Enablers of safety citizenship behaviors of seafarers: Leader-member exchange, team-member exchange, and safety climate

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ABSTRACT

This study examines the organizational factors, leader-member exchange (LMX), and team-member exchange (TMX) affecting seafarers' safety citizenship behavior (SCB) in respect of seafaring lives. Accordingly, we investigate the moderating effect of the safety climate on these relationships. Questionnaire surveys were collected from 283 seafarers in Taiwan's shipping industry. Partial Least Squares-Structural Equation Modeling (PLS-SEM) was employed to test the hypothesized causal relationships and moderating effect. The results showed that each of the safety climate, LMX and TMX were significantly related to the seafarer's SCB; specifically, the safety climate strengthened the relationship between LMX and the seafarer's SCB, but its effect on the relationship between TMX and seafarer's SCB was insignificant. This study contributes to the academic literature on safety since it demonstrates the moderating role of the safety climate in linking LMX, TMX, and safety citizenship behavior that has been underestimated in previous research. We suggest that marine masters and shipping companies should specifically consider the influence of LMX and TMX within a ship, and reinforce a safety climate to improve safety performance.

Keywords: Seafarers, Leader-Member Exchange, Team-Member Exchange, Safety Climate, Safety Citizenship Behaviors

1. Introduction

Being a seafarer has always been one of the most dangerous occupations (Lu and Tsai, 2010). According to a report by the National Institute for Occupational Safety and Health (NIOSH) (2018) between 2011–2017, the seafarer's rate of fatal injuries of 18.4 per 100,000 workers in the marine transportation industry was nearly six times that of all U.S. workers. The shipping company's primary safety goal is to minimize the risk to property (ships, containers, and machinery), personnel (employees, crew, and passengers) and the environment (air, water, noise) (Chang et al., 2019). In order to improve the safety of shipping and its environment, the

International Maritime Organization (IMO) has developed a number of international conventions related to the safety of commercial vessels and maritime navigation, such as the "International Safety Management Code (ISM Code)"; "International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)"; "International Convention for the Safety of Life at Sea (SOLAS)", "International Convention for the Prevention of Pollution from Ships (MARPOL)", and "Maritime Labor Convention (MLC)" (Zhang et al., 2020). However, in spite of the IMO having several regulations on maritime safety, maritime accidents still occur frequently.

One of the causes of these frequent accidents is the unsafe behavior of crew members and employees (Lu and Tsai, 2010). Such unsafe behavior or human error cannot be avoided by existing regulations or international conventions (Schröder-Hinrichs et al., 2013). Most notably, an estimated 75% to 96% of marine accidents are attributable to human error (Allianz Global Corporate & Specialty, 2018). In addition, Allianz Global Corporate & Specialty (2018) analyzed nearly 15,000 insurance claims for marine liability between 2011 and 2016 and found that human error was the main cause, accounting for 75% of the claims value (equivalent to more than $1.6 billion in losses). Liu et al. (2020) contended that safety citizenship behavior (SCB) is a crucial antecedent of human error and workplace accidents. In addition, one effective means of decreasing the probability of human error/unsafe behavior is to increase the SCB in groups (Guo et al., 2019). While an increasingly large number of extant studies have dealt with eliminating unsafe behaviors or reducing human error in the general workplace, few empirical studies have been conducted on the influence of the relationships between crew members and marine masters or among the crew members themselves.

Crew work is a type of life in which the workplace and the living space are combined together, and the clear hierarchy and departmental divisions make the nature of seafaring work very different from onshore work. Nowadays most shipping companies' merchant fleets are composed of diversified nationalities of crew with different cultures and languages (Jha, 2020), which increases the complexity and difficulty in providing the necessary safety leadership and management on board (Lu et al., 2012). The marine masters have to take full responsibility for the ship's operations and protection of crew, passengers, ship and cargo. Therefore, the marine masters' leadership, crew teamwork, organizational safety climate, and crew's safety behavior have become crucially influential factors in the safety of navigation (Lu and Tsai, 2010). Many previous studies on ship safety have focused on causal models of macro-level antecedents such as the safety climate, safety culture, national culture and the micro-level consequences like job pressure, safety behavior and safety performance, etc. (Lu and Tsai, 2010; Lu et al., 2012). However, given the delicate relationships among the crew members, teams and leaders, such as Leader-Member Exchange (LMX) and Team-Member Exchange (TMX), the lack of research in this regard is a cause for concern.

LMX and TMX have received much research attention that has been directed towards various industries (Seers et al., 1995). As mentioned earlier, crew work is a lifestyle where the workplace and living space are connected. This study identifies an interesting issue, which involves the application of LMX and TMX to such a unique situation characterized by the marine masters' leadership and the close interdependence among team members. This should help to fill the gap in terms of the theory of leadership and team cooperation within the context of a working life at sea.

In seafaring, a special profession characterized by a clear hierarchy and departmental divisions, a marine master takes full responsibility for cargo, crews and the ship while on board, and that makes the nature of his/her leadership and management work very different from that of an onshore general manager. In addition, the intense interdependence between each crew member's duties make teamwork even more important. Furthermore, the diversity of nationalities among the crew enhances the value of research on leadership (LMX) and teamwork (TMX) in relation to SCB. Thus, this study seeks to develop a conceptual model comprising LMX, TMX, the safety climate and SCB and to hypothesize cause and effect relationships in the context of seafaring.

This paper consists of five sections. We first provide a brief sketch of the practical and theoretical motivations in the introductory section. Section two reviews the theoretical background in relation to LMX, TMX, the safety climate, and safety citizenship behavior in order to postulate the research hypotheses. Section three explores the methodology, including model development, measurement, data collection, and analytical procedures. The results of the analyses, and the discussion and conclusion are presented in the fourth, fifth and final sections, respectively.

