NEAR MISS AND INTERVENTIONS: A study of the improvement in health and safety performance following increased near miss and observation reporting

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Abstract

We are often told as humans that we must learn from our mistakes, and the health and safety world is no different to this. After every major disaster, there are repeated call for us to 'not repeat the same mistake again'. Since the early 1930's we have followed the belief that major and minor incidents have the same causes as near misses, and therefore we have been guided to learn from near misses to help prevent the serious incidents. However, more recently we have seen the questioning of the wisdom of this, whilst others still hold the theory dear. We have seen studies and been taught that by reporting near misses, we can learn from them and improve the number of accidents we have, yet not actually established why the improvement occurred, only that it coincided with increased reporting of near misses.

This study aimed to find out if an improvement in accident performance following the encouragement of near miss and observation reporting is a result of interventions put in place. To achieve this, we looked at the reporting data of a large UK construction business to establish that they had achieved an improvement in accident performance through the encouragement of near miss reporting, and the level of interventions introduced following the reporting of near misses. We also conducted an online survey to establish the attitudes, beliefs and behaviours regarding near miss reporting of a sample of Construction Workers and their Supervisors or Line Managers of the organisation. We also asked about their opinions on how often interventions were introduced and the effectiveness of the interventions. Finally, we reviewed the literature of a large number of studies into near miss reporting, which looked at everything from the benefits of having a reporting system, attitudes to reporting and how the knowledge can affect our decisions.

What we found out was that there was insufficient evidence that the level of interventions introduced correlated to the improvement in accident performance. However, we did establish that an effective reporting culture can affect people's attitudes towards reporting, increase their awareness of the hazards around them and encourage them to be safety conscious in their behaviours. We found that whilst there was insufficient data about the interventions introduced, that in the opinions of the majority of the sample group, interventions were being introduced regularly, but not every time and that the interventions introduced were effective.

We also found that a near miss reporting system should minimise any barriers to reporting such as conflict with management and fears of retaliation and actively feedback to the person reporting the concern. It should be developed to maximise the learning it can provide the organisation in terms of management information and trend analysis.

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Abbreviations

AFR	Accident Frequency Rate
BIM	Building Information Modelling
CO	Construction Operative
HiPos	High Potential Incidents requiring a potential severity rating of 4 or 5
H&S	Health & Safety
HSES	Health, Safety, Environment & Sustainability
LMS	Line Manager/Supervisor
LTIR	Lost Time Frequency Rate
N=	Survey Population
n=	Number of respondents to a question
NM	Near miss
NMMS	Near miss Management System
Obs	Observation

Introduction

The relationship between the numbers of near misses, minor incidents and major accidents dates back to 1931 when Herbert William Heinrich published his book Industrial Accident Prevention, A Scientific Approach (Wikipedia, 2016). Since then there have been a number of studies (Bird & Germain, 1966); (Heinrich, et al., 1980), with various 'iceberg' or 'triangle' models (similar to Figure 1) showing the ratio between major accidents and a larger number of minor and near miss events.

However, over the years certain elements of Heinrich's premise have become accepted as truisms. "*This is by now a quite famous piece of safety reasoning,"* (Ward, 2012, p. 4). Other studies have supported the premise that learning from near miss events helps reduce the number of accidents. According to Jones, et al. (1999, p. 63) "*… an increased focus on the importance of near misses, and thus increased reporting and learning from them, the accidents fell. When the organisation relaxed on near misses, the accidents increased*."

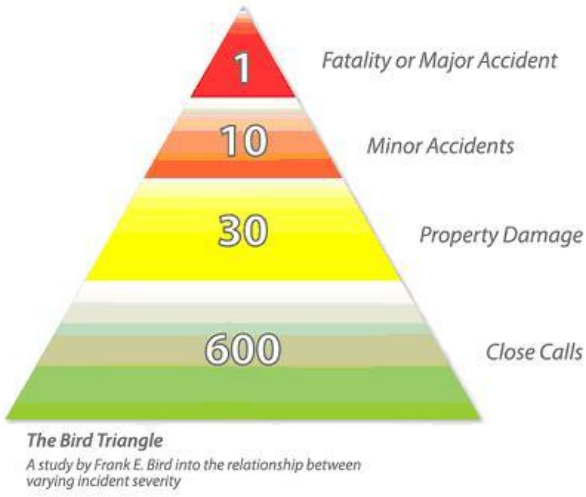


Figure 1Typical 'Bird' triangle into the relationships between inicdent severity

Using these models, it is widely recognised by Health and Safety (H&S) professionals that the reporting of near misses helps an organisation to prevent reoccurrences and the likelihood of major or fatal accidents; *"… a 'near miss' should be regarded and treated as an important warning that an accident may occur*" (Jones, et al., 1999, p. 59).

