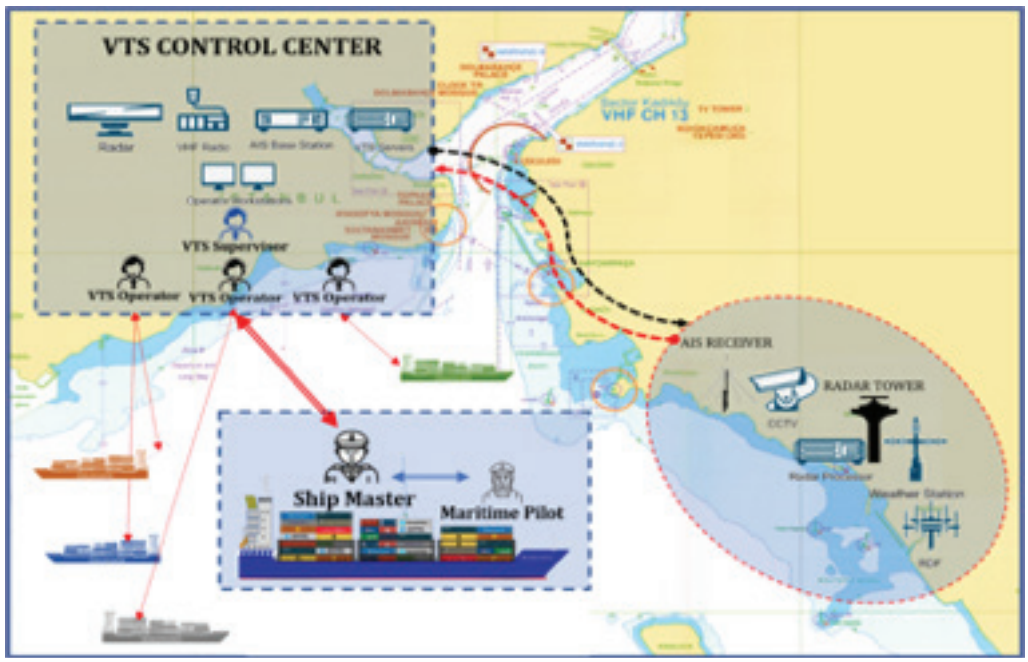

Figure 1.
Work organization between VTS and ships.

The VTS practices have often been a matter of debate. In parallel with rapid changes in technology, the infrastructure of the VTS is also exposed to frequent changes, which has often created difficulties in determining its legal structure. The VTS is not authorized to interfere with communication between shipmasters and pilots, if there is a pilot onboard. Ship maneuvers are carried out by shipmasters or pilots from the bridge. When the VTS is authorized to give instructions to ships, these instructions must be focused on the final result only, not the maneuvers or courses. These decisions must be taken by shipmasters and/or pilots (IMO, 1997).

2.2. Concept of Conflict

Conflict means disagreements arising from various sources such as differences in aims, inconsistent attitudes or behaviors and emotions between two or more people or groups (Koçel, 2014). Encountering certain conflicts is quite likely in work environments like sea transport, where numerous parties who are interdependent have to work together. Increased interdependence makes one's behavior more meaningful to others (Folger et al., 2013). When personal or group interests are different or there is no conformity in terms of priority, again conflicts are likely to appear in organizations (Donaldson, 1995). The sources of conflicts are classified into two categories: structural factors and personal factors. Structural factors source from the nature of the organizational factors such as job allocation, functional dependence, scarce resources, different aims, status differences, and uncertainty in authority. Personal factors result from interpersonal differences such as skills, abilities, characteristics, perceptual differences, moral judgements, values, attitudes, and communication barriers (Ceylan et al., 2000).

In the literature, inter-organizational or intra-organizational interactions illustrated in Figure 1 have been studied with regard to conflicts. Accordingly, the shipmaster and the maritime pilot represent the ship organization, whereas the VTSOs represent the VTS organization. Nas and Kahraman's study that analyses the conflicts between shipmasters and maritime pilots during port maneuvers found that differences in "job fields", "responsibilities", "methods used", "abilities", and "safety culture levels" caused

interpersonal conflicts (Nas and Kahraman, 2013). Another study examines the relationship between the masters and pilots. It is mentioned that there are conflicts between the "economic needs of the shipowners" and "the safe passage considered as public interest" (Quick, 2013).

