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The development and evaluation of a Learning from Incidents toolkit

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Abstract

This paper describes the development and evaluation of a toolkit to support organisations in improving their learning from incidents (LFI) activities. Grounded in adult learning theory, extensive literature review and empirical research within the energy sector, the LFI Toolkit has five key components: a Process Model; a Framework; a Questionnaire; a set of Guidelines; and a series of Engagement Exercises. The LFI Toolkit fosters participatory learning enabling broader employee engagement, sensemaking and contextualisation. The Toolkit was developed and evaluated through participatory co-design methodology including

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two large energy companies. The data were drawn from four participatory co-design workshops and a stakeholder engagement review meeting including practitioners from a variety of organisations and roles – shopfloor workers, frontline and middle managers, senior leaders, health and safety specialists and representatives of professional bodies. The findings provide insight into the clarity, usability and relevance of the Toolkit and the feasibility of its application across other companies.

Keywords

Learning from incidents; organisational learning; participatory research; participatory action research; adult learning

1. Background: LFI issues and adult learning principles

Effective learning from incidents (LFI) is critical for safe working. An LFI process is effective when it enables organisations to accumulate and embed knowledge of causes of incidents in ways that can prevent future incidents (Lukic, 2012). Many organisations have invested in LFI, however, near-misses and incidents continue to occur, sometimes at catastrophic scale, as exemplified by the recent BP's Deepwater Horizon oil spill or the Santiago de Compostela train derailment.

A typical LFI process starts with an incident being reported and investigated to identify the causes (Lindberg et al., 2010). Investigation reports typically produce recommendations for changes. From these, high-level 'learning points' are abstracted and disseminated throughout

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the organisation or the industry. These 'learning points' usually focus on policy or process changes that need to be put in place to prevent or ameliorate future incidents. Several key issues in current organisational approaches to LFI have been identified (Lukic, 2012; Lukic et al, 2010; 2012a; 2012b; Margaryan et al, 2016). An outcome of these literature analyses was a conceptual framework of LFI that is outlined later in this paper. We shall not reiterate the full findings of the analyses here, but would like to highlight a few key issues that have particularly stimulated the work described in this paper.

The first issue identified in the literature is that organisations often miss key opportunities for learning throughout the incident lifecycle (Cooke and Rohleder, 2004). Often, learning activities are planned as the last step in the lifecycle, after the incident has been investigated and analysed by investigators (Lukic, 2012). A thorough investigation is a necessary but insufficient foundation for learning from incidents. Opportunities for learning occur from the point of initial reporting and investigation to the implementation of actions to prevent future incidents. To capitalise on these opportunities, organisations would benefit from integrating various types of learning activities and pathways to employee participation throughout the lifecycle of an incident (Lukic et al, 2013). Such continuous and broader engagement with LFI would help foster organisation-wide learning and improvement in safety practices.

The second issue is that organisational LFI initiatives tend to be limited to dissemination of findings from incident investigations. This means that in LFI, 'learning' is conceptualised as the knowledge and information about the causes of incidents developed by investigators and disseminated to others in the organisation who are expected to learn from this information (Drupsteen and Guldenmund, 2014). However, dissemination of information alone is unlikely

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to result in the necessary changes in behaviour and professional practice to prevent future incidents (Lukic et al., 2012a). In order to learn, people have to use information in ways that are meaningful to their jobs (Carroll, 1995). Learning initiatives based around unidirectional flow of information often struggle to engage the workforce, missing the opportunity to capitalise on employees' experiential knowledge of their local contexts (Pedler, 2002).

The third issue is that LFI initiatives are seldom grounded in what we know about how people learn individually and as part of collectives such as teams and organisations (Lukic et al., 2010). Research in adult learning has demonstrated that people learn not only by reading reports and circulars, but also by guided reflection, deliberate practice, giving and receiving feedback and by observing and emulating other people's behaviour (Ericsson et al, 2006; Fuller and Unwin, 2004; Malloch et al, 2011; Smith et al, 2008; Snowden, 2002; Weick et al., 2005). Our literature review suggests that LFI initiatives seldom provide opportunities for employees to reflect on incident information and to make sense of it in ways that are meaningful for their specific jobs. This is partly because those responsible for safety in organisations often have limited knowledge of adult learning principles, how people learn in the workplace, how to design effective learning processes that lead to improved safety, and how to rigorously evaluate the effectiveness and quality of the outcomes of these learning processes (Gordon, 2008).

How can adult learning theory help us address these issues? Several key principles of adult learning based on nearly a century of research (Knowles et al, 2012; Lindeman, 1926) could help us rethink LFI initiatives in organisations. The first principle is that *adults are motivated to learn when they experience a need and when they believe that engaging in a learning*

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activity will help them satisfy that need (Carver and Scheier, 2005; Knowles, 1972). Adults engage in learning largely in response to pressures they feel from their current life or work situation. Therefore, adults' orientation to learning is problem-centred rather than topic-centred and their time perspective is focused on immediate rather than postponed application of knowledge. A key implication for LFI is timing of learning - that is, grounding LFI activities in real-life concerns and specific workplace contexts of workers. Whilst safety in the workplace in general is of importance to workers, their engagement in LFI processes and initiatives may be suboptimal if these do not tap into their specific needs, organisational context and workplace situations. Because adults need to know why they need to learn something before undertaking to learn it, LFI initiatives should stimulate workers to discover for themselves the gaps between where they are now and where they want to be with regards to safety.

