Industrial Health 2023, **61**, 419–431

Original Article

Support for safety in the fire service: a test of reciprocal causality for safety motivation

Sharifah N.N. SYED-YAHYA[1], Mohd Awang IDRIS[1, 3]* and Akihito SHIMAZU[2]

[1]Faculty of Arts and Social Sciences, Universiti Malaya, Malaysia
[2]Faculty of Policy Management, Keio University, Japan
[3]PSC Global Observatory, University of South Australia, Australia

Received March 17, 2022 and accepted November 9, 2022
Published online in J-STAGE November 16, 2022
DOI https://doi.org/10.2486/indhealth.2022-0064

Abstract: Much research has identified safety motivation as an essential individual-level antecedent of safety performance. Recently, scholars have shown interest in workplace support as an essential factor of safety motivation. While support from different sources is theoretically distinct, each is argued to be not just an antecedent, but also an outcome of the other. A similar reciprocal relationship is also expected between support and safety motivation. Our research utilised the Self-Determination Theory (Deci & Ryan, 1985) and Social Cognitive Theory (Bandura, 1988) to examine the role of each source of support on safety motivation; and investigate their reciprocal relationships. We used structural equation modelling to analyse three-wave longitudinal data (three months apart) from 314 firefighters throughout Malaysia. The result confirmed direct relationships and interestingly, denied that reciprocal relationships exist between organisational support, social support, and safety motivation over time. Our study recommends that the fire department should encourage support from all sources, primarily from senior management since it is the catalyst that activates support from other sources.

Key words: Reciprocal causation, Perceived organisational support, Supervisor support, Co-worker support, Longitudinal

Introduction

Much research have investigated safety motivation as one of the essential individual-level triggers of safety performance[1–3]. In safety-critical industries such as the fire service, safety motivation creates an environment that encourages employees to engage in safety-related behaviours, thus reducing accidents and injuries in the line of duty[3]. Unlike other conventional occupations such as manufacturing or office workers, firefighters rush into dangerous situations instead of avoiding them, risking getting injured. For example, in Malaysia, 155 firefighters were reported injured during 2017 and 2018, representing 1.3% of the total operation's strength[4]. Therefore, a motivation to stay safe during operations is essential.

For decades, researchers have expanded the safety performance model[5] by demonstrating safety motivation not only as a predictor of accidents and injuries[6] (lagging outcome of the safety system) but also as a leading outcome and preceded by other factors (e.g., safety climate, safety support). Neal and Griffin[6] found evidence that employee safety motivation meaningfully influenced their safety behaviour and negatively affected the occurrence of accidents. In another study, Vatankhah's[7] study among flight

*To whom correspondence should be addressed.
E-mail: idrma@um.edu.my

attendants discovered that safety motivation reduces safety violations. Based on the notion that safety motivation potentially has critical impact on firefighters' behaviour and accident reduction, we aim to investigate the antecedents of safety motivation within the service. Specifically, we used the Self-Determination Theory (SDT;[8]) to explain how various sources of support in the workplace influence safety motivation.

In recent years, interest has grown in investigating the effects of workplace support as an organisational factor on safety performance[9, 10]. As an essential dimension of the safety climate domain[11], workplace support is often identified as a vital job resource in the workplace. Indeed, workplace support is also an important predictor of safety performance which is translated through a myriad of processes. In the workplace, support from various sources are known to counter the negative effects of stress, burnout and other adverse work outcomes[12]. Support at work has also been known to increase job satisfaction[13], improve safety behaviour[14], and reduce accidents and injuries[15]. Indeed, in emergency services such as the fire service, support provides assurance and trust to the firefighters to complete arduous daily tasks[16].

Support within the workplace stems from various sources. In fact, workplace support can emerge from macro-organisational level (i.e., perceived organisational support [POS]) which is top-down in nature (vertically), and also micro-organisational level (i.e., supervisor and co-worker support)[17, 18] which is from lateral direction (horizontally). For this paper, we define three different sources of support, namely POS, supervisor support, and co-worker support. While POS is a form of organisation commitment[19], support elicited by supervisors and co-workers are socially inclined (e.g.,[20, 21]). Therefore, we postulate that these sources of support are mutually distinct. Hence, we expect that support from different directions and sources (i.e., perceived organisational support, supervisor support, and co-worker support) will have varied effects on employees; and they should be tested separately in theory and measurement which is lacking in previous literature. Despite receiving much attention in research, POS, supervisor support, and co-worker support are rarely examined within the same study (see[22, 23] for exception). For example, Syed-Yahya *et al.*[24] relied on support from supervisors and co-workers to deduce that workplace safety support influence safety performance among firefighters. Although the findings from each study were able to validate their hypotheses, whether and how other unobserved types of support may influence the findings are inconclusive.

