Safety Science 172 (2024) 106426

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Does it do the same as we would? How trust in automated shipboard systems relates to seafarers' professional identity

Asbjørn Lein Aalberg *, Siri Mariane Holen, Trond Kongsvik, Aud Marit Wahl

Industrial Economics and Technology Management, Norwegian University of Science and Technology, 7491 Trondheim, Norway

ARTICLE INFO

Keywords:
Trust
Maritime
Automation
Autonomy
Professional identity
Safety
Seamanship

ABSTRACT

In this qualitative study, we explore the concept of trust in safety-critical automated shipboard systems and how it relates to the professional identity of seafarers. For maritime safety, it is critical that human–automation interaction builds on appropriate trust in an automated system. Although there is momentum in researching trust in automation, few studies have addressed this topic using qualitative methods and sociocultural approaches. This study builds on rich data from interviews and observations of maritime officers on battery-electric domestic car ferries with state-of-the-art automation in Norway. The results show how seafarers progressed from initial skepticism to trust and sometimes overreliance on the systems. The development of trust was contingent on systems behaving according to professional standards rooted in professional identity, such as sailing according to good seamanship. This comparison was enabled by individual hands-on experiences. Professional identity clarifies the context-specific antecedents of trust exhibited by seafarers when core tasks are automated. Understanding and, to some degree, aligning systems with professional identity could help achieve trustworthy systems with appropriate trust exhibited by users. The safety opportunities and challenges created by the interplay between trust and professional identity are discussed.

1. Introduction

Maritime transport is a cornerstone of the world economy, with over 11 billion tons of goods being transported each year (International Chamber of Shipping, 2022). A prominent ongoing change is the introduction and implementation of maritime autonomous vessels (MASS) and shore-based control centers for controlling, maneuvering, and monitoring ships. Although higher levels of autonomy are in the making, widespread application of new technology on ships is already taking place, leading to incrementally "smarter," or more "intelligent" ships (Hult et al., 2019). Such automated systems could improve safety but may also introduce new sources of error during operations (Hoem et al., 2018), such as mode confusion or automation complacency (Wilson et al., 2020). Therefore, scholars have called for the development of more human-centric sociotechnical system architectures (Noy et al., 2018). Seafarers still play an important role in the monitoring and handling of these systems, and researchers have pointed to the need to focus on human and organizational perspectives of operating intelligent ships (for example (Praetorius et al., 2020)), which could lead to resilient human–machine interaction (Zieba et al., 2010).

Resilient human–machine interaction depends on professionals' adequate trust in automated technology. Both overly trusting and rejecting the use of a trustworthy system may decrease safety potential (Lee & See, 2004). Trust in automation is influenced by different characteristics of the operator, technology, and work context as well as by experience with the systems in question (Hoff & Bashir, 2015). In this paper, we take special consideration to the sharp end operator: Regarding the maritime context, and sociocultural approach might of special importance for experiences with technology, as the seafaring profession is characterized as strong and proud (Hult, 2012) and contains attributes that from a face value might be at odds with trusting automation, such as a belief in independence and reliance on practical, experience-based knowledge (Aalberg & Bye, 2020). In the analysis, we have identified the relevance of professional identity in the development of trust in automated systems, a relation only a few studies have previously addressed. One example was Walsham (1998), who pinpointed a general transition in professional identity towards trusting abstract systems.

Empirically, our work is based on qualitative inquiry of car and passenger ferries operating with auto-crossing and auto-docking

* Corresponding author.
E-mail address: asbjorn.lein.aalberg@ntnu.no (A.L. Aalberg).

https://doi.org/10.1016/j.ssci.2024.106426
Received 3 July 2023; Received in revised form 13 November 2023; Accepted 7 January 2024
Available online 16 January 2024

systems. Car and passenger ferries (roll-on roll-off) constitute a critical part of the infrastructure in Norway, connecting remote geographical areas such as islands to the mainland. Auto-crossing (or auto-transit, auto-sail) is a state-of-the-art advanced autopilot system used on approximately 30 connections in Norway. The system ensures that the ferry stays on a pre-planned route with fixed waypoints and arrives at set timestamps by controlling acceleration, retardation, speed, and route. The officer in command initiates the system on a touchscreen fitted to the bridge. The screen plots the projected path, as well as the current position. Auto-docking (or automatic arrival) is a system that also automates the final part of the journey by automatically arriving and pulling the vessel up to the dock, after confirmation by the captain. With both systems installed, captains can leave all steering during the journey to automation, while themselves being responsible for oversight, outlook, and that the system is used within limits.

In the study, we spent nine days onboard ferries with such systems installed, observing practice, and conducting 31 qualitative interviews with in total 33 seafarers. Our aim is to explore the following research question: *What characterizes seafarers' trust in automated systems?*

From the outset, our study was oriented toward exploratory fieldwork to investigate how professional identity relates to ensuring safety in the context of the increasing use of new technology in the industry. Through abductive analysis (Alvesson, 2018), it became evident that trust in automation was a salient topic, and that the development of trust was related to potential vulnerabilities rooted in the seafarers' professional identity. We argue that aspects of professional identity constitute an implicit performance standard to which automated systems are compared. This comparison influences the development of trust, and consequently, how the systems are used. Such development of trust is contingent on the individual hands-on experience of how the system performs (trustworthiness), according to professional standards. We claim that when automated systems challenge the core aspects of professional identity, undesirable distrust and disuse are likely to occur. However, if the systems are regarded as an extension of their existing professional competence and practice, they are more likely to be trusted and properly used but also sometimes misused because of overreliance. Furthermore, we argue that the concept of professional identity has the potential to clarify more of the context-specific antecedents of trust exhibited by a given profession when core tasks are automated. We believe that when developing safety–critical automated systems, tapping into and, to some degree, aligning development with seafarers' professional identity could foster appropriate trust.

In the following section, we introduce the theoretical basis for trust in automation and professional identity. Thereafter, a description of the method and scientific approach are provided. The findings of the study are presented in section four and then discussed in the context of theory and previous research, highlighting potential safety challenges and opportunities. Section six concludes the paper.

2. Trust in automation

Trust is a widely researched topic in various disciplines, including psychology, sociology, and economics (Hoff & Bashir, 2015). A common feature of the variety of research is the notion that trust can lead to positive effects such as cooperation, performance, and effectiveness. Trust is not only a characteristic of human relationships, but also human relations to technology. In shipping as well as in other contexts, trust can be considered to mediate the relationships between humans and organizations and humans and technology.

2.1. Trust in technology

Inspired by interpersonal trust, trust in technology is defined as the belief that a specific technology has the attributes necessary to perform, as expected, in a given situation in which negative consequences are possible (Mayer et al., 1995). However, a slight nuance is the consideration of trust as an attitude: 'the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability' (Lee & See, 2004, p. 54). Regardless, risk and vulnerability are inherent to technological trust. Trust in technology has been found to influence the acceptance and adoption of new technological solutions (Lankton et al., 2015), which is relevant to our study considering auto-crossing and auto-docking.

The extent to which a given population trusts risk-managing entities, such as the government, police, healthcare systems, or businesses, can be described as institutional trust (Fjaeran & Aven, 2021; Pidgeon et al., 2010). When it comes to automated shipboard systems, this applies to the degree of trust an operator has in the shipping company, international and national governing organizations such as IMO, or other businesses or professions that they must interact with in daily work, such as vessel traffic services, port service providers, and various technology suppliers. According to Luhmann (2018), trust simplifies complexity. With sufficient trust in, for example, navigators or automated systems, it is not necessary to regularly monitor how the crewmembers or safety–critical technology performs. Therefore, trust fosters efficiency. Pidgeon et al. (2010) found that trust and distrust towards risk managing institutions exists along a continuum ranging from uncritical emotional acceptance to complete rejection. They use the term 'critical trust' to highlight that a healthy kind of distrust can be found somewhere between these two extremes and explain it as a "practical form of reliance on a person or an institution combined with a degree of skepticism" (ibid: p. 134). Ashleigh and Stanton (2001) argued that trust is likely to move dynamically along a continuum through upward or downward spirals.

McKnight et al. (2011) argued that trust in technology rests on a combination of institution-based trust in technology, the propensity to trust technology in general, and trust in specific technology. Propensity to trust is a generalized trust, independent of the type of technology. It therefore signals trust in technology in general, and that the use can yield favorable outcomes. Institution-based trust is therefore contingent on a propensity to trust. This could involve, a belief in the existence of good support, for example, from producers and vendors, but also that certain types of technology can be trusted in a specific context. In relation to auto-crossing/docking, institution-based trust for example might relate to trust in equipment suppliers and the belief that automated systems are suitable and safe in a maritime setting.

The trustworthiness of a specific technology is associated with three related belief dimensions (Mcknight et al., 2011). *Reliability* refers to technology operating consistently and properly. *Functionality* refers to the extent to which technology can do what is needed, and *helpfulness* concerns the technology's capabiltiy to bring adequate assistance. This specific trust involves confidence in the technology to the extent that the user engages in an initial reliance, and explores all its features ("deep structure use"). The view of trust in technology involves both personal and contextual factors in addition to concrete technology. 'Propensity' is a personal factor that might vary, but also the consideration of suppliers and organizations involved play a role in the development of trust of a specific technology, and the actual use of it.

