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Development of the Framework for a Self-Assessment Tool to Assess the Effectiveness of Reporting within a Safety Critical Industry

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Development of the framework for a Self-Assessment Tool to assess the effectiveness of reporting within a Safety Critical Industry

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ABSTRACT: There is currently a large amount of literature to provide guidance on the areas that should be considered when developing a reporting system. However there is no current methodology of monitoring the performance and compliance of a reporting system.This paper outlines the development process for a Self-Assessment Tool (SAT) assessing the effectiveness of safety reporting within safety critical activities. The paper outlines the need for such a self-assessment tool, the areas that will be assessed (and the rationale behind their selection), selection of the platform and finally the planned validation exercises for the paper

1 INTRODUCTION

Learning from mistakes and incidents has long been seen as a cornerstone of safety management as far back as the Heinrich (1941) triangle for safety management where he shows that for each major accident or incident there are many near misses and unsafe conditions.

Therefore it is crucial to ensure that each and every hazard is identified and assessed as demonstrated within the Carter and Smith (2006) statistical model for accident causation whereby an unidentified hazard will have both an unknown severity and likelihood and therefore an unknown risk to the organisation. In order to ensure that organisations have as many risks identified as possible, Safety Management Systems (SMS) are increasingly rolled out within organisations and more recently becoming a regulatory requirement (Civil Aviation Authority (UK), 2010; Edwards, 2005; Mitchison & Papadakis, 1999; Stolzer, Halford, & Goglia, 2010).

One of the common features of a SMS is a system of eliciting hazard reports from staff within the organisation and using these reports to augment the risk model within the organisation (Edwards, 2005). Therefore a key factor in the performance of a SMS will be the quality of data being submitted via hazard reports from staff.

There is a lot of existing literature addressing the steps organisations should consider when rolling out a SMS reporting system focusing on both the cultural (Dekker & Stoop, 2012; J Reason, 1997; James Reason, 1998, 2004) and the design and implementation of a reporting system (Lawton & Parker, 2002; Williamsen, 2013). While this literature can provide a large amount of guidance for the development of a reporting system, there is no unified methodology to assess a reporting system and to provide weighting on the importance of these factors.

Within Safety Management there are two primary approaches to reporting, Proactive and Reactive. Proactive approaches are intended to identify risks before they lead to a loss within the organization, reactive approaches in comparison report after a loss has happened with the intention of preventing a reoccurrence of similar incidents (Johnson, 2003).

Reporting has been moving towards a proactive approach, previous methodologies such as the Maintenance Error Decision Aid (MEDA) (Boeing Airplane, 2000) were focused on analysing an incident after they it occurred by providing taxonomy for the assessment of an incident. These approaches only produce a safety benefit after an unsafe incident has happened which is somewhat paradoxical. Proactive techniques allow the robustness of a system to be monitored and should allow the risk assessment to be constantly updated. This approach is also reinforced by industrial standards such as the which require a constant review of standards. In order to maintain performance of a SMS reporting system steps need to be taken within the organisation in order to ensure that quality reports will be continuously submitted into a SMS. The SAT is intended to unify the existing literature into an assessment methodology, which will provide criteria for a reporting system to be scored against and, crucially, provide a weighting on the impact of influencing criteria based on industrial case study experience.

Self-assessment tools have been previously used within organisational human factors case studies. A notable example can be found in Nieva and Sorra (2003) whereby a self-assessment approach was successfully used within a hospital environment to provide a way of assessing the safety culture. The self-assessment tool developed to assess safety re-

porting will look at a broader focus compared to the safety culture assessment in Nieva and Sorra (2003) however the concept has been used successfully within an organisational human factors case study.

The SAT will be developed in the following steps:

1. Identification of Criteria and Scoring
2. Prototyping and initial development
3. Industrial Feedback & Validation

The SAT is intended to be used across a variety of different industries therefore certain sections will have to be adapted to suit the industrial context. The most notable of these will be the regulatory environment category. Initially the SAT will be targeted to the Biotech manufacturing and the Aerospace Maintenance Repair and Overhaul organisations.