The main contribution of this paper is to investigate the reversed and reciprocal relationships between the different sources of support and safety motivation. In general, studies have shown that support directly influence safety motivation as part of employee internal process[25–27]. In other words, support, which perhaps acts as an extrinsic motivation, influences employee safety motivation, and each source of support affects the individual motivation uniquely via different mechanisms. For instance, supervisor support and co-workers support act as proximal effect when employees need to interact with their supervisor and co-workers daily. Regular interactions between teams and among members of the team, also with respective supervisors will form a sense of motivation relating to safety engagement. On the other hand, POS, is more on collective group perception about how the organisation treat employees fairly and provide support when necessary. Unlike supervisors and co-workers, POS is more distal and resides at organisational level. Thus, identifying the unique roles of these different sources of support which influence the support–motivation process is crucial. Guided by the Social Cognitive Theory (SCT;[28]), we argue that while support from management, supervisors and co-workers may mutually influence each other, we also postulate that employees' safety motivation has reversed and reciprocal relationship with each source of support to maintain safety in the dangerous work environment.

Secondly, the current study adds to literature by investigating an emergency service industry which is lacking compared to other industries[11, 29–32]. The fire service represents the high-risk organisation which is different in context unlike other occupations. Firefighting aims to save lives and property, while at the same time, they must ensure the safety of the crew. While provisions of quality personal protective equipment (PPE) and constant safety training helps in building a safe working environment, in emergency situations, there is a constant need for fast decisions which involves a lot of firefighter internal processes (i.e., safety motivation). Thus, an investigation of safety support and safety motivation in the fire service is critical.

Thirdly, the current study is conducted on firefighters within an eastern environment which echoes top-down principle and military-like leadership style[33]. The study is undertaken in Malaysia, where, like other South-East Asian countries (e.g., Thailand, Vietnam), its collectivist culture is likely to promote a stronger sense of attachment and mutual support[34], therefore supporting the reverse and reciprocal relationship proposed in this study. This gap in knowledge is particularly important for practitioners to

address safety issues in eastern emergency services, which will provide insight on the appropriate solutions.

Lastly, we expect to fill the gap in research to explore the reversed and reciprocal relationships between different sources of support and safety motivation[6, 13] by incorporating a cross-lagged, longitudinal design that includes both predictors and outcomes within the same model. So far, a plethora of previous research on support and safety motivation suffers from quality methodology where the causal relationships hypothesised cannot be determined[2, 26]. A longitudinal assessment would provide a more valid result of the causality relationships where it examines change over time and therefore eliminates the likelihood of common method bias[35].

Hypothesis Development

The different sources of support at work

Literature has established that support exists in various forms such as organisational[19] and social support[36]. These different types of support function differently in the work environment[14] while attending to different employee needs. According to organisational support theory, perceived organisational support (POS;[19]) refers to the general beliefs of employees about whether their contributions and well-being are valued by the management. Specific to safety, POS is an employee perception of management's commitment to safety, and this represents the macro-level support for safety in the organisation.

On the other hand, supervisor, and co-worker support, represent the social dimension of organisational safety[37] at micro-level. Social support is the extent to which there are opportunities for assistance and advice from supervisors and co-workers[38–40]. Supervisor and co-worker support symbolise how an employee interpret their support from the proximal relationships in the workplace. Although support from supervisors and co-workers are treated as general social support[20, 41], we argue that supervisors and co-workers provide a distinct form of support and should, therefore, be tested exclusively.

Regardless, although theoretically and empirically distinct, the POS, supervisor support and co-worker support are equally essential to influence work outcomes[23, 42]. While both supervisors and co-workers provide support that is social in nature, POS is fundamental to the organisational structure[43]. As opposed to the general workplace support, our study is specific to safety support which is relevant to the fire service.

Association between support at work and safety motivation in the fire service

In the context of the current study, we use Deci and Ryan's[8] Self-Determination Theory (SDT) to explain the manifestation of safety motivation from support in the workplace. In line with SDT, organisational and social support act as external factors that regulate and maintain internal employee motivation (e.g., safety motivation). Although motivation can be explained in several ways[44], however, our study is more focused on safety motivation as it is the fundamental principal of the fire service. For this study, safety motivation refers to "an individual's willingness to exert effort to enact safety behaviours and the valence associated with those behaviours"[6].

According to SDT, POS is an organisational context safety support[45] that is able to shape employee's external motivation through compliance of appropriate rules and procedures related to safety[46]. Several studies have empirically found that POS leads to general work motivation. For example, a cross-sectional study by Gillet *et al.*[47] among police officers discovered that POS positively relates to self-determined motivation, while, and in a longitudinal study among self-initiated expatriates, it was found that financial POS positively leads to controlled motivation[48].

In similar line, supervisor support also serves as an essential factor to improve workplace conditions[49]. Support from the immediate supervisor, being the only channel from the management to the individual, is also a specific form of external motivation, demanding compliance, rewards and punishments, only, more robust than POS because of the supervisor's proximity to the employee[14]. There are also a plethora of studies among police officers[47], nuclear power plant operators[50] and postgraduate students[51] which found that supervisor support has a positive association with safety motivation either through direct effect or interaction.

On the other hand, while POS and supervisor support provide external motivation through compliance, co-worker support is a form of inherent lateral support which affects employees personally. Co-workers in each group interact daily as part of a group norm[15]. Consequently, through co-workers, employees develop internal motivation when they obtain assistance, confide in their problems, and learn new skills or knowledge to help them through the day. Building on this notion, the following hypotheses are proposed:

Hypothesis 1: Perceived organisational support and social support (i.e., supervisor support and co-worker

support) will each be positively associated with safety motivation over time.