2. Literature Review and Hypotheses Development

2.1 Literature review on LMX, TMX, Safety climate, and SCB

2.1.1 Leader-member exchange (LMX)

In drawing on the theory of social exchange, LMX refers to the mutual and reciprocal quality relationships between supervisors and subordinates (Hofmann et al., 2003). Leaders categorize their subordinates according to "in-groups" when they are trustworthy, responsible, and able to meet or exceed the leader's expectations, and "out-groups" when they are not (Jha and Jha, 2013). Compared with subordinates in out-groups, those in in-groups are usually willing to perform more than the in-role behavior, and are more responsible toward completing the tasks and facilitating the success of their work unit. A high LMX relationship quality represents a positive exchange relationship between the supervisor and his/her subordinates, as evidenced by traits such as trust, respect and loyalty. By contrast, a low LMX relationship quality represents a negative exchange relationship, which is reflected by behavior such as conflicts or dissatisfaction with each other (Lee et al., 2021). There are two major views on the measurement of LMX, with one involving a single dimension that highlights the overall quality of the exchange relationship at work, and the other being multi-dimensional. Overall, LMX is an important concept in the past theoretical and empirical literature, as it has been proved to have an impact on subordinates' attitudinal and behavioral outcomes, trust, respect, the psychological contract, performance, safety citizenship behavior, job satisfaction, turnover intention, innovative behavior, and organizational commitment, etc. (Mumtaz and Rowley, 2019).

2.1.2 Team-member exchange (TMX)

Most of the tasks on board are complicated and require work to be done in teams, which increases the importance of understanding the role of team member interactions referred to as team–member exchange (TMX). TMX can be defined as "the individual member's perception of his or her exchange relationship with the peer group as a whole" (Seers, 1989: 119). Banks et al. (2014: 275) contended that TMX was the "exchange quality with other team members, not as unique individuals, but in their shared role as team members".

TMX denotes the quality of the working relationship between an individual and her/his team members. It affects whether an individual is willing to spontaneously perform extra-role tasks, showing reciprocity, sharing feedback, expressing appreciation and exhibiting trust in other members (Liden et al., 2000). TMX can be used to evaluate the quality of reciprocal relationships between a member and his/her peers. TMX can also measure the degree of reciprocity between a team member and other members (Seers et al., 1995). TMX is increasingly valued by scholars because of its predictive power in helping to improve OCB, job performance and satisfaction, organizational commitment, and turnover intention (Chen, 2018).

2.1.3 Safety climate

Zohar (1980) explored the essence of a safety climate and defined it as a "… summary of molar perceptions that employees share about safety." The concise definition of a safety climate is the employees' subjective evaluations of safety-related procedures, practices, and policies, etc., which will affect personal interests and work (Fenstad et al., 2016). Lu et al. (2012) analyzed the safety behavior of a liner crew from a national cultural perspective. Singh and Verma (2020) examined the safety climate in manufacturing organizations. Lu and Tsai (2010) investigated the safety climate of a container ship crew and expressed this in six dimensions, including management safety practices, supervisor safety practices, safety attitudes, safety training, job safety, and co-workers' safety practices. Fenstad et al. (2016) conducted a study on 244 Norwegian high-speed ferry crew that resulted in four safety climate dimensions, i.e., general safety orientation, the captain's safety orientation, vague procedures, and safety training. In short, it is clear that researchers have not reached a consensus on the measurement of the safety climate.

Accordingly, LMX, TMX and the safety climate are variables at the environmental level that each, to some extent, have an impact on SCB. However, there exist essential differences among these three constructs. LMX focuses on the vertical exchange relationships between the supervisors and individual subordinates, while TMX emphasizes the horizontal exchange relationships between team members. The former two underline the employees' daily operations and practices and, correspondingly, the safety climate is located at a higher level in the organization and reflects the employees' beliefs and perceptions regarding the safety norms and policies in the workplace.

2.1.4 Safety citizenship behavior (SCB)

Safety citizenship behavior (SCB) is an evolutionary concept of organizational citizenship behavior (OCB) (Hofmann et al., 2003). Traditional safety management theories (e.g., safety compliance behavior) only ask workers to comply with rules and regulations, and neglect the role of guiding and encouraging workers to have the willingness and enthusiasm to practice safety at work. SCB implies that "extra-role voluntary behaviors are beneficial to the organization" (Liu et al., 2020: 1), which can make up for the lack in traditional safety management theories. Curcuruto et al. (2019) defined SCB as "voluntary work behaviors that hold a positive value to the organization but are not necessarily recognized by the formal reward system". Hofmann et al. (2003) integrated OCB research into multiple dimensions of safety citizenship behavior, for instance helping, whistleblowing, and initiating safety-related change, etc. Curcuruto et al., (2019) further developed an SCB scale and identified two themes: proactive and prosocial SCB. An empirical study was conducted involving 265 employees of Taiwan Container Terminals, and it was found that LMX is positively related to the safety climate, and in turn that the safety climate positively affects the employees' safety citizenship behavior. Specifically, the safety climate was found to play a mediating role between LMX and the employees' SCB (Lu et al., 2017).