Research shows that organisations that use a near miss reporting system effectively will see an improvement in their safety performance, as interventions are put in place to prevent a recurrence. According to Borg "*Organisations that have managed to achieve effective Near miss reporting programs have achieved outstanding safety performance."* (2002, p. 1)

Many organisations now use near miss events as a positive indicator of performance (Jones, et al., 1999, p. 62) and recognise that having a near miss

reporting system is important element to learning lessons and improving their safety performance.

However, much of the research conducted so far has focused on either the ratio of event severities (the triangle), the effectiveness of reporting systems used by specific industries, how near miss reporting improves the safety performance of an organisation or disproving the Heinrichs' work. What is not clear is whether it is purely the introduction of interventions that are causing the improved accident performance or not. For example, are there other changes occurring in the process such as increased hazard awareness, or changes in attitudes and beliefs about safety and the organisation?

> "A paradox of incident learning is that incidents cause accidents and disasters, yet they are needed for learning to occur
>
> *(Cooke & Rohleder, 2006)*

Whilst it is believed that the cause of any subsequent improvement in accident performance is down to the organisation learning from the reported near misses and introducing interventions (fixes) to the causes; it is not clear from the studies that this is entirely true. Equally, do organisations investigate and establish the cause(s) for every single near miss regardless of the potential severity. According to Dillon & Tinsley (2008, p. 1) "Although organizations appear to learn from obvious failures, we argue that it is harder for them to learn from "near-misses"—events in which chance played a role in averting failure"

Another factor in the lack of research in this area may be due to the difficulties in proving the effectiveness of interventions introduced or because of the sheer volume of near misses reported. To some it may seem as a logical conclusion, but the problem with this is that it is an assumption, and proactive organisations spend a significant amount of time and effort in trying to encourage their workforce to report near misses. This can clearly be seen by the variety of industry specific studies into improving near miss reporting. (Jones, et al., 1999) By questioning this assumption, we open up the theory to other possibilities and understanding of what is happening when the reporting of near misses is encouraged by an organisation and the accident performance improves.

For example, the author has previously observed a phenomenon where there were improvements in safety performance even when it appeared that interventions were not put in place. Employees within a section of a large organisation were given loose targets of reporting one near miss or hazard a day. The driver for this was mainly due to pressure from the organisation's client, to improve the number of near misses reported. As the teams were encouraged to report near misses and hazardous situations, the number of reports increased dramatically. Subsequently, several lagging safety performance indicators improved with little or no intervention. This poses the question as to why this would happen. Did the organisations extra attention on safety result in individuals changing their behaviour (Hawthorne effect), Did the act of reporting a hazard make them think more about other hazards, or make them more safety conscious, Did the line managers become more conscious of the potential criticism for safety failings, or were interventions introduced without the knowledge of the organisation? Whatever the reason there was a clear trend occurring in that by encouraging near miss reporting, accident performance improved for the duration that the encouragement of reporting was maintained.

By studying this further, we can confirm that the improvements in accident performance from the encouragement of near miss reporting are either because of interventions introduced or identify other areas for further study. This will either prove that encouraging near miss reporting is an important factor in organisational learning, or give organisations a better understanding of the impact the encouragement for reporting is having.

To study this further, we are going to look at a very large organisation within the United Kingdom (UK) Construction Industry. In order to protect the organisation from any potential embarrassment, the information provided has been kept anonymous and simply referred to as the 'Participating Organisation'. A British organisation which is one of the UK's largest infrastructure companies that has global operations with an estimated worldwide workforce of 30,000 employees, with an order book of £12.7 billion in 2017. Its construction activities range from major projects such as the 2012 Olympics, highways and rail infrastructure to street lighting and public utilities. Its UK operations have major offices in London, Derby, Sheffield and Scotland and includes operations in Northern Ireland and the Republic of Ireland. Whilst its UK operations account for approx. half of the total employees, the majority of the projects rely heavily on sub-contractors, with some long-term contracts having a typical 80/20 split between sub-contractors and direct employees.