2.2. Trust in automated technology

Automation is based on complex technological solutions, and trust in automation has become a separate, interdisciplinary stream of research (see (Hoff & Bashir, 2015; Lee & See, 2004)). Based on Castaldo et al. (2010), we consider trust in automation as the belief from a trustor that an automated system will produce positive results in situations of perceived risk and vulnerability.

The safety of an automated ship depends on whether the systems are operated appropriately and are not misused or disused. Lee and See (2004) referred to *calibrated trust* as trust that matches the capabilities of an automated system, which leads to appropriate use. In contrast, when trust exceeds a system's capabilities, there is a situation of overtrust, which might lead to *misuse* of the system. Misuse indicates an overreliance on automation, which may result in a failure to monitor the system and decision biases (Parasuraman & Riley, 1997). Distrust involves a trust that falls short of the system's capabilities, involving *disuse* or not utilizing the system to its full potential (Lee & See, 2004, p. 55). Disuse occurs when automation is neglected or underutilized; for example, owing to the occurrence of false alarms and omissions (Parasuraman & Riley, 1997).

In this way, trust influences when and whether operators rely on automation, and therefore influences the efficiency and safety of a system (Hoff & Bashir, 2015). Trust influences a person's willingness to believe in information from a system or make use of its capabilities. In their review, Hoff and Bashir (2015) that variability of trust in automation might be distinguished into three layers. First, the *dispositional* trust layer refers to the basic tendency to trust automation in general, and involves factors such as culture, age, and personality traits. Second, *situational trust* highlights the specific human-automation interaction and the environmental and operator metal context of this interaction. These factors include workload, perceived risk, self-confidence, and system complexity. Finally, *learned trust* develops through the experience of the automated system and involves factors such as the system reputation, experience with similar systems, and experience of the system design. Thus, trust varies in three dimensions; the operator, the automated system, and the environment (ibid.:413).

In their model, Hoff and Bashir (2015) included self-confidence as a factor of internal variability related to situational trust. Wahl, Kongsvik, & Antonsen (2020) studied the training of dynamic positioning operators and found that confidence in oneself as a professional is essential in operating automated systems and comes from a certain level of assertiveness and trust in one's ability to control the system both while automated and in cases where the operator must take manual control. Hoff and Bashir [7] provided an example of how a high degree of trust in automated aid and low self-confidence may lead to the more frequent use of automation. They also point to 'computer self -efficacy' in their study and how the operators' judgment of own ability to use a computer is associated with trust in automation. Prinzel III (2002) explained that self-efficacy in general refers to the expectations that people hold about their abilities to accomplish certain tasks and reports that overconfidence among pilots can impair performance in certain situations, for example, not using automation because of a high level of trust in manual navigation skills.

2.3. Professional identity and trust

In their systematic review of the factors influencing trust in automated systems, Hoff and Bashir (2015) uncovered several areas that require further scrutiny. Related to dispositional trust, they mentioned culture-based research as particularly scarce. Moreover, Hynnekleiv and Lützhöft (2021) recently indicated that aspects such as the skills, values, and culture of professionals are possible moderators of the relationship between subjective trust and trustworthiness of the automated system. Understanding professional culture and identity is important for understanding informal rules of work practices and decisions (Antonsen & Bye, 2015). Seafarers' professional knowledge is deeply rooted in their individual and collective identity as seafarers. This is not related to nationality or ethnicity but rather to a professional culture that is displayed among its members by the sense of a community and by the bonds of a common identity (Helmreich & Merritt, 2019). Although strong, knowledge and attitudes are tacit and often taken for granted (Wahl, 2020), shaped primarily by belonging to a community of practice and situated learning (Lave & Wenger, 1991). What makes identity of special importance is its strong relation to behavior (Siebert & Siebert, 2005).

Professional identity[1] as a term concerns an individual's self-concept of their professional role based on an intertwined whole of experiences, attribute and values (Ibarra, 1999; Schein, 1978), constructed in a social context as an adaptive process. Generally, professional identity is oriented towards trust in one's own capabilities (Öhlén & Segesten, 1998), which accompanies a belief in professional autonomy. The outward expression of professional identity contributes to institutional trust, to the trustworthiness of the professionals or the institution to which they belong (MacNeil, 2011), and is connected to the concept of professionalism. Professionalism can be defined as "shared norms, attitudes, and behaviors that members of a professional community express or display, which allow others to recognize them as part of that community" (Bloom, 2022, p. 1000).

Research has also to some degree explored what profession members trust. Walsham (1998) argued that professional groups have moved towards increased trust in abstract systems instead of embedded social relations. Charatsari et al. (2022) found that technology provoked uncertainties concerning professional experience and personal autonomy.

We see professional identity as a concept that is both individual and collective, as emphasized by Hogg and Abrams, who argue that it "offers a shared, or collective, representation of who one is and how one should behave" (Hogg & Abrams, 1988, p. 3). A view of identity involving a social element with multiple layers is similar to the notions of Wenger's theories on communities of practice (Wenger, 2010), and is also supported by research connecting maritime professional identity with (safety) culture (Antonsen, 2009).

Professional identity in the maritime industry is inextricably linked to the term' *seamanship*, which can be defined as "a blend of professional knowledge, professional pride, and experience-based common sense" (Knudsen, 2009, p. 295). Seamanship represents an idealized standard in the maritime profession, how to behave, and what to know. However, the term has multiple meanings. Seamanship has been argued to represent aspects such as professional competence (Kongsvik et al., 2020), professional culture (Antonsen, 2009), and widely denoting general navigational practices (He et al., 2017). Failing to act in accordance with seamanship has been used in juridical contexts in ways similar to juridical negligence (Reifner & Lilja, 2017). Seamanship also encompasses social dimensions such as taking care of crew members and belonging to a community (Aalberg & Bye, 2020). Seafarers have specifically used seamanship as an opposition to written rules (Bye & Aalberg, 2020; Sydnes et al., 2012); however, seamanship is also considered a foundation for rules, especially international regulations for safe navigation and collision avoidance (Zhou et al., 2020).

Essentially, trust is highly dependent on the characteristics of the user, situational dynamics, and work context. There is a theoretical indication that the sociocultural and identity-related aspects of the maritime industry are related to how they experience technology. In the next section, we provide details of the methods used in the study.

3. Method

This work is based on a qualitative study applying ethnographic methods such as participant observation and interviews with seafarers.

[1] In the research tradition of *professions*, the maritime occupation, even officers, might not be considered as a profession per se, considering the criteria proposed by Abbott (1988), especially own jurisdiction. However, the characteristics of a profession asserted by Kerr et al. (1977) are intuitively relevant for maritime work: expertise, autonomy, identification, and the ethical and collegial upholding of standards.

The research was carried out by four safety researchers with a background in sociocultural studies of work and technology.

3.1. Research context

Three connections operated by two different shipping companies were selected based on opportunistic sampling (Johnson & Christensen, 2019), and we spent time on two different ferries on each connection. All connections had considerable experience with the systems, but only one had an auto-docking installed. All ferries had the system under operation, and all were battery-electric, but varied in terms of connection time, degree of difficulty in navigation, average traffic complexity, and across two different companies. See Table 1 for brief information on these connections. Both companies involved in the study explicitly stated that the primary reason for implementing automated systems was to standardize the energy efficiency performance. On these ferries, manning is typically 4–5 persons on watch duty, with two officers on the bridge (responsible for operating the automated system), one engine chief (responsible for the machinery and maintenance of the automated systems), and one able-bodied seafarer (mainly interacting with the system implicitly when timing tasks during docking, and some cases serve as dedicated outlooks).

3.2. Data gathering

The study applied ethnographic tools including unstructured interviews, semi-structured interviews, and onboard observations. Observations were conducted by two researchers who spent three days at each connection and were documented through field notes. Passive participant observation (Spradley, 1980) was the primary observation technique. We observed activities such as handovers, coffee and lunch breaks, crew familiarization training, crossing and docking, cargo and passenger handling, guided tours, and technical failures.

During observations, mostly when spending hours on the bridge, unstructured interviews (De Fina, 2019) were conducted, asking the informants about their experiences with the automated systems and generally how they perceived their work. These interviews were performed without a defined interview guide and were documented through extensive field notes.

The semi-structured interviews were conducted in an office, where most were audio recorded and using an interview guide (see Appendix A). The themes in the semi-structured interviews were: i) background as seafarers, including work practice and roles; ii) how is it to be a seafarer today; iii) what systems and technologies are you using; iv) what good seamanship is; v) experiences with automated systems; vi) attitudes towards autonomous vessels; and (vi) trusting and relying on the automated system. We strived to distance ourselves from a priori hypotheses, theories, and literature to capture the life world of the informant and to allow for spontaneous exploration in the field. The length of the interviews ranged from 20 min to 70 min, most around 45 min. In total, 31 interviews were conducted with in total 33 informants (see Table 2), including three group interviews. The primary data used in the analysis consisted of interviews with the bridge crews. The distribution of informants across genders reflects the fact that the maritime profession consists primarily of males.