The second fundamental principle of adult learning is that *experience is the richest source of learning for adults* (Smith and De Frates-Densch, 2008). Throughout their life, adults accumulate a growing well of experience that they bring into their learning activity. Because adults define themselves largely by their experience, they have a deep investment in the value of their personal experiences. When adults find themselves in situations in which their experience is not used or is minimized they will disengage or engage only suboptimally. Therefore, within LFI initiatives a greater emphasis must be placed on approaches that tap into the experiences of workers – that is, on experiential learning (Billett, 2010; Boud and Walker, 1990; Kolb, 1984) such as group discussion, case study, simulation, role play, or participatory co-design. To make learning more meaningful and integrated, LFI initiatives should enable workers to apply new learnings to their own workplace situation focusing on

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contextualization and sensemaking rather than transmission of information (Weick, 1995).

The third principle of adult learning is that *adults have a deep psychological need to be self-directing and to be seen and treated by others as being capable of self-direction (Boekaerts et al., 2005)*. Adults avoid, resist and resent situations in which they feel treated like children, for example being told what to do and what not to do, being talked down, punished, or judged. Adults tend to resist learning situations and learning activities that are inconsistent with their self-concept as autonomous individuals and that do not take into account their agency (Billett et al, 2005; Lukic et al., 2013). In adult learning contexts, the role of the 'teacher' - in LFI that is safety manager, supervisor or anyone else facilitating LFI - is to engage in a process of a mutual inquiry with workers rather than to transmit his or her knowledge to them and then evaluate their conformity to it. Therefore, in LFI initiatives, the learning climate should lead workers to feel accepted and respected rather than fearing blame, punishment or ridicule engaging workers in a process of self-diagnoses of their needs and self-evaluation of their learning (Lukic et al., 2010).

The Engaging with Learning from Incidents project (LFI-Engage, http://www.gcu.ac.uk/academy/lflengage/) project sought to address these issues and principles by developing a toolkit to support companies in improving LFI processes and practices - the Learning from Incidents (LFI) Toolkit. Specifically, the LFI Toolkit sought to:

- help organisations integrate various types of learning activities throughout the lifecycle of an incident (continuous learning)
- engage the workforce in LFI by capitalising on the employees' knowledge of their local workplace (employee engagement)

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- provide opportunities for employees to reflect on incident information and to make sense of it in ways that are meaningful for their specific work contexts (sensemaking and contextualisation)
- integrate experiential learning activities moving away from the information dissemination model of LFI (experiential learning)
- engage in a process of a mutual inquiry with employees (participatory co-design)

In line with adult learning principles, the development and evaluation process was underpinned by a participatory action research approach, through which researchers and practitioners sought to jointly rethink and change organisational LFI practices drawing on collective inquiry, reflection and experimentation (Chevalier et al, 2013). This paper reports the development and initial formative evaluation of the LFI Toolkit at two sites of two multinational energy companies. The individual components of the Toolkit have been published in several journals as detailed in Section 2. Therefore, rather than elaborating on the individual components of the Toolkit, the main purpose of this paper is to describe the methodology, the process and the findings of the evaluation of the overall Toolkit.

2. Learning from Incidents (LFI) Toolkit

The LFI Toolkit is aimed at frontline managers, safety managers and frontline employees to guide the implementation of LFI initiatives across company sites http://publishing.energyinst.org/heartsandminds/toolkit/learning-from-incidents The LFI Toolkit forms a part of the Energy Institute's Hearts and Minds programme. The Energy Institute is the international professional body for the energy industry. The Hearts and Minds

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programme consists of a variety of toolkits and activities aimed at improving safety and engaging workforce in safety development http://www.energyinst.org/heartsandminds . The programme is used by many high-risk organisations around the world, predominantly in the energy sector, to inform their safety policy and practice. Grounded in adult, workplace and organisational learning theory, the LFI Toolkit extends the remit of the Hearts and Minds programme by helping organisations engage employees in continuous, participatory and experiential learning throughout the incident lifecycle (Littlejohn et al, 2017; Lukic et al., 2012a; Lukic et al., 2010; Lukic et al., 2013; Margaryan et al, 201).

The LFI Toolkit consists of five components. Component 1, the *LFI Process Model* (Figure 1) helps organisations map LFI activities across a site to phases of the LFI lifecycle: reporting incidents; investigating incidents; developing incident alerts; disseminating recommendations and lessons learned from investigation; contextualising this information and implementing actions (Lukic et al., 2012b). The LFI Process Model is empirical; it was devised from an analysis of LFI activity on different industrial sites (Lukic, 2012). The model supports organisations in understanding the inter-relationship of existing LFI activities on sites and integrating opportunities to learn throughout the lifecycle of an incident rather than only at the end of the lifecycle.