In a study examining the Singapore Strait Vessel Traffic Services, interviews were conducted with shipmasters and without exception, all the masters stated that the VTS is in a better position to obtain an overall picture of the traffic situation and up-to-date information. However, they are hesitant to follow the instructions of the VTSO in any risky situation. The main reasons for this hesitation were the legal responsibility of the operator and the master in case of an accident and the doubts about the competence of operators in preventing accidents, and the standard of education (Segar Abdullah, 2000). Still another study carried out by Bach, (2009) on the interactions between the VTSOs and maritime pilots points to the "differences in aims" as one of the most important causes of conflicts. According to this study, pilots might get exposed to the economic pressure from stakeholders and be forced to berth the vessel to port despite the unfavorable weather conditions. On the other hand, the VTSO might want to close the port due to weather conditions, which would put economic pressure on the stakeholders. In the same study, other likely causes of conflicts, such as "the information pilots and operators need to get from each other", "the nature of their relationship", "communication difficulties", "personal competition", "stress" and "cooperation" are analyzed. Mansson et al. (2016) analyze the maritime traffic system involving the views of the VTSOs, shipmasters, pilots, and tugmasters. The maritime traffic system, in this study, is thought to be a complex socio-technical system involving persons speaking different languages, being from different nationalities, social environments, and geographies. The likely causes of conflicts have been listed as follows: communication, trust problems, language and teamwork difficulties, VHF (Very High Frequency) and Standard Marine Communication Phrases (SMCP) problems, role-related problems, and lack of standardization and coordination (Mansson et al., 2016).

When the literature is examined, it is seen that there are conflicts between the stakeholders providing interdependent services in maritime traffic. It is understood that the source of these conflicts consists of the "nature of work" and "technical issues" as well as interpersonal role conflicts such as trust, competition, and teamwork difficulties.

2.3. Concept of e-Navigation

E-navigation was defined as "the harmonized collection, integration, exchange, presentation and analysis of marine information aboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment." by IALA (NAV, 2007).

The concept of e-navigation first got included in the agenda of the MSC (Maritime Safety Committee) as a proposal in December 2005 at its 81st meeting (Rivkin, 2016). The proposal pointed to the need of a new concept that will provide safer maritime traffic to mitigate losses of mariners and ship owners. It was also added that to meet this need, ships and coastal services had to be equipped with modernized and reliable equipment (MSC, 2005). The idea behind this proposal could be read as a radical and rational purpose to minimize human errors likely to appear due to various individual characteristic differences, which is a serious potential for conflicts. The proposal also pointed out that, although various electronic navigational and communication technologies had been used, almost half of the marine accidents occurred due to navigational errors. It was noted that a lack of an effective coordination of advanced technologies, shortages in standardization in both ships and coasts, and the complexities and ambiguities encountered are likely to threaten and create risks for the global shipping (MSC, 2005).

The 85th Meeting of the MSC in December 2008 was of great importance in the development of e-navigation. At this meeting, the required strategy to improve and implement e-navigation was approved. The points involved in this strategic plan could be highlighted as follows:

- Mariners need information to plan and implement navigation.
- Mariners want to check their compliance with the relevant regulations.
- Coastal users need information about the static and dynamic variables regarding the ships.

E-navigation, which proposes an internationally accepted and well integrated system, tries to respond to the information requirements mentioned above. In addition, it is proposed that automated and standardized reporting functions for optimum communication of audio and navigation related information. Thus, information exchange would be simplified and integrated by reducing reporting formalities. In short, e-navigation systems should be flexible, able to compensate for errors, address data reliability and integrity, promote good decision-making, improve performance, and prevent individual errors.

In 2014, the MSC 94 approved the first e-navigation strategy implementation plan (SIP) covering 2015-2019 term and decided to strengthen the communication between ships and coasts (LR, 2014). Due to implementations delays, the plan was updated in 2018 and the following five solutions were decided to be the primary actions to be taken (MSC, 2018):

Solution 1: Improved, harmonized and user-friendly bridge design,

Solution 2: Means for standardized and automated reporting,

Solution 3: Improved reliability, resilience and integrity of bridge equipment and navigation information,

Solution 4: Integration and presentation of available information in graphical displays received via communication equipment,

Solution 5: Improved communication of VTS Service Portfolio (not limited to VTS stations).

While solutions 2, 4 and 5 focus on the effective transfer of maritime traffic information among the relevant parties (ship-ship, ship-shore, shore-ship, shore- shore), 1 and 3 focus on the workable and practical use of the information and data on board (MSC, 2018:2-3). As a result, it is seen that e-navigation seeks to provide solutions to problems under the 5 topics for wide range of users of maritime transportation. In this study, the sources of conflict between the e-navigation user "VTSOs" and "bridge team" was identified and risk assessments were made considering the perspective of VTSOs. The findings were examined within the scope of e-navigation solutions and efforts were made to reveal the contributions and deficiencies.