2 SELF ASSESSMENT CRITERIA

A review of available literature was carried out which exposed 6 high level evaluation criteria for the SAT which are shown in Table 1

Table 1 High Level Assessment Criteria

Evaluation Criteria	Sub Criteria
Meeting the Requirements of the Regulatory Environment	Regulatory Requirements
	"Good Practice"
Usability of reporting forms and feasibility of reporting Procedure	Reporting Form Design
	Reporting Procedure
Provision and value of Feedback	Feedback loop To Reporters
	Value of Feedback for the organization
	Value of good catches to the organization
Education and Promotion of the Reporting System	Training
	Reporting Awareness
Motivation	Safety Culture
	Stimulation of Reporting
External Influences from the Industrial sector	External factors

A literature review was carried out covering the thematic areas that were identified and shown within Table 1.

Once a high level overview of a reporting process was established the high level categories shown in Table 1 started to emerge. Once these categories were established the literature review on the evaluation criteria shown in Table 1was carried out and the individual assessment criteria were developed.

In each of the categories there are a number of statements, each of these statements will reflect the best practise that has been identified within the literature, the assessor will then rate each of these statements reflective of their organisation.

2.1 *Meeting the Requirements of the Regulatory Environment*

The Regulatory Environment will vary depending on the industry that is being assessed. Typically safety critical industries such as Aerospace and the Process industry have fairly explicit regulations governing the use of reporting systems within Safety Management. Obviously the regulatory environment will depend on the industry the SAT is being applied to; therefore initially two industrial regulatory environments will be proposed the aerospace maintenance industry and the biotech industry

Within the aerospace industry the international governing body of civil aviation ICAO produces a Safety Management System manual, which calls for a methodology to collect information from staff with regards to incidents that can occur within the working environment. EASA Part 145 specifically requires for a Safety Management system that involves collecting information on incidents, near misses and hazards within the organisation. This requirement is reflected within the industrial best practice, the overall industrial body looking after the interest of international civil aviation ICAO (2006) published a Safety Management System Manual, which also calls for a methodology to collect information from staff with regards to incidents that can occur within the hanger. However both the EASA Part 145 regulations and ICAO do not provide any specific guidance on the steps that should be implemented to stimulate reporting within an organisation and solely provide technical requirements that should be fulfilled. However regional bodies operating under the EASA framework do provide additional guidance material, an example of this can be found within the United Kingdom Civil Aviation Authority's CAP716 publication (Civil Aviation Authority (UK), 2006)

For the Process industry; the European Union Seveso (E.U, 2012) directive requires for a safety management system that incorporates near miss reporting and management. However the idea of including near misses (which may lead to an accident) in the safety management system is relatively new.(Jones, Kirchsteiger, & Bjerke, 1999)**.** Furthermore Seveso incorporates mandatory reporting of accidents involving hazardous substances onto a Europe Wide register called the MARS database. (Major Accident Reporting System) which is a publically available database to facilitate "*the exchange of lessons learned from accidents and near misses*

involving dangerous substances" (European Commission, 2012). Again the regulations simply state that an organisation has to have an accident and near miss reporting system, however there is no direct guidance as to how organisations should set up and monitor the a reporting system so the SAT could provide guidance that could plug this gap in the literature.

Regulations can also require organisations to maintain mandatory reporting. The EASA Part 145 regulations for aerospace maintenance for instance require organisations to perform "Mandatory Occurrence Reporting" wherein certain incidents and/or near misses that concern airworthiness of an aircraft (EASA, 2013) will also have to be considered in a reporting system.

The regulations provide a bare minimum level of safety management. For instance the EASA 145 regulations requires that there is a reporting system implemented as part of the SMS and management are encouraged to promote safety management as one of the pillars of safety management depicted within the International Civil Aviation Organisation (2013) manual for Safety Management, however safety managers could benefit from more concrete guidance on safety promotion and a way to ensure that they would be compliant with regulations. . Previous industrial experience such as Cromie et al. (2012) shows that a lack of management involvement in a SMS can seriously affect the performance of the SMS. While the SAT will go considerably beyond what the regulations currently provide, due to the impact non-compliance can pose to an organisation it would be negligent not to consider compliance as an assessment criterion.