Informed participation was arranged in accordance with the guidelines of the governing regulatory instance of the National Centre for Research Data AS.

Table 1
Characteristics of the three ferry connections visited.

Connection	Traffic volume	Crossing time	Difficulty of navigation	Auto-docking or auto-crossing installed
1	Higher	Approx. 25 min	Medium	Both
2	Lower	Approx. 10 min	Lower	Auto-crossing
3	Medium	Approx. 20 min	Higher	Auto-crossing

Table 2
Characteristics of the 33 informants.

Category	Distribution of informants (33)
Male / Female / Other	31 / 2 / 0
Bridge crew / Engine / Deck	19 / 9 / 5
Age (approximately) up to 40 / 41–60 / 61–75	13 / 14 / 4

3.3. Coding and analysis

Thematic analysis was applied to develop themes through initial inductive coding, and then theory was used to cyclically inform the empirically driven analysis. As we reinterpreted empirical clues in light of theory, the analysis can be denoted as abductive (Alvesson, 2018). In the analysis, field notes and observations were combined to better understand the meaning of statements and actions by adopting an interpretive approach. For this purpose, we adapted the guidelines for thematic analysis of Braun and Clarke (2006). Thematic analysis involves coding transcripts into higher-order levels of themes. The coding and analysis followed five steps (see Fig. 1): 1) Familiarization: we transcribed interviews and read them to gain an overview and immersion. 2) Initial coding: The coding was conducted in Nvivo (release 1.7.1), primarily by the first author. Initial codes were data-driven rather than theory-driven as in vivo and process codes (Saldaña, 2013), the latter especially concerning observations.

To prevent the loss of context, coding excerpts contained information concerning informant attributes. Excerpts included the surrounding text, and we alternated between re-reading the whole interview and revising the codes. 3) Searching for themes: This step involved the aggregation, merging, and searching for appropriate thematic categorization of codes, including an analysis workshop with some of the authors. 4) Reviewing themes: Here, we cross-checked themes to codes and vice versa as well as an developing the initial thematic 'map.' During Step 4, all co-authors joined for analysis workshops, using the code sheet and themes as material. The abductive approach led to a fluctuation between the identified empirical themes and theoretical concepts that were found to be relevant. The themes (from Step 4) motivated the exploration of trust theories. The themes were then revisited and refined using new theoretical concepts. For example, this involves the categorization of "vulnerabilities," which is related to the definition of trust in automation. Finally, in step 5) Defining themes and reporting, we refined themes and a clear narrative by bringing more relevant literature to the analysis and discussion. A guiding quality criterion for emergent findings was to strive for consistency within (internal homogeneity) and discrimination between (external heterogeneity) themes.

4. Findings

Most crew members manifested trust in automated systems through positive attitudes, extensive use, sometimes exceeding procedures, and developer intentions. Many reported simply that they used it "all the time.". In the following section, the findings from the interviews and observations are presented. First, we describe the main mechanisms involved in the development of trust and then describe some aspects that are negatively related to trust.

4.1. Developing trust

Essentially, we found that trust was primarily developed through own hands-on testing of system performance, observing its positive effects, enabled through participation in the development of the systems,

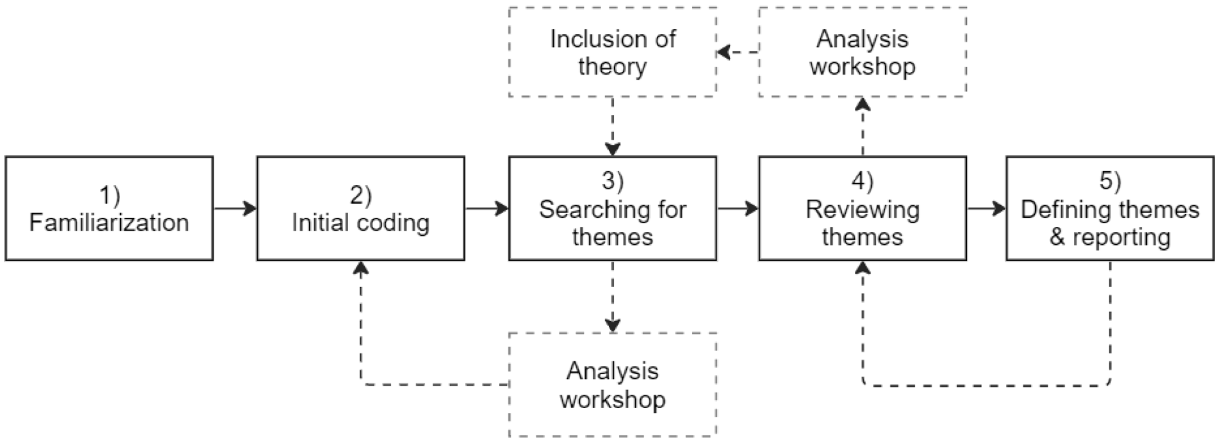

Fig. 1. Steps in the coding and analysis.

and their openness to technological change.

4.1.1. Positive hands-on experience of system performance

The main element in gaining trust for navigators was hands-on experience with the system while sailing, in contrast to theoretical courses or formal training. Even hearing their colleagues telling them that the system works was not sufficient to gain trust; however, second-hand experience encouraged experimentation. Initial skepticism could exist for months before the actual hands-on use of the equipment.

One of the captains we spoke to and observed in his work illustrates this process quite well. He explained that he had watched one of the other ferries on the connection sailing with an early version of the autocrossing system and thought *"what kind of nonsense is this?"*, referring to what he considered an unusual sailing pattern. This skepticism persisted for months until he had his own hands-on experience with the system. From that moment, trust developed quickly, as demonstrated by the situation in which we observed him leaving the chair during the docking phase. This happened during the shift change just after we came on board, where an off-duty captain sat on the PC next to the officer on watch (OOW) captain, who was sailing with automatic docking. The off-duty captain was confused with something in the Safety Management System and discussed with the OOW. To help make sense of the issue, the OOW left the chair and went to the PC to read and provide another set of eyes to figure it out before returning to the chair. It is not probable that this would have happened during manual docking and was a violation of safety procedures, thus indicating an overreliance on the system.

The importance of one's own experience was also apparent by comparing seafarers on Connection 1, which exhibited quite high trust in both autodocking and autocrossing, with seafarers on ferries with only autocrossing installed (Connection 2 and 3). Even though several on Connection 2 and 3 quickly gained trust in the autocrossing system, they were more skeptical towards autodocking, leaving the system with practically no margin of error. The following quote from the captain on Connection 3 illustrates this:

> *"Well, I guess it is ok to try it. This is highly dependent on the fact that it works continuously. Most accidents occur during this phase [docking]. One must trust it at a 100 % level. If it is 99 % - one deviation – the whole system will be discarded."*

To experience how the ship behaved in various situations, both visual confirmation from the screens and holding the thruster handles seemed to be important for developing trust. The tacit feeling of how the ship moved enabled making sense of the system's behavior and compared to projections of what the system was communicating about its planned route on the screen. Informants often noted this, quite reductionistic, as "seeing" it work:

> *"I felt confident in it [the autocross system] quite fast when I saw that it worked."*

However, the system would not only be assessed by what itself was projecting but also implicitly compared to what the navigators themselves considered appropriate to do in particular situations. This is exemplified by what a captain without experience with autodocking told us, contemplating what to do to develop trust:

> *"Well, it would be to be present to monitor it over time. To see that it does what it is supposed to do - That it does what we would have done."*

In addition to experiencing the systems' specific maneuvers, the experience of immediate reward in terms of reducing workload and ensuring the reliability of transportation increased trust. Several informants noted that using the system was associated with the ability to relax slightly more, especially when tired or during simultaneous tasks such as answering a phone call while sailing. Such immediate gratifications led seafarers to rely on the systems to a large degree, especially when stressed out or tired, or in need of extra attention capacity for outlook, as this quote illustrates:

> *"[When] you need a little extra focus, you can use it and all of us [on the bridge] have two sets of eyes that we can focus one hundred percent (100 %) on [watch-keeping], because we know it's going to sail to where it is going unless we have to give way because a boat is coming [...]. Therefore, the system is absolutely a top notch."*

We found that it was essential for the crew to perceive automated systems as tools that they could choose to apply rather than as an entity that has authority over the captain. This aspect involved both the feeling of being responsible for what the vessel does and, by extension, the tools and systems to apply in various situations. The decision latitude and authority of captains are fundamental characteristics of seafaring, and increasing automated systems introduce tension towards this ideal. Valuing such independence was associated with the development of "seamanship" capabilities by experiencing and solving situations that occurred at sea on their own. Many of the officers on ferries have previously sailed abroad in overseas shipping or cruise shipping, and several emphasized the physical and psychological capacity to take care of themselves and the boat, both in daily operations and in extreme situations. One particular aspect was creativity in applying tools that fit the situation using practical wisdom.