Reversed and reciprocal associations between different sources of support

While the roles of POS, supervisor support, and co-worker support have been widely demonstrated to affect positive work outcomes, the true pattern of the relationships among these different sources of support and safety motivation have not been tested simultaneously in the literature. As mentioned earlier, testing these distinct sources may provide a better understanding of how the various sources of support converge to promote an integrated literature on support at work.

Although distinct, we suggest that all the three dimensions of workplace support are intercorrelated and they mutually influence each other. In other words, while we expect that POS leads to supervisor support and co-worker support, and supervisor support leads to co-workers' support, over time, there are also possibilities of reciprocal processes emerging. According to Social Cognitive Theory (SCT;[28]), supervisors, as an agent of the organisation are responsible for enacting what has been espoused by the organisation, therefore exhibits specific behaviours necessary to achieve the overarching goal for safety. While employees observe this behaviour, employees perceive that supervisors and the organisation share the same goal. Subsequently, employees adopt and enact this behaviour (support for safety) through social learning and maintain this behaviour by reciprocating similar behaviour upwards and sideways. Moreover, in a close-knit team, such as the fire service, supervisors provide support through translating management policies and procedures to employees, while support from co-workers are provided by replicating supervisor's behaviour. Co-workers reciprocate this behaviour by communicating and discussing these policies and procedures with each other. To provide example, Yoon and Thye[52] found that an increase in POS elevates employees' perceptions of supervisor support, while in a different line of research, supervisor support leads to POS[53]. Therefore, we postulate that POS leads downwards to supervisor support and that this relationship is reversed and reciprocal in the opposite direction.

This reasoning leads to the following hypothesis:

Hypothesis 2: Perceived organisational support and social support (i.e., supervisor support and co-worker support) will be positively, and reciprocally associated over time.

Reversed and reciprocal associations between the different sources of support and safety motivation

The primary theoretical contribution of this study is the exploration of the reversed and reciprocal relationships between different sources of support and safety motivation. Building on the concept of SCT's reciprocal determinism, the assertion is that support from management, supervisor and co-worker support (environmental factors) create awareness among employees on the overarching goal of safety (individual), which in turn induce employee safety motivation (behaviour). Consequently, the safety motivation will create a more robust supportive environment in the workplace.

Research has used SCT to explain how environment (i.e., support from managers and supervisors) influences employees' perception on organisational support (individual feeling) and, in turn, affects employee behaviour[13]. As explained earlier, SCT's reciprocal determinism creates a circular motion where one action activates a reaction from an earlier action, and this motion is then repeated via reciprocation. In other words, when employees in a workplace feel motivated to work safely, they will likely detect that the higher order to achieve safety is shared within their work environment. Detecting the norms for safety created by senior management, employees then have the incentive to provide support to others which activates the motion to achieve safety. Consequently, supervisors and management will create a further supportive environment by reciprocating safety motivation with further support. Thus, the proposition that safety motivation among employees can influence support from different sources is as follows:

Hypothesis 3: Positive, reciprocal associations will exist between safety motivation, and each source of social support (i.e., perceived organisational support, supervisor support and co-worker support) over time.

All three hypotheses introduced above are illustrated and eventually tested through the hypothesised model which is presented in Fig. 1.

Methods

Participants and procedure

This research comprised three phases of data collection, each three months apart, to assess the changes in stressors (i.e., support variables) to changes in strains (i.e., safety motivation). The chosen time-gap is congruent with the current trend for longitudinal studies in safety research[54] where most safety-related research has included stress

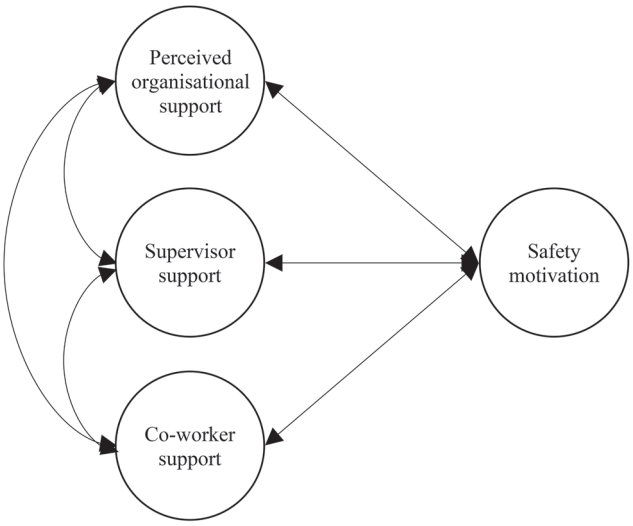

Fig. 1. Hypothesised model.

and strain. Upon obtaining approval for survey from the administrators of the Fire and Rescue Department of Malaysia, we distributed the paper-and-pencil format questionnaires at each team's respective fire station. Each participant gave a written informed consent prior to each survey by completing and signing the standard Universiti Malaya consent forms. All administration was individually completed on-site, and completed forms were immediately collected to guarantee respondents' privacy and confidentiality. We distributed and collected 650 questionnaire forms for each phase. Subsequently, due to selective attrition, some participants dropped out for several reasons, such as being on sick leave on the day of data collection, transferred to another location and several other issues. Finally, we retained data from 314 firefighters (response rate=40.1%) who sat through three waves of form-filling to test our hypotheses. We discarded forms with unmatched codes and missing data. The study was reviewed and approved by the Universiti Malaya Research Ethics Committee (UMREC), (reference: UM.TNC2/UMREC-206).