3. METHODOLOGY

In this study, the conflict sources were first determined by interviewing 7 VTS supervisors, and questionnaires were distributed to 40 VTS operators to obtain risk scores. Then, in the discussion section, conflict sources were evaluated with e-navigation solutions. The conceptual process of the research is shown in Figure 2. The conflicts and risks threatening maritime traffic safety encountered between the VTS operators and bridge team are identified. For this purpose, the literature review about the conflict was first done. Although some similar studies had been found, from the perspective of the VTS operators, a research focusing on the conflicts encountered with the bridge team could not be reached. In order to obtain the opinions of the VTS operators on the source of conflict with the bridge team, a semi-structured interview form was developed based on the literature found (Thompson and Davis, 2007; Segar Abdullah, 2000; Nas and Kahraman, 2013; Quick, 2013; Bach, 2009; Mansson et al., 2016) and expert opinions gathered. This expert team was composed of VTS managers and academics. The developed semi-structured interview form was submitted to the VTS supervisors. After that, the data collected has been analyzed through content analysis method, which is "an observational research method that is used to systematically evaluate the symbolic content of all forms of recorded communications" (Kolbe and Burnett, 1991).

The sources of conflict obtained as a result of the analyses were listed and presented to the VTS experts again. A data collection tool consisting of conflict sources was developed in accordance with the critiques and requests of the experts. In this tool, each conflict source is accepted as a hazard threatening the maritime traffic. Risk is the resultant value of the two components of the hazards. The components of the hazard refer to the consequence and frequency. "For example, a hazard with a high probability of occurrence and a high consequence has a high level of risk" (Kristiansen, 2013). In order to assess the hazards on this form, the scales of the frequency and consequence of hazards have been developed based on expert opinions. The memory of the VTSOs, with the experience of all the incidents related to the maritime traffic in the VTS area, has been accepted as the data source. The experience of the shipmasters and pilots was excluded from this research. Since VTSOs assess the risk of maritime traffic in general framework, shipmasters only evaluate

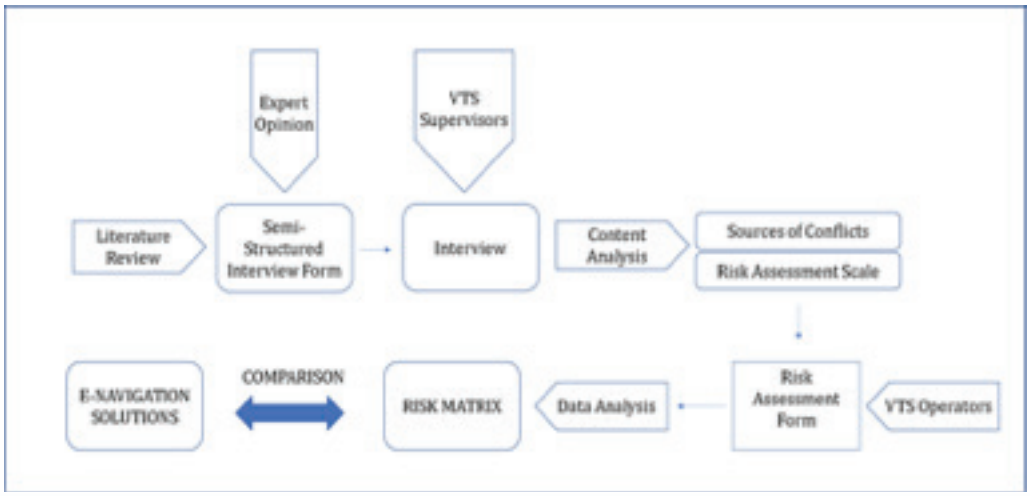

Figure 2.
Study process.

the risks for their own ships and close-in targets. Therefore, the final risk assessment form was applied to the VTS operators. The data obtained from the VTSOs were analyzed and the risk scores of the hazards related to conflict sources were determined and included in the risk matrix.

The risk scores determined through the data analysis are presented in the 5x5 L Type Risk Matrix Table, which is also used in PIANC reports, and indicated in Table 1. According to Table 1, the conflict sources in the R3 region are in the "unacceptable risk zone", the ones in the R2 region are "considerable", and those in the R1 region are in the "acceptable risk zone". At the last stage, the conflict items have been evaluated within the scope of the solutions offered in the e-navigation strategy and the extent to which the solutions can contribute has been discussed.

