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Anti-Learning Behavior Toward Safety Risk: The Roles of Internal Context and Social Contagion

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ABSTRACT

Managing safety has become increasingly important in global operations. Surprisingly, the literature provides limited clues on what influences future accident hazards after the happening of a recent minor operational incident (MOI) in an organization. We examine the impacts of internal context (direct MOI experience) and external context (indirect MOI experience) on a focal organization's future serious accident hazard. Using an archival incident dataset from the liner shipping industry and drawing upon normalized deviation and social contagion theory, we find that after a recent MOI in a focal organization, the direct (internal context) and indirect (contagion source) MOI experience "increase" the likelihood of accident hazard. Furthermore, within the indirect MOI

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experience, there is "no" differential impact between related (same type and same region) and unrelated experience, whereas within related experience, spatial (region) and social (type) proximity do not differ in influencing the chance of future serious accident hazard happening. Our findings provide important implications for theory, practice, and policy-making in safety management. [Submitted: January 24, 2020. Revised: September 1, 2020. Accepted: September 21, 2020.]

Subject Areas: Accident, Direct and Indirect Experience, Hazard Model, Liner Shipping, Minor Operational Incident, Normalized Deviation, and Social Contagion Theory.

INTRODUCTION

Liner shipping transports more than 100 million TEU (20-foot equivalent units) goods across the globe annually (World Shipping Council, 2019), and makes up 60% of international trade in terms of volume of goods (Statista, 2018). However, this mode of transportation also faces serious disasters such as major fires, collisions between vessels, oil spills, and so on. These disasters can cause significant damage to container ships, seafarers, and the environment (Maritime Herald, 2019). For instance, the ship Maersk Honam had a fire accident (2018) that was one of the "worst containership disasters in recent history" (Hand, 2019), which in resulted hundreds of destroyed containers and five crew members lost their lives. According to the European Maritime Safety Agency, during 2011–2015, cargo ships accounted for 45% of accidents out of all types of ships (European Maritime Safety Agency, 2016). Although liner shipping companies face pressures to more efficiently transport goods across the globe, safety issues can result in tremendous casualties and require costly recovery. Consequently, safety studies in the shipping industry have received increasing attention in recent years (Erol & Başar, 2015; Heij & Knapp, 2018; Rajapakse, Emad, Lützhöft, & Grech, 2019; Xu & Hu, 2019).

Many scholars have taken an organizational learning perspective to understand accident occurrence. This perspective assumes that when organizations experience a catastrophic event, they learn from it, which helps reduce the likelihood of a similar event occurring in the future. For instance, scholars have examined the positive effects of organizational learning from train crashes (Baum & Dahlin, 2007) and orbital vehicle launch failures (Madsen & Desai, 2010). Recently, researchers have begun to consider the antecedents to accidents (Dahl, Fenstad, & Kongsvik, 2014) and how learning from past accidents influences future accident hazards, that is, the likelihood that a serious accident will occur in the future, by taking an organizational learning perspective (Madsen, 2009). However, what happens if firms engage in anti-learning behavior? This perspective has not been fully examined in the safety literature.

Normalized deviation offers a theoretical lens to understand anti-learning behavior (Vaughan, 1996). Normalized deviation was originally developed to explain the space shuttle challenger disaster, where the organization discounted the importance of problems that did not immediately result in a disaster. Specifically, the organization observed unexpected deviations in the O-ring with each shuttle launch; the unexpected deviations became normalized over time, which ultimately led to the tragic space shuttle challenger explosion. By discounting unexpected deviations and treating them as normal, organizations follow the anti-learning behavior. Drawing on this general perspective, we examine how normalized deviation emerges on liner ships, which increases the risk of a severe accident. Liner ships may experience a minor operational incident (MOI), which is a minor event that does not result in severe damage. Ships that accumulate more MOIs will normalize them and treat them as expected outcomes. This creates a laxer environment on the ship in which the crew members do not diligently resolve small issues. We hypothesize that a ship's internal context can shape the crew members' behavior toward risk. As firms experience more MOIs, they tend to discount the importance of such events and assume more risky behavior. We further hypothesize that the external context can influence the crew members' behavior toward risk. If a ship observes another ship's MOIs, which did not result in a severe outcome, its crew members will then take on more risky behavior (normalized deviation). That is, the anti-learning behavior is socially contagious.

We theorize that the "cumulative" MOIs prior to time T can predict the future accident hazard. When an MOI occurs at time T, we reassess the future accident hazard, which is influenced by the cumulative MOIs. To this end, the cumulative MOI experience that occurs prior to the most recent one may even lead organizations to normalize risky behaviors and discount safety measures. Consequently, the likelihood of future serious accidents may increase. This can be particularly true when there is a high level of proximity between the cumulative MOI experience and the most recent one (e.g., the MOIs are geographically close to each other, or their types are homogeneous).

Liner shipping offers an ideal setting to study the relationship between anti-learning behavior and risk because it is one of the most global and hazardous industries in the world (Department of Industrial Relations, 2019), which involves ocean carriers servicing different countries by consigning cargoes by sea to different locations worldwide. The physical movement of cargoes across oceans and ports by ships exposes the workers (seafarers) to various risks at work. In addition, liner shipping is an industry with low profit margin and slack resources (Junior, Beresford, & Pettit, 2003), and therefore organizations may engage in anti-learning behavior and treat MOIs as normal deviations. Hence, organizations may consider MOIs as normal and acceptable. Furthermore, unlike incidents that happen in other high-hazard sectors (e.g., the mineral and chemical industries), the liner shipping industry faces less screening and inspections.[1] Hence, stakeholders exert less pressure by penalizing organizations for having an incident. For instance, it has been documented that only severe pollution spills in the ocean that are near to the shore get penalized by maritime authorities (e.g., Danish Maritime Authority, 2019). Collectively, this explains why the internal context of the ship environment may lead to more risky operations.

The external context, or other peer ships, can also influence how ships manage their risk. What becomes acceptable operating behavior in one ship may

[1] Regulatory inspections on land (e.g., manufacturing facilities and railroads) are much more accessible compared with liner ships that stay in ocean most of the time. Timely inspections by regulators or third-party auditors are difficult in our context; thus, the anti-learning perspective and normalized deviation play much stronger roles in our context compared with other industry examples (e.g., train crashes, orbital launch vehicle failure, etc.).

influence other related ships in what they consider acceptable. Social Contagion Theory (SCT) can help us understand how other ships' lax operating procedures (normalized deviation) can influence a focal ship's internal behavior toward risk. Specifically, SCT argues that ideas, practices, or behaviors can diffuse through direct interactions or observational processes whereby the recipient organizations make decisions according to the collective mind of the "crowd" (Angst, Agarwal, Sambamurthy, & Kelley, 2010). From this perspective, social contagion leads organizations to rationalize a minor adverse event as normal, consequently increasing the hazard of a future disaster. In this study, we argue that prior cumulative MOI experience from the external context can be the source of social contagion. Broadly, we argue that normalized deviation is contagious to other ships. Collectively and more broadly, this research addresses the following research questions: "*What are the effects of a ship's internal (direct prior cumulative MOI experience) and external (indirect prior cumulative MOI experience) environments on its future accident risk?*"