An example that demonstrates how seafarers perceive the system as a tool rather than a means of control is the use of autocrossing in ways contrasting to developers' intentions; the autocross system was designed with a fail-safe mode in case of operators failing to intervene in alarms, in which the vessel would stand still just outside the dock (similar to more widespread dynamic positioning, DP, systems). In foggy weather, the operators would deliberately let the autocross system enter the fail-safe mode by not activating manual maneuvering at the set point. The system's ability (intended as an emergency stop) to stop in a precise pre-designated area just outside the docking area enabled the navigator to relieve tension and provide time for orientation before commencing the docking task. This example simultaneously demonstrates a high level of confidence in performance. The informants told us that they had tested this ability by simply testing it to see if it worked for themselves.

The difference between perception as a tool versus a control mechanism was even more evident when the informants reflected on autonomous or remote-controlled vessels, in contrast to the automated system: *"Navigator: It is the angle… It is a huge difference from a tool to… Just to take over [control]. […] I am sure that most see it as positive if it is a tool."*. This quote illustrates that autonomous ships were perceived as taking over control, but the automated systems under study were just another helpful aid.

4.1.2. Involvement in software development process

To obtain software with an adequate standard, tapping into seafarers' expert knowledge in the development phase seemed to be crucial for both the trustworthiness of the system and for developers to signal good intentions. Only some of the captains in the study were directly involved in software development, whereas others indirectly provided feedback through those in contact with developers. Several informants explained that these processes took a long time with several iterations. Typically, a captain was first given a rough sketch of how the software was meant to operate, with to 3–4 suggestion on how the automated route could be planned. The ordinary way of sailing was then logged, both with regard to the route and changes in speed along the route. The software was then developed for testing, and developers came onboard the ship to log the software in use. After feedback from the captains, the software was again "tuned" in several rounds, as this quote illustrates: "*We sent it back and said "this is not good enough". 'No, it's okay', they said. And we said 'no, it is not. It was a marathon, not a sprint."*.

Considering that each connection had its own characteristics combined with several variables such as sea and wind conditions, there was a need for context-specific fine-tuning. It seems that the navigators themselves were often the drivers of the process of making changes in the software. The process demanded resources from both developers and crew members; however, in the end, it made a crucial difference that enabled the trust needed for applying it in operation:

> *"When I talked to colleagues, some said 'no this doesn't work, can't be bothered to use it.' You must stick to it to the end and bother to get engaged. It did not work on the first attempt; it was more like 2–3-4–5 attempts. Now it's almost unthinkable not to have it."*

Thus, seafarers had a higher threshold for acceptable performance than system developers, and incremental changes based on their own observations and wishes were crucial for developing a system that they could trust, which can be seen as a form of representation of user-centered development.

4.1.3. Openness to technological change

Younger seafarers seemed to be more positive towards new technology and technological developments in general, as this quote from a young captain illustrates: *"Everything new is cool. It is fun. […] We are positive towards the technology, you know, to see how far we can go with it."*.

Although general reluctance was associated with older officers, we also interviewed several officers older than 60, who were positive to the incremental improvements provided by technology. Several described that a fundamental aspect of a good seafarer is to strive for incremental development of knowledge and skills. However, when we asked the crew members to contemplate their attitude and experience with technology in general, a common response was to indicate a generalized lack of openness to such change, for example quotes like "*one is always skeptical towards something new, that's just how it is,*" but also highlighting that seafarers tend to be more conservative than others. A tendency toward openness to technology change might be considered an element that increases the probability of trying the technology, but in our material, it was not particularly important for the development of trust itself.

Informants highlighted the effect of earlier experience with automation, which acted as a spillover effect on openness towards new automated technology. Specifically, several dynamic positioning (DP) systems are widely used in petroleum offshore operations. It seemed like several bridge crew members with offshore experience described this as a difference between how quickly the crew became accustomed to the automation: "*some find it is less okay to trust. For example, older captains. However, I, who am used to trusting DP-systems… [trust it]*." The perception that trust was generalized from experience with other similar systems was shared between those with and without experience with such technology.

In conclusion, openness to technological change and user-centered development led seafarers to experiment with technology hands-on. During this hands-on experience, they compared the system with their implicit professional standards to determine whether it could produce positive results. User-centered development increased the system performance, and this comparison led to the development of trust in the automated system and its wide use.

Despite the fact that most navigators often used these systems, there were significant variations in their use. Some used it in specific situations, whereas others sailed with it most of the time, with notable exceptions. Quite a few informants reported using the system widely but at the same time expressed negative attitudes. Moreover, some informants did not use the system at all. This variation represents the degree of mistrust. In the next section, we describe the main factors that contribute negatively to trust.

4.2. Risks and vulnerabilities negatively related to trust

Considering our understanding of trust in automation as a belief from a trustor that an automated system will produce positive results in situations of perceived risk and vulnerability, we highlight the elements that represent potential risks and vulnerabilities that reduce trust. These risks and vulnerabilities were especially pertaining to i) how system performance was not good enough, ii) implications for their professional competence, and iii) pleasure from working. Some of these issues were prevalent in the current versions of autocrossing systems and some were problematic in earlier versions.

4.2.1. System performance is not aligned with good "seamanship"

Through the implicit comparison of the automated systems to a professional standard, navigators sometimes found that the system did not produce the expected positive results. These issues especially pertained to communication with other vessels and providing service and comfort for passengers, aspects that they referred to as *"operating according to good seamanship."* This was related to a preoccupation with avoiding a loss of reputation and perceived professionalism among passengers and fellow seafarers.

To avoid traffic conflicts, displaying predictable and clear behavior according to the established navigation practice was considered important for safety reasons. Maneuvering according to informal standards was also considered to demonstrate good navigator navigational abilities. Therefore, informants reported disengaging the automated systems earlier than necessary due to a wish to act according to "good seamanship.".

Seamanship here meant to conduct early and clear communicative maneuvers to bring adequate solutions to potential vessel conflicts, even sometimes in discrepancy with rules. The informants reported that using predefined routes and hard-coded rules in auto-crossing could confuse other vessel(s). These issues led several informants to contemplate hypothetical scenarios in which they would act upon professional sound judgment incorporating elements such as intuition and values in contrast to blindly following hard-coded rules. Specifically, these scenarios were associated with the COLREG[2]'s lee-way rules. They contrasted this ability to provide practical solutions to concrete situations at hand with automated systems' capabilities in general, as illustrated in the following quote:

> *"The big scare is for example large cruise ships into the side [of our boat]. In case of conflict, we do not take the chance of going straight to the aft, even though we are the stand-on vessel, when we have the opportunity to go just behind [the cruise ship]. Is a computer able to make such a decision?"*

An underlying concern integrated in the appreciation of seamanship was other vessels' preconceptions of navigators on car ferries as only capable of following a "railway track,"' i.e., not having to make any turns and just follow a railway track. Therefore, they generally did not like that the system did not sail human-like. For example, while using autocrossing just outside the quay, a captain stated "*see, the boat is positioning a bit crooked, I would not do that*". In certain situations, such as poor weather conditions, the informants noted that they would pay extra attention to such behavior: *"I do not sail with the autocross when it is that kind of [poor] weather condition. […] I help with both thrusters, so she [the ship] does not end up all crooked"*. This particular issue also represented a safety concern, particularly when navigating shallow and narrow waters.

Navigators were also oriented towards sailing in a way that was 'smooth' for the passengers, and by extension also themselves. This motive led to early versions of the autocrossing system being disused because of too staccato movements and unwanted vibrations, even though the systems worked in an "objective" sense. The navigators imagined how the passengers would think of "weird" sailing, such as abrupt movements or being close to another object. For example, when we observed a captain not using the autocrossing system as he navigated through a narrow passage, he stated that if he were to use the autocrossing in this particular situation, the passengers would think, *'What is he doing up there?'*. Such experiences led crew members to contemplate perceptions and preconceptions of automated systems' ways of thinking and machines in general. Several informants, whether using the system or not, exhibited a simplistic understanding of how the automated system worked, and were skeptical of the intelligence of future automated systems, whereas humans were better at making holistic judgments.

4.2.2. Worry of reduced navigator skills

A prominent concern among almost all the participants was the short- and long-term effects on skills when automation was widely used. In the short term, the lack of manual sailing inevitably led to a diminished ability to take over manual control. As one informant noted, after sailing with autocrossing for some days, he had to *"sail a couple of rounds before I get the flow back."*. The manual sailing was related to "feeling," which could be regarded as perceived control through hands-on experiences. Even identical ships had different "feel," some informants noted. An experience of reduced ability led to several sporadic disengagements of the system to regain feelings of control. For example, a captain's skepticism towards increased automation was rooted in a reduced "feeling":

> "*I am more skeptical of the auto-docking than the auto-crossing. It concerns own senses. […] I usually call it 'feeling the boat' in the fist and in the fingers, and I will only get it in one way: through sailing and feeling manually*."

In the longer timeframe, informants seemed to factor into a more progressive de-skilling issue. The automated system therefore also constituted an opportunity to reflect on "old" seamanship and the younger generations, including a tendency towards sometimes romanticizing established practice and the "real" seafaring. Seamanship was related to the fact that older navigators sailing the "old way" had mastered the skill of maneuvering a ship without the assistance of high-powered motors and technological aids. In contrast, navigators perceived younger generations to not possess the same capabilities and, consequently, were more dependent on advanced technology, as illustrated in the following quotes:

> *"The younger ones now sail sideways[3] into the dock […] They have not been able to get to the dock with the old boats. That I shall promise you."*.

