EXPLORING THE VALUE IN NEAR MISS REPORTING FOR CONSTRUCTION SAFETY

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Near miss reporting forms part of most contemporary Safety Management Systems across many industries, including construction. It is often seen as a leading indicator that demonstrates attention to safety through the vigilance and commitment of the workforce, the quantity of near misses raised often providing the measure of its value. Its prominence can be attributed to its positioning as the 'foundational layer' in Heinrich's Accident Pyramid, although the causality also often ascribed therein is dubious. However, such reporting also brings problems of system misuse as a tool for blame, increased administrative burdens on safety professionals, and questions have been raised about the contribution such process actually bring to practice. Yet logic dictates that there should be some value in near miss reporting, however the process of reporting, including when and how reports are raised and what information is requested, will inevitably influence such value. A large database of near miss reports (n=3,519) submitted over two years to a UK civil engineering contractor has been analysed to reveal high level patterns within the data. Findings reveal a number of issues with the system and its data suggesting problems for both workers and safety managers, and reflecting problems also identified in other industries, and suggesting areas of focus for the development of a system able to overcome such problems in practice.

Keywords: leading indicators, near miss reporting, safety, value

INTRODUCTION

A Near Miss (NM) can be defined as: the combination of unsafe conditions and unsafe actions that arise at work in an event that leaves workers defenceless against harm, but which did not actually cause harm, but may or may not cause property damage, damage to the environment and/or loss of time. It is therefore perhaps unsurprising that Near Miss Reporting (NMR) is a common feature of contemporary safety management systems across all industries, including civil engineering and construction (Oswald *et al.,* 2018). Often considered a leading indicator, and thus evidence of a pro-active approach to safety (Lingard *et al.,* 2017), companies across the world have eagerly adopted or developed NMR systems and processes for use within their operations, looking to capture NM knowledge and place mitigations in place to avoid any reoccurrence with potentially more serious consequences.

However, research has shown there can be problems inherent in NMR, and it can be suggested that any impact on practice has yet to be fully realised. For example, a general lack of rigor in many such systems has been noted as problematic (Wirth and Sigurdsson 2008), whilst others such as Gnoni *et al. (*2017:158) debate whether the

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number of reported NMs can ever be '… credibly used as a positive or negative indication of safety'.

Yet there remains sufficient evidence from both within and without the construction industry to not yet 'throw the baby out with the bathwater', and so efforts should perhaps instead be directed at the enhancement and development of NMR systems to the point where they are able to demonstrably add value to safety management on construction sites. This paper presents the first steps in such a project, with the overarching research question that asks, 'where is the value in near miss reporting?', and shares early findings from the analysis of a large body of data produced by a 'typical' NMR system of a large UK civil engineering company. Further research is also proposed to support the overarching project aim: to develop a NMR system able to enhance the value of NM reporting in the construction industry.

CONTEXT

The Case for Near Miss Reporting

Underpinning the popularity of NMs within occupational safety management is Heinrich's (1931) Accident Pyramid. NMs form the bottom layer of this pyramid, a set quota of NMs apportioned against relative quantities of minor then major injuries, with one fatality at the top. A variety of ratios have been used in this pyramid over time, for example Phimister *et al.,* (2003) focused on the bottom of the pyramid and asserted that there were 10 minor injuries, 60 incidents resulting in property damage or loss, and 600 incidents without loss or damage for every, one incident of serious injury. However, although the numbers change the overarching approach in the application of this model ascribes a causality within the pyramid that Heinrich himself cautioned against (Oswald *et al.,* 2018). Despite this, the misapplication of this theory still continues, and has resulted in many companies trying to 'capture' as many Near Misses as possible to 'prevent' the fatality at the apex (Choudhry 2014), something Manuele (2011:52) simply describes as a 'myth'.

However, NMR has brought benefits to many industries across the world, from Nuclear (Uth and Wiese, 2004) to Transport (Aldred and Goodman, 2018; Kongsvik *et al.,* 2012) to Aviation (Tinsley *et al.,* 2012) to Petrochemical (Fabiano and Currò, 2012) and so should not be dismissed because of a theoretical hiccup. The desire to capture data on incidents has a long history within organisational safety management practice (van der Schaaf and Kanse 2004), able as it is to support organisational learning and make positive future changes to practice. Indeed, as the factors that cause NMs are the same as those that also cause accidents, once distracting ratios are set aside the process of learning from NMs becomes critical in order to avoid reoccurrence, when different opportunities and contexts could result in a much more serious outcome (Phimister *et al.,* 2003; Tinsley *et al.,* 2010; Cui *et al.,* 2018).