In addition the SAT could be extended to provide guidance to Safety Management as to how to assess these areas using techniques such as task modelling as described within (Builes, Balfe, Leva, & Douglas; Douglas, Cromie, Leva, & Balfe, 2014) and provide a form of assessment beyond what the regulations currently provide for.

2.2 *Usability of reporting forms and feasibility of reporting Procedure*

This concerns the design of the reporting form and the procedures surrounding reporting. There has been previous research into design considerations for the reporting form The method of reporting was highlighted as a factor that can affect the uptake of reporting: reporting forms that increase the level of paperwork, do not allow the reporters to report the details they want to report,reporting systems that are intrusive or take them away from their day-to-day operations can all affect reporting. (IMO, 2008; Leveson, 2011; Oltedal & McArthur, 2011). Methods like the day-to-day methodology as described within Leva, Cahill, et al., (2010) are intending to solve this problem by providing a way of integrating reporting in the daily operations. In this case by developing a web based reporting system that integrates existing paperwork requirements with the report collection system and also provides a benefit to staff by using the reporting data to produce a shift handover briefing automatically which could simplify the process for staff. The reporting method should be easily accessible, should not be time consuming and should be designed to slipstream into their daily work practises. Kongsvik, Fenstad, & Wendelborg, (2012) highlight that some industries such as the maritime industry have large levels of paperwork and are reluctant to increase the amount of paperwork, which suggests than an approach that would utilise existing paperwork as a method of data collection may be a good way forward. Lappalainen, Vepsäläinen, Salmi, & Tapaninen, (2011) conducted a survey of attitudes to reporting within the Finnish maritime industry and found that reporting "*requires excessive paperwork, and thus maritime personnel felt that the safety management system burdens them with useless practices"* (Lappalainen et al., 2011, p. 9). Long forms, complicated procedures or insufficient time within their workflow are also identified as a deterrent in Evans et al., (2006).

The form design and procedure is possibly the factor that is under the largest level of influence from safety management. Research within industry has commonly found that a poorly designed form can be a significant barrier to reporting (Kongsvik, Fenstad, & Wendelborg, 2012) and that organisations will frequently purchase commercial-off-the-shelf solutions (Douglas, Leva, & Cromie, 2015) for their safety management systems. These approaches may not be suitable for all industrial environment and can potentially pose a significant barrier to reporting when compared to bespoke solutions that are designed with the specific industrial context in mind, an example of this can be found within Leva, McDonald, Sordo, Righi, and Mattei (2014) where a proactive reporting and risk management system was implemented around existing work practises to ensure that the act of reporting does not lead to an increase in paperwork and workload ensuring that staff have the resources to submit reports and ultimately there will be better data beings submitted into the SMS.

The SAT can provide a method of assessing the design and application of a reporting system with regards to its industrial context and to expose areas where management will be able to augment the SAT to improve its application within industry.

2.3 *Provision and value of Feedback*

The importance of adequate feedback within the reporting culture has long been cited as an important factor for reporting. In Evans et al., (2006) over two thirds of the interviewed hospital reporting staff had identified lack of feedback as the greatest deterrent to reporting within the hospital. This is also reflected by O'Leary, (2002); Reason, (1998, 2004) which all stress the importance of feedback within the reporting culture. Furthermore the ISO, (2011) 31000 standard for risk assessment stresses the importance of feedback within all levels of the risk assessment process, reporting could form part of that process. The presence of feedback to reporters is a key consideration for the health of a reporting system

Reason, (1991, 1997) highlights that organisations should keep reporters up-to-date with any actions that are taken based on reports received. Seeing that their reports are analysed and used to actively improve safety can significantly improve the reporting culture within an organisation.

The role of feedback to reporting was also referenced in the (Cooper, 2000) model of safety culture using the principle of reciprocal determinism wherein management attitudes can affect the level of reporting, and reporters can also influence management attitudes.