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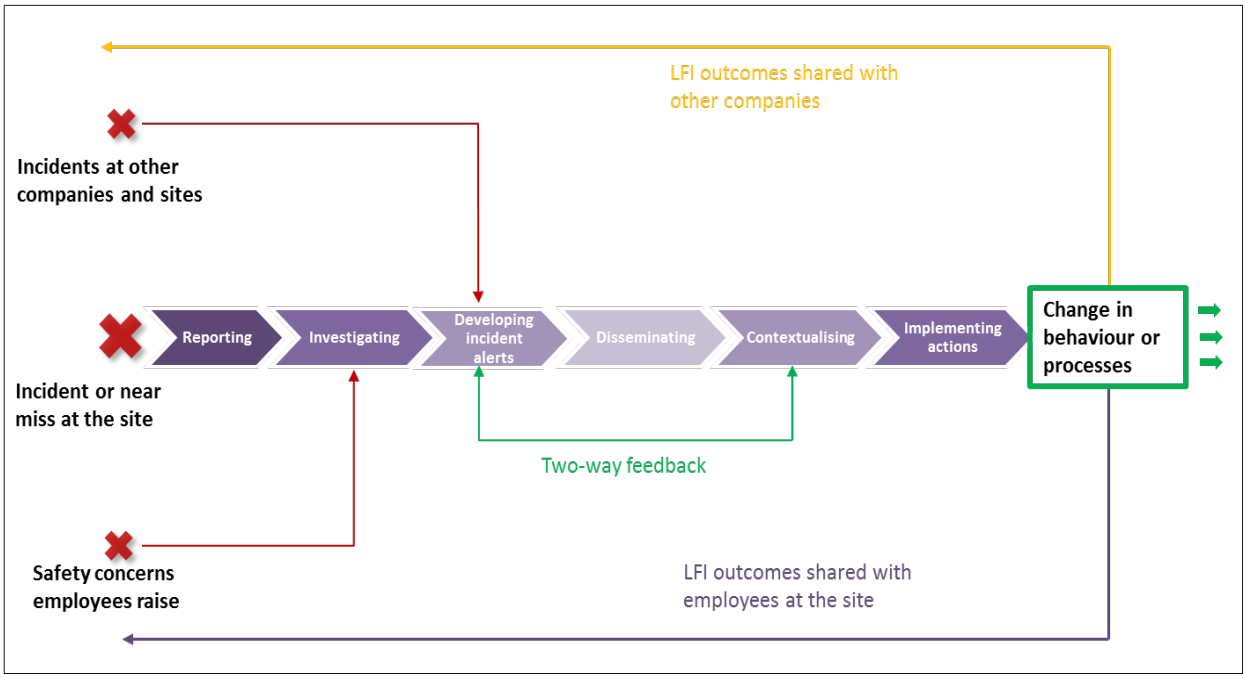

Figure 1. The LFI Process Model (diagram adopted from Littlejohn et al, 2017)

Component 2, the *LFI Framework* (Figure 2), contributes a set of key concepts and factors synthesised from theories of adult, workplace and organisational learning to guide the development of effective LFI activities. The literature review underpinning the LFI Framework is reported in considerable detail in Lukic et al. (2010) and (2012a). In summary, five key factors comprise the LFI Framework. First, the *context of learning*, for example formal training versus informal, on-the job learning. Second, the *participants of learning*, with the emphasis on the importance of engagement with a broad range of employees across organisational levels by building on their sense of individual agency. Third, the *processes of learning*, ranging from relatively 'quick fix' solutions such as skills training, punitive decisions or technical changes (so called single-loop learning (Argyris and Schoen, 1996)) to deep and open inquiry into causes, values and system failures underpinning incidents (double-loop learning). Fourth, the *type of the problem causing the incident*, ranging from

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simple to complex, complicated and chaotic (Snowden, 2002). Simple problems are those where the cause and effect relationships are clear and solutions straightforward. Within complicated problems, causal relationships are not readily evident requiring an in-depth analysis to uncover these and to identify a solution. In contrast, complex problems involve non-linear situations where causes and effects are intertwined in complex ways, so that they can often be surfaced only in hindsight rather than determined in action. Chaotic problems are usually unforeseen requiring rapid, decisive action, with little time for an in-depth analysis. The final, fifth component of the LFI framework is *type of knowledge and skill* to be learned (e.g. conceptual, procedural, dispositional, locative, recognising that different types of learning activities are required to learn different types of knowledge).

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Figure 2. The LFI Framework (diagram adopted from Littlejohn et al, 2017)

Component 3, the *Learning from Incidents Questionnaire (LFIQ)* is a 46-item diagnostic instrument to help organisations identify employees' perceptions and experiences of the LFI processes and practices. The LFIQ is structured around the six phases of the LFI Process Model (see Component 1) and the five elements of the LFI Framework (Component 2), thereby operationalising these for use in practice. The LFIQ was validated through a study involving 781 employees from two energy companies (Littlejohn et al, 2017).