The value of the data obtained from NMs should therefore be considerable. Adams (2005) suggests that the voluntary reporting of incidents provides important information which cannot be obtained by any other means, other than by someone getting hurt of course. Improved safety performance has also been associated with high rates of incident reporting (Storgard *et al.,* 2012) and as such NMR remains a recognised method for improving safety and a well-accepted practice across a wide range of industries (Anderson *et al.,* 2013).

Problems in Practice

Like any organisational or management system, NMR processes vary from one firm to another (Marks *et al.,* 2014), with the most common means of documenting NMs being via a secure online database, allowing for anonymous reporting through pre-determined criteria. However, many such systems try to do more than just NMR (as the system that generated the empirical data for this study does) and often also aim to secure other safety-related observations and feedback from the workforce, including successes and good practice, in a way to enhance and develop worker engagement overall. However, despite such laudable intentions, there are fundamental challenges in building a system able to both incorporate NMs and successes coherently (Madsen *et al.,* 2015) and in trying to do too much, additional complications can arise. One of the most obvious limitations of NMR systems is that they can be expensive to set up and maintain. Although there are off-the-shelf solutions available, many companies develop their own in-house systems. However, as Oswald *et al. (*2018) found, implementing a bespoke 'stand-alone' SOR system on a construction project without due consideration of what constitutes best practice can lead to unintended consequences.

For example, the volume of reporting can be problematic in two very different directions. Construction as an industry has a history of under-reporting its accidents, and thus there is the potential for NMs to also be underreported as part of that shared culture. However, underreporting of NMs also happens across all industries, stemming from a complex mix of factors (Prang and Jelsness-Jorgensen, 2014). Overall, this results in a lack of understanding and awareness of actual incident rates and the daily number of errors that occur in the workplace; the NMR process failing to reflect actual events (Kohn *et al.,* 2000; van der Schaaf and Kanse 2004.). Factors of influence range from workers simply having the time to engage with reporting (Kongsvik *et al.,* 2012) to more fundamental confusion as to what a NM actually is, and so when they should be reported. Gnoni *et al. (*2017) found certain NM events that involved unsafe conditions were frequently underreported, which overall create blind spots within the data when more complex scenarios are involved. This is a common problem within NMR, as Hasanspahić *et al.,* (2020) found in their research of NMR in the shipping industry where underreporting is also problematic, with the most significant barrier to NMR at sea being the seafarers' own difficulties in identifying near-miss events.

Paradoxically however, this problem does not mean that NMR systems are under-subscribed. In some cases the volume of data generated by such systems, particularly when they also attempt to capture other safety management aspects and good practice, can be so vast as to be unmanageable (Gnoni *et al.,* 2017). Indeed, the problems of not knowing what to report are often countered by an encouragement to over -report rather than under to ensure everything potentially relevant is captured by the system (Cambraia *et al.,* 2010), exacerbating the issue. For those tasked with processing the data, usually the occupational safety team themselves, this can add considerably to workloads (Oswald *et al.,* 2018) as reviewing, analysing and actioning reports can be very time consuming (Coyle *et al.,* 2005).

An additional complexity worthy of note, that impacts both under and over reporting, is the positioning of blame within this process. A no-blame approach to safety management is also now a common part of the contemporary safety zeitgeist (Sherratt 2016), yet the fear of being blamed for something, even if no accident occurred, can

still hinder reporting (Beasley *et al.,* 2004). Indeed, van der Schaaf and Kanse (2004) found that data may be edited on input to avoid blame or liability in the case of a NM, as workers seek to avoid discipline and any legal consequences. The use of the NMR itself to ascribe blame is a more unexpected consequence of the process, yet Oswald *et al. (*2018) found many examples of reports naming and blaming other workers, organisations and those in positions of authority when any violation of safety rules was witnessed, no matter how small. This perhaps says more about the rules and their status on that case-study project; however, it is recognised that NMR should be undertaken in a way able to support a no-blame culture in practice (Gnoni *et al.,* 2017).

The Importance of Value

Critical to any NMR system is that its outputs and outcomes are readily able to add value to the organisation's operations, and the resources required to operate that system are proportional to those gains. As with all management, the process must be effective and efficient, and for NMR this means the system must produce data able to enhance understanding and subsequent organisational learning and change. However, as the previous section considered, this is not always straightforward.

In their examination of a NMR system on a UK construction site, Oswald *et al. (*2018) found that instead of providing robust safety knowledge, the bespoke NMR system (which also sought to capture many other safety observations both good and bad) was flooded with 'easy to see' observations around PPE or behaviour violations. However, these were already well known to the safety management team, and were therefore of no real surprise or utility, and '… added little… other than the need for administrative time in managing the vast database it created…[of] volume with little value' (Oswald *et al.,* 2018:44).