Study context

We undertook a study among high-risk professions specifically, we chose the firefighting industry to represent a different context of high-risk organisations which is scarce[11]. Safety support research on the fire service is especially limited within an eastern environment with high power distance between leader and employees[55]. The current study addresses this gap in safety literature. The final group of participants were made up of newly recruited and long-serving crews. Most participants were men (98.8%), between 20 to 30 yr of age (44.7%) and graduated from secondary school (98.8%). Most participants were on general rescue and firefighting tasks (51.9%), followed by engine drivers (27.3%) and medic team members (14.6%), with the rest working on forensics or as hazardous material experts, scuba divers or motorcade riders. All participants worked a 12-h day or night shift in a 10-d rotation.

Measures

The questionnaires were translated from English into Malay, the primary language used in Malaysia, using the back-translation method[56]. All scales were measured on a Likert scale ranging from '1' to '5' ('1'=strongly disagree to '5'=strongly agree).

Perceived Organisational Support (POS). POS was measured using three items from Perceived Organisational Support for Safety by Tucker *et al.*[15], and three of six items adapted from the Survey of Perceived Organizational Support (SPOS) by Eisenberger *et al*[19]. Both measures were amended to suit the fire service. We combined these scales into one higher-order factor; example items include: "The Chief of this fire station takes the safety ideas of firefighters seriously"; and "Help is available from the Chief when I have a problem concerning safety issues". Reliability for this scale was acceptable across all three time points (α=0.95, 0.96, 0.96, respectively).

Supervisor support. Supervisor safety support was measured using four items from Smith and DeJoy[33]. A sample question is "My supervisor shows personal concern about firefighter safety". Reliability for this scale was acceptable across all three time points (α=0.91, 0.90, 0.93, respectively).

Co-worker support. Co-worker safety support was measured using three items devised by Tucker *et al*[15]. A sample question is "My co-workers are helpful in getting the duties carried out safely" Reliability for this scale was acceptable across all three time points (α=0.85, 0.87, 0.85, respectively).

Safety motivation. Safety motivation was assessed using three items from Neal *et al.*[57]. An example is: "I believe that it is important to reduce the risk of accidents in the line of duty". Reliability for this scale was acceptable across all three time points (α=0.90, 0.90, 0.93, respectively).

Analytic strategy

Before testing our research hypotheses, the data was screened for missing values and outliers, then checked

for instrument reliability and validity using Statistical Package for the Social Sciences (SPSS; Version 27, IBM, Endicott, NY, USA). Next, we used maximum-likelihood estimation for the expectation-maximisation algorithm to replace the missing values in the remaining forms. AMOS software package (Version 20, IBM, Endicott, NY, USA) established the validity of the measurement model[58]. Then, a comparison of three competing models were used to analyse the longitudinal associations of the research variables. Model 1 is a three-factor model with all items for each phase (Time 1, Time 2 and Time 3) loaded on one latent variable each. Model 2 is a six-factor model where all support items (POS, supervisor support and co-worker support) loaded on one latent factor, and safety motivation items loaded on a second latent factor for each phase (Time 1, Time 2 and Time 3). Model 3 is a 12-factor model in which items for four variables were loaded onto their unique latent factors and assessed separately at Time 1, Time 2, and Time 3. We used confirmatory factor analysis (CFA) and structural equation modelling to test the adequacy of the model fit for all models. We also conducted repeated-measure analyses of variance (ANOVA) on the four variables to examine the stability of the mean levels of each research variable.

Then, we compared four cross-lagged models (Models 3−6) to test the research hypotheses. Firstly, a stability model (Model 3) was tested to determine stability between each latent variable from Time 1 to Time 2, and Time 2 to Time 3. In addition, we also tested each latent variable from Time 1 direct to Time 3. Secondly, we tested the normal causal model (Model 4)—cross-lagged pathways from all variables added to the stability model—from Time 1 to Time 2, and Time 2 to Time 3, also from Time 1 to Time 3. Thirdly, a reverse causal model (Model 5) was tested, which have the same parameters as Model 4, only the pathways were reversed. Finally, the reciprocal causal model (Model 6) was tested, which contained all pathways from formerly tested models (Models 3–5). This model tested whether reciprocal relationships existed between POS, social support (i.e., supervisor support and co-worker support), and safety motivation. Next, we determined the model fit according to the chi-squared statistic (χ^2); the Incremental fit index (IFI); the Tucker–Lewis index (TLI;[59]); comparative fit index (CFI;[60]); the root-mean-square error of approximation (RMSEA;[61]); and the Akaike Information Criterion (AIC:[62]).

Results

Validity and reliability

Principal components analysis was used to identify and compute composite scores for the factors underlying the measures used for POS, supervisor support, co-worker support and safety motivation. We examined all support items together for each wave (Time 1, Time 2 and Time 3), and separately for safety motivation. For support items, the factor analysis indicated that there are three distinct factors were underlying firefighter responses to the support items. For safety motivation, only one distinct factor was found, and the items were highly internally consistent. The factor loading matrix for safety support items is presented in Tables 1–3 and Tables 4–6 for safety motivation. We also conducted a Harman one-factor test[60] to determine whether common-method variance is a problem. An unrotated factor analysis was conducted on all 16 items. The factors together accounted for 41.0 percent (T1), 41.7 percent (T2) and 43.3 percent (T3) which is less than 50% of the total variance therefore indicate that there is no common method bias[63].