We examine the impacts of the internal context and external context (social contagion) on future serious accident hazards in the context of the liner shipping industry. In addition, we investigate whether related and unrelated (e.g., geography and accident type proximity) and region- and type-related prior MOI experience exert heterogeneous impacts on future accident hazard. We summarize our key reasoning and findings as follows: We argue that cumulative MOIs represent a relaxed environment in which the organization considers deviations from operating policies and procedures acceptable. Furthermore, because the relaxed policies and procedures do not result in a serious accident, the reassessment of the most recent deviation, that is, the most recent MOI, further leads to normalized deviation, which can increase future accident hazards. In line with our theorizing, we find that if the organization sees its peer organizations with relaxed procedures, it will further accept deviation as an appropriate behavior (social contagion). However, the lax procedures can lead to a serious accident, which is driven by both the internal environment (the ship's previous MOIs, i.e., normalized deviation) and the external environment (other ships' previous MOIs, i.e., social contagion). This research contributes to safety management literature by investigating an underexplored question: how organizations' internal and external contexts influence future serious accident hazard after a most recent MOI. We shed light on that after a recent MOI, the prior direct and indirect MOI experience significantly predict future serious accident hazard, suggesting that both the internal context of the organization and viral contagion source from the external environment (industry peers) are crucial predictors of future accident hazard. We also contribute to the normalized deviation by showing that the accumulation of MOIs reflects normalized deviations in ships and that anti-learning behavior is socially contagious. In other words, the mutual interactions among industry peers regarding spatial proximity (same region) and social proximity (same type) play critical roles in predicting future accident hazards. Prior research has not looked at how anti-learning behavior is socially contagious, especially as it relates to safety issues. We also show that when we contrast the strengths of different contagion sources, the contagion effects are indifferent between related versus unrelated and spatial versus social sources. That is, the social contagion of anti-learning behaviors is on proximity of ships and the type of incidents that occur.

We organize the rest of the paper as follows: In section THEORETICAL BACKGROUND, we review the related literature to identify the research gap and position our study. In section HYPOTHESIS DEVELOPMENT, we present the research model and formulate the hypotheses. In sections DATA AND METHODOLOGY, RESULTS, and ADDITIONAL ANALYSES, we present the data and method, discuss the results, and provide additional analyses, respectively. Finally, in section DISCUSSION, we discuss the theoretical and managerial implications of the research findings, conclude the paper, and suggest future research topics.

THEORETICAL BACKGROUND

Three streams of research related to this research are as follows: safety and accident research; internal context and safety; and social contagion. These streams of literature help position the research in the literature and inform the theoretical development of the hypotheses.

Safety and Accident Research

Over the past few decades, much research on operational performance has focused on conventional performance objectives like cost, quality, flexibility, and delivery (Ward & Duray, 2000). More recently, research in operations management has recognized the importance of managing safety and preventing disasters (Altay & Green III, 2006; Power, Klassen, Kull, & Simpson, 2015; Wiengarten et al., 2017; Pagell, Wiengarten, Fan, Humphreys, & Lo, 2019; Wiengarten et al., 2019). This trend aligns with the emerging goal of socially responsible operations (Besiou & Van Wassenhove, 2015) because it has the aim of "saving lives and reducing human suffering" (Gupta, Starr, Farahani, & Matinrad, 2016). Over the last decade, the MOIs and accidents (Lloyd's List) in maritime shipping, including all kinds of vessels (e.g., container ships, tankers, dry bulkers, etc.), caused more than 2,000 deaths of seafarers per year (George, 2015). These statistics highlight the importance of safety management in the shipping industry. The types of MOIs and accidents include collisions, wrecked/stranded, fires/explosions, seafarer/passenger deaths, pollution (e.g., oil spillovers), hull/machinery damages, and so on. Researchers have developed various tactics for ship managers to prevent and mitigate accidents in shipping operations, including the Bayesian network (Eleye-Datubo, Wall, Saajedi, & Wang, 2006), the analytic hierarchy process, computer simulation models, laboratory experiments (Korkut, Atlar, & Incecik, 2005), and the fuzzy fault tree analysis (Sii, Ruxton, & Wang, 2001). Some of these methods have helped maritime practitioners effectively reduce risks and save costs (Knapp, Bijwaard, & Heij, 2011). However, "standard management methods, as we know them, may not directly apply to disaster situations" (Altay & Green III, 2006) because many contingencies affect safety management in operations. In particular, factors in the organization and its external environment may play a critical role in affecting future accidents. To this end, we investigate how an organization's internal context (the focal ship's "own prior MOI experience") and its situated external context ("other ships' prior MOI experience") affect future accident hazards after the happening of a recent MOI in the organization.

Two streams of literature study the relationship between prior adverse incident experience and future accident likelihood, namely, organizational learning and normalized deviation theory. The former argues that experiential learning from self or others' failures or misconducts can alert organizations to make improvements and therefore reduce the likelihood of future accidents. For instance, Baum and Dahlin (2007) adopted organizational learning theory to study the aspiration performance of railroads. Using a similar theoretical lens, Madsen and Desai (2010) investigated the learning effects within the global orbital launch vehicle industry. The latter, however, emphasizes that organizations may treat small deviations (e.g., MOIs) as normal and inevitable, leading to an anti-learning behavior (Vaughan, 1996). Normalized deviation was originally developed to explain the space shuttle challenger disaster, where the organization discounted the importance of problems that did not immediately result in a disaster. We argue that normalized deviation can diffuse from one organization to another organization, so becoming contagious. That is, social connections may shape organizations' attention toward adverse events. Thus, the focal organization will also accept the deviations as normal and inevitable, when closely related peer firms also discount the importance of small operational problems (or MOIs). From this perspective, ships with anti-learning behavior or normalized deviation will experience MOIs at a higher rate, whereas those that learn should experience MOIs at a lower rate. Given the distinct characteristics of the shipping industry (weak institutional environment for regulating safety, and low profit margin and low slack resources in the liner shipping industry), we adopt the normalized deviation and social contagion perspectives to understand how MOIs predict the future accident hazard.

Internal Context and Safety

In the safety literature, the internal context refers to the organization's safety culture, climate, and mindfulness toward safety. Organizational culture is the underlying shared values and assumptions held among organizational members (Schein, 2010). Zohar (2003) noted that a safety culture involves "shared perceptions with regard to safety policies, procedures, and practices." Researchers also note that safety culture tends to be a tacit or unarticulated shared assumption among diverse organizational members (DeJoy, Schaffer, Wilson, Vandenberg, & Butts, 2004).