Table 1.
Shell Group Risk Matrix (Source: PIANC, 2016.).

		CONSEQUENCE				
FREQUENCY	Several times per hour	R1	R2	R3	R3	R3
	Several times a day	R1	R2	R2	R3	R3
	Several times a week	R1	R1	R2	R2	R3
	Several times a month	R1	R1	R1	R2	R2
	Several times a year	R1	R1	R1	R1	R2
	Very Low	Low	Medium	High	Very High	
	Economic	<10k	10-100k	100-1000k	1-10M	>10M
	Health & Safety	Slight injury	Minor Injury	Major injury	Single fatality	Multiple fatality
	Environment	Slight effect	Minor effect	Localised effect	Major effect	Massive effect

For the implementation of the study and the conduct of the survey, the Istanbul Vessel Traffic Services Center has been chosen for its significant experience in these services. The VTS in Turkey first started operations in 2003 at the Turkish Straits (Istanbul and Çanakkale). Then, other centers were included: İzmit (2016), Izmir (2017), and Mersin (2018) (DGCS, 2019). The İstanbul VTS, with experience in this industry for over 16 years, provides VTS services for an average of 50,000 ships a year. The VTSOs employed at this center monitor about 2,500 local traffic movements a day despite the difficult geographical conditions of the Istanbul Strait with a length of 17 miles (UDHB, 2019). Within the Istanbul VTS Centre, 40 VTS supervisors and operators are employed. All these operators have received VTSO education in compliance with the IALA standards, and they all have the certificate of oceangoing masters.

3.1. Development and Application of Semi-structured Interview Forms

In this study, semi-structured interview was used. This type of interview form is one-on-one interviews using open-ended questions, where the interviewee can be more involved in the interview process and enable interviewers to clear up misunderstandings. (Ryan et al., 2009; Thompson and Davis, 2007). The themes are shaped by the interviewer within a framework to guide the process. This framework and flexibility of the responses constitute the semi-structured aspect of this method (McIntosh and Morse, 2015).

Prior to the completion of this semi-structured form, a pre-interview had been carried out with some experts from the VTS managers and academics to determine the research questions as well as the content of the interview. The semi-structured interview form with 32 open-ended questions was made considering the literature review and the expert opinions. These open-ended questions comprise aims, knowledge, relations, communications, role conflicts, interpersonal conflicts, risk perceptions, cultural differences, ergonomics and fatigue. This form was submitted to 7 VTS supervisors employed at the İstanbul VTS during their shifts after having received permission from the Directorate General of Coastal Safety.

The interviews were recorded, with their consent, in order to avoid any discrepancies or missing points while analyzing them. The details about the participants are indicated in Table 2.

The audio records were analyzed through content analysis, and the similar data were collected in the themes. These themes will later help to determine the conflict source to prepare the risk assessment form, data collection tool of the study.

Table 2.
Details of participants interviewed.

Date	12-15 May 2017
Qualifications	oceangoing master
Average working experience in VTS	11 years
Average working experience at sea	10.85 years
Average age	46.16
Average duration of interviews	53 minutes
Number of participants	7

Table 3.
Details of survey participants.

Date	11-19 July 2017
Qualifications	oceangoing master
Average working experience in VTS	8.13 years
Average working experience at sea	11.65 years
Average Age	40.41
Number of participants	40 (16 supervisors, 24 operators)

3.2. Development and Application of Risk Assessment Forms

Prior to the completion of the risk assessment form, the opinions of the VTS supervisors had been received and, in compliance with their suggestions, some statements were either deleted or combined.

While determining the frequencies, the form including "once an hour/ once a day/ once a week/ once a month/ once a year" was changed after having received the opinions of the participants, into "several times an hour/ several times a day/ several times a week/ several times a month/ and several times a year". For the consequences to be encountered, the following options were included: "very low/ low/ medium/ high/ very high". The last form was tested with the VTS supervisors and it was found satisfactory in terms of adequacy, comprehensiveness, and suitability. According to the developed risk assessment form, the most frequently encountered conflict threatening the maritime traffic between the ship and the VTS was determined, and the participants were asked to evaluate the frequency of the occurrence of these conflict sources and the extent of the consequences they might cause according to the 5-grade scale.