Based on careful reviews of the safety and accident prevention literature, researchers have realized that the root causes of workplace incidents may be exceedingly complex, with nonlinear interdependent variables involving organizational, group, and individual factors (Hofmann et al., 2003). This study adopts LMX, TMX and SCB to cover the possible antecedents of onsite accidents, injuries and fatalities. Besides, many studies have provided empirical evidence that supports the positive relationship between the safety climate and safety behaviors in the fire services, mining and construction industries, etc. (Schwatka and Rosecrance, 2016). As stated above, the impacts of LMX, TMX, the safety climate and SCB in terms of improving workplace safety and accident prevention are now well recognized. However, there is little research that applies these concepts to the quite unique seafarer's workplace. In particular, the moderating effects of the safety climate among LMX, TMX and SCB have rarely been studied.

2.2 Hypotheses development

The LMX relationship is derived from the theory of social exchange, and subordinates believe that they are obliged to report to their supervisor with a high-quality relationship (Hofmann et al., 2003). High levels of interaction, trust, feedback and rewards with supervisors shape quality relationships, which go beyond the general work description and requirement. If employees have superior LMX relationships with their supervisors, as they respond to the supervisors they will perform beyond the normal requirements of their job role (i.e., by engaging in civic behavior) in exchange for more benefits, empowerment, or more attention from their leaders. Thus, high-quality LMX will facilitate the employees' civic behavior. The literature on LMX and safety citizenship behavior is relatively scarce, but there are many extant studies that have contributed to the impact of LMX on organizational citizenship behavior. LMX is one of the decisive factors of organizational citizenship behavior (Jha and Jha, 2013). Through high-quality LMX relationships, subordinates are committed to not only in-role work, but also automatically devote themselves to extra-role jobs, and finally improve the overall performance of the organization. The higher the quality of LMX, the better the organizational citizenship behavior (Lu et al., 2017). The shipping industry is one of the most risky industries and therefore, to ensure safety, interactions and teamwork between the marine masters and crew play an extremely important role on board. When crew members perceive their marine master's kindness, care, tolerance and encouragement toward them, those who belong to the in-group will repay the supervisor with dedication, loyalty and support.

Popescu et al. (2012) discussed the issue of leadership in merchant shipping, and disclosed that when crew members believe in the marine master's competence in execution, they will submit to the marine master's authority and show full respect. Therefore, in a high-quality LMX relationship, the marine master and other crew members will work together to solve problems and this will lead to mutually reinforcing teamwork behaviors. On the contrary, when the LMX relationship is of low quality, there will be less safety citizenship behavior expressed and this will exert a negative impact on ship safety. Hence, on the basis of the above findings and inferences from the relevant literature, this study puts forward the following hypothesis:

H1: LMX positively influences the ship crew's safety citizenship behavior.

TMX refers to the reciprocity and exchange between individuals and team members, and provides resources and assistance to other members. This relationship affects team members' willingness to engage in spontaneous extra-role behavior (Seers, 1989), and is also one kind of citizenship behavior. When members perceive a high-quality TMX, following the theory of social exchange, they will respond via mutual assistance and approval (Seers et al., 1995).

Since sailing work is usually carried out in the form of team work, understanding the communication and exchange relationships between crew members and the marine master and other team members is essential to navigation safety. Liden et al. (2000) believed that the quality of TMX may differ in the communication process and content between team members. Low-quality TMX will limit interactions with colleagues and tasks will be completed more independently, while high-quality TMX will involve interactions with other team members coupled with mutual trust to complete tasks (Love and Forret, 2008). The quality of communication between team members will have a vital impact in terms of ensuring navigation safety when at sea. With high-quality TMX, the crew will dedicate themselves to working and outperform the requirements of their safe work duties. i.e., safety citizenship behavior, and make more efforts to cooperate with other team members. Conversely, in the case of low-quality TMX, the crew will make fewer efforts to work as a team on the ship's operations and will only engage in in-role work without safety citizenship behavior. As a result, this study hypothesizes the following:

H2: TMX positively influences the ship crew's safety citizenship behavior.

The safety climate describes an individual's perceived value of safety within the workplace, which is a singular form of organizational climate (Neal et al., 2000). Christian et al. (2009) classified the safety climate into two levels, individual and group. When policies, practices, and procedures in a given work environment are recognized and valued by group members, the safety climate is formed. Clarke (2006) suggested that the safety climate is a vital predictor of safety behavior and links to accidents. Consequently, the safety climate plays an important role in reducing potential risks, mitigating accidents, and driving a positive impact on the safety behavior of employees. Lee et al. (2007) conducted a survey on employees of OHSAS 18000 certified companies in Taiwan and confirmed that the safety climate has a positive impact on organizational citizenship behavior. This study thus proposes the following:

H3: The safety climate positively influences the ship crew's safety citizenship behavior.

The theory of LMX and TMX is rooted in the exchange relationship, just as it was previously mentioned that the high-quality exchange relationship between a supervisor and his/her subordinates or between subordinates will bring about better safety citizenship behavior. Past research on the safety climate has revealed that safety performance varies widely across organizations (Hofmann et al., 2003). Therefore, in a strong safety climate, safety behavior will be viewed by employees as a legitimate and reciprocal channel for exchanging high-quality LMX or TMX relationships, which will cause individuals to expand their role in safety citizenship behavior. On the contrary, in a weaker safety climate, although there exists good quality LMX and TMX among supervisors and subordinates, employees will be less likely to regard safety behavior as a way of being rewarded, and therefore the probability of their enlarging their role in safety citizenship behavior be will lowered (Hofmann et al., 2003).

