Leading and lagging indicators of occupational health and safety: The moderating role of safety leadership

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ABSTRACT

In response to the call for empirical evidence of a connection between leading and lagging indicators of occupational health and safety (OHS), the first aim of the current research is to consider the association between leading and lagging indicators of OHS. Our second aim is to investigate the moderating effect of safety leadership on the association between leading and lagging indicators. Data were collected from 3578 employees nested within 66 workplaces. Multi-level modelling was used to test the two hypotheses. The results confirm an association between leading and lagging indicators of OHS as well as the moderating impact of middle management safety leadership on the direct association. The association between leading and lagging indicators provides OHS practitioners with useful information to substantiate efforts within organisations to move away from a traditional focus on lagging indicators towards a preventative focus on leading indicators. The research also highlights the important role played by middle managers and the value of OHS leadership development and investment at the middle management level.

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1. Introduction

Occupational health and safety (OHS) measurement relies heavily on lagging indicators, such as incidents of workplace injury, as these measures provide important feedback information about deficiencies and safety incidents that have occurred (Reiman and Pietikäinen, 2012). Lagging OHS indicators are, however, a reactive measurement approach to safety management and measure events or outcomes that have already happened (Hopkins, 2009; Laitinen et al., 2013; Reiman and Pietikäinen, 2012). As such, lagging indicators are “failure-focused” (Sinelnikov et al., 2015). Recent research emphasises a more proactive evaluation of OHS activity that emphasises leading indicators, or inputs, that allow organisations to predict safety concerns and that may reduce the likelihood of an OHS incident occurring (Grabowski et al., 2007; Lingard et al., 2011; Reiman and Pietikäinen, 2012). Leading indicators can be thought of as eliminating or controlling the precursors to harm and as such offer organisations the opportunity to detect and mitigate risks or risk increases before an OHS incident occurs or a hazardous state is reached (Sinelnikov et al., 2015).

Sinelnikov et al. (2015), in their study of the state of knowledge and practice on the use of leading indicators of OHS, explained that although there is increasing interest in leading indicators, there is a need for further evidence of the link between leading and lagging indicators. These authors also noted the potential enabling impact of leadership in terms of implementing leading indicators. As recognised in the social information processing perspective (SIP), leadership behaviour is an important determinant of the development of employee job attitudes and behaviours (Chen et al., 2013). The aim of the current research is to address the research gaps noted above by considering: 1) the association between leading and lagging indicators of OHS, and 2) the moderating effect of safety leadership on the association between leading and lagging indicators.

The structure of the paper is as follows. First, the literature on leading and lagging indicators of OHS will be reviewed. Hypotheses are then developed in relation to how leading and lagging indicators are likely to be associated and whether this association is moderated by safety leadership. Second, the methods used for the study are described. The third section of the paper presents the results of the study, while the fourth section provides a discussion of the study’s results and contribution. The final section of the paper provides an overview of the study’s limitations and avenues for future research.

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2. Theory

The following sections review the literature on leading and lagging indicators of OHS and, drawing from a social information processing (SIP) perspective, an argument is made for the moderating effect of safety leadership on the association between leading and lagging indicators.

2.1. Leading and lagging indicators of OHS

Injuries and accidents in the workplace can engender potentially damaging consequences for individual employees and have serious work performance outcomes at the organisational level (Battaglia et al., 2015; LeBeau et al., 2014). Lagging indicator data provide necessary information on safety performance related to injuries and accidents that can motivate people to work on improving safety performance (Reiman and Pietikäinen, 2012). Relevant lagging data include workplace injuries and near misses (Goldenhar et al., 2003; Li et al., 2013; Probst et al., 2013), often based on self-reported incidents (Wachter and Yorio, 2014).

Sinelnikov et al. (2015) have explained that leading indicators, in contrast, can eliminate or control the precursors to harm and provide early warning signals of potential failure. Leading indicators are associated with active, positive steps that organisations can take to avoid an OHS incident (Baker et al., 2007; Blair and O’Toole, 2010; Grabowski et al., 2007; Lingard et al., 2011). Lagging indicators on the other hand are failure focussed and measure OHS incidents that have already happened (Hopkins, 2009). Leading indicators are valuable therefore as they enable organisations to identify and correct deficiencies to prevent or mitigate the worst effects of injuries or damage.