The İstanbul VTS Center located at Istinye/Istanbul was visited at six times based on the shift changes. At this center, 40 operators and supervisors work in 4 shifts. The forms were submitted to the survey participants during the shift changing times and collected at the next shift changing times. 36 forms (90% of the sample) were collected, and 4 of them were cancelled due to the missed information. The survey participants comprised 40 operators (32 operators from the İstanbul VTS Center and 8 operators from the Izmir VTS Center). The details about the survey participants are indicated in Table 3.

4. ANALYSIS AND FINDINGS

In this study, 40 participants responded to the survey. For each conflict source, frequency values are expressed as F1, F2, … F46, consequence values are expressed as C1, C2, … C46, and operators are expressed as O1, O2, ... O40. In the first stage, the average of consequence (1) and frequency (2) was calculated by taking the average of the answers given by each of the 40 operators according to the formula below. In the second stage, the risk score (3) of each conflict item was calculated by multiplying the average score of frequency with the average score of consequence. In the final stage, the frequencies and consequences of 46 sources of conflict were included into the risk assessment table.

$$Avg\,(C_x) = \frac{\sum_{x=1}^{n} O_x}{n\text{-}Null} \ldots \quad (1)$$

$$Avg\,(F_x) = \frac{\sum_{x=1}^{n} O_x}{n\text{-}Null} \ldots \quad (2)$$

$$R = Avg(C_x) \cdot Avg(F_x) \ldots. \quad (3)$$

Table 4 presents the average values of consequences (C), frequencies (F), and risk scores (R) of the conflict items identified in the risk assessment study.

Table 4.
Consequence, frequency, and risk scores of conflict sources.

NO	CONFLICT SOURCES	C*1	F*2	R*3
K1	Shipmaster is concerned with ship safety only.	3.46	2.87	9.92
K2	Maritime pilot does not follow the speed limit.	3.65	3.70	13.51
K3	Shipmaster does not follow the speed limit.	3.63	2.45	8.88
K4	Shipmaster is hasty due to commercial concerns.	3.05	2.53	7.70
K5	Additional workloads due to delays in sending the Sailing Plan reports	1.95	3.35	6.53
K6	Not updating the arrival times	1.90	3.13	5.94
K7	Discrepancies in reported information	2.13	2.88	6.11
K8	Required environmental information to be requested from the ship	2.38	2.88	6.83
K9	Doubts about environmental information received from ships	2.58	2.56	6.60
K10	Incompliance of information on speed received from ships and that determined by VTS	2.30	2.70	6.21
K11	Not reporting technical deficiencies of ships	3.83	2.38	9.12
K12	Poor quality of VHF audio	3.58	4.20	15.02
K13	Not updated VTS equipment	3.54	4.28	15.13
K14	Not user-friendly interfaces of VTS systems	3.03	3.76	11.39
K15	VHF range does not cover entire VTS area	3.45	3.72	12.82
K16	Communication problems due to latching of one of VHF stations	3.64	2.68	9.74
K17	Technical problems create work stress.	3.55	3.88	13.76
K18	Inadequacy of seafarers' knowledge of English language	3.28	3.68	12.04
K19	Inadequacy of operators' English language	2,71	1,47	3,99
K20	Not using SMCP in communication	2.50	2.85	7.13
K21	Leadership challenge between parties	2.60	2.35	6.11
K22	Efforts of parties to dominate each other	2.70	2.15	5.81
K23	Interference of parties with each other's work	2.73	2.30	6.27
K24	Not having enough information about other's work	2.65	2.15	5.70
K25	Negative effects of hierarchical structure of maritime culture between parties	2.38	2.03	4.81
K26	Getting involved in role conflicts	2.53	1.87	4.73
K27	Negative effects caused by having known each other before	2.00	1.79	3.58
K28	Inadequacy in empathy	2.70	2.65	7.16
K29	Styles used by parties in communication	2.54	2.72	6.90
K30	Differences in risk perception levels by parties	3.05	2.85	8.69
K31	Negative effects caused by work in different physical environments	2.38	2.60	6.20
K32	Commercial pressures imposed on operators	2.30	1.94	4.47