In the shipping industry, one critical responsibility of shipping companies is to implement appropriate safety drills and training activities to ensure that each crew member can adequately engage in safety communication while working on board, and to unremittingly improve the safety management skills of the marine master and crew, including handling an emergency and environmental protection (Lu and Tsai, 2010). Under a strong safety climate, the crew will use safety as one important tool to mutually exchange benefits with the marine master or colleagues. During the exchange process, the crew's active participation in safety-related matters will also be expanded, which will increase safety citizenship behavior. Conversely, under a weak safety climate, the emphasis on safe behavior will be reduced. Although the marine master and crew may conduct high-quality safety exchanges, crew members are unlikely to regard safety as an important means of social exchange, nor are they likely to increase their safety citizenship behavior. Thus, we suggest the following two hypotheses:

H4: The safety climate moderates the relationship between LMX and the ship crew's safety citizenship behavior.

H5: The safety climate moderates the relationship between TMX and the ship crew's safety citizenship behavior.

This study has established a conceptual framework consisting of LMX, TMX, the safety climate, and safety citizenship behavior based on the research purpose and literature review, as shown in Figure 1.

<Insert Figure 1 about here>

3. Methodology

3.1 Sampling

The sampling targets are officers and ratings in the Taiwan shipping industry (including container and bulk ships; national-flagged and flag-of-convenience ships). Since crew members have been working at sea for long time, it is not easy to collect questionnaire data. In order to increase the response rate, questionnaires sent by e-mail were used in this study.

The sampling frame was selected from a list of crew obtained from (1) the alumni directory of the Department of Merchant Marine and the Department of Marine Engineering of National Taiwan Ocean University, and (2) the Maritime Training Center of National Taiwan Ocean University and National Kaohsiung University of Science and Technology. Regarding the former, we requested that the tutors provide a list, with telephone numbers and e-mail addresses, of graduated alumni who were still serving on board. As for the latter, we informed the class of the Maritime Training Center of the questionnaire survey's content, and asked students who were willing to fill in the questionnaire to provide an email address to facilitate the sending of the questionnaire. We collected 336 questionnaires, of which 53 failed to meet the requirements set by this study and were excluded (including incomplete answers and those crew who had been off the ship for more than 6 months). This resulted in a valid sample size of 283 with an effective response rate of 84%.

3.2 Non-response bias test

Since the data collected in this study were cross-sectional, we performed *t*-tests to examine the non-response bias (Armstrong and Overton, 1977). We collected 208 questionnaires from the first wave. In order to increase the sample size, we sent a second mailing of questionnaires to those non-respondents two weeks later, and as a result received an additional 75 questionnaires. Therefore, the total of 283 respondents were divided into two groups according to their different response times (Group 1: n = 208, 73.5% and Group 2: n = 75, 26.5%). There were no significant differences between these two groups at the 5% significance level. Thus, the issue of non-response bias was not a concern for this sample.

3.3 Measures

The questionnaire used in this study was developed from studies in English and then translated into Chinese by a bi-lingual expert who was proficient in English and Chinese. To avoid potential language problems, we used the back-translation method to verify the meaning equivalence. Two native Chinese-speaking professors who were awarded their Ph.D. degrees in the UK took part in this process. Five-point Likert-type scale anchors were used for the four main dimensions. The respondents were asked to circle the level of agreement for each question, where 1 stood for "Strongly Disagree" and 5 for "Strongly Agree".

The measures for LMX were compiled from the LMX-7 scale, which was built by Scandura and Graen (1984). The reasons were because LMX-7 is still the most commonly-used scale with higher internal consistency, and with a higher correlation between LMX-7 and some essential organizational variables such as job performance, work attitude, role conflict, and role clarification, etc. (Joseph et al., 2011).

The measures for TMX were adapted from studies by Seers (1989), and Seers et al. (1995). Four questions were used to measure the quality of relationships among team members using a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The measures for safety climate were adapted from Hahn and Murphy (2008). There were six questions in relation to the following: (1) New employees can quickly learn the company's safety rules; (2) When employees fail to comply with the company's safety rules, they will be told; (3) Employees and managers work together to ensure work safety; (4) When it comes to employees' health and safety issues, there are no shortcuts; (5) The company treats the safety and health of employees as a high priority in management; (6) When working, I can report safety issues freely. Drawing on the study of Lu et al., (2017), seven items were used to measure safety citizenship behavior. The constructs and measures are listed in Table 1.

<Insert Table 1 about here>

3.4 Common method bias

Drawing on the study of Podsakoff et al. (2003), we conducted statistical analyses to test for common method bias. A Harmon one-factor test (Podsakoff et al., 2003) was carried out based on the four variables in the conceptual model comprising LMX, TMX, the safety climate, and safety citizenship behavior. We found that all four dimensions were identified and the most covariance explained by one factor was 40.74%. The variance should ideally be less than 50% (Podsakoff et al., 2003). Thus, the influence of common method bias is not a serious problem in this study.

4. Empirical Results

4.1 Respondents' profile

More than 80% of the respondents were male (n=233, 82.3%) and over 80% were under 39 years old (n=237, 83.8%). More than 40% held titles – Others Officer (n=120, 42.4%), Chief Officer (n=53, 18.7%), Others Engineer and Ratings (n=45, 15.9%), Second Engineer (n=13, 4.6%), and Chief Engineer (n=7, 2.5%). The respondent's last served ship type, the container ship, accounted for the largest share, reaching 60.1% (n=170), followed by bulk carriers, accounting for 16.6% (n=47), and oil tankers, accounting for 11.3% (n=32).