Several informants concluded that the issue of younger navigator competence explicitly arose in the case of technological breakdown or that complex traffic situations invoked a need for the appropriate application of professional judgment and other types of experience-based skills: *"there are too many aids now […] if something happens, you cannot read a book"*. This was especially described as a problematic aspect for the younger generation of seafarers without sufficient manual experience: *"Auto-docking might do it just as well [as us], but if something fails and one have never sailed manually, one does not have the feeling the day one has to take over."*.

However, in contrast, the younger generations were deemed to be more effective at mastering technology and operating efficiently in terms of energy consumption, indicating computer self-trust and an increased tendency to use and experiment with the systems: *"It is a game to them, and they are the gamer generation*.".

Thus, the concern for reduced seafarers' competence led to reduced trust in oneself (and colleagues), which can be seen as a negative effect of the system, and therefore represents reduced trust in the automated systems' ability to provide positive results.

4.2.3. Reduced joy due to lack of ship handling

Some of the informants explicitly stated that the motivation for choosing the profession was to sail and maneuver the boat, and that increased automation might therefore reduce engagement. For example, one of the captains we spoke to was amidst a transition from working at sea to onshore, specifically pinpointing this issue:

> *"Whether it is a wonderful cloudless sky, a calm day – or if it is a full storm – it's one of the most joyful things I do. And it is clear to me now that more and more of it will disappear"*.

Some noted that the shift towards automated systems led to going from executing to monitoring, and indicated a fundamental role change as a navigator that they did not like, as illustrated by this quote: *"Your function on the bridge now is to control that the ship does what it has been told to do. While earlier, it was I who did that."*.

Some indicated a negative attitude toward the changed role but used the system anyway. For example, a captain emphasized that *"it's modern torture to sit and only watch*; however, the same captain also reported using the system "*all the time"*, indicating that albeit trusting the system in its performance, negative feelings can coexist.

5. Discussion

Based on these findings, we will now discuss the characteristics and development of trust in automation and argue that trust could be closely linked to seafarers' professional identity.

[2] Convention on the International Regulations for Preventing Collisions at Sea (1972).

[3] The thrusters on these ships can turn 360 degrees and equipped with enough power, the ship can essentially sail sideways, whereas older ships equipped with propellers are more one-directional and therefore allegedly are more difficult to maneuver during approach to dock, especially in certain wind conditions.

5.1. What characterizes seafarers' trust in the automated systems?

Trust in the automated systems was developed by experiencing an adequate system performance. This experience was primarily obtained through engaging in own practical testing and experimenting with the systems, in which a comparison to some kind of implicit standard was made. The intention to try the system was based on openness to technology and peer encouragement. Adequate system performance according to professional standards was heavily dependent on the crew's involvement in fine-tuning the software together with the developers. In line with previous research by Hoff and Bashir (2015) and McKnight et al. (2011), trust seemed to rely on aspects of the individual, such as openness to technological change (dispositional trust), context, such as different levels of trust in various positions and weather conditions (situational trust), and interaction with systems, for example, the importance of hands-on experience (learned trust). Openness to change might be related to McKnight et al.'s (2011) use of the propensity to trust concept.

Most officers exhibited a high level of trust in the system, supporting the idea that automation is an aid for officers (Chan et al., 2023); however, notable variations were observed. This variation ranged from the absence of trust and disuse, mistrust and disuse in situations where it could have been used, and overtrust and overreliance, for example, not adhering to requirements for periods of manual control. The same person was found to trust the system in one situation, such as in good weather conditions, but not in others, such as during strong winds. Thus, trust is situationally dependent (Hoff & Bashir, 2015). From the outset, trust gradually increased through positive interactions. These findings are consistent with the understanding that trust is not a fixed category but rather a continuum (Pidgeon et al., 2010) and tangent to evolving trust in an upward spiral (Ashleigh & Stanton, 2001). Moreover, considering the system performance variation according to weather conditions, the accompanying variation in trust arguably reflects calibrated trust (Lee and See, 2004).

Regarding the trustworthiness of a system, the three dimensions of McKnight et al. (2011) supported the trust that stems from perceiving the system as precise in its arrival time is tangent to *reliability*, thus operating consistently. The lack of "seamanship" maneuvers pertains to reduced *functionality*, that is, does what needs to be done. Finally, the effect of autocrossing on workload might be considered perceived *helpfulness*, in that it provides adequate and responsive assistance. Although most were positive towards using the systems, observations of disuse or mistrust were explicitly related to the performance of the system, such as the belief that the system did not optimize energy consumption, not sailing the shortest route, and sailing abruptly and not human-like.

Seafarers' trust was intertwined in a multilateral network of trustors and trustees. Their trust in the systems on board was associated with institutional trust in the system provider's reputation, as demonstrated by the positive development process. Through conceptions of professionalism, their attitudes towards the autocrossing system were related to their perceived trust from passengers. Considering some of the notions of poor performance, the implementation of such a system might also be interpreted as onshore management exhibiting distrust in, or devaluing of, seafarers' own professional competence and work. The use of automation seemed also to relate to officers' trust in oneself (self-efficacy) in at least two ways; There were indications that especially younger navigators had a lower self-efficacy in handling the ship manually, that may have contributed to an overreliance on the system. Higher self-efficacy in using technology seemed to lead to confidence in trying and experiencing how the system might lead to positive effects, which is in line with the findings of Wahl et al. (2020). It was also related to the disuse of the system due to considering themselves to be superior to the automated system, in accordance with the findings of Prinzel III (2002). Confidence in oneself as a professional can be considered a precondition for appropriate use. However, this can also lead to unsafe outcomes through the disuse of a trustworthy system.

There were some indications of a discrepancy between the trust expressed verbally and that represented through practice. For example, one of the captains stated, *"it is modern torture to sit and only watch"* indicating a negative attitude towards automated systems. On the other hand, he stated that he used the system "*all the time,*" and subsequent observations supported this. Thus, the captain was confident in the system performance, but was clearly aware of its potential negative effects. This acknowledgment of the captain shows a tension between use and trust, perhaps in this concrete situation, motivated by the immediate gratification of reducing the workload by engaging the system. This somewhat paradoxical example shows that one should be careful when conjoining concepts to represent the same underlying phenomenon. Therefore, there is a notable difference in defining trust as a belief or attitude (Castaldo et al., 2010), and between trust and reliance actions (Lee & See, 2004). The captain might believe that the system will perform as intended but still have some negative attitudes towards it and may realize negative effects but overly rely on the system due to, for example, immediate benefits in reduced workload.

5.2. How trust is related to professional identity

Based on emergent analysis, we argue that norms rooted in professional identities act as references for system performance (see Fig. 2). Professional identity as a term concerns an individual's self-concept of their professional role based on an intertwined whole of experiences, attributes, motives, beliefs, and values (Ibarra, 1999; Schein, 1978), constructed in a social context as an adaptive process. Professional identity as a construct is relevant both for individual and collective notions (Hogg & Abrams, 1988), hence both giving the answer to "who am I", "who are we", and similarly "what we do." The automated steering of a ship to some degree represents a new colleague; therefore, implicit performance standards are applied to this system to gain confidence in its abilities. This effect can also be seen in relation to the fundamental social nature of human–machine interaction (Degani et al., 2017). The seafarers relied on the automation to learn "that it does what we would have done" and observed positive outcomes, and not hurting vulnerabilities, to gain confidence in the systems' ability to produce good results.

We contend that the potential risks and vulnerabilities of a trustor largely reflect professional identity attributes. Recall our understanding of trust in automation as "*a belief from a trustor that an automated system will act to produce positive results in situations of perceived risk and vulnerability.*" Perceived *positive results* (based on Castaldo et al. (2010)) can be summarized as the seafarers' experience of i) optimization of work-related goals, such as keeping time schedules and energy optimization, ii) reduced workload, and iv) increased perceived redundancy and extended repertoire of tools. *Risks and vulnerabilities* can be summarized as seafarers' worrying for or feeling i) loss of reputation and perceived professionalism among passengers and fellow seafarers, ii) loss of professional competence, iii) loss of professional independence, and iv) reduced joy. These vulnerabilities seem to be core aspects of their professional identity and will be discussed below.