Despite the potential worth associated with leading indicators of OHS, definitions of the construct are unclear (Reiman and Pietikäinen, 2012). Writers, for example, have used a variety of terms to depict leading OHS activity including upstream, heading, positive, and predictive indicators (Hinze et al., 2013). One approach to defining leading indicators is to focus on how they can be differentiated from lagging or trailing indicators (Dyreborg, 2009; Hopkins, 2009; Kjellén, 2009). The distinction is not, however, without its complications. It is possible that a lagging indicator may also act as a leading indicator if, for example, it is able to predict another OHS outcome or event (Dyreborg, 2009).

Hopkins (2009) provided a considered discussion of leading and lagging terminology within the context of personal and process safety. Personal safety problems refer to problems that affect individuals and the term “lagging” typically relates to injuries and fatalities. Process safety hazards, on the other hand, are those arising from the processing activity in which a plant may be engaged and result in damage to the plant and have the potential to generate multiple fatalities. For such events, a lagging indicator relates to harm and failure and may include a major catastrophic event such as an explosion or a fire. These, however, are rare events and it becomes difficult to create a meaningful measure over time. In the case of personal safety, the distinction between leading and lagging indicators is somewhat less problematic. In this context, the term lagging indicator generally refers only to measures of OHS incidents, such as reported OHS incidents, unreported OHS incidents, and near misses. In contrast, leading indicators are those that directly measure aspects of the OHS management system, such as the frequency or timeliness of audits.

Having established the importance of leading indicators, we draw attention to ongoing discussion about the content of leading indicator domains. The following list of leading indicators represents a synthesis of the leading indicator literature that highlights specific domains (also see Shea et al., 2016).

Accountability for OHS that involves a proactive OHS workplace culture and emphasises a sense of shared responsibility and accountability for OHS is important. Such a culture promotes active scrutiny and transparency in reporting and is likely to positively influence safety behaviour in the workplace (Dyreborg, 2009; Fernández-Muñiz et al., 2009). Audits and workplace OHS inspections, designed to provide appropriate and comprehensive information, are seen to be of value with the proviso that appropriate and timely corrective action is taken to address identified issues (Carson and Snowden, 2010; Hallowell et al., 2013; Sinelnikov et al., 2015).

Consultation and communication about OHS is considered a priority, including regular, formal and informal communication and consultation about OHS (Dejoy et al., 2004; Grabowski et al., 2007; Health and Safety Executive, 2005).

Empowerment and employee involvement in decision making about OHS encourages employees to take responsibility for their behaviour and leads to positive safety behaviour outcomes (Nahrgang et al., 2011; Wurzelbacher and Jin, 2011). Management commitment and leadership is valuable and is demonstrated in active engagement in areas such as OHS information gathering, behaviour as OHS role models and support for OHS as a high priority across the organisation (Choudhry et al., 2007; Frazier et al., 2013; Health and Safety Executive, 2005; Lingard et al., 2011; Zohar, 2010).

Positive feedback and recognition for OHS is considered to be a leading indicator but not including rewards that might lead to under-reporting of incidents or injuries (Daniels and Marlow, 2005).

Prioritisation of OHS, embedded in the organisation having primary alongside efficiency and productivity, has emerged as an important leading indicator (Glendon and Clarke, 2016; Health and Safety Executive, 2005; Van Dyck et al., 2013; Zanko and Dawson, 2012).

Risk management of OHS, including risk assessment, control, inspection and maintenance of psychosocial, physical and/or physiological dimensions of OHS, has emerged as a valuable priority (Fernández-Muñiz et al., 2009; Hopkins, 2009; Kjellén, 2009; Pidgeon, 1991).

Systems for OHS are important and are typically implemented and maintained by managers and in work groups. Such systems include workplace policies, processes and practices designed to control and monitor OHS (Frazier et al., 2013; Payne et al., 2009; Pidgeon, 1991; Wachter and Yorio, 2014; Wurzelbacher and Jin, 2011).

The provision of OHS training, information, tools, and resources that promote preparedness to act and provide relevant response plans are key leading indicators of OHS (Health and Safety Executive, 2005; Lingard et al., 2011).