Next, three competing measurement models (Models 1 to 3) were compared to determine the distinctiveness of the three sources of support and safety motivation, and the overall validity of the hypothesised models. As predicted, Model 1 (three-factor model) and Model 2 (six-factor model) produced poor fit statistics. Model 3 made a better fit. Overall, the CFA results (Table 7) confirmed that the three sources of support and safety motivation were distinct.

Evaluation of competing models

Table 8 presents the descriptive statistics for the revised measures. Each measure indicated adequate internal consistency reliability over time ($\alpha > 0.84$). Most of the correlations between the research variables were significant, indicating that most support variables and safety motivation are associated with each other via both the cross-sectional, and longitudinal paths. We also found that all variables were stable over time, except for POS using analysis of variance test (ANOVA) (Wilks' Lambda=0.95, F (2, 312)=8.10, $p<0.001$, partial $\eta^2=0.05$), which fluctuates from Time 1 (M=4.13, SD=0.62) to Time 2 (M=4.06, SD=0.69) to Time 3 (M=4.20, SD=0.64).

The results for model-fit and model-fit comparisons of the four cross-lagged models are presented in Tables 9 and 10 respectively. Although the test of fitness of each model was acceptable, the normal causal model (Model 4) exhibited the best fit statistics and χ^2 difference tests results, which is presented in Fig. 2.

Table 1. Factor loadings and communalities for 13 items for all Time 1 Safety Support Scale (N=314)

Items	POS	Supervisor support	Co-worker support
Safety support #1	0.875		
Safety support #2	0.863		
Safety support #3	0.848		
Safety support #4	0.882		
Safety support #5	0.875		
Safety support #6	0.838		
Safety support #7		0.831	
Safety support #8		0.836	
Safety support #9		0.870	
Safety support #10		0.880	
Safety support #11			0.880
Safety support #12			0.849
Safety support #13			0.874

Based on a principal components analysis with Varimax rotation and Kaiser normalization; POS: Perceived organisational support; factor loadings <0.4 are suppressed.

Table 2. Factor loadings and communalities for 13 items for all Time 2 Safety Support Scale (N=314)

Items	POS	Supervisor support	Co-worker support
Safety support #1	0.909		
Safety support #2	0.903		
Safety support #3	0.876		
Safety support #4	0.898		
Safety support #5	0.901		
Safety support #6	0.891		
Safety support #7		0.831	
Safety support #8		0.856	
Safety support #9		0.866	
Safety support #10		0.908	
Safety support #11			0.858
Safety support #12			0.895
Safety support #13			0.816

Based on a principal components analysis with Varimax rotation and Kaiser normalization; POS: Perceived organisational support; factor loadings <0.4 are suppressed.

Table 3. Factor loadings and communalities for 13 items for all Time 3 Safety Support Scale (N=314)

Items	POS	Supervisor support	Co-worker support
Safety support #1	0.890		
Safety support #2	0.890		
Safety support #3	0.886		
Safety support #4	0.876		
Safety support #5	0.911		
Safety support #6	0.904		
Safety support #7		0.886	
Safety support #8		0.886	
Safety support #9		0.895	
Safety support #10		0.884	
Safety support #11			0.868
Safety support #12			0.862
Safety support #13			0.845

Based on a principal components analysis with Varimax rotation and Kaiser normalization; POS: Perceived organisational support; factor loadings <0.4 are suppressed.

Table 4. Factor loadings and communalities for 3 items for all Time 1 Safety Motivation Scale (N=314)

Items	Loading
Safety motivation #1	0.893
Safety motivation #2	0.923
Safety motivation #3	0.921

Based on a principal components analysis with Varimax rotation and Kaiser normalization; POS: Perceived organisational support; factor loadings <0.4 are suppressed.

Table 5. Factor loadings and communalities for 3 items for all Time 2 Safety Motivation Scale (N=314)

Items	Loading
Safety motivation #1	0.916
Safety motivation #2	0.928
Safety motivation #3	0.895

Table 6. Factor loadings and communalities for 3 items for all Time 3 Safety Motivation Scale (N=314)

Items	Loading
Safety motivation #1	0.921
Safety motivation #2	0.955
Safety motivation #3	0.938

Hypotheses testing

Hypothesis 1 predicted that all sources of support would each be positively associated with safety motivation over time. Model 4 assessed this hypothesis and only supervisor support was found to predict safety motivation (β =0.23, p<0.01) positively after three months (Time 1 to Time 2), but not at Time 2 to Time 3. No other source of support predicted safety motivation Thus, Hypothesis 1 is only partly supported.