Loss of reputation and perceived professionalism. When the seafarer disengaged the automatic crossing when navigating in a narrow passage (albeit "objectively" safe) due to a wish for keeping passengers' perceived safety high, this is an example that implicitly says that the automated systems failed to adhere to a navigation norm. One could therefore argue that automated systems that replace the core tasks of the maritime profession are trusted, partly based on how the system operates according to the norms rooted in professional identity attributes, just as if they were a new colleague. Moreover, system performance that adheres to the norms of "good seamanship" is inextricably linked to professional identity. Albeit quite diverse in meanings, "seamanship" from a sociocultural perspective represents an idealized standard in the maritime profession, how to behave, and what to know. Seamanship

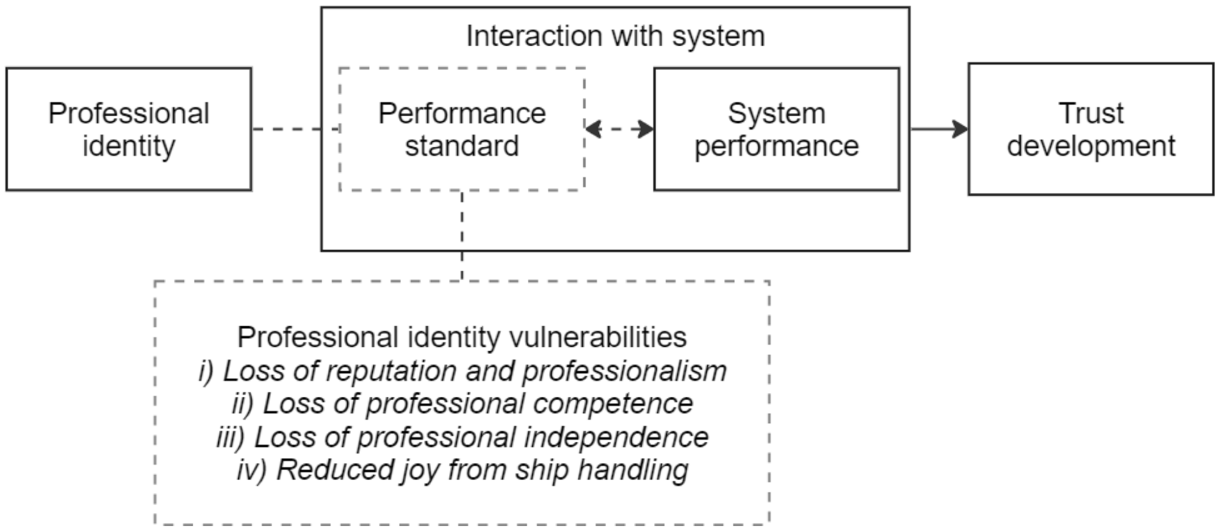

Fig. 2. How professional identity relates to trust development through an implicit performance standard.

essentially relates to all Ibarra's (1999) dimensions of professional identity, experiences (e.g., the emphasis on practical experience at sea to form knowledge and practices), motives (e.g., pride in their work), values (such as valuing human interaction), attributes (specific skills or individual dispositions of the seafarer), and beliefs (e.g., the notion that experience-based judgment is superior to following written procedures).

Loss of professional independence. Professional independence (or autonomy) is also related to trust through the appreciation of the control and authority of their work, which can be considered a professional *attribute* in Ibarras (1999). We claim that systems that challenge maritime officers' perceived control and authority can be easily distrusted. In our findings, this is showcased by the antagonism exhibited towards higher levels of automation, specifically autonomous systems. The negative attitude was often followed by indicating the aspect of perceiving the autonomous system as in "control" versus automated systems as "tools." This skepticism was strong even before and in the absence of interactions with the system performance.

The reluctance to trust a formal artifact undermining their independence bears resemblance to earlier findings related to the proceduralisation of maritime work and identity discrepancy. The introduction of the ISM code initiated elevated bureaucracy through safety management systems (Størkersen, 2018). Both Anand (2011) and Knudsen (Knudsen, 2009) in their research found experiences of the shipmaster transitioning from primarily maneuvering ships to being a "clerk," indicating a clear shift and tension in their professional identity. Considering this identity discrepancy, seafarers are hesitant to trust formal artifacts that challenge their professional autonomy, such as procedures or ICT-enabled monitoring (Bye & Aalberg, 2020; Knudsen, 2009; Sampson et al., 2019). Moreover, Sampson et al. (2019) argued that the accompanying monitoring enabled by ICT manifests a lack of trust exhibited by land-based organizations. In other words, we can conclude that seafarers' trust in automated systems is contingent on perceiving technology as a *resource for action*, as opposed to *means of control* (Dekker, 2003).

Loss of professional competence. Navigational competence was another professional identity attribute that influenced trust. Seafarers contemplated their own professional competence in their beliefs about automated systems, specifically worrying about their effects on navigation skills. Both in the short- and long-term, such worry pertained to considerations on what competent seafarers should know, for example, the appreciation of tacit feelings with the boat, and the capability of situated practical wisdom in decision-making.

Reduced joy from ship handling. For centuries, in the long-lasting history of seafaring, navigators and captains have steered ships as a main task, both symbolic and action-wise, and the future of automation was seen as discrepant to this fundamental idea. As the strong statement from one of the captains clearly illustrates ("it is one of the most joyful things I do"), ship handling could be a primary motivation for work. Feelings of losing one of the core tasks inherent to the occupation is intuitively related to professional identity *motives* (Ibarra, 1999).

In addition to specific vulnerabilities acting as system performance references, professional identity may help explain why trust in automated systems is highly dependent on hands-on testing. There are several other possible explanations for this finding, which we will turn to first. While it was expected that personal experiences would be more influential than second-hand experiences, it was remarkable just how important the hands-on experiences were. The relevance of physical experience is tangent to the findings of Rae et al. (2013), who found that interactions through the physical embodiment of an artifact increased trust in a robot, whereas remote control did not. The embodied learning framework (Stolz, 2015) posits that it is not possible to segregate the body and mind from the world, and that learning occurs through all entities, which might help explain the significance of bodily experiences in learning to trust. The process by which professional experimentation with automation embodies change might also be a form of what Viktorelius and Sellberg (2022) label as bodily-awareness-in-reflection, which they apply to simulation-based training.

In Ibarra's (1999) model of professional identity, *experiences* is a dimension that concerns the background and occurrences that influence professionals' thinking and reflections on their practice and role (Provan et al., 2018). Several informants believed that it was their own experience, in contrast to formal education, which forms a good seafarer and develops seamanship capabilities. This finding is in line with earlier research on seamanship (for example Bye & Aalberg, 2020). Scholars have also posited that it is through embodiment the professional is experimenting with future professional selves in their professional identity adaptation process is through using your body (Stolz, 2015). In this sense, their physical interaction with the new automated system creates a situation in which the operator might experience and reflect on the potential future professional self. Finally, an underpinning theoretical notion in professional identity development is that it culminates in professional independence (Bloom, 2022). Therefore, one could assume that the higher the independence, the higher the trust yourself and observations. The impendence of maritime officers might therefore represent a dispositional factor for (mis)trust: for professionals exhibiting "strong" professional identities, their own experiences are more important, relatively speaking.

5.3. Safety implications

Increased automation is expected to reduce risk by reducing human errors and increasing redundancy (Hoem et al., 2018). However, these effects are founded on the alignment of the high trustworthiness of a system and subjective trust. Understanding seafarers' professional identity attributes could help designers develop automated systems with higher trustworthiness and resolve potential conflicts with identity to increase trust.

By exploring professional identity when developing automation, one can tap into more informal aspects of work rather than purely "objective" measurement, leading to a better understanding of work-as-done (Hollnagel, 2015). The implicit comparison of a maritime officer with a system is something other than formal testing using objective criteria. It taps into the tacit knowledge of seafaring, perceived professionalism, and qualitative "good seamanship." Particularly in the conceptual phases of new automated projects, one should emphasize an understanding of the potential tension with identity to avoid persistent distrust in the absence of physical artifacts for the seafarer to experiment with.

This research calls for a user-centered approach to the design and implementation of such systems. Incorporating an understanding of professional identity in the development of new automated technology in the maritime domain is an approach that not only contributes to increasing the trust that maritime officers have in the system, but also to ensuring the trust passengers have in automation, considering the officers' preoccupation with a mental model of passengers in their interaction with such systems. Thus, we believe that tapping into a professional identity in the development process can increase the trustworthiness of the system by improving it, thereby reducing the risk of lower professionalism perceived by passengers and society.

6. Conclusions

Seafarers exhibited a high level of trust in autocrossing and autodocking, sometimes relying excessively on the systems. This trust partly depended on the system's alignment with the norms inherent in professional identity, as revealed by testing and experimenting with the system. The dynamic and prolonged development phase of the systems enabled a system that eventually satisfied the minimum requirements in terms of this professional standard. Our study contributes to the literature by demonstrating that professional identity is relevant to understanding the context-specific nature of trust when automating the core tasks of a profession. These findings are likely to be relevant to other industries in which automated and autonomous systems are implemented, especially within occupations with a "strong" identity.

Our study has some limitations considering the trustworthiness of qualitative research (Guba, 1981). First, regarding transferability, it is worth noting that ferries are quite special compared with other types of transportation. In terms of trust, Norwegian society might be characterized by a relatively high degree of institutional and interpersonal trust. A limitation concerning the credibility of our findings is that we did not follow the process of developing trust over time. The researchers are safety researchers with an interest in the sociocultural and sociotechnical aspects of work, which might, to some degree, influence what has been regarded as interesting findings.

The future of sociotechnical maritime transportation systems will become increasingly complex with the need to compensate for adaptive capacity (Woods, 2015) to ensure resilience. To increase this capacity, the interface between professionals and technology will be a crucial element by uniting the situated decision-making capabilities of humans with the processual power of automated technology. Future autonomous systems should be compatible with professional operators such that calibrated trust can be achieved. Future research should be directed to find strategies to avoid de-skilling professional competence and to ensure an adequate level of maritime professionals' independence. More research should be directed towards understanding the relationship between trust in automated systems and professional identity through other research methods.