Based on the above review, we propose that the construct of leading indicators of OHS, that eliminate or control the precursors to harm, offers organisations the opportunity to detect and mitigate risks, or risk increases, before an OHS incident occurs or a hazardous state is reached (Grabowski et al., 2007; Lingard et al., 2011; Reiman and Pietikäinen, 2012; Sinelnikov et al., 2015). The following hypothesis is formed to reflect the impact of leading indicators of OHS on mitigating OHS incidents:

H1 Leading indicators of OHS will be negatively associated with lagging indicators of OHS

2.2. Safety leadership as a moderator

Safety leadership has emerged within the OHS literature as a key construct. Wong et al., 2016, for example, in their review of the safety leadership literature concluded that workplace supervisors have substantial influence on the safety performance of their
employees. Much of the research has considered safety leadership as an antecedent to lagging indicators such as injury rates (Barling et al., 2002; Vredenburgh, 2002; Zohar, 2002) and employee exposure rates to hazards (Gershon et al., 2000). Wong et al. (2016) extend the discussion of the direct relationship between safety leadership and outcomes to consider the moderators of trust and safety culture. There has also been evidence in the literature of safety leadership as a moderator of antecedent-OHS outcome associations.

For example, Huang et al. (2004) established that the positive effect of the quality of the execution of organisational safety policies on safety outcomes was strengthened under conditions of strong supervisor support for safety. More recently, Griffin and Hu (2013) found that the degree to which a leader encouraged and promoted safety-related learning moderated (i.e., intensified) the positive association between safety monitoring and employee safety participation. In a study examining young workers’ safety, Teed et al., 2008 found that the association between transformational leadership and safety outcomes was moderated by passive leadership (i.e., management by exception and laisse-faire leadership behaviours), such that the positive association was weaker under conditions when leaders demonstrated more passive leadership behaviours. Similarly, Simard and Marchand (1997) provided evidence which indicated that when supervisors encouraged safety participation, employees were more likely to comply with safety rules.

With respect to the leading indicators research, Sinelnikov et al. (2015) demonstrated that safety leadership potentially enables leading indicators of OHS. Their analysis showed that when leading indicators receive more attention in management communication and when managers have greater expertise with respect to leading indicators, it is easier to take preventive action through leading indicators. Theoretical support for the proposition that safety leadership moderates the association between leading and lagging indicators of OHS can be found in the social information processing perspective (SIP; Salancik and Pfeffer, 1978). A key tenet of the SIP perspective is that job attitudes are not formed exclusively as a result of the objective aspects of the work itself, such as the tasks or practices, but rather they also develop from how the work is socially constructed. Thus, when confronted with new policies, procedures or practices, the information gathering and processing capacity of employees is typically circumscribed (Groth et al., 2002). As a consequence, they must rely on social cues (i.e., information) within their work environment in order to construct perceptions and attitudes which, in turn, influence their behaviour (Boekhorst, 2014).

Leaders are powerful actors in the social interaction processes that develop within organisations and therefore they are usually important sources of such cues through their explicit statements and behaviours (Gonzalez-Roma and Peiró, 2014). They provide followers with essential information about organisational practices and policies as well as other work related issues (Gonzalez-Roma et al., 2002). According to the SIP perspective there are three primary processes by which a leader can influence a follower’s job attitudes and work behaviour.

First, leaders can do so by guiding the subordinate’s job and role perceptions and this influence may be particularly acute for middle-level managers (Chen et al., 2013). With regard to OHS, the information provided to new incumbents about the OHS aspects of their job by middle-level managers may be particularly credible, given their higher status, relative to junior-level managers. By the same token, while senior managers are typically the architects of the organisation’s OHS policy, middle-level managers are likely to enjoy much closer social proximity to their followers and therefore their cues about safe work practices are likely to be seen as highly salient (Meyer, 1994). This is consistent with the findings of Wu et al. (2010), which indicated that the middle manage-

Fig. 1. Model of the proposed moderating effect of safety leadership on the association between leading and lagging OHS indicators.

ment group has a primary responsibility for safety interaction or directions, guidance and advice; safety informing or the reinforcement and communication of the organisation’s safety policy; and safety decision-making or the implementation of safety strategies through planning, resource allocation, and safety improvement. Indeed, Wu et al. (2010) found that, relative to their junior and senior counterparts, the role played by middle-level managers was the strongest predictor of safety climate.

Second, according to the SIP perspective, leaders can have the effect of shifting members’ attention and shaping their interpretations (Grant et al., 2010). For example, leaders who are focused on safety can, by virtue of the cues they provide, make the OHS aspects of the job, which may have been ignored or minimised by employees, far more prominent and focal. Similarly, the social cues given by leaders who place a strong emphasis on safety can provide employees with a frame for assessing the level of risk associated with their role, potentially shaping their interpretation of their job as one in which OHS incidents are not seen as an inherent and acceptable risk.