Researchers have begun to recognize the importance of the internal organizational context to safety performance. For instance, Dillon et al. (2016) conducted a study of near-misses at The National Aeronautics and Space Administration (NASA) and found an inverse relationship between safety culture and the frequency of near-miss events. Pagell, Johnston, Veltri, Klassen, and Biehl (2014) noted that an emphasis on "getting work done over doing work safely" results from safety practices that do not go beyond explicitly stated safety procedures and policies. That is, mindlessly following safety procedures and policies may not result in safety outcomes. This further suggests that safety culture may not be appropriately measured by observing if an organization simply follows the safety procedures and policies. As a result, safety culture (the internal context) is more about the values and commitment to safety than the policies and procedures alone. Emerging research supports the view that the internal organizational context is more strongly related to safety performance than simply implementing policies and procedures (Naveh et al., 2005; Høivik et al., 2009; Dillon, Tinsley, Madsen, & Rogers, 2016). The internal context refers to organizational members' attention to "unexpected deviation that needs to be corrected" (Weick et al., 2008). Mindful organizations pay careful attention to safety problems and have a safety culture (Lo, Pagell, Fan, Wiengarten, & Yeung, 2014), whereas less mindful organizations lack the capability to reduce distraction and cannot hold an intended safety object in mind (Weick, Sutcliffe, & Obstfeld, 2008). Studies have shown that MOIs are seldom interpreted as failures because organizational members tend to interpret them as "good fortune" and pay insufficient attention to them (Tinsley, Dillon, & Cronin, 2012; Dillon et al., 2016). As a result, a lack of mindfulness (or mindlessness) to safety indicates a weak internal context where the "capability to detect and manage unexpected events" is not present (Weick et al., 2008). Hence, if MOIs frequently occur in an organization, it could imply that the organizational members have lower levels of attentiveness to safety. Organizations with low attentiveness to safety will discount warning signals that may lead to bigger problems in the future. Consequently, the more frequently MOIs occur in an organization, the lower is its internal safety context. Under such circumstances, the organization does not pay enough attention to safety issues and takes more risks (Tinsley et al., 2012). Taken together, the frequency of MOIs indicates the level of internal safety context in the organization.

Social Contagion Research

Social contagion refers to the spread of social norms among individuals or organizations (Christakis & Fowler, 2013). The social contagion literature asserts that the diffusion of practice or innovation may occur from an existing adopter to nonadopters through direct information transmission or the observational mechanism (Angst et al., 2010; Aral & Walker, 2011). In other words, prior adopters are the sources of the contagious effect. More recently, network theory of contagion was proposed to account for the collective minds varying between communities, suggesting that social connections play a critical role in shaping individuals' attention toward adverse events (Scherer & Cho, 2003).

An important question in the social network literature relates to how the social structure could influence individuals' perceptions (Burt, 2000). This implies that we cannot expect homogenous influence exerted from contagion sources while neglecting social structural characteristics. Accordingly, researchers have used SCT to explain the effects of network centrality and proximity (Ibarra & Andrews, 1993), and social and spatial proximity (Angst et al., 2010) on the "contagious" process of organizational practices or innovations. For instance, Angst et al. (2010) found that greater proximity and closer social characteristic between adopter and nonadopter organizations promote the diffusion of electronic medical records in hospitals. Aral and Walker (2011) observed that the mechanism driving social contagion in product adoption and sales is to create different viral features in product design that can eventually attract more attention among peers.

The literature has proposed two underlying mechanisms that create the social contagion effect, namely, "cohesion" and "structural equivalence" (Bovasso, 1996). Cohesion applies to the circumstances when individual organizations in a network have direct transactions and are well connected to one another. Structural equivalence explains the scenarios where the positions of two parties are almost identical in a network (Marsden & Friedkin, 1993; Scherer & Cho, 2003). In some literature, scholars use "role equivalence" as the alternative interpretation of structural equivalence. Different roles played by organizations may influence how the contagion effect diffuses within the network. Regardless of which mechanism may be applicable in understanding the social contagion process of MOI experience, it turns out that the contagion source (peers' MOI experience) can be transmitted to the focal organization, hence strengthening the effect of the most recent adverse event, that is, the most recent MOI in our context, in the organization. Moreover, both mechanisms suggest that a higher degree of proximity between the contagion source and the focal event would enhance the transmission of the contagion effect.

Taken together, the literature above informs accident research in the liner shipping industry and the feasibility of applying social contagion theory to understand accident hazards. It appears that SCT enables a nuanced understanding of the contingencies that influence future serious accident hazard through the interactions and observations between the focal organization and the contagious source (other peer organizations).

HYPOTHESIS DEVELOPMENT

Informed by previous literature on safety management, organizations' internal environment, and social contagion studies, we develop hypotheses about how an organization's internal and external environments affect future accident hazards. In doing so, we conceptualize MOI experience into direct (within the ship) and indirect (other peer ships). We further theorize how the internal context increases future accident hazards and how the external context exerts contagion influence to increase future accident hazards. Moreover, we also develop a theoretical framework incorporating the proximity between the contagion source (peers' MOI experience) and the recent focal MOI occurring in the organization to examine the possible differential effects on future accident hazards.

Direct MOI Experience on Accident Hazard

The safety and accident literature suggests that an organization's internal context can predict safety performance (DeJoy et al., 2004). That is, a sustained consciousness or awareness of ongoing internal operations enhances safety performance. In contrast, recent MOI's experience may lead organizational members to discount events or information that could influence safety. Vaughan (1996) described the concept of "normalized deviation" where organizational members start to treat small deviations in organizations as expected normal outcomes when they have experienced several similar MOIs previously, which over time increases the organization's exposure to risk. Vaughan (1996) investigated how the 1996 space shuttle Challenger explosion was a result of the organization's treating anomalies, that is, wearing of the O-rings, as normal and expected outcomes over time. Thus, the organization did not detect the O-ring wearing conditions that led to the 1986 space shuttle Challenger explosion. The normalization of such minor safety incidents creates a risky internal safety climate and exposes the firm to possible severe safety accidents in the future. If such incidents frequently occur, organizational members typically have lower levels of attentiveness to safety. Organizations with low attentiveness to safety will discount a warning signal in reassessing future accident hazards, that is, when a recent MOI occurs. Hence, the more direct MOI experience an organization has, that is, the more frequently MOIs occur in the organization, the higher the future accident hazards after a recent MOI. Under such circumstances, the organization does not pay enough attention to safety issues and takes more risks (Tinsley et al., 2012; Lo et al., 2014). Therefore, we propose the following hypothesis:

H1: *The direct MOI experience (internal context) that has accumulated before a focal ship's recent MOI significantly increases the focal ship's future serious accident hazard.*

Contagion Effect of Indirect MOI Experience

We argue that the external environment (indirect experience), that is, other ships' MOI experience, which is observable to a focal ship, can be salient to the focal ship's future accident outcome. Likewise, a contagion effect derived from other ships' MOIs is viral, exerting a social contagion influence that can eventually increase future accident hazards after the focal ship encountered an MOI itself. According to SCT, both the cohesion and structural equivalence mechanisms are indicative of the contagion effect triggered by other ships' MOI experience. Specifically, a cohesive shipping network in which the focal ship and other ships are connected through business cooperation and industrial associations (e.g., ships operating on the same route in a coordinated manner, being members of the same liner shipping association, etc.) or a structurally equivalent position within the shipping network between the focal ship and peer ships (e.g., ships operating in different maritime routes compete with one another for market share or serving the same customer in cargo transshipment) enables the transmission of the contagion effect, that is, MOI experience, from other ships to the focal ship. In tackling the uncertainty in safety management, organizations tend to treat an MOI as normal and inevitable (Wolf, 2001). In addition, the prevalence of MOIs among peers, that is, other ships, can serve as a source to reduce uncertainty about safety violations and the associated consequences perceived by the focal ship. This is because the occurrence of MOIs seems to be normal on other ships, and seeing other ships with relaxed procedures, the focal ship will further accept such practices as appropriate behavior (social contagion). However, the lax procedures will lead to serious accidents. The more experience of MOIs among other peer ships, the more likely that the focal ship may rationalize the occurrence of its own MOIs to be normal and inevitable. Consequently, the focal ship would tend to be even less mindful of preventing future accidents. Based on the arguments above, we propose the following hypothesis:

H2: *Other ships' (indirect) MOI experience that has accumulated before a focal ship's recent MOI significantly increases the focal ship's future serious accident hazard (contagion).*

Relatedness of Experience

Prior research has revealed the role of spatial and social proximity in the transmission of information based on SCT (Angst et al., 2010). It is likely that the relatedness between experience, that is, the extent to which the focal ship's recent MOI is homogeneous to the contagion source, may predict future accident hazards. In the context of liner shipping, related incident experience mainly refers to region and type homogeneity. The former corresponds to spatial proximity, and the latter stands for social proximity in the literature. MOI experience that is homogenous to the focal ship's recent MOI exerts homogeneous influence, strengthening the contagion effect of prior MOI experience on the focal ship's future serious accident hazard. Consequently, the focal ship is more likely to rationalize a recent accident of its own as normal and inevitable compared with when the MOI experience is not homogenous to the recent MOI of its own.