Funding

This research was funded by the Research Council of Norway (grant number: 324726).

CRediT authorship contribution statement

Asbjørn Lein Aalberg: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Project administration. **Siri Mariane Holen:** Investigation, Formal analysis, Writing – original draft, Writing – review & editing. **Trond Kongsvik:** Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. **Aud Marit Wahl:** Formal analysis, Writing – original draft, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Acknowledgments

The authors thank the participants and companies that contributed to this study. We are also grateful for the helpful comments provided by an anonymous reviewer.

Data availability

Data that support the findings of this study are not openly available because of reasons of sensitivity and privacy as per informed consent, but some anonymized data are available from the corresponding author upon reasonable request.

Ethics Approval

The research project' research ethics was notified to and approved by the governing regulatory instance National Centre for Research Data AS, protocol number 948264, approval date 17.03.2022. The project was conducted in accordance with the application of the Norwegian University of Science and Technology's guideline *Collection of personal data for research project*.

Informed Consent Statement

Informed consent was obtained from all the subjects who were interviewed using a sound recorder. In accordance with the National Centre for Research Data AS, only oral consent was obtained from participants who could not be identified from the gathered data.

Appendix A. Interview guide

(1) **INTRODUCTION**
- Briefly inform about the project, background, and how the information will be processed according to the information letter. Voluntary participation, can withdraw consent. Anonymity. Audio recording.

(2) **Can you tell us a bit about your background as a maritime professional?**
   - Facts: Education, years in the profession, various positions, different types of vessels.
   - Why do you work on a boat? What aspects of working on a boat do you value the most?

(3) **What are you proud of or happy to have achieved in your career?**
   - Do you have any experiences that have shaped you as a seafarer?
   - What do you consider good seamanship?
   - Is this a profession you plan to continue in the future/in the coming years? (Why or why not)

(4) **Can you tell us a bit about the role you have in your work today?**
   - Walk us through a typical day! What does a regular shift look like for you?
   - Can you tell us about the cooperation on board?

(5) **How has your profession changed since you started?**
   - Adjust for the informant's age/experience/role.
   - Changes in systems/technology used – changes/developments?

(6) **What is most important for you to do to avoid accidents in your workday/your role?**
   - What dangerous situations can arise in your job? Can you tell us about a situation that has occurred? What did you do, and why?
   - What is important to do to avoid dangerous situations, e.g., collisions, personal injuries, engine room fires, grounding?

(7) **Can you tell us a bit about which systems and technologies you use in your work and how you use them?**
   - Which systems do you particularly like/rely on or dislike/don't rely on at all? (Why, why not) – experiences with systems not working as intended?
   - Is it easy to ask for help if something doesn't work or is difficult to understand? Whom can you ask?
   - **What experiences have you had with auto-docking, auto-crossing?**
   - Can you start from the beginning of the project?
     - Can you describe how the system works?
     - How often/much is ad/ac used, advantages/disadvantages.
     - Easy/difficult to operate, what competence is needed?
     - Safety aspects, are there new risks?
     - Have you experienced any errors/dangerous situations with the system? What happened? Why?
     - What did you do?
     - Have you had to override the system in some situations?
   - What does it take for you to trust a system? How did you learn it?

(8) **How does automation affect how you do your job?**
   - Does automation make your job easier or more difficult?
   - Does automation affect the operation of the ferry service?
   - Does automation affect passengers in any way?
   - Does automation affect well-being, working environment, and team cohesion in the crew?

(9) **Attitudes toward autonomy**
   - What do you think about ferries that can drive themselves? Different degrees of autonomy.
   - Where have you heard about it?
   - Why positive/negative
   - Is it discussed on the ferry?
   - What can be dangerous/challenging (in terms of safety)?
   - Imagine that you are starting to work on a self-driving vessel tomorrow.
     - On the boat
     - Surveillance

(10) **In conclusion:**
   - Is there something on your mind that you haven't had a chance to say?
   - Would you like to highlight any key messages for our future work?

(11) **Thank you for taking the time to speak with us!**

References

Aalberg, A.L., Bye, R.J., 2020. The intangible concept of good seamanship – a comparison of the ingredients of seafarers' descriptions using a hybrid qualitative-quantitative approach. In: Baraldi, P., Di Maio, F., Zio, E. (Eds.), Proceedings of the 30th European Safety and Reliability Conference and the 15th Probabilistic Safety Assessment and Management Conference. Research Publishing, Singapore; Scopus, 4551–4558. https://doi.org/10.3850/978-981-14-8593-0_3974-cd.

Abbott, A., 1988. The system of professions: An essay on the division of expert labor. The University of Chicago Press, pp. xvi, 435.

Alvesson, M., 2018. Reflexive methodology: New vistas for qualitative research (Third edition). Sage.

Anand, N., 2011. New technologies, work, skills and identity: The case of maritime industry [Cardiff university]. https://orca.cardiff.ac.uk/54459/1/U584560.pdf.

Antonsen, S., 2009. The relationship between culture and safety on offshore supply vessels. Saf. Sci. 47 (8), 1118–1128. https://doi.org/10.1016/j.ssci.2008.12.006.

Antonsen, S., Bye, R.J., 2015. "Vi" og "de andre" ["We" and "the others"]. In: Antonsen, S., Kongsvik, T. (Eds.), Sikkerhet i Norske Farvann [safety in Norwegian Waters], 1st ed. Gyldendal Norsk Forlag AS.

Ashleigh, M.J., Stanton, N.A., 2001. Trust: Key Elements in Human Supervisory Control Domains. Cogn. Tech. Work 3 (2), 92–100. https://doi.org/10.1007/PL00011527.

Bloom, T.J., 2022. Understanding Professionalism's Interplay Between the Profession's Identity and One's Professional Identity. Am. J. Pharm. Educ. 86 (9) https://doi.org/10.5688/ajpe8956.

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3, 77–101. https://doi.org/10.1191/1478088706qp063oa.

Bye, R.J., Aalberg, A.L., 2020. Why do they violate the procedures?–An exploratory study within the maritime transportation industry. Saf. Sci. 123, 104538.

Castaldo, S., Premazzi, K., Zerbini, F., 2010. The Meaning(s) of Trust. A Content Analysis on the Diverse Conceptualizations of Trust in Scholarly Research on Business Relationships. J. Bus. Ethics 96 (4), 657–668. https://doi.org/10.1007/s10551-010-0491-4.

Chan, J., Golightly, D., Norman, R., Pazouki, K., 2023. Perception of Autonomy and the Role of Experience within the Maritime Industry. J. Mar. Sci. Eng. 11 (2), Article 2. https://doi.org/10.3390/jmse11020258.

Charatsari, C., Lioutas, E.D., Papadaki-Klavdianou, A., Michailidis, A., Partalidou, M., 2022. Farm advisors amid the transition to Agriculture 4.0: Professional identity, conceptions of the future and future-specific competencies. Sociologia Ruralis 62 (2), 335–362. https://doi.org/10.1111/soru.12364.

De Fina, A., 2019. The ethnographic interview. The Routledge Handbook of Linguistic Ethnography, 154–167.

Degani, A., Goldman, C.V., Deutsch, O., Tsimhoni, O., 2017. On human–machine relations. Cogn. Tech. Work 19 (2), 211–231. https://doi.org/10.1007/s10111-017-0417-3.

Dekker, S., 2003. Failure to adapt or adaptations that fail: Contrasting models on procedures and safety. Appl. Ergon. 34 (3), 233–238. https://doi.org/10.1016/S0003-6870(03)00031-0.

Fjaeran, L., Aven, T., 2021. Creating conditions for critical trust – How an uncertainty-based risk perspective relates to dimensions and types of trust. Saf. Sci. 133, 105008 https://doi.org/10.1016/j.ssci.2020.105008.

Guba, E.G., 1981. ERIC/ECTJ annual review paper: Criteria for assessing the trustworthiness of naturalistic inquiries. Educ. Commun. Technol. 75–91.

He, Y., Jin, Y., Huang, L., Xiong, Y., Chen, P., Mou, J., 2017. Quantitative analysis of COLREG rules and seamanship for autonomous collision avoidance at open sea. Ocean Eng. 140, 281–291. https://doi.org/10.1016/j.oceaneng.2017.05.029.

Helmreich, R.L., Merritt, A.C., 2019. Culture at work in aviation and medicine: National, organizational and professional influences. Routledge.

Hoem, Å., Porathe, T., Rødseth, Ø., Johnsen, S., 2018. At least as safe as manned shipping? Autonomous shipping, safety and "human error.

Hoff, K.A., Bashir, M., 2015. Trust in Automation: Integrating Empirical Evidence on Factors That Influence Trust. Human Factors: J. Human Factors Ergonom. Soc. 57 (3), 407–434. https://doi.org/10.1177/0018720814547570.

Hogg, M.A., Abrams, D., 1988. Social identifications: A social psychology of intergroup relations and group processes. Taylor & Frances/Routledge, pp. xv, 268.