Finally, proponents of the SIP perspective argue that leaders can affect subordinates’ attitudes and behaviours by providing a role modelling function (Chen et al., 2013). It is often the case that the behaviour of unit leaders and line managers is easily observable by their followers and it communicates to employees the behaviours that are expected and supported by the organisation. Thus, when a leader reliably and repeatedly models behaviours that are consistent with the OHS policy and practices, employees observing this behaviour are likely to learn vicariously what are deemed appropriate actions and what is valued by the organisation. Indeed, there is empirical evidence that supports this as Cree and Kelloway (1997) found that the level of safe work practices modelled by leaders had consequences for the safety behaviour of their followers.

In view of the impact that characteristics of middle managers can have on the enactment of leading indicators, our second hypothesis becomes:

H2 Safety leadership of middle managers will moderate the association between leading indicators and lagging indicators of OHS, such that the association between leading indicators and lagging indicators of OHS will be increasingly negative at lower levels of safety leadership.

Fig. 1 presents a summary of our conceptual model.

3. Method

3.1. Sample

The sample for this study was recruited via a national multi-industry survey conducted in Australia between September 2013 and November 2014. We targeted large employers and six organisations were recruited into the study with OHS managers being approached through professional networks. Sixty-six workplaces (each a single worksite of an organisation) agreed to participate in the survey and were representative of six industries identified in the Australian and New Zealand Standard Industrial Classifica-
tion (ANZsic, 2006): Arts and Recreation Services; Construction; Electricity, Gas, Water and Waste Services; Health and Community Services; Mining; and Transport, Postal and Warehousing.

The survey was administered to 10,362 employees and 3605 employees responded, resulting in a response rate of 35 percent. Twenty-seven respondents were deleted as they did not identify as belonging to a specific workplace and could not be included in the multi-level analysis; this reduced the sample size to 3578. Workplace size ranged from 4 to 532 employees with a mean size of 54 employees. Of the respondents, 24 percent were middle managers or line managers and the remainder (76 percent) worked in other roles. Most (77 percent) were employed on a continuing basis, 57 percent were working full-time, 61 percent were male and approximately half (52 percent) had been working for their organisation for five years or less.

3.2. Measures

3.2.1. Leading indicators

Leading indicators were measured using the Organizational Performance Metric – Monash University (OPM-MU: Shea et al., 2016). The OPM-MU is a revised version of the Organizational Performance Metric developed at the Institute for Work & Health, Ontario Canada (IWH-OPM: IWH, 2011,2013). The OPM-MU is an 8-item scale that has been reported to be a reliable and valid measure of leading indicators of OHS (Shea et al., 2016). Employees were asked to report on their perceptions of the workplace they worked in most often, rather than the organisation overall, using a 5-point scale (ranging from 1 = strongly disagree to 5 = strongly agree), according to the extent to which they agreed or disagreed with the eight statements (e.g., Formal OHS audits at regular intervals are a normal part of our workplace). The OPM-MU is shown in Appendix A. This measure has been validated in Shea et al.’s (2016) study. The current study uses the same data set and the Cronbach alpha coefficient was .88.

3.2.2. Safety leadership

The safety leadership measure used in this study was the operations manager safety leadership scale developed by Wu et al. (2010). This is a 12-item scale that is intended to measure aspects of safety leadership. Sample items are: objectively analyse the causes of injuries, I visit the workplace to assess safety, and I encourage employees to be safe in their working behaviour. Middle-level and line managers in each workplace were asked to report on their perceptions of their own safety leadership, using a 5-point scale (ranging from 1 = strongly disagree to 5 = strongly agree), with respect to the 12 statements. Safety leadership ratings were available for all but one workplace. The average number of middle managers and line managers providing leadership ratings was 13 per workplace.

Our analysis of the safety leadership measure, using exploratory factor analysis, revealed a single-factor scale, with all items loading significantly on one factor, which explained 52 percent of the common variance. The Cronbach’s alpha coefficient for the safety leadership measure was excellent (α = .91) and consistent with the reliability coefficient reported by Wu et al. (2010; α = .95).