4.2 Measurement model and validity

This study conducted a confirmatory factor analysis (CFA) to assess the quality of the measurement model by presenting certain common evidence of the construct reliability and validity. First, to improve the validity of this reflective measurement model, unsuitable indicators with factor loadings of less than 0.6 were removed as recommended by Hair et al. (2010). The verification of the modified model was completed by removing low factor loading items TMX4, SC1-SC3, and SCB7 as shown in Table 2. In addition, this study adopted the variables R^2 (item reliability), construct reliability and variance extracted to assess the overall measurement reliability. In referring to Table 2, the reliability index R^2 (squared multiple correlation) of all items exceeded the threshold value of 0.5 recommended by Koufteros (1999), which shows that the variables used in this study were appropriate. Table 2 also shows that the critical ratios (CR) for each measurement item were significant at the 0.05 level, offering acceptable evidence of convergent validity and uni-dimensionality (Hair et al., 2010). The average variance extracted (AVE) was used for evaluating a construct's convergent validity. Table 3 reports the values of composite reliability (CR), which was greater than 0.7, and average variance extracted (AVE), which was greater than 0.5, to support the satisfactory convergent validity. In order to assess discriminant validity, each construct's AVE should be compared with the squared inter-construct correlation of that same construct and all other reflectively measured constructs in the model (Podsakoff et al., 2003). The results from doing so provide evidence of discriminant validity as shown in Table 3. The means and standard deviations for each construct and the positive direction of the correlations between the constructs were all significant at the $p < 0.01$ level (see Table 3). The empirical results of the measurement model produced adequate indexes in terms of reliability, convergent validity, and discriminant validity. Taken together, the results from the instrument development process showed that the theoretical constructs exhibited good psychometric properties.

<Insert Table 2 about here>

<Insert Table 3 about here>

4.3 Empirical results of the structural model

Through the reliability and validity analyses, we then used Partial Least Squares-Structural Equation Modeling (PLS-SEM) to examine the causality of each latent variable and verify the five hypotheses proposed by this study. The reasons why we adopted PLS-SEM were because of the relatively loose restrictions on the measurement scale, sample size and residual distribution that have made PLS an effective analysis method (Hair et al., 2017). The path coefficient (β value) is the standardized regression coefficient, which is used to describe the strength and direction of the relationship between the explanatory variables and the response variables, while the R-squared (R^2) value denotes the percentage of the variance that has been explained by the explanatory variables.

4.4. Hypothesis testing

To judge whether a hypothesis was supported or not, we observed the standardized path coefficient which was estimated via the 95% bias-corrected and accelerated (BCa) bootstrapping method with 5,000 resamples. First, in testing the fit of the structural model, we found that the standardized root mean square residual (SRMR=0.067) was lower than the threshold value of 0.08, which means that this model was satisfactory (Hair et al., 2017). As to the explanatory power of the endogenous variables, it was found that $R^2 = 0.213$, indicating that 21.3% of the variance in the crew's safety citizenship behavior had been explained by the leader-member exchange, team-member exchange, and safety climate. Researchers in the marketing field claim that an R^2 greater than 20% is high enough (Hair et al., 2017). Thus it represented the quality of this proposed model (Hair et al., 2010). Furthermore, the bootstrapping procedure showed that the relationships among LMX, TMX, SC and SCB were significant, because the BCa bootstrap procedure confidence interval did not contain a zero (see Table 4). Hair et al. (2017) stated that if the 95% CI does not include a "0", then the path coefficients are statistically significant.

In taking a closer look at each path coefficient and the corresponding statistics, Hypotheses 1, 2, and 3 were supported by the model as shown in Figure 2 and Table 4. The standardized beta coefficient β=0.162, bootstrap t-value =2.173, and $p < 0.05$ indicated that significant positive relationships existed between LMX and SCB and H1 was supported. H2 was also supported since β=0.288, the bootstrap t-value =4.460, and $p < 0.001$ led us to infer that TMX is a strong predictor of SCB. Moreover, the results also supported a significant positive relationship between the safety climate and safety citizenship behaviors (β=0.149, bootstrap t-value =2.357, and $p < 0.01$). Thus H3 was supported.

<Insert Table 4 about here>

<Insert Figure 2 about here>

4.5 Moderating effect test

H4 and H5 suggest that the safety climate moderates the relationships between LMX and SCB and TMX and SCB, respectively. The moderator variable exerts the main effect on the endogenous variable, but also has an interaction variable's effect (predictor×moderator). If the path coefficients of the interaction terms for the endogenous variable differ significantly from zero, then the moderating effect is sustained (Hair et al., 2017). Table 5 presents the results of the path estimates and bootstrap t-values of the interaction effects. The interaction/moderating effect of SC on the relationship between LMX and SCB was statistically significant as shown in Figure 3 (β = 0.155, t=2.175, $p<0.05$). In addition, when the interaction effect was added to the model, R^2 increased to 0.242, so that R^2 increased by 4.8%. This explains the moderating effect of SC in terms of improving SCB. Thus, H4 was statistically supported. However, the moderating effects of SC on the linkages between TMX and SCB (β = 0.064, t=1.405, $p>0.05$) were not significant at $p < 0.05$, and thus H5 was not statistically supported in this study.

<Insert Table 5 about here>

<Insert Figure 3 about here>

5. Discussion

5.1. Theoretical implications

This study has significant theoretical implications for safety and social exchange research. First, by integrating the LMX as well as TMX framework into a study on the safety climate and the associated crew members' safety citizenship behaviors in relation to ship safety, we extended the proactive safety research by revealing that LMX and TMX influence the ship crew's safety citizenship behavior. Previous theoretical and empirical research (Lu and Tsai, 2010; Lu et al., 2017) has demonstrated that the safety climate and LMX are beneficial to cultivating the employee's OCB within an organization, as well as for achieving higher levels of safety performance. However, these studies have focused on the role of the leader and the safety climate and have thus precluded the possibility of examining TMX as a contextual factor that influences the crew members' safety behavior. Our results show that a ship's operations are far more complex and that the resulting safety performance depends on the consequences of the fit and misfit between the crew members and the marine masters. Specifically, the findings suggest that, depending on the quality of the TMX level, a high level of LMX quality positively influences the crew members' safety citizenship behavior and safety performance. An interesting finding is that the extent of the influence of TMX on the crew members' safety citizenship behavior is higher than that for LMX and the safety climate. These findings have urged us to incorporate TMX into the theoretical framework in order to understand the safety behavior of crew members in ship operations.