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Component 4, the *LFI Guidelines,* includes specific guidance for each of the LFIQ items, providing recommendations on how to address potential gaps and put the guidelines into practice, pointing out potential links with other related Hearts and Minds tools where possible. For example, a guideline on one of the LFIQ items recommends that organisations '*Encourage employees to reflect on the importance and relevance of incident alerts to their work'*. Suggestions for implementing this guideline include: *'Within incident alerts, provide space where employees can add their reflections and actions relevant to their work'* and '*Ask all supervisors and team leaders to discuss with their work groups what changes in behaviour would improve their work. Refer to the Hearts and Minds SAFE Tool for guidance on how to achieve behavioural change*'.

Component 5, *the LFI Engagement Exercises*, consists of four participatory co-design workshop exercises to help employees reflect on incidents and apply lessons from these to their own job, workplace processes and behaviour. The first exercise titled 'Improving LFI at your site' helps employees jointly examine and improve their local LFI process. This exercise builds on the results of the LFIQ survey for that particular site. The second exercise, 'Developing incident alerts', provides an opportunity for employees to devise incident alerts from real-world investigation reports. This exercise enables employees to provide suggestions on how incident information can be made relevant for various work groups and their specific job tasks in their organisations. The third exercise, 'Engaging with dissemination', engages workers in reflecting on the ways in which incident alerts are disseminated within their site. This activity provides an opportunity to contextualise the incident alerts relating these to employees' own work. The fourth exercise, 'Engaging with lessons learned', helps workers make sense of the previous incidents. The exercise guides

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employees in reflecting on how these apply to their own work and developing concrete actions to address any potential similar issues at their site. The overall structure and the contents of the LFI Toolkit are summarised in Figure 3:

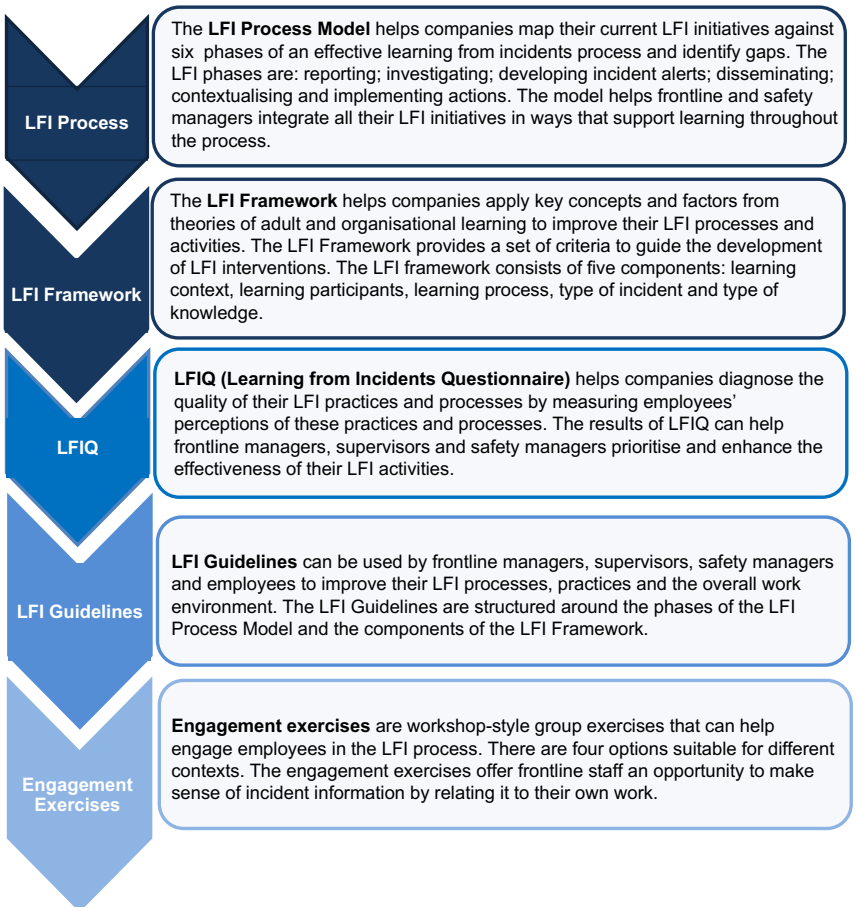

Figure 3. Overview of the LFI Toolkit

The LFI Toolkit was developed and tested in partnership with two industrial sites, following a collaborative, participatory co-design approach underpinned by adult learning principles (Spinuzzi, 2005). The rationale was to enhance the usability of the Toolkit by building on the local knowledge and expertise of workers (Pedler, 2002). This approach enabled us to engage

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the beneficiaries of research (workers, frontline managers, safety managers, the representatives of the Energy Institute) in co-creation of research outputs for practical use (Klein, 1998; Perkmann & Walsh, 2007; Wierdsma, 2004). The methodology is detailed in the next section.