3.2.3. Lagging indicators

Lagging indicators were operationalised as self-reported OHS incidents. Respondents were asked to report the number of OHS incidents they had been personally involved in at work over the past 12 months. These self-report measures (sourced from Probst et al., 2013) were: reported OHS incidents, unreported OHS incidents (OHS incidents that were not reported to management) and near misses (situations that could have caused an injury/illness, but did not). Our inclusion of multiple measures of OHS incidents is consistent with recent research advising investigation of a range of lagging indicators (Christian et al., 2009; O’Neill et al., 2013). While there is some debate on whether near-misses are a leading or lagging indicator (e.g. Hinze et al., 2013), following Probst et al. (2013), for the purposes of this study we categorise near-misses as a recordable incident.

3.2.4. Control variables

We included organisational tenure (years) and employment status (coded 1=continuous, 0=other) as controls in our analyses as research has indicated that less experienced workers (Breslin and Smith, 2006) and lower status employees (Lundberg, 1999) are more likely to experience an OHS incident at work. We also included role overload as a control variable as it has been shown to be a job demand (Wincent and Örtqvist, 2011) related to employee outcomes (Andrews and Kacmar, 2014). Role overload was measured using the 5-item Quantitative Workload Inventory (Spector and Jex, 1998), which measures both the volume and pace of employee workload. The role overload measure had excellent internal reliability (α = .89) in the current study. To statistically control for unobserved heterogeneity on OHS outcomes at the organisational level, we included K-1 dummy variables in the regression models, where K is the number of organisations (n = 6) in the sample (Cohen et al., 2003).

3.3. Procedure

University research ethics approval was obtained before survey distribution. Once ethics approval was confirmed, all employees at each participating workplace had the opportunity to complete the survey. The invitation to participate and distribution of the survey depended on both workplace context and whether the questionnaire was completed using paper-and-pencil or online. Paper-and-pencil surveys were distributed at staff meetings or through the internal mail. In workplaces where employees gathered for staff meetings, provision was made for the researchers to attend meetings to distribute information sheets and surveys. Respondents completed the questionnaires at the staff meeting and returned them in a sealed envelope directly to the researchers. In other organisations, the survey was distributed through the internal mail where respondents completed the survey in their own time and returned the questionnaires in a sealed envelope to a secure central collection point within their workplace. Where the questionnaire was administered online, the researchers provided the OHS manager with an email containing a link to the online survey; this email was sent by the OHS manager to employees. Privacy legislation in Australia prevents employers from sharing employee email addresses with researchers. Respondents completing the surveys online or those who completed the pencil-and-paper surveys at their own pace were sent two reminders, via a global email or a newsletter sent by the OHS manager, two and four weeks after the initial invitation. All respondents were assured of anonymity.

3.4. Statistical analysis

The data were collected from employees nested within workplaces. Multi-level modelling, using the SPSS Mixed Procedure (Heck et al., 2013), was employed to test our hypotheses. Multi-level (also called hierarchical linear) modelling is appropriate for nested or hierarchical data, such as in the present study, for which the assumption of independence of observations is violated (Raudenbush and Bryk, 2002). In our two-level regression models, OHS incidents were the level-1 dependent variables, leading indicators the level-2 independent variable, and safety leadership the level-2 moderator variable. As recommended by Tabachnick and Fidell (2013), to generate correct standardised regression weights in moderated regression, all variables were z-standardised prior to
analysis. Standardisation is a form of grand mean centering commonly performed on predictors in multi-level analysis (Mathieu and Taylor, 2007). OHS outcome data were log transformed to improve normality and linearity.

4. Results

4.1. Aggregation

In line with the majority of leadership studies, we defined safety leadership as a group-level construct (Taggar and Ellis, 2007). Leading indicators has been conceived in the literature as both an individual- and as a group-level variable. Indeed, as discussed earlier in this paper, Hopkins (2009) referred to personal and process OHS leading indicators and, in the climate literature, safety climate has been treated as an individual-level construct (psychological safety climate) and as a group-level phenomenon (Christian et al., 2009). Here we construe leading indicators as a group-level construct. We accept that individual workers will have perceptions regarding worksite OHS policies, practices and procedures, however, we argue that when employees at a worksite share these perceptions, a group-level phenomenon emerges. We calculated the within-group correlation (\( r_{wg} \)) and the intra-class correlation ICC(2) values to ascertain whether ratings of these constructs were adequate for aggregation to the workplace level. The mean \( r_{wg} \) values (calculated for a multi-item scale assuming a uniform null distribution) were .97 for leading indicators and .97 for safety leadership, indicating a high level of within-group agreement (LeBreton and Senter, 2008). The ICC(2) values, which measure the reliability of the group means, were .90 for leading indicators and .58 for safety leadership. The ICC(2) value for safety leadership was slightly below the commonly used lower bound of .60 (cf. Glick, 1985), which was possibly related to the relatively small number of middle managers and line managers in each workplace. Taken together, these results provide support for aggregation of OHS leading indicators and safety leadership to the workplace level (Bliese, 2000).