K33	Not involving shipmaster in communication when pilot is onboard	2.97	3.28	9.76
K34	Negative effects on communication caused by cultural differences	2.18	2.35	5.12
K35	Requests of pilots to embark later and to disembark earlier	3.55	3.13	11.09
K36	Delays in sector passage notices	2.23	3.62	8.04
K37	Additional workload caused by objections from ships on planning made	2.05	2.58	5.28
K38	Difficulties in communication due to high workload of operators	2.72	3.45	9.38
K39	Additional workload on operators due to inadequate information from agents to ships	2.72	3.28	8.92
K40	Non-convenient rest area for operators	2.83	3.55	10.04
K41	Non-ergonomic working environments for operators	2.79	3.57	9.95
K42	Personal characteristics of operators are not suitable for their jobs.	2.69	1.65	4.44
K43	Lack of safety due to neglect while observation of ships with pilot onboard	2.98	2.46	7.32
K44	Lower tendency of Turkish shipmasters than of foreign shipmasters to comply with recommendations	2.85	2.38	6.79
K45	Shipmasters' lack of knowledge of maritime traffic rules	3.45	2.54	8.76
K46	Relatively more communicative workload on ships with pilots on board compared to ships without pilots on board	2.48	2.79	6.92

**1 C: 1, very low – 5, very high, *2 F: 1, several times an hour – 5, several times a year, *3 R: Risk Scores (1-25).*

Frequency of the conflict sources were examined; the most common found was Not updated VTS equipment (4.28). This is followed by Poor quality of VHF audio (4.20), Technical problems create work stress (3.88), Not user-friendly interfaces of VTS systems (3.76), VHF range does not cover entire VTS area (3.72), Maritime pilot does not follow the speed limit (3.70), Inadequacy of seafarers' English language (3.68), and Delays in sector passage notices (3.62).

The consequence of the sources of conflicts were examined. Not reporting technical deficiencies of ships (3.83) emerged as the most serious source of hazard. This is followed by the sources of conflicts: Maritime pilot does not follow the speed limit (3.65), Communication problems due to the latching of one of the VHF stations (3.64), Shipmaster does not follow the speed limit (3.63), Poor quality of VHF voice (3.58), Technical problems create work stress (3.55), Requests of pilots to embark later and to disembark earlier (3.55), and Not updated VTS equipment (3.54).

While evaluating the risk scores obtained, risk matrix as an evaluation instrument used to analyze the frequency of a source and the consequence has been use. The consequence averages of the conflict items are written on the x-axis and the frequency averages are written on the y-axis to determine which region they are located on the risk matrix in Figure 3.

In the study, the risk scores of the conflict source have been classified as "unacceptable", "considerable", and "acceptable". In this research, considering the matrix, the conflict sources with risk levels determined in the "unacceptable" category are listed as follows;

- Not updated VTS equipment,
- Poor quality of VHF voice,
- Technical problems create work stress,
- Maritime pilot does not follow the speed limit,
- VHF range does not cover entire VTS area,
- Inadequacy of seafarers' English language,
- Not user-friendly interfaces of VTS systems,
- Requests of pilots to embark later and to disembark earlier.

The fact that the risk scores of some conflict sources are high may be a situation specific to İstanbul VTS, which is the application place of the study. However, discussions will be held with e-navigation solutions regardless of the ranking of risk scores.

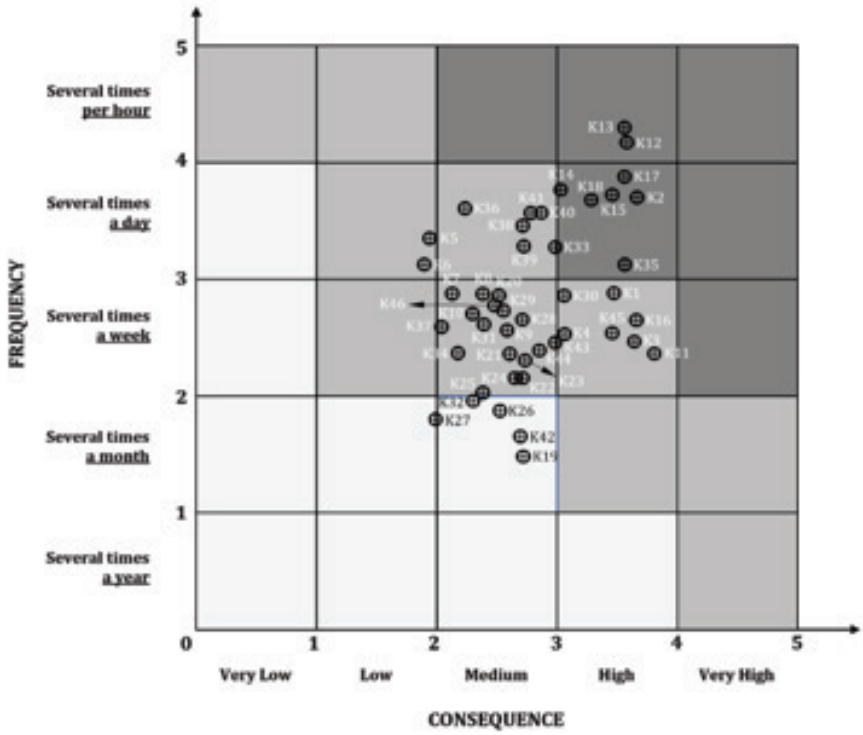

Figure 3.
Location of conflict sources in Risk Matrix.