3. Evaluation methodology and procedure: Participatory co-design

Participatory co-design methodology is based in participatory action research approach (Chevalier et al, 2013). As Spinuzzi (2005) emphasised, although participatory co-design research may draw on various qualitative and quantitative methods or combinations of these, 'these methods are always used to iteratively construct the emerging design, which itself simultaneously constitutes and elicits the research results as co-interpreted by the designer-researchers and the participants who will use the design' (p. 164). Therefore, participatory co-design is an appropriate methodology to apply in developing a practitioner-focused LFI Toolkit. Practitioners contribute deep and tacit understanding of their local contexts. Traditional intervention research often fails to capture the detail and complexity of the relevant inputs and tactics missing important information on how the intervention would work in real-life settings (Stead et al., 2002). Participatory co-design and formative evaluation allow for this local, contextual knowledge to be integrated into research outputs making the tools, activities and processes produced by researchers more useful, feasible and relevant (Glasgow et al., 2003).

Broadly, participatory co-design involves 3 *iterative* phases through which a product is developed and formatively evaluated (Kennedy et al, 2010; Spinuzzi, 2005): initial

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exploration, discovery and prototyping. Initial exploration involves researchers familiarising themselves with the users and their organisational practices. Discovery helps researchers and users discuss and clarify users' goals and agree on desired outcome of the project. At prototyping stage, researchers and practitioners iteratively co-design and shape the product for organisational fit, usability, clarity and ease of use. All these stages are often conducted on site involving one or more users. In producing the LFI Toolkit, engagement with a broad representation of practitioners as early as possible was deemed essential.

In line with the methodology, the development and formative evaluation of the LFI Toolkit included three steps. First, the Learning from Incidents Questionnaire, LFIQ, was developed and validated (for a detailed description see Littlejohn et al, 2017). Second, participatory co-design workshops were used to collaboratively develop the LFI Guidelines and Engagement Exercises. Third, the resultant draft Toolkit was formatively evaluated at a Stakeholder Review Meeting organised by the Energy Institute and attended by experts – senior managers, safety managers, human factors specialists and academics – from a range of industries and public bodies. This paper reports the outcomes of the second and third phases focused on the collaborative development and formative evaluation of the LFI Guidelines and Engagement Exercises. The development and validation of LFIQ are not discussed in this paper as they are extensively reported elsewhere (Littlejohn et al, 2017).

Two sites in two different, multinational, energy companies in the UK and Canada were involved in co-design workshops. We deliberately selected diverse sites in order to test the effectiveness of the Toolkit in different organisational contexts. Site 1 is a large upgrader site (a facility that upgrades bitumen into synthetic crude oil) in Canada. Site 1 has approximately

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1500 employees and is a part of a multinational oil and gas company. Site 2 is a wind power plant in the UK. It has approximately 60 employees and is part of a UK energy company. Two participatory co-design workshops were held at each site (four workshops in total). Each site had a contact person - someone who was responsible for LFI at the site - whom we termed the 'gatekeeper'. This gatekeeper invited employees from across the site to volunteer for the co-design workshops via an invitation email. The workshop participants were selected using a combination of stratified and convenience sampling methods. At Site 1, the workshops had 12 participants; at Site 2 there were 9 participants. These participants were engaged in a broad cross-section of roles across each site, ranging from shopfloor workers, senior and middle managers, frontline managers, safety managers and contractor representatives (Table 1). Therefore, although the sample was small, it was diverse.

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Table 1: Participants of co-design workshops, by role

Role	**Site 1 N**	**Site 2 N**
Senior manager	0	1
Middle manager	3	3
Frontline manager (immediate supervisor of shopfloor workers)	4	2
Shopfloor worker	0	1
HSSE (Health, Safety, Security, Environment) professional/safety manager	5	1
Administrator	0	1
Total	*12*	*9*

Each workshop lasted 5-6 hours, excluding lunch and coffee breaks. The majority of participants at both sites took part in both workshop sessions, with the exception of two people at Site 1 and one individual at Site 2 who participated in only one of the sessions. These participants were briefed on the outcomes of the sessions they did not attend by the gatekeeper who encouraged them to share their ideas by email. Overall, consistency of participation and views was achieved for the workshop sessions. Facilitated by the third author of this paper, the workshops followed a set agenda and session plan (for an example see https://figshare.com/articles/WorkshopPlan_pdf/5082280).

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During the first workshop at each site, the participants were presented with the LFI Process Model followed by group discussion centred on mapping out the site's current activities corresponding to each of the phases of the Process Model. This activity helped identify gaps and links in the LFI process at the site. The participants were then asked to comment on the usefulness of the LFI Process Model (Figure 1) and invited to suggest how the Model could be used at their site. After this introductory activity, the participants were presented with a draft version of the LFI Guidelines; each guideline was discussed one-by-one by the participants. When discussing the Process Model and the Guidelines, the participants were asked to consider three main criteria:

- *Clarity* – How clear and understandable are the model and the guidelines?
- *Usefulness* – How might the model and the guidelines help improve LFI processes and practices at the site?
- *Feasibility* – What is the feasibility of embedding the model and the guidelines within your company?

The researcher encouraged the participants to be critical about the Model and the Guidelines and to suggest improvements, exclusions and additions. In line with the iterative nature of the evaluation methodology, the guidelines were revised on the basis of the findings from the first workshop. The updates ranged from minor changes in wording to improve clarity to the removal of recommendations which were found to have limited impact at the sites and the inclusion of suggestions to help operationalise the Guidelines.