Further problems arise when the consequences of reporting are not easily identifiable by those making the reports. For NMR, the action taken to resolve or mitigate a workplace safety issue is the demonstrable outcome of the organisational learning from the system, and thus also a demonstration of its value. Workers will question whether reporting makes a difference, which in turn underpins their motivation to engage (Wu *et al.,* 2008). The perceived competence and mindset of the safety management team also has influence and can deter reporting if workers feel nothing will change (Wagner *et al.,* 2013), whilst Evans *et al. (*2006) also found the 'usual' outcome of an incident influences whether they are reported or not in healthcare settings. The subsequent actions consequentially taken from NMR are therefore critical in the self-validation and continuous development and enhancement of the NMR system. Should a NMR system not add value, i.e. not generate readily utilisable data which can create practical change that enhances safety performance, it could actually be far more detrimental to wider organisational safety culture than having no NMR system or process at all.

METHOD

Data for this project comes from a large case-study civil engineering company (annual turnover approx. £300m) that undertakes both short and longer-term construction operations in a number of regions across the UK. The company operates an online NMR system with access for all staff and supply chain partners to facilitate health and safety reporting. The process used by this company to collect its data is not unique or uncommon in the industry, and the company itself is accredited to a high standard for

its approach to health and safety and has won national awards for their efforts. The company and the data can therefore be considered representative of current 'best practice' within the industry.

The data analysed here was collected between May 2018 and October 2020 and comprises a total of 3,519 individual reports. Although this data is drawn from just one company, each report is a data point itself making this a considerable sample overall. As the aim of this study is to explore the value in near miss reporting, this sample presents a valid opportunity to undertake that endeavour within the specific context as stated. Generalisation of the findings is not claimed at this stage, but it is suggested that the peripatetic nature of the construction workforce and the commonality of practices across the industry will enable them to likely find fit with comparable companies across the UK.

In order to begin to explore the value within this data, a mixed method approach involving predominantly quantitative and more limited qualitative analysis was undertaken. This included high-level analysis of the data, including consideration of the processes that shaped its collation, and the dominant patterns found within the data ultimately collected. It must be noted that this paper only presents a very high-level initial analysis of this data due, in large part due to constraints of space, and a more detailed qualitative analysis of the data points themselves is planned to develop these initial findings further. The statistical software package SPSS was used to support the quantitative analysis, with Chi-square analysis used to explore relationships as they emerged from the data.

FINDINGS AND DISCUSSION

'Cleaning' the Data

The data for this project is naturally occurring (Lincoln and Guba 1985) and was created by many different authors with an assumed shared goal: to improve and enhance health and safety management within the company. The data has not been subjected to any researcher bias or influence, and thus has considerable ecological validity, however this also brings challenges. In their work exploring unsafe acts and conditions that also drew on a similar body of NMR data from a large civil engineering project, Smith *et al. (*2017) found the classifications originally ascribed within the raw data problematic. Specifically, they found 'muddling' between the use of the labels of 'unsafe conditions' and 'unsafe acts', and in many cases an inappropriate label had been used by the person inputting the data, creating repercussions for its utility. In order to undertake subsequent analysis meaningfully, Smith *et al. (*2017) determined a benchmark for classification to ensure a level of validity and reliability and undertook a re-categorising process, through which a not inconsiderable 90% of records in a sub-sample of n=48 were reclassified.

A similar problem emerged in this study, reinforcing the findings from Smith *et al. (*2017) and further highlighting the complexities in categorisation for all those tasked with generating such data. Although Smith *et al. (*2017) were concerned with the nuances of causality in their conditions/acts evaluation, in this data similar confusion was found in the classifications of Near Misses and Safety/Environmental Concerns. Reporting in the data was constrained to one of three categories by the system: Near Miss, Safety/Environmental Concern, and Safety Suggestion. As noted above, the working definition of a NM for this study is: 'The combination of unsafe conditions and unsafe actions that arise at work in an event that leaves employees defenceless

against harm, but which did not actually cause harm, but may or may not cause property damage, damage to the environment and/or loss of time'. Using this definition as a benchmark, the data was reclassified at this level, and overall n=890 NM reports were reduced to n=682, whilst n=2414 Concerns increased to n=2622. This was a less dramatic shift in the data than Smith *et al. (*2017) experienced, only a 10% overall bi-directional 'swing' to Concerns from Near Misses, but still suggests that a shared understanding of terminology is important among the workforce as similar problems of labelling presented here are also found in previous research (Gnoni *et al.,* 2017; Hasanspahić *et al.,* 2020). This raises considerations for the development of an effective system in which fundamental agreement as to what things are is readily achieved, and how data can be meaningfully labelled for future use. Further analysis of this specific phenomenon, including considerations of how best to mitigate such subjectivity in future, is planned for later in this project, however this finding already raises questions about the value of NMR data in its raw form, and suggests an inherent need for expert re-evaluation and intervention at some point prior to its utilisation which speaks to system resourcing in operation.