5. DISCUSSION AND RECOMMENDATIONS

Technological improvement: The sources through which a VTS gets in touch with ships are all technology-focused. Today, many technological devices that facilitate maritime transportation are used on bridges and at VTS centers. However, incompatibilities encountered in the operation of technological devices are important factors that cause accidents (Kaptan et al., 2021). Many of the VTS supervisors interviewed emphasized the importance of advanced technology in carrying out their jobs. One of the most important results of this study is *Not updated VTS equipment* with the highest risk score. The main source of this problem is that the systems used by the VTS, while providing INS, TOS and NAS services, do not keep up with the developing technology. The VTSOs have clearly underlined the urgent need for renewed and updated İstanbul VTS, which is around sixteen years old. The interviews have indicated that certain actions have already been taken in updating Istanbul VTS. The other VTS centers in Turkey, Izmir, Mersin, and İzmit have already been provided with updated technological infrastructure. *Technical problems create work stress* can be solved with the technological solutions introduced within the scope of e-navigation. In this context, e-navigation works to improve the range and quality of the VHF, integrate and standardize onboard and onshore interfaces and equipment that cause technical problems. S-Mode, CMDS, Maritime Cloud, and Single Window applications can be given as examples.

Accessibility of accurate maritime information: It was stated that many problems were encountered both while communicating and trying to obtain information such as weather condition, current, and visibility. *The required environmental information to be requested from the ship, Doubts about environmental information received from ships and Incompliance in information on speed received from ships and that determined by VTS* were also found to be highly risky by the operators. In addition, such inconveniences are thought to cause further workloads and delays. All these findings show that the operators need reliable navigational information and when they fail to provide this, they conflict with the shipmasters. To eliminate the source of this conflict, ship and coast-based systems need to get integrated. Therefore, it is necessary to integrate technological infrastructures of the ship and the shore-based systems with the *Common Maritime Data Structure* (CMDS) proposed under e-navigation Solution 4. The aim of the CMDS is to ensure that the information obtained from widespread and reliable sources in maritime areas is exchanged in an integrated manner, considering all social stakeholders. In addition, in order to avoid repetitions by entering similar information by different sources,

relevant sources should work in coordination with each other (MSC, 2015).

Communication: It is thought that the conflict sources of *Poor quality of VHF audio, VHF range does not cover entire VTS area in the unacceptable risk zone,* and *Communication problems due to the latching of one of the VHF* stations with a relatively lower risk score can be solved by the *VHF Data Exchange system* (VDES) provided under Solution 2. The VDES is a system developed both for the overload of AIS channels and for the problems in providing verbal communication. In this context, the aim is to increase the range and quality of the verbal communication in the first stage and to provide the possibility of communication via satellite systems in the second stage (IALA, 2017). Regarding the conflicts encountered due to *Inadequacy of seafarers' English language and Styles used by the parties in communication*, the VDES is planned to develop communication in the written form through which the mariners who have difficulties in oral communication will be able to communicate in writing and thus prevent conflicts. There are also decisions to develop 4G, 5G, HF, satellite systems, and Maritime Cloud project to solve the communication problem (NCSR, 2014).

Role conflict: The sources of conflict *Maritime pilot does not follow the speed limit and Requests of pilots to embark later and to disembark earlier* have been found in the "unacceptable" region in the risk matrix. There are also sources of conflict that arise from the lack of clear determination of responsibilities in the maritime service provider, such as *Interference of the parties in each other's work, Ship master does not follow the speed limit, and Getting involved in role conflicts*. Implementing of result-oriented advice and instructions given by the VTSOs can be a conflict source in the responsibility area of the maritime pilots and shipmasters. In the e-navigation system, 16 marine service portfolios have been determined, including pilotage and VTS, and it has been decided to review and reorganize the tasks and responsibilities for these services, which will help prevent role conflicts.

User interface: It is stated that the *Not user-friendly interfaces of VTS systems* occurs as a result of the failure to meet the user needs of the İstanbul VTS system. In the Integrated E-Navigation System meeting organized by the IALA in 2013, the need was stated for a functionality similar to S-Mode in order to overcome the difficulties experienced in communicating with ships and access to the needed information due to the diversity and complexity of the interfaces used by the VTS. The S-Mode is actually proposed for the standardization of bridge navigation systems under the Solution 1 by adapting the S-*Mode* applications to the VTS centers: standardization and access to information can be provided in interfaces used by the VTSOs all over the world.