Furthermore, in contributing to the safety literature, this study has drawn upon safety climate research and demonstrates that various levels of the safety climate have led to different safety citizenship behaviors. Specifically, this research demonstrates the moderating role of the safety climate in linking LMX, TMX, and safety citizenship behavior. Our findings demonstrate the moderating effect of the safety climate, suggesting the importance of the safety climate in strengthening the potential positive impact of LMX on the crew members' safety citizenship behavior. We show that the safety climate strengthens the relationship between LMX and the crew members' safety citizenship behavior in ship operations. To be specific, a high LMX quality will foster safety citizenship behavior as experienced by seafarers in ship operations when the safety climate is high rather than low. The results are consistent with the study by Hofmann et al. (2003).

However, we do not support the moderating role of the safety climate in the relationship between TMX and the crew's safety citizenship behavior (SCB). It is not surprising that the results give rise to such different moderating effects of the safety climate on TMX and LMX in terms of the crew's SCB. As we discussed in the hypothesis development, the safety climate plays an important role in predicting the crew's safety citizenship behavior. The safety climate in shipping can be defined as the crew members' perceptions of safety policies, practices, and procedures within an organization at a given point in time (Lu and Tsai, 2010). According to a study by Lu and Tsai (2010), the safety climate in seafaring includes safety policy, safety management, and perceived supervisor safety behavior. While the safety climate may be emphasized in a shipping company, the value placed on and the attitude towards ship safety will be developed by the leaders or senior managers and passed down through the organization to the crew members. On the other hand, TMX refers to the quality of the working relationships among the crew members on a ship and the exchange of reciprocity. A high TMX relationship is formed between crew members through mutual help behaviors, information sharing, and communication (Seers et al., 1995). Thus, the moderating effect of the safety climate on the relationship between TMX and SCB is distinct from the relationship between LMX and SCB. In fact, by examining another PLS-SEM framework using only TMX and the interaction between TMX and the safety climate, the results show that the moderating effect of the safety climate has a significant and positive influence on the crew's SCB. This indicates that an insignificant influence of the moderating effect of the safety climate on the relationship between TMX and the crew's SCB in the conceptual model could be influenced by a suppression effect (Cheung and Lau, 2008).

5.2. Practical implications

Our study has important practical implications for ship safety practices. In recent years, the International Maritime Organization and shipping companies have increasingly advocated the influence of social and organizational factors in improving safety. Although the roles played by LMX and TMX have been widely discussed, relatively little research has empirically investigated these relationships in ship safety operations (Lu et al., 2017). Our findings reinforce the extant studies on safety research, emphasizing that front-line relationships for LMX and TMX and the organizational safety climate can have a positive influence on the safety behavior of their ship crews. We would like to suggest that it is critically important for marine masters or shipping companies to note the traits of LMX and TMX. Shipping companies can enhance their safety performance by recruiting crew members who have personalities suited to teamwork and by encouraging marine masters to develop close, supportive relationships with crew members. The results also indicate that high quality LMX can foster the crew's safety citizenship behavior. This has important practical implications because marine masters often follow the company's safety policy to give crew members orders and do not consider the impact of the quality of LMX. Developing a high quality LMX relationship is important and vital to enhancing ship safety. Similarly, working to reinforce relationships among crew members in the ship's operations via TMX can increase the crew's safety behavior.

Another implication of the current study is that the safety climate and LMX can simultaneously influence the crew's safety citizenship behavior. The measurement of safety citizenship behavior has consisted of several items that have focused on compliance and participation in safety-related behaviors within a firm. Given this, our research findings indicate that crews will tend to initiate safety activities that fit the safety climate of the company when they perceive a high level of the LMX relationship. Accordingly, if a shipping company wishes to promote an improvement in safety, it appears that positive marine master-crew member relationships need to be formulated within the safety climate.

5.3. Limitations and future research

Despite the interesting research findings from current empirical analyses, this study has several limitations in relation to future research. First, because the survey used in this research was only based on cross-sectional data that were only collected for one year, we were unable to investigate how the quality of LMX and TMX, as well as the safety climate, changed over time. This could limit the extent to which we can develop reliable causal models and examine reverse causality. Perhaps a high degree of safety citizenship behavior will lead to high quality LMX and TMX relationships. It would therefore be useful to examine these relationships in an empirical study to prove the causal inferences. Second, we could not gather real accident data from the individual participants as a dependent variable in the study. Thus, the study's applicability might be questioned as it is unclear whether social exchange relationships and safety citizenship behavior will lead to a decrease in ship accidents. Related research has found that safety behavior is significantly related to accidents (Hofmann and Morgeson, 1999; Zhang et al., 2020). Third, a potential limitation is that it might be argued that the measurement of LMX, TMX, and safety citizenship behavior is affected by common method bias. However, with the complicated hypothesized linkages (i.e., the moderating effect) between variables, the common method bias could not affect our research findings. The final limitation is that our sample was composed primarily of crew in container ships (60.1%). Shipping vessels include container ships, dry bulk ships, tankers, and other specific ships. Although container shipping is an important transport mode for general cargo in spite of representing only 13.1% of the capacity in terms of dead-weight tonnage in 2018 (UNCTAD, 2020), the working environment for container shipping is significantly different from that for bulk shipping. This raises further questions about the generalizability of the results. Accordingly, we suggest that future research could consider different types of vessels and involve samples with more crew members from bulk ships.