Rating the Risk

A further categorisation requested by the system when the NM is inputted is a rating of the risk (no-low-moderate-significant). This was a prescribed category within the system, with users asked to 'please select a value' when making their evaluation from the drop-down menu. As shown in Fig 1, across all types of reports the majority of incidents were determined to be low risk, with the fewest considered to be a significant risk to company operations.

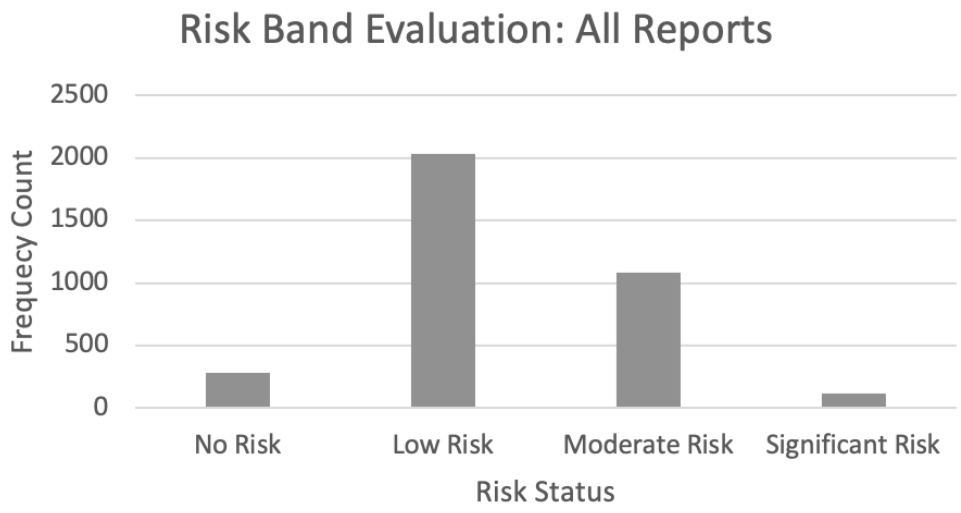

Fig 1: Risk Band Evaluation, All Reports.

When NMs are extracted from the data as a whole and their risk profile evaluated, the picture changes to include more reports of incidents with moderate risk, although the profile at either end of the continuum remains relatively similar, with a slight shift from 8% as no risk in all reports to 5.1% in NMs and a corresponding shift from 3.3% as significant risk in all reports to 7.6% in NMs. This can be seen in Fig 2.

Further analysis involving the cross-tabulation results of risk band with the type of report submitted is presented in Table 1. Chi-square analysis was undertaken to explore whether the type of report (Near Miss, Safety/Environmental Concern, Safety

Suggestion) was associated with a certain risk profile within the data thus labelled, testing the null hypothesis that: there is no relationship between the type of report and risk band.

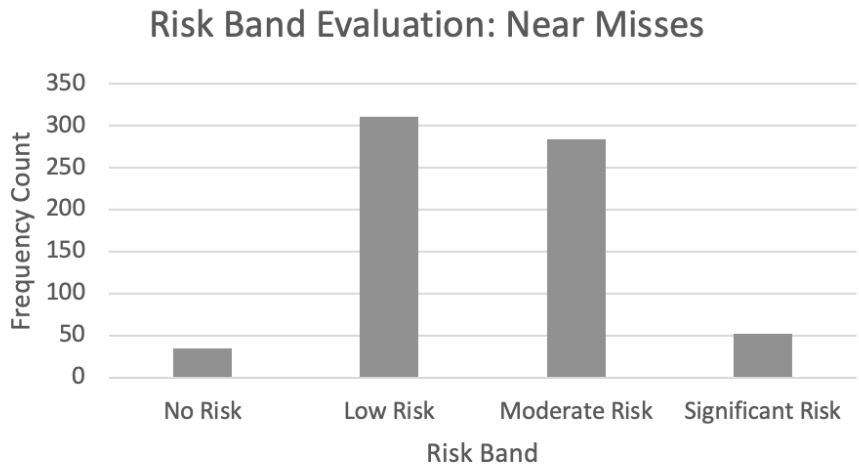

Fig 2: Risk Band Evaluation: Near Miss Reports

The Chi-square reveals a significant relationship between the type of report and risk band at a 95% confidence level, indicating that the type of report determines the level of risk associated with it.