### 4.2. Multi-level modelling

Table 1 presents the means, standard deviations, and inter-correlations among the study variables.

The first hypothesis, that leading indicators would be negatively associated with lagging indicators of OHS, was tested with respect to three lagging indicator measures: reported OHS incidents, unreported OHS incidents, and near misses. With regard to the reported OHS incidents, after controlling for type of role, organisational tenure, and role overload, leading indicators were not significantly related to this lagging indicator (see Table 2, Model 1). In terms of unreported OHS incidents, leading indicators of OHS was a statistically significant predictor, with higher levels of leading indicators being associated with fewer unreported incidents (see Table 2, model 3). Similarly, leading indicators were negatively related to near misses (see Table 2, model 5). Therefore, hypothesis 1 was supported for unreported OHS incidents and near misses.

The second hypothesis, that safety leadership will moderate the association between leading indicators and lagging indicators of OHS, such that the association will be increasingly negative at lower levels of safety leadership, was also tested with respect to three lagging indicator measures: reported OHS incidents, unreported OHS incidents, and near misses. No statistically significant interaction was observed between leading indicators and safety leadership for reported OHS incidents (see Table 2, model 2). The interaction between leading indicators and safety leadership was statistically significant for unreported OHS incidents (see Table 2, model 4). To aid in the interpretation of this interaction effect, we plotted the simple slopes of leading indicators and OHS outcomes using the conventional low (1 SD below the mean) and high (1 SD above the mean) values of the moderator, safety leadership (Aiken and West, 1991).

As shown in Fig. 2 the association between leading indicators and unreported OHS incidents was strongly negative when safety leadership was high (one SD above the mean; \( \beta = -0.92, \ p < 0.01 \)) rather than low (one SD below the mean; \( \beta = 0.08, \ p > 0.05 \)). A statistically significant interaction was also observed between leading

### Table 1

Means, standard deviations, and inter-correlations among the study variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Continuing role</td>
<td>0.77</td>
<td>0.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. Organisational tenure</td>
<td>2.74</td>
<td>1.30</td>
<td>.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Role overload</td>
<td>3.54</td>
<td>1.09</td>
<td>.08</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Leading indicators</td>
<td>3.62</td>
<td>0.73</td>
<td>.08</td>
<td>−0.12</td>
<td>−0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Safety leadership</td>
<td>4.09</td>
<td>0.58</td>
<td>.02</td>
<td>−0.01</td>
<td>.03</td>
<td>.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Reported incidents</td>
<td>0.57</td>
<td>3.13</td>
<td>.06</td>
<td>.04</td>
<td>.07</td>
<td>−0.02</td>
<td>.11</td>
<td></td>
<td></td>
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<tr>
<td>7. Unreported incidents</td>
<td>0.9</td>
<td>5.00</td>
<td>−0.01</td>
<td>.01</td>
<td>.07</td>
<td>−0.13</td>
<td>−0.01</td>
<td>.58</td>
<td></td>
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<tr>
<td>8. Near misses</td>
<td>1.09</td>
<td>7.18</td>
<td>.01</td>
<td>.02</td>
<td>.07</td>
<td>−0.11</td>
<td>−0.00</td>
<td>.33</td>
<td>.53</td>
</tr>
</tbody>
</table>

Note: \( p < 0.05, \ * p < 0.01. \)

### Table 2

Results of multilevel regression analyses.