Next, Hypothesis 2 proposed that all sources of support are positively and reciprocally associated with each other over time. Model 6 tested this hypothesis and while we expect that there exists reciprocal association in the hy-

Table 7. Measurement model (N=314)

CFA Model	χ^2	*df*	χ^2 /df	IFI	TLI	CFI	RMSEA	AIC
Model 1 (Three-factor model)	8,509.47	1,222.00	6.96	0.49	0.47	0.49	0.14	8,819.47
Model 2 (Six-factor model)	5,984.78	1,219.00	4.91	0.67	0.65	0.67	0.11	6,300.78
Model 3 (12-factor model)	2,200.32	1,066.00	2.06	0.92	0.91	0.92	0.06	2,516.32

χ^2: Chi-square value; *df*: degrees of freedom; CFA: confirmatory factor analysis; IFI: Incremental Fit Index; TLI: Tucker-Lewis Index; CFI: Comparative Fit Index; RMSEA: Root Mean-Square Error of Approximation; AIC: Akaike Information Criterion.

Table 8. Scale descriptives and correlations (N=314)

	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. POS T1	4.14	0.62	(0.95)											
2. Supervisor support T1	2.68	1.04	0.40***	(0.91)										
3. Co-worker support T1	4.23	0.53	0.19**	0.20***	(0.85)									
4. Safety motivation T1	4.43	0.51	0.28***	0.29***	0.44***	(0.90)								
5. POS T2	4.06	0.69	0.47***	0.13*	0.15**	0.19**	(0.96)							
6. Supervisor support T2	2.67	1.01	0.17**	0.44***	0.11*	0.12*	0.22***	(0.90)						
7. Co-worker support T2	4.22	0.51	0.20***	0.21***	0.36***	0.28***	0.38***	0.30***	(0.87)					
8. Safety motivation T2	4.37	0.52	0.22***	0.31***	0.23***	0.36***	0.25***	0.31***	0.47***	(0.90)				
9. POS T3	4.21	0.64	0.44***	0.12*	0.03^{ns}	0.16**	0.50***	0.10^{+}	0.12*	0.16**	(0.96)			
10. Supervisor support T3	2.76	1.03	0.22***	0.41***	0.13*	0.16**	0.12*	0.43***	0.09^{ns}	0.21***	0.34***	(0.93)		
11. Co-worker support T3	4.24	0.55	0.16**	0.15**	0.19**	0.18**	0.16**	0.13*	0.28***	0.15*	0.30***	0.28***	(0.85)	
12. Safety motivation T3	4.40	0.59	0.17**	0.13*	0.07^{ns}	0.15**	0.18**	0.11*	0.17**	0.26***	0.34***	0.22***	0.45***	(0.93)

Cronbach's alpha coefficients are listed on the diagonal; POS: Perceived organisational support; T1: Time 1; T2: Time 2; T3: Time 3; $^{+}p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.001$; ns: not significant; SD: standard deviation.

Table 9. Structural model fit statistics (N=314)

Structural models	χ^2	*df*	χ^2 /df	IFI	TLI	CFI	RMSEA	AIC
Model 3 (Stability model)	2,200.32	1,066.00	2.06	0.92	0.91	0.92	0.06	2,516.32
Model 4 (Normal causal model)	2,144.94	1,048.00	2.04	0.92	0.91	0.92	0.06	2,496.94
Model 5 (Reverse causal model)	2,162.57	1,048.00	2.06	0.92	0.91	0.92	0.06	2,514.57
Model 6 (Reciprocal causal model)	2,117.36	1,031.00	2.05	0.92	0.91	0.92	0.06	2,503.36

χ^2: Chi-square value; *df*: degrees of freedom; IFI: Incremental Fit Index; TLI: Tucker-Lewis Index; CFI: Comparative Fit Index; RMSEA: Root Mean-Square Error of Approximation; AIC: Akaike Information Criterion.

Table 10. Structural model comparisons

Model comparisons	$\Delta\chi^2$	Δdf	*p*
Normal causal model vs. stability model	55.38	18.00	***
Reverse causal model vs. stability model	37.75	18.00	***
Reverse causal model vs. normal causal model	17.62	0.00	
Reciprocal causal model vs. stability causal model	82.95	35.00	***
Reciprocal causal model vs. normal causal model	27.58	17.00	*
Reciprocal causal model vs. reverse causal model	45.20	17.00	**

χ^2: Chi-square value; *df*: degrees of freedom; Δ: change; *$p<0.05$; **$p<0.01$; ***$p<0.001$.

pothesized relationships, our analysis revealed that it only partially supported Hypothesis 2. We observed bidirectional reciprocal relationship between POS and supervisor support over six months (Time 1 to Time 3). However, the reversed relationship between POS and supervisor support is not positive, not as hypothesised (β=−0.15, $p<0.01$). We also observed reversed association at Time 1 to Time 2 (β =0.13, $p<0.05$) and negative reversed relationship at Time 2 to Time 3 between POS and co-worker support (β =−0.14, $p<0.01$).