In safety management, organizations deal with uncertainties and risks in mitigating future accident hazards, whereas managers face considerable pressure in mitigating risk hazards due to resource constraints such as a misalignment between safety goal and economic goal (Lo et al., 2014). Therefore, relatedness between the contagion source and the focal ship's own recent MOI can lead the focal ship to reduce the uncertainty about the violation of safety. On seeing other ships with relaxed procedures, the focal ship will further accept violation of safety as appropriate behavior (social contagion), in particular, when the focal MOI is homogenous to the contagion source. Hence, the contagion effect can be more viral to the focal ship, increasing future serious accident hazard to a greater extent. Consequently, we expect that the contagious effect will be more influential when the MOI experience is related to the focal ship's recent MOI than when it is unrelated. Thus, we propose the following hypothesis:

H3: *Among the indirect MOI experience (contagion source), experience related to the focal ship's recent MOI is more strongly associated with future serious accident hazard than experience unrelated to the focal ship's recent MOI.*

Proximity of Experience

Other ships' MOI experience in the same water[2] or type with the focal ship's recent MOI refers to region- or type-related experience. The SCT literature defines the two kinds of experience as spatial and social proximity (Angst et al., 2010). Therefore, it is worthwhile to explore possible differential influences of the two proximities, that is, spatial versus type proximity, on future accident hazards. We postulate that spatial proximity can lead to a higher future accident hazard than that of social proximity.

[2] See section 4. The database has divided the liner shipping waters into 33 administrative regions.

Dong et al. (2015) showed that a model considering spatial proximity increases model fit in predicting a zone-level crash in ocean shipping. In the maritime industry, ships pay attention to various region-related indicators, such as ship domain (a dedicated area that needs to be kept clear for other ships), navigation skill, safety regulation, service commitment level, and so on, required on a specific shipping route (Qu, Meng, & Suyi, 2011). These indicators tend to be homogenous on the same shipping route (Lin & Chang, 2018), making the contagion source, that is, other ships' MOI experience, more readily transmitted to the focal ship. However, compared with spatial proximity, social proximity (type-related experience) seems less likely to transfer contagious influence from the source (other ships' experience) to the focal ship because MOI types may not help reduce the uncertainty about safety management. For instance, a ship having had a fire-related MOI may not relate this MOI to peers' previous fire incidents because fire hazard is ship specific. Thus, the focal ship is less likely to seek insights from peers that have social proximity with itself. As such, the MOI experience associated with spatial proximity (region related) can be more readily observed by and spread to the focal ship than MOI with social proximity. We propose the following hypothesis:

H4: *Among the indirect MOI experience that has proximity with the focal ship's recent MOI, spatial proximity is more strongly associated with future serious accident hazard than social proximity.*

DATA AND METHODOLOGY

The liner shipping industry offers a favorable setting to investigate the social contagion effect on accident hazards. The data come from the Llyod's List Intelligence database, which consolidates all the global merchant sea-going liner ships (over 100 tonnages) registered under the International Maritime Organization (IMO) and their incident reports. The database contains rich details of MOIs and accidents on individual container ships, such as the date, building country, classification society, and so on. The data for our analysis are less susceptible to selection bias because the database contains information on all merchant sea-going "container ships" worldwide that have been registered with IMO, that is, the entire population (there are in total 7290 merchant container ships registered under the IMO in the database). Moreover, the United Nations Convention on the Law of the Sea (UNCLOS) makes it mandatory that the flag state (the state under whose laws the vessel is registered or licensed) should conduct an inquiry into every marine incident (Audit Scheme, International Maritime Organization). Under this legal requirement, all the maritime authorities have a legal obligation to make timely reports of maritime incidents, ensuring a high incident-reporting rate to the maritime authorities. Lloyd's List has compiled all the historical incident reports, and this archival dataset is considered the most comprehensive and reliable among all the commercial maritime databases (Marine Accident and Casualty Investigation Boards).

Given that the number of the entire population is large in scale (7,290 ships in the database), it is impossible to code the entire database manually. Moreover, we need to make inquiries of each record based on multiple conditions (e.g., same type and/or same region, etc.). To minimize human coding errors, we code the inquiry process using a Java-based variable coding program to enhance the reliability and efficiency of variable construction. Specifically, our Java codes are based on a set of searching and matching algorithms to count the total number of cases that meet the searching criteria. The input of the program is a scalar of container ships that have one MOI at time *T* (this is in line with how we construct our sample: in order to be included in the sample, a container ship should have at least one MOI at time *T* during the observation years), whereas the output is the count of container ships that meet the matching criteria, including year range, region, accident type, and so on. The searching algorithm helps identify container ships that meet the criteria (based on the predetermined matching algorithm) from the 7,290 candidates. For instance, based on the unique ship code, we can count the total number of MOIs occurring in the same region and being of the same type with the focal MOI observation. We randomly select roughly 10% (39 out of the 381 observations) of the results generated from the Java program and compare them with the manually constructed results, yielding 100% consistency. Hence, we confirm the reliability and accuracy of the Java-based program for constructing variables. To measure lagged variables, we consolidate a container vessel sample from 1985 to 2013 (a 29-year study period) that experienced at least one MOI (at time *T*), allowing all the 1-year lags of prior MOI experience to be included in the analysis. In total, we use 381 ship-year observations for the analysis. There are 361 unique container ships in our sample.[3] Table 1 gives the year distribution of MOIs and accidents.

Our primary research objective is to assess the impact of MOI experience on future serious accident hazard right after a focal ship's most recent MOI. That is, we consider the future accident hazard rate when a focal container ship has an MOI in time *T*. In other words, either a serious accident happens at time $\mathrm{T} + \Delta \mathrm{t}'$, or no serious accident happens (censoring) during the observation period starting from time *T*. Hazard models have been widely used to estimate the risk of a future event (e.g., accident hazard) in relation to several explanatory variables of interest (Ball, Siemsen, & Shah, 2017; Dhanorkar, Siemsen, & Linderman, 2017; Nanga, Odai, & Lotsi, 2017). We use the number of MOIs prior to the most recent minor MOI to predict the likelihood of future serious accidents because we investigate how prior MOIs may "amplify" the tendency of not paying attention to the relaxed safety environment due to the most recent MOI. Moreover, the hazard model can resolve the "censoring" issue. Specifically, in our study context, there are cases where a ship has a minor accident but does not have a serious accident during the observation period (right censoring). The hazard model can better deal with the censoring issue, so leading to better estimation (see Dhanorkar et al. (2016) for a similar practice). We adopt the Cox proportional hazard model because it does not require a specific distribution assumption, providing additional flexibility (Dhanorkar et al., 2017)

[3] Recall that in order to be included in the sample, a container ship should have at least one MOI at time *T* during the observation years. The final number of observations (381) implies that compared with the total number of ships in the database, that is, 7,290, our sample is not very large. This may be due to that both MOI and serious accident are rare events. Nevertheless, once a serious accident occurs, it can lead to severe consequences. Meanwhile, the relatively small sample size does not discount the validity of the research questions raised in the present study, because our focus is the estimation of future serious accident hazard based upon the prior MOI experience, which does not consider ships "not" having a single MOI observation at time *T* during the study years.