6. Conclusion

To sum up, we conclude that (a) the safety climate has a positive influence on the crew's safety citizenship behavior, (b) LMX and TMX significantly affect the crew's safety citizenship behavior, and (c) the safety climate has a moderating effect in the relationships between LMX and the crew's safety citizenship behavior. To be specific, in a high safety climate, crew members are more likely to think of safety citizenship behavior as part of their formal duties. On the contrary, this relationship would not have been found if the attitude toward the safety climate had not been as positive. These findings are consistent with previous studies on ship safety that emphasize the safety climate as being important (Lu and Tsai, 2010) in influencing the crew's safety citizenship behavior in regard to ship safety. In addition, we found that TMX positively influences the crew's safety citizenship behavior. We suggest that marine masters and shipping companies should specifically consider the impact of LMX and TMX on ship safety, and reinforce a safety climate to improve safety performance.

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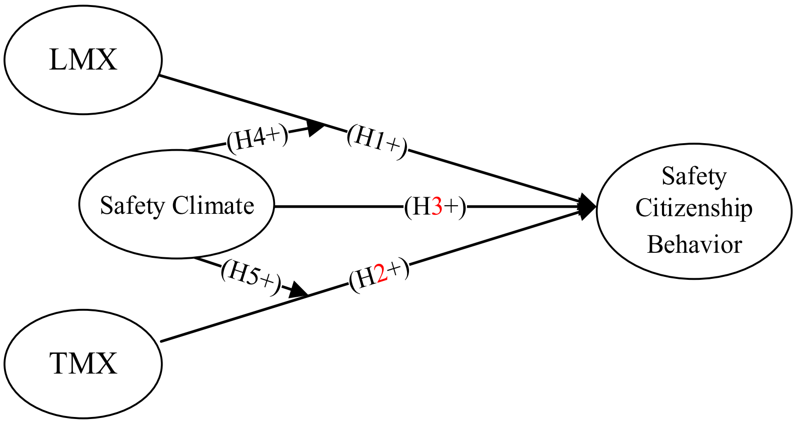