<table>
<thead>
<tr>
<th></th>
<th>Reported incidents</th>
<th>Unreported incidents</th>
<th>Near misses</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 3</td>
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<tr>
<td>Within level</td>
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<td>Continuing role</td>
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<td>.07*</td>
<td>−0.02</td>
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<tr>
<td>Organisational tenure</td>
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<td>.09*</td>
<td>.05*</td>
</tr>
<tr>
<td>Role overload</td>
<td>.09*</td>
<td>.09*</td>
<td>.12*</td>
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<tr>
<td>Between level</td>
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<td></td>
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<tr>
<td>Leading indicators</td>
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<td>.05</td>
<td>−0.32*</td>
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<tr>
<td>Safety leadership</td>
<td>.05</td>
<td>.05</td>
<td>−0.25*</td>
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<tr>
<td>Leading indicators:Safety leadership</td>
<td>−.10</td>
<td>.03</td>
<td>−.50*</td>
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<tr>
<td>R² (OLS)</td>
<td>.08</td>
<td>.08</td>
<td>.03</td>
</tr>
</tbody>
</table>

Note: \( p < 0.05, \ * p < 0.01. \) Standardised coefficients reported. Fixed effects for organisations were included, but not reported for ease of presentation.
indicators and safety leadership for near misses (see Table 2, model 6). As shown in Fig. 3, the association between leading indicators and near misses was more negative when safety leadership was high one SD above the mean; (β = −0.76, p < 0.01) rather than low (one SD below the mean; β = 0.04, p > 0.05). Taken together, these results support the interaction effects specified in hypothesis 2 for unreported OHS incidents and near misses.

5. Discussion

Leading indicators of OHS, such as near misses as well as reported and unreported incidents, provide important feedback to organisations about deficiencies in the management of OHS (Reiman and Pietikäinen, 2012). Although such data are valuable, there has been a call for research that provides an additional focus on OHS leading indicators as these eliminate or control the precursors to harm, as opposed to lagging indicators, which measure events or outcomes that have already occurred (Grabowski et al., 2007; Hopkins, 2009; Lingard et al., 2011; Reiman and Pietikäinen, 2012; Shea et al., 2016). It has been further suggested that leading indicators research can be enhanced by examining the factors associated with, or that enhance the impact of, leading indicators. Suggestions include consideration of the impact of factors such as leadership commitment, engagement, understanding, and support (Sinelnikov et al., 2015). Our focus on leadership as a factor that moderates leading-lagging indicator associations is consistent with the priority given to leadership elsewhere as an important factor in terms of influencing safety outcomes (Martínez-Córcoles et al., 2011; Wong et al., 2016) and with the theoretical arguments presented in the SIP perspective (Salancik and Pfeffer, 1978). In response to these developments within the literature, the aim of the current research has been to consider the direct association between leading and lagging indicators of OHS and the moderating effect of safety leadership of middle managers on these associations.

The results indicate that leading indicators are negatively associated with the lagging indicators of unreported incidents and near misses, but are not predictive of reported OHS incidents. The negative associations between OHS leading indicators and both unreported incidents and near misses supports the impact of the former as eliminating or controlling precursors to harm (Grabowski et al., 2007; Lingard et al., 2011; Reiman and Pietikäinen, 2012; Sinelnikov et al., 2015). The results do not provide evidence, however, of an association between leading indicators and reported incidents as an outcome measure. The lack of a significant association may be a result of the increase in communication flows that characterise leading indicator activity. Specific leading indicator areas, for example, include increased OHS consultation and communication (Dejoy et al., 2004; Dyreborg, 2009; Fernández-Muñiz et al., 2009; Grabowski et al., 2007). Such activity could actually encourage high incident reporting as a form of feedback and therefore nullify the expected negative association between leading indicator activity and the lagging indicator of reported OHS incidents. Indeed, some studies (Blegen et al., 2004) have found that strong safety management systems and strong safety cultures in organisations may actually increase the reporting of OHS incidents.

With respect to the expected moderating effect of safety leadership, our findings indicate that the associations between leading indicators and both unreported incidents and near misses become increasingly negative at higher levels of safety leadership. In other words, a leader who prioritises safety creates an environment where leading indicators are more likely to reduce near misses and unreported incidents. Again, there is no significant association with reported incidents but, consistent with the argument made previously, it is possible that stronger safety leadership, combined with activity to prevent OHS outcomes, could actually nullify any expected reduction in the reported incidents. That is, the combination of stronger safety leadership and OHS outcome prevention could actually increase willingness to report any incidents.