Table 1: Year distribution of MOIs and accidents.

Year	MOI Frequency	Accident Frequency	Year	MOI Frequency	Accident Frequency
1985	8	3	2000	13	0
1986	13	1	2001	9	3
1987	14	0	2002	18	1
1988	18	2	2003	15	9
1989	10	5	2004	13	5
1990	12	2	2005	22	5
1991	9	2	2006	20	5
1992	8	2	2007	14	7
1993	9	0	2008	15	8
1994	10	0	2009	12	4
1995	12	1	2010	16	6
1996	10	0	2011	10	3
1997	10	1	2012	18	5
1998	17	1	2013	15	3
1999	11	1	Total	381	85

Note: The sample includes container vessels from the year 1985 to 2013 that experienced at least one MOI. Accidents are rare events; ships without an accident in a year (there are 296 = 381–85, ships without an accident) indicate right-censored data for the survival analysis.

in estimating accident hazards. We specify the Cox proportional hazard model for our research context as follows:

$$h_i(t) = h_0(t)\exp\{\beta_0 X_0 + \beta_1 \text{MOI } \textit{experience} + e\} \quad (1)$$

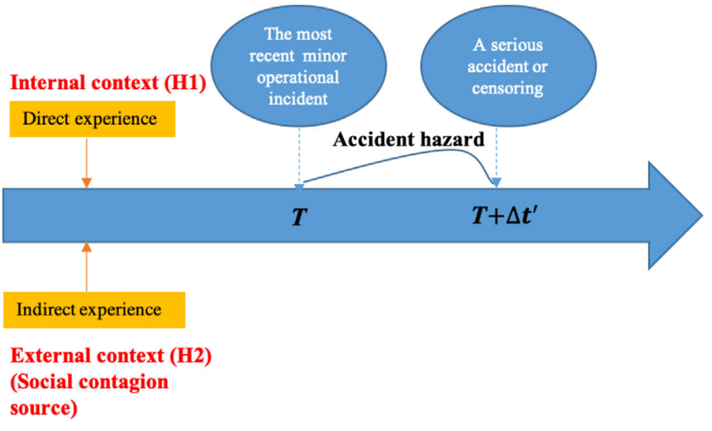
where $h_0(t)$ refers to the baseline hazard rate and $h_i(t)$ indicates the proportional increase in hazard, given a set of control variables in the vector X_0 and the independent variable of our interest, that is, MOI experience, and *e* stands for the estimation error. We use a panel hazard regression analysis.[4] Figure 1 depicts the research model.

Dependent Variable

We measure the dependent variable as the future serious accident hazard for ship *i* in year *T*. Hazard modeling requires the beginning, that is, MOI date at *T*, and ending times (future accident date, if any) for a focal ship year (the unit of analysis in this study). In case that there is no future serious accident on a focal ship after a recent MOI, it is considered to be right "censored." The database defines a serious accident as an event that "results in serious personal injury, ship damage, or loss" (Lloyd's List). Note that the categorizing MOI and serious accident is based on the criteria set by Lloyd's List experts and we strictly follow it and do not use our

[4] Ships have a documentation system to store knowledge so we can use a panel analysis to assess the accident hazard over time. For instance, the classification society will document safety- and technical-related information for each ship and provide them under the operating and insurance companies' inquiry. Also, every ship that is registered with the IMO will be assigned a unique number for tracking safety performance and technical performance. Besides, operating firms of container ships keep tracking safety management and technical maintenance over time.

Figure 1: Research model.



Note: Organizations re-assess the accident hazard following the happening of the most recent MOI at time *T*. Direct and indirect experience are cumulative MOI counts prior to the most recent MOI on the ship.

own categorizing to introduce possible subjectivity. Examples of serious accidents include total loss of the ship (e.g., sank), seafarer death, or pollution (e.g., oil spill) of the environment. One specific example of a serious accident in the database is as follows (due to confidentiality, the IMO number and ship details are removed):

> "Water entered No. 2 hold containing fishmeal cargo which subsequently fermented, giving off gases and causing the death of 1 crew."

In addition, the database defines a container ship MOI as an "abnormal event occurring in the course of operations of sea-going ships" (Lloyd's List). One example of an MOI from the database is as follows:

> "Mooring ropes parted whilst vessel was loading cargo, vessel shifted from berth, causing an oil loading hose to damage a manifold on vessel. Vessel later reported in service."

Independent Variable

We measure prior cumulative MOI experience as the count of all MOIs on the focal ship i (direct MOI experience) or from other ships (indirect MOI experience), where both are 1 year prior to the date of the focal ship's recent MOI at time T. That is, the independent variable is the count of all the MOIs in a 1-year lag (year $T - 1$.). Therefore, we omit ships that have been launched for less than 1 year due to insufficient lagged data. We use a 1-year lag because preliminary analyses suggest that when the lag year is greater than one, there is no statistically significant association between the independent variable and the dependent variable in the later years. Including the cumulative count lags (e.g., from year $T - 1$ to year $T - 2$) in the models causes serious collinearity issues.

Table 2: Key variable construction.

Variable name	Category	Operationalization
Direct experience ($T_{(-1)}$; *all*)	Internal environment	Count of all the focal ship's MOIs in year $T-1$
Direct experience ($T_{(-1)}$; *same type*)	Internal environment	Count of the focal ship's MOIs in year $T-1$ that are of the same type as the focal ship's MOI in year *T*.
Direct experience ($T_{(-1)}$; *different type*)	Internal environment	Count of all the focal ship's MOIs in year $T-1$ that are of different types from the focal ship's MOI in year *T*.
Indirect experience ($T_{(-1)}$; *all*)	External environment	Count of all other ships' MOIs in year $T-1$.
Indirect experience ($T_{(-1)}$; *same type*)	External environment	Count of other ships' MOIs in year $T-1$ that are of the same type as the focal ship's MOI in year *T*.
Indirect experience ($T_{(-1)}$; *same region*)	External environment	Count of other ships' MOIs in year $T-1$ that are in the same region as the focal ship's MOIs in year *T*.
Indirect experience ($T_{(-1)}$; *same type and same region*)	External environment	Count of other ships' MOIs in year $T-1$ that are in the same region and of the same type as the focal ship's MOI in year *T*.
Indirect experience ($T_{(-1)}$; *same region/ different type*)	External environment	Count of other ships' MOIs in year $T-1$ that are in the same region but of different types from the focal ship's MOI in year *T*.