Feedback can also be provided through action, for example a member of staff submits a near miss report citing an unsafe scaffolding, the scaffolding is replaced quickly after the report is submitted and crucial the reporter has seen that their report produced an improvement in safety (Johnson, 2003).

While the existing literature stresses the importance of feedback, for instance both Reason and Johnson stress that reporting will decline significantly without a decent level of feedback; there is little literature on how this feedback should be delivered. There has however been research into possible methods such as how to use visual feedback such as dashboards, newsletters etc. but there is a gap in the literature that actually looks at the effectiveness of the feedback. One of the intentions of the case studies is to ask staff in different industries about how they would like to see feedback and the effectiveness of different approaches with a scope of developing an ability to assess the suitability of the feedback method as part of the SAT.

There is also organisation-wide feedback carried out in some organisations (Johnson, 2003) for example a European airline publishes frequent "news letters" (O'Leary, 2002) that provide feedback that is seen by the whole organisation based on error reports and their subsequent investigations. This can act as a way to stimulate reporting organisation wide as staff will see that reports are taken seriously by management. While this method may work for a large organisation such as an airline a SME may not simply have the numbers of incidents and/or safety information to make a newsletter viable or enough resources to produce one. An example of news letters can be found within the Chirp (Confidential Human Factors Incident Reporting Programme) is an aviation (since 2003) and maritime reporting programme. (CHIRP Charitable Trust, 2007) It is an independent reporting system for all individuals employed or associated within these industries. The identity of reporters to CHIRP is kept confidential, information about the report is made accessible to the industry as freely available feedback newsletters that are sent out to the various industries within aerospace (Such as Commercial, General Aviation, Maintenance) CHIP gets a good level of response as reporters are confident it will be confidential, and that the reports they make will be helpful to their colleagues within their industry. (CHIRP Charitable Trust, 2007) This reinforces the ideas put forward in Reason (1997) in where feedback is important to encourage reporting. CHIRP is always managed by a charity that is separate and unrelated from the Airlines, Air Traffic Control providers, Maintenance Providers and Regulatory authorities, so there is no fear of ramification.

As with the design and procedure criteria, the feedback is another area which is under the influence of management. Existing regulations and industrial standards including ISO31000 (Iso, 2009) frequently call for feedback but provide no real guidance as to how this should be delivered within the organization despite how critical feedback is to the performance of a reporting system (Evans et al., 2006; McAfee & Winn, 1989). The SAT could form a way for management to assess the level of feedback they give, determine its effectiveness and to identify ways of improving the feedback given within the organization.

2.4 *Propagation and Education of Reporting Systems*

Many organizations are stimulated to set up a reporting system either by regulatory or industrial best practice. Leveson (2011) highlights that instructions to organizations to develop or increase use of a reporting system are commonly found in official reports to incidents and naturally organizations keen to prevent incidents from reoccurring will implement a reporting system as per the investigation recommendations. However organizations frequently fail to keep a sustained reporting system in place and the uptake of a reporting system frequently declines after a period of time as shown in industrial case studies such as in Cromie et al., (2012) where the use of a reporting system declined

shortly after the system was implemented, therefore in order to achieve a consistent improvement of safety from a reporting system; organisations will have to implement steps to ensure that staff will continue to make reports after it has been implemented.

The role of management in the education and propagation of reporting has frequently been citied within the literature. For example in Schein, (1973) it is argued that management should set an example for the safety behavior within the organization. In the reporting context this involves management encouraging staff by setting the example from above and providing endorsement and support from the staff within the organization onto the importance of reporting and to encourage "safe" behaviors in this way.

Smith (1999) found that there is a major flaw" in the idea that people will do what you want if you positively reinforce the behaviour, it can potentially have the opposite effect, people offered money to complete a simple task took 50% longer than those who were asked to do it for nothing.

There is debate within the literature regarding the roles of mandatory and voluntary reporting systems. Cohen, (2000) provides evidence from industry that fully voluntary reporting systems actually produce better quality reports than mandatory-reporting systems would produce and could also serve as an indicator for the safety culture within the organization as reports coming in a voluntary system will be submitted as a result of a good attitude from a reporter.