Figure 1 Conceptual Framework

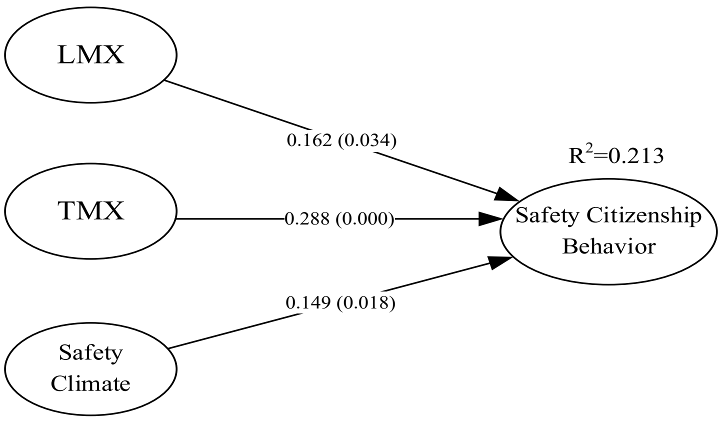

Figure 2 Structural Model

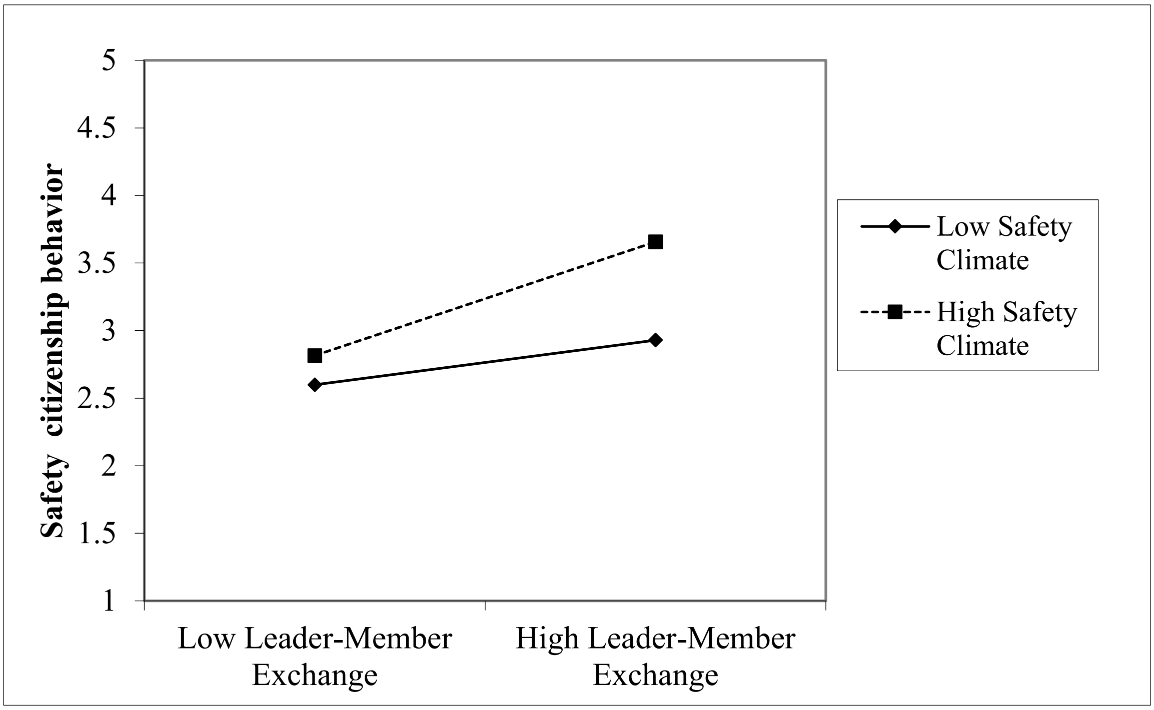

Figure 3 Moderating effect of SC on the relationship between LMX and SCB

Table 1 Constructs, Measurement Items and Prior Studies

Constructs	Measurement items	Prior studies
LMX	LMX1: Stand with your Leader LMX2: Leader understands my job problems and needs LMX3: Leader will help and "bail me out" from trouble LMX4: Characterize working relationship with my leader	Scandura & Graen (1984); Graen & Uhl-Bien (1995)
TMX	TMX1: Make suggestions about better work methods to team members TMX2: Team members understand my problems and needs TMX3: Voluntarily help my team members TMX4: Switch job responsibilities with other team members to make things easier	Farmer et al. (2015), Seers (1989), Seers et al. (1995)
Safety Climate	SC1: New employees can quickly learn the company's safety rules SC2: Employees failing to comply with the company's safety rules will be told SC3: Employees and managers work together to ensure work safety SC4: Employees' health and safety issues have no shortcuts SC5: The safety and health of employees are a high priority in management SC6: When working, I can report safety issues freely	Hahn & Murphy (2008)
SCB	SCB 1: Attending safety meetings and making safety-related recommendations SCB 2: Volunteering for safety committees and checking that co-workers follow safety rules SCB 3: Expressing opinions on safety matters SCB 4: Helping teach safety procedures to new workers SCB 5: Helping other crew members learn about safe work practices SCB 6: Trying to prevent co-workers from being injured on the job SCB 7: Being aware of the safety of co-workers	Lu et al. (2017)

Table 2 Results of Measurement Model

Latent and Observed Variables	Mean	SD	Std. factor loading	Critical Ratio	R^2
Leader-Member Exchange (α = 0.861)					
LMX1	3.73	0.859	0.708***	-	0.501
LMX2	3.67	0.896	0.785***	12.123	0.616
LMX3	3.70	0.926	0.866***	13.131	0.750
LMX4	3.64	0.913	0.765***	11.841	0.585
Team-Member Exchange (α = 0.774)					
TMX1	3.89	0.754	0.690***	-	0.470
TMX2	3.75	0.805	0.707***	9.666	0.500
TMX3	3.89	0.757	0.806***	10.196	0.649
Safety Climate (α = 0.788)					
SC1	3.69	1.168	0.736***	-	0.541
SC2	3.66	1.051	0.730***	10.731	0.533
SC3	3.85	0.895	0.775***	11.168	0.600
Safety Citizenship Behavior (α=0.918)					
SCB1	4.13	0.718	0.724***	-	0.524
SCB2	4.11	0.702	0.736***	15.270	0.541
SCB3	4.00	0.744	0.734***	12.059	0.539
SCB4	4.13	0.765	0.853***	14.059	0.728
SCB5	4.19	0.743	0.893***	14.692	0.797
SCB6	4.32	0.719	0.856***	14.114	0.733

Goodness-of-fit**:** $\chi 2/df$=1.700, RMSEA=.050, RMR=.030, GFI=.929, AGFI=.900, NFI=.936, RFI=.921, IFI=.937, TLI=.966, CFI=.972.

Table 3 Mean, Standard Deviation, CR, AVE and Discriminant Validity

Factors	Mean	SD	LMX	TMX	SC	SCB	CR	AVE
LMX	3.684	0.755	**0.828**				0.863	0.613
TMX	3.843	0.640	0.427^{***}	**0.814**			0.778	0.540
SC	3.731	0.874	0.456^{***}	0.696^{***}	**0.885**		0.791	0.558
SCB	4.146	0.616	0.512^{***}	0.524^{***}	0.421^{***}	**0.792**	0.915	0.644

Note: CR= Composite reliability, AVE= Average Variance Extracted, LMX= Lead-member exchange, TMX= Team-member exchange, SC= Safety climate, SCB= Safety citizenship behavior. The square root of the construct's AVE is provided along the diagonal (given in bold). The inter-construct correlation is shown off the diagonal, and N= 283.

Table 4 Results of the Structural Equation

Hypothesis	Predicted Relationships	Std. Path Coeff. β.	Bootstrap *t*-value	BC 95% Bootstrap CI	R^2	Significant
H1:LMX→SCB	Positive	0.162*	2.173	0.017-0.312	0.213	Supported
H2:TMX→SCB	Positive	0.288***	4.460	0.169-0.410		Supported
H3:SC→ SCB	Positive	0.149**	2.357	0.030-0.277		Supported

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; BC= Bias Corrected; CI = Confidence Interval.

Table 5 Moderating Effects of Safety Climate

Hypothesis	Predicted Relationships	Std. Path Coeff.	Bootstrap *t*-value	BC 95% Bootstrap CI	R^2	Significant
H4:LMX*SC→SCB	Positive	0.155*	2.175	0.029-0.252	0.242	Supported
H5:TMX*SC→SCB	Positive	0.064	1.405	-0.176-0.094		Not supported

Note: * p < 0.05; **p < 0.01; ***p < 0.001; BC= Bias Corrected; CI = Confidence Interval.