The Lloyds' List database has categorized incidents into the six types, namely, Collision (CN), Contact (CT), Foundered (FD), Fire/Explosion (FX), Hull/Machinery Damage (HM), and Wrecked/Stranded (WS). Hence, we also separately construct variables of *Direct experience* ($T_{(-1)}$; *same type*) and *Direct experience* ($T_{(-1)}$; *different type*) to measure the same and different types of experience, respectively. The database also has divided the regions (SIS zones) where the incident takes place into 33 waters (e.g., West Coast South America, South China & East India, Gulf of Mexico, etc.). Accordingly, we construct independent variables of the same-region experience of other ships, that is, Indirect experience ($T_{(-1)}$; *same region*). We operationalize this variable as "spatial proximity" to test H4. Similarly, we operationalize Indirect experience ($T_{(-1)}$; *same type*) as "social proximity" to test H4. Also, we construct variables that account for experience of same region "and" same type, that is, Indirect experience ($T_{(-1)}$; *same type & same region*), and same region but different type, that is, Indirect experience ($T_{(-1)}$; *same region/different type*).[5] Table 2 gives the categories and operationalization of the independent variables.

[5] Unlike dry bulkers, oil tankers, and liquefied gas carriers that provide service for transport on an unfixed time/route schedule basis (e.g., customized service upon service requests by individual customers), liner shipping has relatively regular routes on fixed schedules (comparable to bus service with fixed routes and time). Therefore, it is feasible to consider the viral contagion sources from the shipping routes and regions.

Control Variables

We control for a number of variables that may have an impact on the hazard of a serious accident. We calculate ship age as the difference (in days) between the accident date and launch date of the ship, divided by 365 days. We take the logarithms of these values to mitigate skewness. We take the logarithm of Dead Weight Tonnage to account for the possible impact of vessel weight on accident hazards. Also, we include various dummy variables such as years of the focal ship's MOI at time *T*, vessel building country, and classification society, that is, the organizations that establish and maintain technical standards for vessel construction and operations, to account for the possible effects of marine shipping policies and technological changes over time on serious accident hazard. Table 2 provides descriptive statistics and correlation matrix. The largest variance inflation factor (VIF) in all models is 2.7, whereas the average VIF is 2.2. Therefore, there is no serious collinearity issue between the variables included in the models.

RESULTS

We present the regression results from the Cox proportional hazard model in Tables 4 and 5. Table 3 presents the results of direct experience on accident hazards. The baseline model (Model 0) only includes the controls. We separately test the impact of the aforementioned independent variables in different models. Both *Direct experience* (beta = 1.75, $p < .01$) and *Same-type direct experience* (beta = 2.90, $p < .01$) significantly increase accident hazard upon the focal ship's recent MOI. Therefore, the focal ship's direct MOI experience plays a critical role in predicting future accident hazards. Thus, H1 is supported.

To test H2, we analyze the impact of other ships' MOI experience on accident hazards. In addition, we separately regress other ships' *same-type*, *same-region*, *same-type AND same-region*, *same-region BUT different type* MOI experience variables (see Table 1 for reference), allowing us to investigate their differential effects among these variables on serious accident hazard. The Cox proportional hazard regression results show that there exist distinct effects among other ships' experience variables. Specifically, *same-type experience* (*Indirect experience* ($T_{(-1)}$; *same type*), beta = 0.06, $p < .05$) and *same-type and same-region experience* (*Indirect experience* ($T_{(-1)}$, *same type and same region*), beta = 0.14, $p < .05$) are statistically significant in increasing future serious accident hazard. Therefore, it seems that contagion source comes from the confluence of type and location, leading to a higher likelihood of a future serious accident. Nevertheless, the remaining two variables, that is, *Indirect experience* ($T_{(-1)}$; *same region*) and *Indirect experience* ($T_{(-1)}$; *same region/different type*), do not have a significant impact on accident hazard. Hence, it appears that only when the MOI experience is of the same type with the focal ship's recent MOI in year *T* is the contagion effect significant. Consequently, H2 is partially supported. In other words, only when the indirect experience is of the same type of the focal ship's recent MOI will the focal ship's future accident hazard increase. Table 5 presents the results of indirect experience on accident hazards.

Table 3: Descriptive statistics and correlation table.

		Mean	*SD*	1	2	3	4	5	6	7	8	9
1	*Direct experience* ($T_{(-1)}$; *all*)	0.021	0.142	1								
2	*Direct experience* ($T_{(-1)}$; *same type*)	0.005	0.072	$.864^{**}$	1							
3	*Direct experience* ($T_{(-1)}$; *different type*)	0.016	0.124	$.496^{**}$	–.009	1						
4	*Indirect experience* ($T_{(-1)}$; *all*)	12.437	10.682	.072	.048	.061	1					
5	*Indirect experience* ($T_{(-1)}$; *same type*)	6.863	4.262	.074	.073	.020	$.501^{**}$	1				
6	*Indirect experience* ($T_{(-1)}$; *same region*)	4.191	4.811	.062	.060	.019	$.567^{**}$	$.835^{**}$	1			
7	*Indirect experience* ($T_{(-1)}$; *same type and same region*)	1.411	2.270	.067	.068	.016	$.354^{**}$	$.919^{**}$	$.552^{**}$	1		
8	*Indirect experience* ($T_{(-1)}$; *same region/different type*)	2.780	3.171	.009	–.006	.028	–.032	–.034	–.009	–.045	1	
9	Vessel age (log)	2.980	0.780	.036	.029	.021	$-.324^{**}$	$-.210^{**}$	$-.146^{**}$	$-.215^{**}$	$.107^{*}$	1
10	Vessel weight (log)	10.037	0.922	–.006	–.027	.035	$.160^{**}$	.068	.072	.052	–.017	$-.256^{**}$

Note: Correlation is significant at the **0.01 and *0.05 (two-tailed).

Table 4: Internal environment (year $T_{(-1)}$): Direct experience on accident hazards.

	Model 0 (baseline)	Model 1.1 (all)	Model 1.2 (related)	Model 1.3 (unrelated)
Variables	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)
Direct experience ($T_{(-1)}$; *all*)		1.75*** (0.67)		
Direct ($T_{(-1)}$; *same type*)			2.90*** (0.92)	
Direct ($T_{(-1)}$; *different type*)				0.83 (1.09)
Controls				
Vessel age (ln)	–1.06*** (0.16)	–1.11*** (0.16)	–1.11*** (0.17)	–1.07*** (0.16)
Vessel weight (ln)	0.01 (0.15)	0.03 (0.15)	–0.01 (0.15)	0.02 (0.15)
Year dummies	Incl	Incl	Incl	Incl
Vessel building country dummies	Incl	Incl	Incl	Incl
Classification society dummies	Incl	Incl	Incl	Incl
Observations	381	381	381	381
Log likelihood	–161.69***	–159.26***	–158.36***	–161.46***

Note: Cox proportional hazard models. Standard errors are clustered on vessels. Dependent variable is serious accident hazard.
***$p < .01$;
**$p < .05$;
*$p < .1$.