Our finding of a moderating effect for safety leadership on leading and lagging associations supports Sinelnikov et al.’s (2015) suggestion of leadership as an intensifying factor for leading indicators. In Sinelnikov et al.’s research, when respondents were asked to provide a list of the most important factors that enabled them to implement leading indicators of OHS, leadership was nominated most frequently. The moderating effect for safety leadership identified in the current research is also consistent with arguments from the SIP perspective and the social construction of work, which state that employees rely on social cues to develop attitudes and behaviours (Salancik and Pfeffer, 1978). Middle managers, consistent with their selection in the current research, provide a powerful and credible source of information for employees. They are a group of leaders who have more credibility, relative to more junior supervisory staff, and greater involvement in policy design (Chen et al., 2013; Meyer, 1994). They also focus attention on key aspects of the work role and, if these managers value safety, this, in turn, will be prioritised by employees (Grant et al., 2010). Finally, as role models who adhere to safe work procedures, these managers allow employees to learn vicariously appropriate behaviours (Cree and Kelloway, 1997).

5.1. Research contribution and implications

First, the findings of our research address Sinelnikov et al.’s (2015) call for ongoing research that provides an empirical link between leading and lagging OHS indicators. The established link strengthens information available to managers about what can be done to prevent OHS incidents from occurring.
Second, our study provides OHS practitioners with evidence of the impact of leading indicator activity. As noted by Sinelnikov et al. (2015), some top-level executives still exhibit a tendency to solely embrace lagging indicators as they are more familiar with traditional OHS performance data. These authors have suggested that some of the responsibility for re-education rests with OHS practitioners; however, to be able to make a case to senior management, these practitioners need access to metrics that clearly show the value of addressing and measuring leading indicators of OHS. The current research assists by providing such evidence of the impact of leading indicator activity on lagging indicators that can be communicated to senior management.

Third, our research highlights the important role played by middle management. As noted above, senior management commitment to OHS leading indicator activity is critical, but there is a need for sustained safety leadership training programs for managers at all levels in order for them to understand their OHS roles and to learn to be safety leaders. Elsewhere Wu et al. (2010) have similarly noted the importance of safety leadership throughout the organisation and the allocation of time and resources necessary to develop safety leadership.

5.2. Limitations and future directions

First, although the research surveyed 3578 employees from firms drawn from six different industries, there is scope for enhancing the generalisability of the findings by examining the association between leading and lagging indicators across a wider range of industries. Second, given the variations in risk exposure across industries, there is scope in future research to explore systematic differences in the impact of leadership and industry risk levels on the association between leading and lagging indicators. Wong et al. (2016), for example, noted the possible boundary conditions of industry risk levels and explained that most of the studies on leadership and safety outcomes were conducted in blue-collar safety critical populations. Third, to reduce the risk of common method variance (CMV) manager ratings of safety leadership were aggregated to the workplace level. A meta-analysis by Christian and colleagues (Christian et al., 2009) showed that self-reported safety outcome data are relatively immune from response biases. Nevertheless, we acknowledge that OHS reporting practices are likely to vary between industry sectors and within workplaces in each sector. Investigation of such differences may be an area of future research. Fourth, our study was limited to medium-to-large organisations; future research could investigate whether the effects are evident in smaller businesses. Fifth, the cross-sectional nature of the study precludes making inferences about causality. The findings of this study would need to be replicated with a longitudinal design before stronger inferences could be drawn in relation to the associations between leading and lagging indicators of OHS. For example, it may take some time for leading indicators to affect lagging indicators and these temporal dynamics are best captured with longitudinal data.

Finally, our research focused on the moderating impact of safety leadership of middle managers on leading and lagging indicator associations and there is scope to investigate variation in impact across all leadership levels. Future work could also examine the implementation of leading indicators and their ongoing measurement in workplaces. Specifically, research could investigate the importance of planning, education, connection with existing processes and practices, and implementation of a regular evaluation process (Hallowell et al., 2013; Sinelnikov et al., 2015).

6. Conclusions

The overall aim of the current research was to examine the association between leading and lagging indicators of OHS and the moderating effect of safety leadership on this association. The research makes a number of contributions. The research provides evidence of an association between leading indicators and lagging indicators of OHS and, as such, contributes to leading indicators research by addressing Sinelnikov et al.’s (2015) call for empirical evidence of a connection between leading and lagging indicators. Evidence of this association also provides OHS practitioners with useful information to substantiate efforts within organisations to move away from a primary focus on lagging indicators, towards a preventative focus on leading indicator activity. Additionally the confirmation of the moderating impact of safety leadership of middle managers in the direct association, specifically at the middle management level, highlights the important role played by this management group and the value of OHS leadership development and investment at the middle management level.

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Appendix A.

OPM- Monash University*

Please read each statement carefully and select the number that best shows your views about health and safety at this workplace.
References


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