Table 1: Association between type of report and risk band

	No Risk	Low Risk	Moderate Risk	Significant Risk	Total
Near Miss	35 (5.1%)	311 (45.6%)	284 (41.6%)	52 (7.6%)	682 (100%)
Safety Suggestion	25 (11.6%)	134 (62.3%)	56 (26.0%)	0 (0.0%)	215 (100%)
Safety/Environmental Concern	223 (8.5%)	1591 (60.7%)	744 (28.4%)	64 (2.4%)	2622 (100.0%)
Total	283 (8.0%)	2036 (57.9%)	1084 (30.8%)	116 (3.3%)	3519 (100.0%)

These very 'high level' findings are of interest as they again talk to the knowledge and understanding of those inputting the data. It is perhaps rather unrealistic to expect workers to be able to evaluate risk meaningfully (many safety managers will happily debate risk levels between themselves!) and these findings show a clear congregation around the two centre points of low and medium, and a statistically significant lack of variation in the data as to the level of risk ascribed. Although greater numbers of NMRs were ascribed as medium risk than for all-reports, it can be argued that low and medium are 'comfortable' assessments. They are not serious enough to be significant, and so the reporter is to some extent absolved of more serious obligations or involvement from making the NMR itself, which would find fit with the observations of van der Schaaf and Kanse (2004). To note something as significant risk would be a much bolder claim, requiring a certain amount of confidence to not only make it but also to stand by in case of future action. The risk pattern for NMRs could also be explained by the use of reporting targets or the encouragement to over rather than under report (Cambraia *et al.,* 2010) which could also likely result in most NMRs being considered lower risk, either by accident or design.

Value as Evidenced by Action

Evaluation of how useful the reports were (and thus value in the system as a whole) was initially made through analysis of the subsequent recorded action taken within the system data. Initial action to remedy unsafe situations was often noted in the reports, however a critical part of NMR is the demonstration of management response, without which the motivation to engage drops within the workforce (Wu *et al.,* 2008; Wagner *et al.,* 2013). Table 2 shows the level of reported further action within the data.

Table 2: Association between type of report and reported further action taken

	Yes	No	Total
Near Miss	47 (6.9%)	635 (93.1%)	682 (100.0%)
Safety Suggestion	48 (22.3%)	167 (77.7%)	215 (100.0%)
Safety/Environmental Concern	244 (9.3%)	2378 (90.7%)	2622 (100.0%)
Total	339 (9.6%)	2378 (90.7%)	3519 (100.0%)

Table 2 reveals that in the majority of all types of report, recorded further action was only taken after a report in 9.6% of all reports to the system, with no recorded action taken for 90.4% of all reports. For NMs this reduces to recorded action taken in response to only 6.9% of NMRs logged in the system, with 93.1% reported as no action being taken. There are two explanations for this: either no action was taken or action was taken and not recorded. The latter is more likely, given the status of the company involved, but this therefore suggests the system is also not supporting the safety managers in the capture and recording of remedial action, perhaps due to the added administration it necessitates (Oswald *et al.,* 2018). It also creates a gap in the organisational learning, but perhaps most detrimentally results in the lack of data to close out the NMR feedback loop, and a lack of information to share with the participating workers. Overall, this raises concerns about the engagement of both workers and the safety managers, and the value this NMR process in its current form is bringing to the organisation.

CONCLUSIONS

Although undoubtedly limited, this high-level quantitative investigation of a large NMR system dataset from a UK construction firm proud of its approach to safety management has already revealed some potential problems with this bespoke NMR system. Analysis has already revealed issues around labelling and nomenclature, around the questions asked to those reporting, and around the value generated by the system from that data, also evidenced by the lack of 'close out' of any learning generated within it.

These findings resonate with studies from a number of different industries, suggesting that construction is not unique in having these problems, but also that there is scope to develop a NMR system able to enhance the value of NM reporting in the construction industry. This paper presents early findings from a project that aims to do just that. Qualitative analysis of the data will form a more nuanced next step in the process, to explore what value is contained with the reports themselves, analysed through a utility-focused lens. Drawing on best practice and lessons learnt from both construction and the many other industries in which NMR forms a core tenet of safety management, it is hoped a system can be developed that adds value to this process to support the continued improvement of safety in construction. The authors welcome comments and feedback from the ARCOM community on this project as it progresses.

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