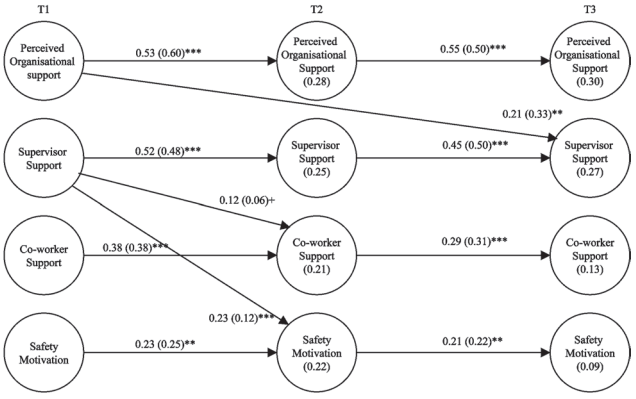

Fig. 2. Normal three-wave causal model (Model 4) for Time 1 to Time 2 and Time 2 to Time 3 (three months apart).
Unstandardised values and R^2 for the latent variables at Time 2 and Time 3 are presented in parentheses. T1: Time 1; T2: Time 2; T3: Time 3.

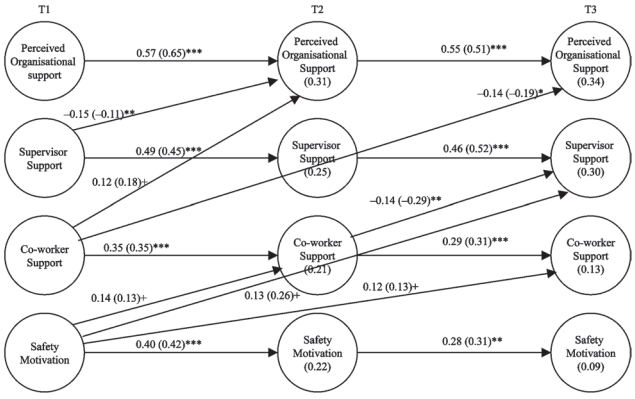

Fig. 3. Reversed three-wave causal model (Model 5) for Time 1 to Time 2 and Time 2 to Time 3 (three months apart).
Unstandardised values and R^2 for the latent variables at Time 2 and Time 3 are presented in parentheses. T1: Time 1; T2: Time 2; T3: Time 3.

Finally, the reciprocal model (Model 6, Fig. 4) also tested Hypothesis 3 which stipulated that positive, reciprocal associations exist between safety motivation and each source of social support. However, we found no support for Hypothesis 3. Neither POS nor social support has a reciprocal effect with safety motivation. It seems that safety motivation only has a weak reversed relationship with co-worker support at Time 1 to Time 2 (β = 0.14, p<0.1) and at Time 2 to Time 3 (β =0.12, p<0.1) (Refer Model 5, Fig. 3). Model 5 also showed that a marginal reversed relationship exists between safety motivation and supervisor support at Time 1 to Time 3 (β =0.13, p<0.1).

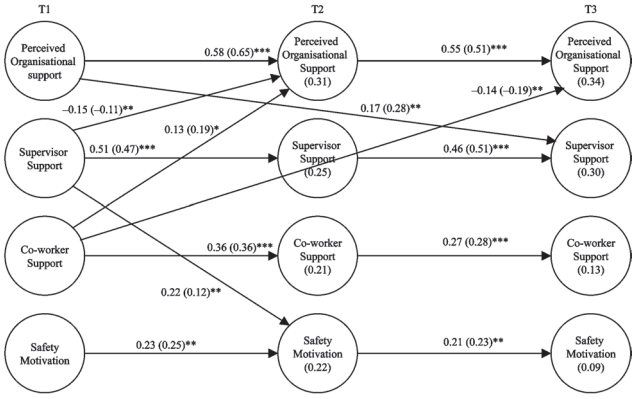

Fig. 4. Reciprocal three-wave causal model (Model 6) for Time 1 to Time 2 and Time 2 to Time 3 (three months apart).
Unstandardised values and R^2 for the latent variables at Time 2 and Time 3 are presented in parentheses. T1: Time 1; T2: Time 2; T3: Time 3.

Discussion

In this study, we proposed and tested a three-wave, cross-lagged research design to examine the reciprocal relationships between different sources of support (i.e., organisational and social support) and safety motivation. Previous studies have proposed unidirectional associations between support and safety motivation, and most have tested these sources of support independently. Our contribution lies in examining these various sources of support with safety motivation within a single study and the time effect of the multidirectional association among the study variables. Our findings provided minimal support for our proposed model.

Overall, we found that only supervisor support influences safety motivation over time. Other sources of support which are POS and co-worker support do not influence safety motivation. In addition, we only found a bidirectional reciprocal relationship between POS and supervisor support, and reversed relationship between POS and co-worker support. Additionally, we discovered no reciprocal association between any sources of support and safety motivation. However, the study found that safety motivation influences supervisor support and co-worker support over time, not as hypothesised.

Theoretical implications

The structural equation modelling (SEM) analysis confirmed the positive relationship between supervisor support and safety motivation. In other words, firefighters' safety motivation increases when they perceive support, specifically in terms of safety from supervisors. Our results concur with studies testing support on general work motivation. Firefighters feel motivated to work safely for the organisation's benefit in return for their supervisor's

support regarding firefighters' safety. As argued earlier in this paper, SDT explains how support from supervisors functions as the extrinsic motivation to regulate the safety motivation (intrinsic motivation) process among employees[8, 44] by way of the motivation to comply.

However, the longitudinal design of our research sheds light on the time effect of the relationships. Specifically, we discovered that although supervisor support immediately affects safety motivation within three months, the effect disappears soon after. This finding suggests that supervisors support only benefits firefighters' safety motivation initially, but after three months, the originally externally induced motivation has been internalised by the firefighters; subsequently, supervisor support no longer wields an effect.