To test H3 and H4, we conduct a series of Wald's tests (Madsen, 2009; Dhanorkar et al., 2017) to examine (1) among indirect experience, whether related and unrelated experience have statistically distinct impacts on future serious accident hazard (H3), and (2) among related experience, whether region-related and type-related experience have statistically distinct impacts on future serious accident hazard. For example, the Wald's test between indirect experience (same type vs. different type) demonstrates that there is no statistical difference between the two groups ($p > .10$), suggesting that experience related to the focal ship's recent MOI does not have a stronger impact on future serious accident hazard than experience unrelated to the focal ship's recent MOI. Also, the Wald's test between indirect experience (same region vs. same type) shows that no statistical difference exists between the two groups ($p > .10$). All the Wald's tests show that the coefficients of the hypothesized relationships (H3 and H4) are not statistically more negative or positive than the baselines (all the p values are greater than .10), suggesting that there is no distinction between related and unrelated (H3) and region-related and type-related (H4) experience. Accordingly, H3 and H4 are not supported.

We conduct a series of robustness checks to compare our results obtained from different model specifications and adopt instrumental variable techniques to address endogeneity issues. To begin with, we use an alternative model, that is, Poisson regression, to compare the results from the Cox proportional hazard model and Poisson model (see Tables A and B in the Online Appendix). Our results do not change significantly in the Poisson regressions. In addition, the current hazard

Table 5: External environment (year $T_{(-1)}$): Indirect experience on accident hazards.

	Model 2.0 (all serious)	Model 2.1 (related-type)	Model 2.2 (related-region)	Model 2.3 (related-both)	Model 2.4 (unrelated)
Variables	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)
Indirect experience ($T_{(-1)}$; *all*)	0.00 (0.02)				
Indirect experience ($T_{(-1)}$; *same type*)		0.06** (0.03)			
Indirect experience ($T_{(-1)}$; *same region*)			0.04 (0.04)		
Indirect experience ($T_{(-1)}$; *same type and same region*)				0.14** (0.07)	
Indirect experience ($T_{(-1)}$; *same region/different type*)					0.00 (0.07)
Controls					
Vessel age (ln)	–1.05*** (0.16)	–2.51*** (0.27)	–2.50*** (0.28)	–2.59*** (0.43)	–2.54*** (0.40)
Vessel weight (ln)	0.01 (0.15)	–0.13 (0.15)	–0.10 (0.15)	–0.05 (0.15)	–0.12 (0.18)
Year dummies	Incl	Incl	Incl	Incl	Incl
Vessel building country dummies	Incl	Incl	Incl	Incl	Incl
Classification society dummies	Incl	Incl	Incl	Incl	Incl
Observations	381	381	381	381	381
Log likelihood	–161.69***	–394.44***	–390.36***	–341.88***	–395.75***

Note: Cox proportional hazard models. Standard errors are clustered on vessels. Dependent variable is serious accident hazard.
***$p < .01$;
**$p < .05$;
*$p < .1$.

model may suffer from endogeneity issues because several unobservable variables, such as management skills, safety culture, and safety procedures/policies on ship, could be confounding factors that correlate with the independent variables (direct and indirect experience variables) and the dependent variable (serious accident hazard).[6] Therefore, we employ an instrumental variable technique, that is, Generalized Method of Momentum (GMM), to address this concern (Wooldridge, 2015; Wiengarten et al., 2017). We provide explanation of the rationale of instrumental variable selection and GMM results in the Online Appendix (see Tables C and D). The GMM method mitigates the endogeneity concern because the results remain unchanged.

ADDITIONAL ANALYSES

As discussed above, it is worthwhile to explore how cumulative MOI experience may affect future serious accident hazard. Thus, we use 2-year cumulative MOI experience to run the Cox proportional hazard regressions, reporting the regression results in Table 6. As can be seen, none of the cumulative independent variables show a significant impact on accident hazard, implying that the impact of prior MOI experience on future serious accident hazard has its largest effect when the experience is recent, that is, year $T_{(--1)}$, than cumulative experience.

DISCUSSION

Our research findings have broad implications for safety management theories, normalized deviation, and social contagion, and for managers seeking ways to mitigate the risk of an accident. We discuss the implications for future research, practice, and policy-making as below.

Theoretical Implications

Research in safety management has investigated various contingency factors that affect accident hazards (Madsen & Desai, 2010; Dillon et al., 2016). Nevertheless, academic research has paid little attention to the role of contextual factors in affecting the accident hazard right after the occurrence of a recent MOI in the focal organization. However, it is timely to understand whether and to what extent the internal context and contagion sources may affect future serious accident hazard after the most recent MOI in the focal organization. To fill this research gap, we adopt the perspective of an organization's internal environment, normalized deviation, and the social contagion theoretical lens to understand the critical roles of direct experience (internal context) and indirect experience (external context: contagion source) in affecting future accident hazard. Our findings suggest that the internal context does affect the focal organization's accident hazard. Also, prior MOI experience of peer organizations is characterized by viral features in creating social contagion, leading to higher serious accident hazard on the focal ship after the occurrence of the focal ship's MOI. Depending on specific features, that is, MOI region and type, between the experience and the focal MOI in the organization, the

[6] We thank one reviewer for pointing out this concern and suggesting robustness check methods.

Table 6: Model extension (previous 2-year cumulative experience).

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
Variable	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)	Coef (*SE*)
Direct experience ($T_{(earlist\ year)\rightarrow(-1)}$; *all*)	0.43 (0.34)								
Direct experience ($T_{(-2)\rightarrow(-1)}$; *all*)		0.15 (0.62)							
Direct experience ($T_{(-2)\rightarrow(-1)}$; *same type*)			0.50 (0.85)						
Direct experience ($T_{(-2)\rightarrow(-1)}$; *different type*)				–0.16 (0.88)					
Indirect experience ($T_{(-2)\rightarrow(-1)}$; *all*)					0.00 (0.02)				
Indirect experience ($T_{(-2)\rightarrow(-1)}$; *same type*)						0.00 (0.01)			
Indirect experience ($T_{(-2)\rightarrow(-1)}$; *same region*)							0.01 (0.01)		
Indirect experience ($T_{(-2)\rightarrow(-1)}$; *same type and same region*)								0.03 (0.03)	
Indirect experience ($T_{(-2)\rightarrow(-1)}$; *different type*)									–0.01 (0.02)
Control									
Vessel age (ln)	–1.10*** (0.17)	–1.06*** (0.16)	–1.07*** (0.16)	–1.06*** (0.16)	–1.05*** (0.16)	–1.04*** (0.16)	–1.04*** (0.16)	–1.04*** (0.16)	–1.06*** (0.16)
Vessel weight (ln)	0.00 (0.15)	0.01 (0.15)	0.01 (0.16)	0.01 (0.15)	0.01 (0.15)	0.01 (0.15)	0.02 (0.15)	0.01 (0.15)	0.01 (0.15)
Year dummy	Incl	Incl	Incl	Incl	Incl	Incl	Incl	Incl	Incl
Vessel building country dummy	Incl	Incl	Incl	Incl	Incl	Incl	Incl	Incl	Incl
Classification society dummy	Incl	Incl	Incl	Incl	Incl	Incl	Incl	Incl	Incl
Observations	349	349	349	349	349	349	349	349	349
Log likelihood	–160.97***	–161.66***	–161.53***	–161.68***	–161.68***	–161.57***	–161.6***	–161.12***	–161.49***

Note: Cox proportional hazard models. Standard errors are clustered on vessels. Dependent variable is serious accident hazard. The observations from the same region of direct experience from year $T-1$ to year $T-2$ are very limited, so we excluded them in the analysis. We dropped observations without previous 2 years' accident records (1986–1987) from the sample so the final sample for the analysis is 349.