Hollnagel, E., 2015. Why is Work-as-Imagined Different from Work-as- Done? In: Resilient Health Care, Volume 2. CRC Press.

Hult, C., Praetorius, G., Sandberg, C., 2019. On the future of maritime transport – discussing terminology and timeframes. TransNav : Int. J. Mar. Navig. Saf. Sea Transport. 13 (2) https://doi.org/10.12716/1001.13.02.01.

Hult, C., 2012. Sjömän och Sjömansyrke 2010 [Seafarers and the seafaring occupation 2010]. Kalmar Maritime Academy, Linnaeus University, p. 203.

Hynnekleiv, A., Lützhöft, M., 2021. Designing for trustworthiness, training for trust. An overview of trust issues in human autonomy teaming. In: NECESSE (1st ed., Vol. 7). The Norwegian Defence University College.

Ibarra, H., 1999. Provisional Selves: Experimenting with Image and Identity in Professional Adaptation. Adm. Sci. Q. 44 (4), 764–791. https://doi.org/10.2307/2667055.
International Chamber of Shipping, 2022. Shipping and world trade: Driving prosperity. Shipping and World Trade: Driving Prosperity. https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-driving-prosperity/.
Johnson, R.B., Christensen, L., 2019. Educational research: Quantitative, qualitative, and mixed approaches. Sage Publications.
Kerr, S., Von Glinow, Schriesheim, J., 1977. Issues in the study of "professionals" in organizations: The case of scientists and engineers. Organ. Behav. Human Perform. 18 (2), 329–345.
Knudsen, F., 2009. Paperwork at the service of safety? Workers' reluctance against written procedures exemplified by the concept of 'seamanship'. Saf. Sci. 47 (2), 295–303. https://doi.org/10.1016/j.ssci.2008.04.004.
Kongsvik, T., Haavik, T., Bye, R., Almklov, P., 2020. Re-boxing seamanship: From individual to systemic capabilities. Saf. Sci. 130, Scopus. https://doi.org/10.1016/j.ssci.2020.104871.
Lankton, N., McKnight, D. H., Michigan State University, Tripp, J., Baylor University, 2015. Technology, Humanness, and Trust: Rethinking Trust in Technology. J. Assoc. Inform. Syst. 16(10), 880–918. https://doi.org/10.17705/1jais.00411.
Lave, J., Wenger, E., 1991. Situated learning: Legitimate peripheral participation. Cambridge University Press.
Lee, J.D., See, K.A., 2004. Trust in Automation: Designing for Appropriate Reliance. Hum. Factors 46 (1), 50–80.
Luhmann, N., 2018. Trust and power. John Wiley & Sons.
MacNeil, H., 2011. Trust and professional identity: Narratives, counter-narratives and lingering ambiguities. Arch. Sci. 11 (3), 175–192. https://doi.org/10.1007/s10502-011-9150-5.
Mayer, R.C., Davis, J.H., Schoorman, F.D., 1995. An Integrative Model of Organizational Trust. Acad. Manag. Rev. 20 (3), 709. https://doi.org/10.2307/258792.
Mcknight, D.H., Carter, M., Thatcher, J.B., Clay, P.F., 2011. Trust in a specific technology: An investigation of its components and measures. ACM Trans. Manag. Inf. Syst. 2 (2), 1–25. https://doi.org/10.1145/1985347.1985353.
Noy, I.Y., Shinar, D., Horrey, W.J., 2018. Automated driving: Safety blind spots. Saf. Sci. 102, 68–78.
Öhlén, J., Segesten, K., 1998. The professional identity of the nurse: Concept analysis and development. J. Adv. Nurs. 28 (4), 720–727. https://doi.org/10.1046/j.1365-2648.1998.00704.x.
Parasuraman, R., Riley, V., 1997. Humans and automation: Use, misuse, disuse, abuse. Hum. Factors 39 (2), 230–253.
Pidgeon, N., Poortinga, W., Walls, J., 2010. Scepticism, reliance and risk managing institutions: Towards a conceptual model of 'critical trust'. In: Trust in Risk Management. Routledge, pp. 131–156.
Praetorius, G., Hult, C., Sandberg, C., 2020. Towards Autonomous Shipping – Exploring Potential Threats and Opportunities in Future Maritime Operations. In: Stanton, N. (Ed.), Advances in Human Factors of Transportation. Springer International Publishing, pp. 633–644. https://doi.org/10.1007/978-3-030-20503-4_57.
Prinzel III, L.J., 2002. The relationship of self-efficacy and complacency in pilot-automation interaction (TM-2002-211925). Langley Research Center, NASA.
Provan, D., Dekker, S., Rae, A., 2018. Benefactor or burden: Exploring the professional identity of safety professionals. J. Saf. Res. 66 https://doi.org/10.1016/j.jsr.2018.05.005.
Rae, I., Takayama, L., Mutlu, B., 2013. In-body experiences: Embodiment, control, and trust in robot-mediated communication. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 1921–1930. https://doi.org/10.1145/2470654.2466253.
Reifner, T.T., Lilja, N., 2017. Gott sjömanskap: En undersökning ur det straffrättsliga perspektivet. https://www.semanticscholar.org/paper/Gott-sj%C3%B6manskap-%3A-En-unders%C3%B6kning-ur-det-Reifner-Lilja/fb0041f1ece554f8db8d6770fd01381103bdc056.
Saldaña, J., 2013. The coding manual for qualitative researchers, (2. ed). SAGE Publ.
Sampson, H., Turgo, N., Acejo, I., Ellis, N., Tang, L., 2019. 'Between a Rock and a Hard Place': The Implications of Lost Autonomy and Trust for Professionals at Sea. Work Employ Soc. 33 (4), 648–665. https://doi.org/10.1177/0950017018821284.
Schein, E., 1978. Career dynamics: Matching individual and organizational needs. Addison-Wesley, MA.
Siebert, D.C., Siebert, C.F., 2005. The Caregiver Role Identity Scale: A Validation Study. Res. Soc. Work. Pract. 15 (3), 204–212. https://doi.org/10.1177/1049731504272779.
Spradley, J.P., 1980. Participant Observation. Holt, Rinehart and Winston.
Stolz, S.A., 2015. Embodied Learning. Educ. Philos. Theory 47 (5), 474–487. https://doi.org/10.1080/00131857.2013.879694.
Størkersen, K.V., 2018. Bureaucracy overload calling for audit implosion [Thesis.]. NTNU.
Sydnes, T., Thunem, A. P.-J., Frette, V., 2012. Alienation and seamanship: A field study on an offshore service vessel. In: 11th International Probabilistic Safety Assessment and Management Conference and the Annual European Safety and Reliability Conference 2012, PSAM11 ESREL 2012, 8, 6480–6487. Scopus. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84873162464&partnerID=40&md5=a00530e11ae813be9cfaa9921ee49945.
Viktorelius, M., Sellberg, C., 2022. Bodily-awareness-in-reflection: Advancing the epistemological foundation of post-simulation debriefing Bodily-awareness-in-reflection: Advancing the epistemological foundation of post-simulation debriefing. Educ. Philos. Theory. https://doi.org/10.1080/00131857.2022.2138337.
Wahl, A.M., 2020. Expanding the concept of simulator fidelity: The use of technology and collaborative activities in training maritime officers. Cogn. Tech. Work 22 (1), 209–222. https://doi.org/10.1007/s10111-019-00549-4.
Wahl, A., Kongsvik, T., Antonsen, S., 2020. Balancing Safety I and Safety II: Learning to manage performance variability at sea using simulator-based training. Reliab. Eng. Syst. Saf. 195, 106698 https://doi.org/10.1016/j.ress.2019.106698.
Walsham, G., 1998. IT and changing professional identity: Micro-studies and macro-theory. J. Am. Soc. Inf. Sci. 49 (12), 1081–1089. https://doi.org/10.1002/(SICI)1097-4571(1998)49:12<1081::AID-ASI4>3.0.CO;2-R.
Wenger, E., 2010. Communities of practice and social learning systems: The career of a concept. In: Social learning systems and communities of practice. Springer, pp. 179–198.
Wilson, K.M., Yang, S., Roady, T., Kuo, J., Lenné, M.G., 2020. Driver trust & mode confusion in an on-road study of level-2 automated vehicle technology. Saf. Sci. 130, 104845.
Woods, D.D., 2015. Four concepts for resilience and the implications for the future of resilience engineering. Reliab. Eng. Syst. Saf. 141, 5–9.
Zhou, X.-Y., Huang, J.-J., Wang, F.-W., Wu, Z.-L., Liu, Z.-J., 2020. A Study of the Application Barriers to the Use of Autonomous Ships Posed by the Good Seamanship Requirement of COLREGs. J. Navigation 73(3), 710–725. Scopus. https://doi.org/10.1017/S0373463319000924.
Zieba, S., Polet, P., Vanderhaegen, F., Debernard, S., 2010. Principles of adjustable autonomy: A framework for resilient human–machine cooperation. Cogn. Technol. Work 12 (3), 193–203. https://doi.org/10.1007/s10111-009-0134-7.