Next, we could not find any support for the reciprocal association of each source of support over time. The unidirectional relationships found between POS and supervisor support and from supervisor support to co-worker support denied our earlier debate that each element of support is an antecedent and an outcome of the other sources of support. It seems that POS positively predicts supervisor worker support in one direction and after a longer time (six months). It seems that employees perceive that the benefits of POS can only affect supervisors after prolonged exposure to POS. This is possibly due to employee perception that the supervisor and top management share the same perspective and for this reason do not recognise the subtle difference between management support and supervisor support.

Similarly, only a unidirectional association was demonstrated between supervisor support and co-worker support but within a shorter period (three months), and then disappears. Seemingly, supervisor support initially leads to the perception of high support by the co-workers but dissipates after three months. We postulate that when co-workers (i.e., team) create a robust supportive environment, employees may no longer sense support from their supervisor.

The best fit model also show that reciprocal associations do not exist between safety motivation and each source of social support. The significant unidirectional association from supervisor support to safety motivation shows that employees who perceive that their supervisor (through social support and job rewards) provide ample support to achieve safety at work, are motivated to also provide support to others. This reaction activates the desire to achieve safety (intrinsic motivation). For example, firefighters who sense that their supervisor spends a lot of time on safety briefings during operations will be motivated to sit through many other safety-related activities.

Practical implications

The study has several practical implications. Firstly, our analysis discovered that POS influences supervisor support and supervisor support leads to co-worker support among firefighters; and that supervisor support leads to safety motivation. Therefore, the fire department must encourage support from all three sources, but mainly from the senior managers because it will be the catalyst that activates support from other sources. According to Smith and DeJoy[33], among the four dimensions of safety climate for firefighters, management commitment produced the most potent effect on employee safety outcomes.

More importantly, our study shows that supervisor support is essential to induce employee safety motivation by creating a supportive work environment. A supportive environment leads to trusting relationships at work, allowing greater access to work resources such as information from supervisors and help obtained from co-workers. Organisations can achieve a supportive work environment by encouraging vertical communications between managers, supervisors, and employees, as well as horizontal communications among employees. Supervisors can also increase support by assigning work tasks to be shared among employees; this creates better support among co-workers and between managers and employees, increasing safety motivation and ultimately achieving a safer work environment.

Furthermore, since these support sources are clearly distinct and have different effects on employees, the fire department can benefit from training programs focused on specific groups or hierarchies[64, 65]. For example, training programs can be tailored to take advantage of POS's influence on supervisor support by enhancing supervisor's mentoring and coaching abilities to maximise impact on co-worker support and safety motivation. Furthermore, the enhancement of supervisor training may produce leaders that could be the key to establishing norms.

Limitations and future research

Our study findings are not without limitations. Firstly, since the study was conducted using self-reported data obtained from a single source, some issues were evident with common method variance[60, 66] providing a questionable conclusion regarding the study relationships. We have attempted to increase accuracy by providing a detailed research information sheet and instructions together with the questionnaire forms[67]. The researcher observes each form-filling session to answer questions and ensure each

completed form's confidentiality. We also overcame the common method variance by conducting a longitudinal study as recommended[35]. However there remained the issue of participants "learning" the survey questions and start to behave differently knowing they are part of the study.

Secondly, our study only focused on the positive factors on employee safety motivation (POS, supervisor support and co-worker support). It is interesting to see if the outcome will be different if future research could explore the negative traits of managers, supervisors, and co-workers, such as autocratic leadership[68], abusive supervision[69, 70] or co-worker antagonism[10] using the same research model.

Thirdly, this study uses data collected from a heterogeneity of newly recruited and long-serving crews, therefore the results must be read with caution. Unless interventions were introduced between the waves of data collection, inferences made in this paper needed further support. Therefore, we recommend future research to select new recruits using the same model because new recruits would be a better population for a longitudinal design with the possibility of acclimating to the new culture.

Finally, the analysis was performed solely at the individual level in this model. All support variables used in the study were variables commonly operationalised as group-level variables. Therefore, the findings may have underestimated the standard errors and thus inflated their significance levels. Future research should combine both individuals- and group-level effects within the same model to explore these effects further.

Conclusion

The findings of this study provided a few important implications concerning the topic of workplace safety literature. We investigated how safety support, an essential organisational factor of safety performance, influences safety motivation and how this association is not reciprocal, which is rarely discussed in the existing literature. This way, our findings shed light on the importance of the different types of sources of support and safety motivation in safety research. Our results also provided more understandings of the time effect of the reciprocal relationship regarding the support–motivation process.

Funding

This work was supported by the Universiti Malaya Research Grant [UMRG grant numbers RP041A-17HNE].

Conflict of Interest

We have no known conflict of interest to disclose.

Acknowledgements

The authors acknowledge the assistance provided by the Fire and Rescue Department of Malaysia. The views expressed in this material are those of the authors and not the Fire and Rescue Department of Malaysia. Responsibility for any errors remains with the authors. Fire and Rescue Department of Malaysia expressly disclaims any liability for any damage resulting from using the material contained in this publication. This research was funded by the Universiti Malaya Research Grant, and this support is gratefully acknowledged.

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