$^{***}p < .01$.

contagion effect varies. Our empirical results shed light on how MOI experiences can influence future accident hazards and that whether or not the social contagion effect manifests is indeed a complex pattern. For example, indirect experience occurring in a different region from the focal MOI in the organization seems to be an ineffective transmission vehicle for the contagion effect. Prior studies in safety management rarely take into account the underlying mechanisms that shape these complex patterns. We, however, present one explanation from the social contagion theoretical perspective that suggests the critical roles of previous direct and indirect MOI experience, as an indicative internal context and viral contagion source, respectively, in increasing future accident hazard after the occurrence of a recent MOI on the focal ship.

So far, research attention to safety and disaster management has largely focused on the association of previous MOI experience on future accident hazards without explaining how organizations interact with one another and how such mutual interactions influence safety outcomes. Our research context, that is, the liner shipping industry, provided a favorable setting in which we could understand how the focal organization (ship with a recent MOI) can be affected by the contagion source through the cohesion and structural equivalence mechanisms of SCT. Hence, we contribute to SCT by empirically validating that the contagion source (prior indirect MOI experience) can be transmitted to the focal organization through an observational process (Angst et al., 2010). From the perspective of anti-learning, we investigate whether or not organizations that do not learn from mistakes actually increase their operational risks, and how the anti-learning behavior emerges, which may be acquired from peer firms. Our findings align with the anti-learning literature (e.g., de Holan & Phillips, 2004; de Holan, Phillips, & Lawrence, 2004). At the theoretical level, an organization's inability to learn and adapt could sap its safety management performance. In addition, the organization's internal context and social contagion sources from the external environment could fortify the negative effect.

We also provide empirical evidence on the distinct impact of various MOI experiences on future accident hazards. In the first place, we find that the social contagion effect is differential between recent and cumulative MOI experience. In other words, the social contagion effect resulting from previous MOI experience appears to be only effective when the experience is recent (1-year lag) rather than cumulative over the years. Hence, the effect of the contagion source, that is, prior experience, has its largest impact on future accident hazards when the source is most recent rather than cumulative. The effect eventually becomes indistinguishable from zero when the experience cumulates.

On the contrary, we also find some variables that may not be indicative of future accident hazards. Specifically, the empirical results are against the predictions in Hypotheses 3 and 4, which imply that within peer organizations' MOI experience, regardless of the relatedness and type/region characteristics of the experience, the contagion effect of MOI experience is indistinguishable. The social contagion source tends to impose the same viral effect on a ship regardless of the relatedness (related vs. unrelated) and proximity categories (region vs. type), suggesting that the social contagion influence has a broader functional boundary than what is expected.

Managerial Implications

Our study provides numerous managerial implications for practitioners and policy-makers. To reduce future accident hazards after a recent adverse event in their organization, the manager should be aware of various contagion sources of MOI experience (e.g., MOI in the same region or of the same type). Therefore, it is important for the manager to pay attention to such contagion effects by preventing organizational members from further deviating from their mindfulness of safety management. For example, training programs should reinforce safety routines in the organization when they face the possibility of contagion from other ships. In particular, there is much to be expected in dealing with a recent MOI in the organization. That is, the MOI should not be treated as a harmless event. Instead, the manager should formulate an improvement plan upon the occurrence of an adverse event and ensure that the plan will be thoroughly implemented by organizational members. On the other hand, it is noticeable that unrelated and different-type experience should be treated as equally important as related and same-type experience. To do so, the manager should not discriminate an MOI experience based on its relatedness and type. The safety improvement plans should be implemented to the same extent. From a policy-making point of view, it is important to institute punitive and supportive means to cultivate a safe international shipping culture. As mentioned before, unlike other hazardous industries (e.g., mining), the penalties imposed on and attention paid to marine incidents by the public appear to be inadequate such that the possible contagion sources induce increasing future accident hazards on ships. It could be ideal that, on the one hand, liner shipping associations could facilitate the sharing of MOI data; on the other hand, ships should be strictly regulated to implement effective improvement measures after the occurrence of an MOI. In sum, proper punitive and supportive mechanisms should be developed and pilot-tested without delay.

Theses practical implications should be useful for organizations' decision-making in managing safety and regulatory agencies' policy-making toward safety issues. To begin with, because prior MOIs within the organization are indicative of a relaxed safety management environment that can amplify organizational members' tendency to "not" follow safety procedures and policies, senior management teams should allocate adequate resources to support decision-making in safety management at the corporate level. It would be a mistake to assume that operations decisions should be solely expressed in economic terms. In particular, when MOIs frequently happen within the organization, managers should reconsider the proposition that most of the operations strategy decisions should be largely framed in economic terms, whereas the social aspect (e.g., safety) can be neglected. It is crucial to understand anti-learning behavior and how it exposes a firm's operations to risk and is socially contagious. Managing risk entails preventing a corporate culture that does not discount small issues, but takes them seriously and mindfully resolves and learns from small events. Firms can develop an internal climate that seeks to reduce small issues so they do not worsen as larger issues. This is similar to developing continuous improvement orientation that firms have done in areas such as quality management or lean six-sigma. However, firms also need to consider the broader external environment and that other firms influence their operations. In this sense, a broader regulatory or institutional environment also shapes risk inside the firm. On the other hand, policy-makers can administer both punitive and supportive tactics to influence organizational decision-making in trading off safety versus economic goals when small mistakes (e.g., MOIs) frequently take place within the organizations. Second, our results shed light on that same type indirect experience from the network creates a social contagion effect, thereby increasing the focal organization's future accident hazard. Indeed, nowadays, there is an increasing recognition that organizations in a network become more closely related to each other. To this end, the decision-making should not ignore the influence of peer organizations in the network. Specifically, organizations need to regularly pay attention to the "contagion" sources from networks and incorporate the learned lessons into their daily decision-making process for safety management. Also, regulatory agencies are also recommended to monitor the entire network's safety performance, enhancing the effectiveness and efficiency of decision-making for risk mitigation.

Limitation and Future Research Avenues

Like other empirical research, our study is subject to several limitations, which can be potential avenues for future studies. First, there is no information on any corrective actions followed by an MOI to improve safety. These corrective actions may have an impact on the likelihood of future serious accidents. It is also worthy of examining how emergency preparedness of ship management and the underlying factors such as safety discipline, crew reliability, and fatigue of crews can help prevent ship accidents (Tac et al., 2020). Supply chain security levels in liner shipping companies and their links with ship safety are also a promising area to extend this research (Tong et al., 2019). In addition, the mandatory safety standard (e.g., International Safety Management Code under International Convention for the Safety of Life at Sea), third-party voluntary safety certifications, and inspections from organizations like the Port State Control (PSC) or Classification Society (e.g., IASC) may also play a role in ensuring ship safety. Similar third-party hazard control standards, such as Hazard Analysis and Critical Control Points (HACCP) certification, bring a positive impact to adopting firms' performance (e.g., Liu, Rhim, Park, Xu, & Lo, 2020). Thus, the impact of third-party hazard control and safety certifications for the liner shipping industry should warrant more attention from researchers. In this study, we focus on the roles of the internal and external contexts in affecting future safety outcomes. Future research may investigate the effects of the certifying and investigation bodies on liner ships' safety performance. For example, do certifications from different classification societies influence the likelihood of serious accidents on ships? On the other hand, will serious accidents affect the likelihood of future MOI through social contagion too?

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Supporting Information

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