The aim of the second workshop was to further refine the LFI Guidelines as well as to test-run the Engagement Exercises. In preparation to the second workshop, the participants were

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sent the LFI Guidelines, which were updated on the basis of the feedback received during the first workshop. First, the feedback and comments received through email were discussed and the wording and content of the Guidelines were revised together with the participants. Second, one of the LFI Engagement Exercises (*Exercise 3 'Engaging with dissemination')*, was tested with the participants, using an incident alert from the site as an example. The participants and the researcher discussed the alert and decided on actions to improve it on the basis of both the guidelines and participants' own suggestions. Third, the instructions for running each of the four LFI Engagement Exercises were discussed in groups. The participants were asked to comment on the clarity, usefulness and feasibility of the instructions and to suggest improvements. In this way, the content and the wording of all four LFI Toolkit components were iteratively updated based on the feedback received. The LFI Toolkit was then validated through a Stakeholder Review Meeting with a range of industry experts. Validation was actuated through feedback from a group of safety experts representing a range of energy organisations located across Europe.

The Stakeholder Review Meeting took place at the Energy Institute and lasted over 5 hours. The aim of the meeting was to gather views on the usefulness, feasibility and clarity of the LFI Toolkit and to identify further suggestions for improvement. Invitations to participate in the event were circulated by the Energy Institute to selected members of the Institute's Human and Organisational Factors Committee and representatives of other companies and public bodies. In total 17 stakeholders from 11 energy and safety sector organisations participated in the event. All participants were middle or senior managers whose roles focused on safety and LFI. Prior to the event, the LFI Toolkit and a scoring sheet to evaluate the Toolkit were sent out to the participants by email. The scoring sheet enabled participants

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to assess each individual component of the Toolkit according to the three criteria of clarity, usefulness and feasibility scoring each on a 1 to 5 Likert scale (1 lowest, 5 highest). A sample scoring sheet is available from https://figshare.com/articles/ScoringSheet_pdf/5082262 Six out of 17 scoring sheets were returned.

The workshops and the Stakeholder review meeting were audio-recorded and transcribed for analysis. The dataset generated through the participatory co-design process consisted of transcripts of the four workshops and the stakeholder review meeting, researcher's notes, as well as evaluation sheets filled out by the participants of the stakeholder review. The transcripts and researchers' notes were thematically coded and analysed using NVivo. The researcher's notes were used to inform the analysis, but were not formally included in the dataset for thematic analysis.

The analysis produced both pre-defined and emergent themes. The pre-defined themes reflected the three criteria used for the Toolkit evaluation: clarity, usefulness and feasibility and also included each of the components of the Toolkit (for example Process Model, LFI Framework, and so on). The emergent themes focused around participants' suggestions for improvement of the various components of the Toolkit, the Toolkit as a whole, and ideas for future development. For each component of the LFI Toolkit, data were compared by site and then cross-checked with the other site to identify within-site and between-site similarities and differences. The scoring sheets collected during the Stakeholder review meeting provided data assessing each Toolkit component. The analysis of scoring sheets included calculation of simple mean scores that were used to further inform decisions focusing on the areas of the Toolkit that needed development and clarification. These codes were checked for reliability.

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Initially, a sample of thematic codes were considered individually by each of the three researchers, then were discussed, compared and refined by reaching consensus about each individual categorisation. Any disparity around a specific categorisation within a particular theme was resolved through team discussion and negotiation. Once overall agreement on the thematic categorisation was reached for each subset of the data, the remainder of the analysis was carried out by one of the researchers.

4. Findings

In this section, we discuss findings from the workshops and the Stakeholder Review Meeting. Workshop participants' quotes are coded in line with the site they worked at (S1=Site 1, S2=Site 2, P1=participant 1, P2=participant 2, etc.). The quotes from the Stakeholder Review Meeting participants are coded by number: SR-S1=Stakeholder 1, SR-S2=Stakeholder 2, etc. Researcher's remarks are coded as 'R'.

The first workshop centred on the LFI Guidelines. Overall, the data suggests that participants considered all guidelines useful. Several changes in the wording were proposed to improve the clarity of the Guidelines. Participants marked 24/48 guidelines as unclear. In addition, participants suggested revisions to enhance the feasibility of some guidelines. The participants' feedback on each guideline was compared between both test sites to ensure that the next iteration represented the diversity of views from the different company settings. In addition to feedback on the wording, participants made suggestions for improvements to a range of other aspects of the Guidelines (21 specific suggestions). For example, participants

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from both sites suggested that the Guidelines should include a note on clarifying and standardising a definition of a near-miss:

> *S1-P1: One thing I feel that's been missing is a clear understanding, for probably just everyone has an understanding of what a near-miss is and what an incident is. It's like we all have our own near-miss tolerance and I think with near-miss reporting and incidents, I have an interpretation of a near-miss. We've used the 'hammer on the beam' example - to me that's not a near-miss.*
>
> ***R: Standard definition?***
>
> *S1-P1: Yes, if it falls and misses somebody it's a near-miss. If it hits somebody, that would be an incident. But you can spread it and cut it up in different ways. And I think there's an opportunity to educate people. And I think there should be a standard definition about a near-miss.*