Workload reduction: In order to solve sources of conflict such as *Additional workload on operators due to inadequate information from agents to ships, Additional workloads due to delays in sending the Sailing Plan reports, Not updating the arrival times, Delays in sector passage notices,* and *Discrepancies in reported information,* the *Single Window* system has been developed within the scope of Solution 2. With this system, the information produced on board and at the VTS centers will be collected in a single window, and reports can be obtained through a single system by allowing visual representation of the information. With this system, especially the information on board ships will be collected and reported automatically and can be shared with other related parties. These units may be the VTS or other relevant stakeholders such as shipping agencies, ports, and customs. It is believed that the workload created by the reports requested by different countries in different formats can be met by the standard reporting systems that will be developed with the same scope.

Ergonomic conditions: *Not convenient rest area for operators and Not ergonomic working conditions for operators* were also considered by the operators as sources of conflict. The operators stated that they got tired early because the working and resting environments did not comply with the working systems and this created work stress. Within the scope of e-navigation, *Human Centered Design* (HCD) is planned for the bridge not only by architects and engineers, but also by the requests of ship personnel (DMA, 2013). With the application of a similar system for the VTS centers, solutions to the ergonomic problems experienced by the VTSOs can be provided.

The e-navigation concept meets the needs of the user and allows safe and secure navigation of the ship. It aims to integrate and present information on board and on shore through a human-machine interface that minimizes the risk of confusion or misinterpretation for the user (Baldauf and Hong, 2016). However, there are situations that arise from the nature of the human being that solutions cannot prevent as long as the human factor exists. It is very important that the shipmaster is informed correctly by the VTSO and the shipmaster should give the correct information about his/her ship in terms of safe navigation. When there is any contradiction in attitudes towards responsibilities, priorities, and authorities, conflicts could be unavoidable. In maritime traffic, where teamwork is required, different methods, perceptions, personality traits, experiences and abilities used by the parties to achieve their goals cause interpersonal conflict. E-navigation is inadequate to find solutions for some conflict sources caused by cognitive and personal features. Although e-navigation solutions focus on the improving technical issues, conflicts caused by interpersonal cognitive and personal features that are not covered by e-navigation solutions have an important place among the conflict sources, such as differences in the risk perception levels of the parties, lack of empathy, leadership challenge between the parties, keeping some information unshared, efforts by the parties to dominate each other, and cultural differences. Nevertheless, by removing the uncertainties, clarifying the distinctions in allocating responsibility, and

standardizing the practices, e-navigation may be able to facilitate and contribute to the effectiveness of maritime navigation.

6. CONCLUSION

When the sources of conflict obtained in the study are examined within the framework of e-navigation concept, it is seen that many of the problems mentioned can be solved by innovations, regulations, standardization and technological systems in order to provide safety at sea. Solutions brought with e-navigation such as facilitating information transfers, integrating and standardizing ship and shore systems, developing common information structures, identifying responsibilities, improving communication and introducing standard reporting systems will play an important role in ensuring safety and effectiveness at sea. With the developed solutions and standardizations, the workload of all units serving in maritime areas will be reduced.

It is foreseen that conflict sources related to technical and infrastructural problems can be solved easily by e-navigation solution strategies, but it is not possible to provide solutions for individual conflict sources yet. On the other hand, the human factor on board and at shore will continue to be important until fully autonomous ships are launched which are degree 4 of IMO's autonomous shipping plan. In these transition processes, it would be appropriate to develop new solution strategies for conflict sources between individuals. Solutions for the development of bridge technology infrastructures developed for e-navigation should also be developed for technological infrastructure in VTS centers.

In application of the study İstanbul VTS Center was chosen as the place of application both in determining the sources of conflict encountered in maritime traffic and applying the risk assessment forms. Not including other VTS center might have prevented revealing any other conflict sources. It is the limitation of this study that regional conflict sources may have a high-risk score. In addition, while dealing with ship-VTS conflicts, the parties involved in the onboard management were included in our research model as the ship master and pilot. However, conflicts were only seen from the perspective of operators working in the VTS centers. Although the operators were thought to be ship masters while developing the research, they answered the questions as VTSO. Future studies could involve ship masters as well, which would contribute to revealing the differences between the risk perceptions of the two different.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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