As discussed within the literature and industrial experience, the use of mandatory approaches to reporting do not appear to provide a concreate improvement in safety due to the key driving factor is to meet a metric and not to improve safety within the organization (Croxon, 2014), therefore the SAT will aim to assess the various criteria that will allow an organization to move to a non-mandatory approach to reporting. Mandatory approaches are common within industry (Douglas et al., 2015) however they frequently produce large amounts of "junk" reports with little safety benefit and require considerable staff workload to pick out the useful report. Therefore the SAT can be used as a tool to assist the organization in moving to a voluntary approach to reporting by assessing the cultural and educational initiatives within the organization and to suggest additional steps that could be rolled out.

2.5 *Motivation*

There are several motivational factors that can influence the likelihood of a person to take the time and effort to submit an accident report into the system. These motivational factors have been explored by studies such as McDonald, Corrigan, Daly, & Cromie (2000) that developed the "Stamina model|" for human factors which included elements such as the individual and organizational roles in human factors.

Management have to be seen to be engaged and leading the reporting system (Kotter, 1996) by both providing feedback to the reports and by leading through education and other approaches such as newsletters, safety dashboards etc. The safety culture within the organization has a critical role in the success of a reporting system. Studies such as Waring (2005) highlight the cultural barriers than can exist within healthcare organisations and the challenges these barriers can bring to the successful uptake of a reporting system. Within hospitals there are steep hierarchies within staff, and Waring (2005) found that high-level staff like consultants were highly unlikely to make reports while low level staff such as junior doctors were far more likely to do so. Therefore there has to be considerable steps implemented to overcome these deep-rooted cultural concerns. A reporting system will only generate a good level of response throughout the organisation if there are no cultural barriers that will negatively affect a group within the organisations confidence to report.

One potential way of improving the culture to the point where people will make reports without the fears of ramification would be to establish a "Just" culture (Dekker, 2012). A just culture accepts that human error is inevitable and is a policy where honest mistakes can be reported without any fears of ramifications in the hope of improving safety. However the "justness" has to be balanced by both sides so dangerous acts of negligence also have to be dealt with accordingly through culpability agreements etc. (Dekker, 2012; Reason, 1997).

A Culpability agreement is an agreement with staff and management. An example can be found in Baines Simmons (2011) and it includes the following categories.

A Culpability agreement would assist in the development of a just culture, as staff will be briefed that genuine errors and concerns are tolerated and unacceptable behaviours are not tolerated. As reported within Walton (2006) junior members of staff may be reluctant to highlight errors or potential errors by a more senior member of staff, a culpability agreement that encourages non-punitive reporting to improve safety may work to overcome this potential barrier.

A popular methodology of attracting staff to use a reporting system is the "Behavior Based Safety" approach. BBS emerged in the 1980s as a simple way to encourage staff to behave in a "safe" manner (Geller, 2005). In Lingard & Rowlinson (1997) Behavioural Based Safety is described as the analysis

of hazards associated with an employee's job is carried out and specific behaviours representing safe and unsafe behaviours are identified. These behaviours are then made to be the bases for the measurement of the employee's safety performance. Measurement can be carried using a specific instrument or by observation in the work place. Motivational activities that focus on the desired behaviour are then implemented and the monitoring is continued for effectiveness. These activities could exist as rewards for positive safety behaviour, such as a cash reward for providing a report on a good near miss (Lingard & Rowlinson, 1997). While the intention of BBS approaches is clear they run the risk of simply rewarding an individual behaviour but not changing their attitude towards safety. In fact Smith (1999) argues that positive reinforcement can cause resentment between management and employees. Due to the nature of BBS approaches the SAT should aim to stimulate organisations to move away from these action reward approaches since BBS approaches have the risk of simply rewarding a single "good" behaviour but fail to encourage a reporter to develop a safer world view and mind-set which is a key potential benefit of a reporting system. One of the ultimate aims of an industrial case study that is described within Douglas et al. (2015) is to assess the effect safety reporting has on hazard perception with the aim of developing the self-assessment tool as a way to help organisations sustain reporting without the need for BBS approaches.