Similar suggestions were made at Site 2:

> *S2-P1: We do see quite a lot [of reports] where it's reclassified. It may have been put in as a near-miss and the HSE Advisor might reclassify it as an observation or vice versa, so there isn't that clarity.*
>
> *S2-P2: That wouldn't take a lot of work, would it? Just a few workshops on clearly defining either an observation or a near-miss.*

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The second workshop centred on testing and discussing an LFI Engagement Exercise on reviewing an incident alert. The experiential learning activity stimulated extensive discussion among the participants, not only around the incident alert in question, but also around the general process of producing incident information and disseminating it at the site. Participants identified several actions to improve the incident alerts. Overall, the findings suggest that the participants viewed the LFI Engagement Exercise as useful.

Following the test-run of this Engagement Exercise, the participants were split into groups, given written instructions for running all four exercises, and asked to discuss the clarity, usefulness and feasibility of the instructions. Overall, the groups viewed all exercises as useful and clear, suggesting only minor changes and clarifications to wording (25 changes in total). The participants also suggested several changes to the format of the Engagement Exercises (9 suggestions) and these were incorporated into the next draft Toolkit. For example, participants from both sites thought that the first exercise, which was designed to examine the whole LFI process at a site and to develop ways of improving it, should be done only with a cross-section of employees rather than with separate work-groups:

> *S1-P2: So 'the workshop can be run with a cross-section of group of employees representing various work groups or with existing work groups'. We had a bit of struggle with the 'existing work groups', because if you do it with just segregated group, does that actually give you the learnings across the whole process? And we didn't think so. We thought that it should be run as a cross-sectional. Unless they're*

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looking for just their portion of it, but the way that this reads is that you're looking at the whole site processes. So, that's the first item.

S2-P4: The only thing we would say is the 'Who's it for?' could be clearer with the cross-sections from various disciplines. You would need that, you'd need different inputs.

Next, the revised LFI Toolkit was sent to the participants in advance of the Stakeholder Review Meeting and extensively discussed at the meeting. Findings suggest that the participants viewed the Toolkit as offering a significant potential and benefits in terms of improving LFI processes and practices as well as general safety. The participants made 23 general remarks on the Toolkit and 39 specific suggestions for additions and clarifications to wording. Of these changes, 9/23 general remarks and 28/39 specific suggestions were integrated into the next iteration of the Toolkit as they were found to increasing the potential impact, usability and clarity of the Toolkit. The remaining suggestions were not incorporated because they were out of scope or because they contradicted empirical research. An example of a specific suggestion that was taken on board and addressed in the Toolkit was the idea to de-emphasise the focus on only shop-floor level employees or safety managers, and clarify that the Toolkit impacts everyone across the site.

SR-S1: When I read it, it was very focused on the people on the floor. When we do investigations the findings that really have a learning potential for improving the organisation and you're going back to management the way we are organised, and

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where's line management in this model? It's very focused on changing behaviour of the people who are out there working on the floor.

The comment was followed by a discussion where the majority of stakeholders strongly agreed that using language that clearly highlights shared ownership and responsibility for LFI across different layers of the organisational hierarchy was very important. Consequently, sections of the Toolkit that discussed who was to engage in LFI were updated to clearly state multiple and cross-organisational shared responsibility.

An example of a suggestion that was not incorporated in the Toolkit was a reference to risk-based prioritisation of learning activities:

SR-S3: To be feasible it needs a risk-based application, especially for Workshops B-D and in the determination of the work groups that should receive appropriate incident alerts. It should be based on the those incidents/near misses which involve activities/processes / technology similar to those on the site and for which an incident under similar circumstances would bring severe safety or environmental consequences.

Although the use of risk-based matrices for safety prioritisation is wide-spread, this participant's suggestion was not included in the Toolkit as it contradicts findings from research. There is no evidence of a correlation between the learning potential of an incident and the level of its hazardousness, therefore focussing on the events with potential severe safety and environmental consequences only might limit learning from smaller, low-impact

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events that could be of great learning importance for the organisation long-term (Drupsteen, Groeneweg, & Zwetsloot, 2013).

In addition to findings based on the data collected during the Stakeholder Review meeting directly, scoring sheets sent by email were also analysed to provide further evidence. The findings from the scoring sheets are summarised in Table 2 (mean scores, out of 5). Although the data are limited to 6/17 participants (35% response rate), we think it useful to include these figures here to indicate the overall level of support for the Toolkit. The findings from the scoring sheets were used to inform the discussions and feedback from the Stakeholder Review Meeting.

Table 2. Stakeholder evaluation of the Toolkit (N=6/17, mean scores, out of 5)

Toolkit component	**Clarity**	**Usefulness**	**Feasibility**	**Overall**
LFI Process Model	4.33	4.33	4.00	4.22
LFIQ	3.83	4.17	3.50	3.83
LFI Guidelines – Overall	4.17	4.17	4.17	4.17
LFI Guidelines – Reporting	4.50	4.33	4.00	4.28
LFI Guidelines – Investigating	4.33	4.00	3.83	4.06
LFI Guidelines – Developing incident alerts	4.33	3.83	3.67	3.94
LFI Guidelines – Disseminating	4.33	4.33	3.83	4.17
LFI Guidelines – Contextualising	3.67	3.83	3.33	3.61
LFI Guidelines – Implementing actions	4.00	3.83	3.83	3.89
LFI Engagement Exercises - Overall	4.17	3.67	4.00	3.94

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LFI Engagement Exercise 1	4.00	4.00	4.17	4.06
LFI Engagement Exercise 2	4.60	4.00	4.20	4.27
LFI Engagement Exercise 3	3.80	3.40	3.00	3.40
LFI Engagement Exercise 4	4.20	3.80	3.80	3.93

The component that achieved the best overall evaluation score was the LFI Process Model. The participants highlighted the process model as the most useful and implementable at their site because it helped critically rethink the whole LFI approach enabling identification of gaps in processes and practices. The LFIQ scored somewhat less. The participants suggested that some LFIQ questions could be misinterpreted in other cultural contexts. The participants of the Stakeholder Meeting debated the feasibility of running a moderately long questionnaire such as LFIQ at their sites, but agreed that collecting such data on the LFI process is important concluding that an online questionnaire of that length would be warranted. Overall, findings from the Stakeholder Review Meeting indicated that the Toolkit components were clear, useful and feasible, with only minor changes needed to improve the Toolkit.

In addition to the suggested changes, the participants highlighted several key questions to be explored in future development of the Toolkit:

- How will the Toolkit be used in different cultural and organisational contexts?
- What are the ways to measure actual change in behaviour after the LFI process is completed?
- How best to identify the learning potential of an incident before the LFI activities are developed?

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5. Conclusions

The paper described the process of developing and evaluating the LFI Toolkit to improve the LFI process and practices in organisations. The Toolkit sought to address key issues in the way LFI is currently conceptualised in organisations and to help organisations rethink these on the basis of adult learning principles. Specifically, the LFI Toolkit sought to help organisations foster continuous, experiential and participatory learning enabling a broader employee engagement, sensemaking and contextualisation. The findings provide insight into the clarity, usability and relevance of the LFI Toolkit and feasibility of applying it in other companies.

The participatory co-design methodology adopted from the early stages of the Toolkit development offered qualitative and iterative changes to the product allowing for recognition of local knowledge enhancing long-term usability of the Toolkit. This approach allowed for inclusion of views of a diverse sample of practitioners in the energy sector industry as well as from professional safety organisations, acknowledging the local context and expertise. The Toolkit was subject to employees' scrutiny and formative evaluation, whereby the elements were approved or challenged. The participatory co-design approach helped foster an environment for surfacing tacit knowledge of the industry context which is not represented in formal and codified knowledge usually accessible to university researchers. It was important to establish good working relationship within the co-design sessions so that they could be based on openness and trust between the researchers and the participants. The iterative nature of the sessions allowed for the impact of the research to be constantly evaluated. In this way, improvements were made at different stages of Toolkit development. Such integrated

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development of the Toolkit represents a productive approach in engaging the employees and stakeholders translating research into practice.

The limitations of the study stem from the difficulties of conducting research in real-world workplace settings (Bruneel et al., 2010). The relatively small size and limited diversity of the groups imposed limitations on the breadth of findings. The study would have benefited from more participants and from the involvement of other sites. Although effort was made to include a greater variety of respondents, the use of a mixture of stratified and convenience sampling was the most pragmatic option (Denzin & Lincoln, 2005). Although the sample size was small, we undertook steps to compensate by triangulating various sources of data that strengthened the validity of the findings (Tashakkori & Teddlie, 1998). The study used qualitative data from two co-design workshops at the two test sites and the Stakeholder Review Meeting and the quantitative data from the scoring sheets in order to develop and evaluate the LFI Toolkit. The benefits of data triangulation may have been limited by the fact that the qualitative and quantitative data were provided by the same participants. However, the consistency of views of the same participants involved in the process and their detailed familiarity with the LFI Toolkit outweighed the potential limitations of having the same respondents. Only one of the four Engagement Exercises could be tested within the co-design workshop format; comments were collected from practitioners for the remaining three Engagement Exercises. Finally, the findings may have been affected by self-selection bias, whereby only those employees who are already engaged in safety and learning from incidents issues may have volunteered to participate in co-development of the toolkit. Those who are not engaging with safety issues may have not been included. It is possible that this pattern would be replicated when a toolkit like this is used in organisations, since engagement with

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the toolkit is voluntary. How could those people be encouraged to engage with learning from incidents? One way would be to understand the reasons why they are not engaging examining their individual motives, values, constrains and needs and tapping into their specific experiences and workplace contexts.

Future studies should investigate the validity and usability of the other Engagement Exercises and determine the impact of the overall LFI Toolkit on behaviour of employees in various contexts. A further trial of the Toolkit in various contexts – including in non-Western countries and cultures - is needed to develop a better understanding of the Toolkit's full benefits and its applicability across a range of sectors.

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