2.6 *External Factors*

The external factors criterion focuses on industrial factors outside of the organisation. These can range from the impact of disasters elsewhere within the industry to ligation concerns (Waring, 2005). While these factors aren't under the influence of the management, they can have a profound impact on the performance of a reporting system within industry and as a result the management should implement initiatives in order to lessen their effects.

The SAT can therefore consider the impact of a incident, litigation etc. on the health of a reporting system and possible initiatives that could be implemented by management in order to mitigate some of these external effects.

3 NEXT STEPS

Now the assessment criteria for the SAT have been identified the tool can be developed. Once the assessment criteria have been selected the next step will be to select the scoring system for the self-assessment tool. Due to the role reporting has within safety management systems it is proposed to implement a model of safety management maturity as the scoring system for the self-assessment tool. The Safety Culture maturity model (McCusker, 2001) developed by the UK health and safety executive provides five levels of safety culture, ranging from an emerging safety culture (Level 1) to a continually improving safety culture level 5. Each level of the safety culture features an improvement in both consistency and safety culture from the previous level. While this maturity model is focused at general safety culture, it will still be suitable for the use of reporting culture as reporting culture is widely accepted to be a component of the wider safety culture (James Reason, 1998; Wang & Sun, 2012). The McCusker (2001) maturity model was adapted by A. D. Swain (1983) based on experience within the aerospace industry. The Edwards (2005) model consists of the following five levels of safety management

- No or Very Little Safety Management
- Just the Basics
- Managing Safety Reasonably Well
- Proactive safety and efficiency
- Innovative on safety and efficiency

The levels from the Edwards (2005) model are more suitable for the use in self-assessment while still based on the accepted model for safety culture maturity. These 5 levels from the Edwards (2005) will be used to provide a quantitative score for each of the criteria. This can then be used to provide a quantitative method for assessment and using techniques such as dashboards etc. they can then be used to help managers monitor the performance of the reporting system and provide guidance for improvement.

3.1 *Validation*

The tool will be validated throughout the development lifecycle of the tool. The criteria will be validated using an example of a deficient reporting system scenario. A number of participants will be asked to score the various sections based on the mocked up case study and an inter-rater reliability analysis will be used to assess the effectiveness of the self-assessment tool. The Validity of the SAT will also be monitored during the implementation phase based on focus groups of users.

The primary area of validation will come from case study experience in the Biopharma and Aerospace Maintenance, Repair and Overhaul industries where action research approaches have been used to expose areas for the SAT and to determine impact weighting for the assessment process. The research techniques that have been used involve semi-

structured interviews, task modelling and a bespoke survey methodology as outlined within (Douglas et al., 2015). These approaches will be used to validate the assessment criteria and also to determine the score weighting that will be used to develop the assessment report.

3.2 *Tool Platform*

The tool will be developed using an online web based system which has been demonstrated to be successful in previous research projects such as the development of the "daily journal" safety management system as described within Strauch (2015) where a similar platform approach was used successfully within an organisation.

Since the SAT is seen as part of an overall methodology to assess reporting it will share the platform with the SCOPE tool and it is planned to have a concept of interoperability for the self-assessment tool. SCOPE is a software tool developed by TCD to allow a process to be modeling using a BPM similar approach (Builes et al.; Douglas et al., 2014), integrating the SAT with this platform will assist within the overall development process.

It is intended for the tool to be used by safety managers, therefore it is envisioned that the criteria assessment score will be outputted to a dashboard system that will provide a quick and easy overview on the deficiencies within their reporting system and will provide an easy indication on where improvements can be made. The dashboard approach will be particularly useful in the process of ensuring regulatory compliance which is cited within the literature as a key driver for the rollout of a reporting system (Leveson, 2011).

4 CONCLUSION

There is currently a large amount of literature to provide guidance on the areas that should be considered when developing a reporting system. However there is no current methodology of monitoring the performance and compliance of a reporting system. This paper depicts the design process that will be followed in developing this new methodology of assessment. Once a prototype has been developed then the assessment tool can be validated and implemented as part of the overall InnHF methodology

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