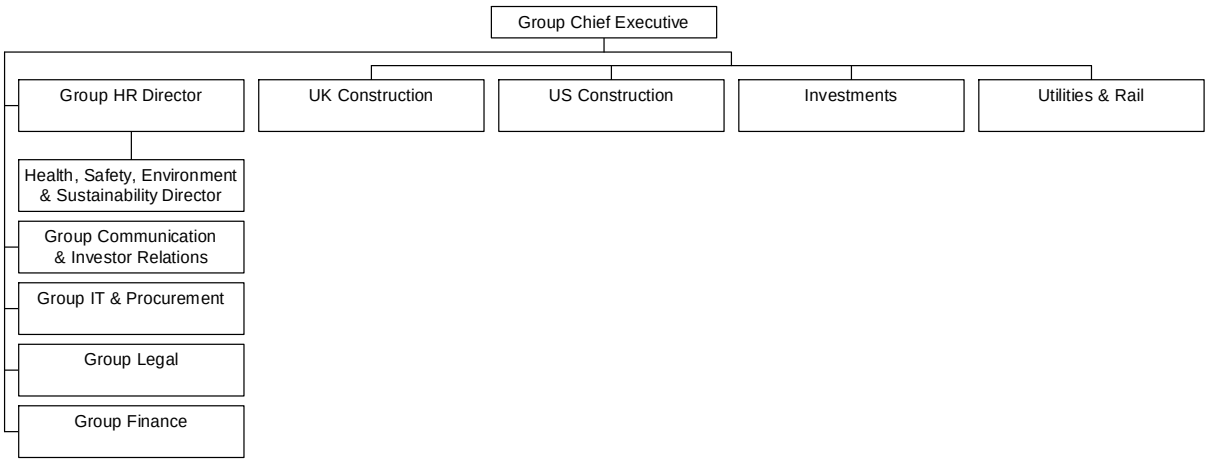


Figure 2 High level Organisational Structure of the Group

The organisation defines a near miss as:

"An event which, in slightly different circumstances, could have resulted in harm to people, the environment or damage to property",

and an observation as:

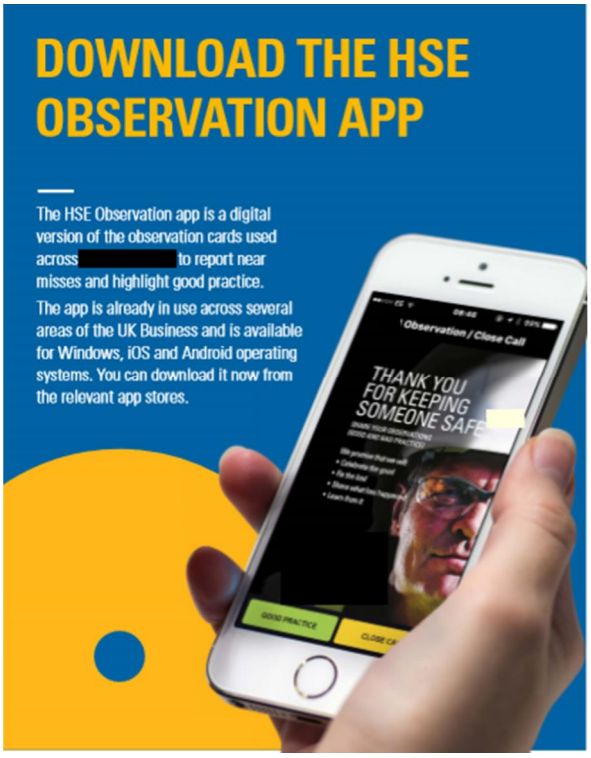
"An observation should describe circumstances which may cause (or prevent) an incident to occur, including

- *Positive observations (e.g. proper equipment, neatly bundled cables, fire/earthquake drills, training, etc) or*
- *Safety hazards (e.g. exposed cables/wires/bolts, slippery floors, unbalanced loads, etc)" (Participating Organisation, 2017)*

Most of the systems for reporting are paper based, however certain parts of the organisation operate a call centre which take details of near misses and observations and more recently the organisation has introduced a mobile application for smart phones and tablets to report observations (see Image 1).

Like many other large employers, the organisation has a Zero Harm goal for its health and safety performance. For them this means zero fatalities, zero permanently disabling injuries and each business unit aims for zero accidents and injuries. Zero

Image 1 HSE Observation App poster courtesy of the participating organisation



Harm means delivering on shared commitments, such as eliminating fatal risks and hazards, maintaining Zero Harm day to day, keeping the public safe from harm, keeping all their people healthy, working with their customers and making safety personal.

The business also operates what it calls 'The Golden Rules'; which are four health and safety rules which it states must not breached and are about setting the highest personal standards (Organisation, n.d.). These include:

1. Be fit for work
    - I will advise my supervisor prior to starting work if I have any health issues (mind and body) which mean I am unfit to work
2. Always receive a briefing before starting work
    - I will only start work once I have been briefed and fully understand the task, associated risks, controls and rules
    - I will follow all of these rules
3. Report all unsafe events and conditions
    - I will take care of myself and others at all times, positively intervening when something is not safe or correct
    - I will ensure that I maintain equipment issued to me in a satisfactory condition and report any defects immediately to my supervisor
4. Stop work if anything changes
    - I will ensure that work stops and the supervisor is informed when there are changes to the planned safe system of work or I am concerned that the activities are unsafe
    - I will only restart work once I have been re-briefed on the new risks, controls and rules

Whilst we are not looking at the implications of rule setting within this research, rule No3. (Image 2) is relevant to this study, and we will look at mandatory reporting further.

The UK business is supported by a Health, Safety, Environment and Sustainability (HSES) function of approx. 300 employees. Whilst the function is made up of direct employees, the majority are based on and costed to

Image 2 'The Golden Rules' courtesy of the participating organisation

construction projects, with a small central team providing support on policy, procedures, reporting and areas such as innovation, specialist advice and bidding. The function is led by a UK HSES Director, with several HSES Directors or Heads of individual business units leading regional and project based managers, advisors and support staff (Figure 3). The overall aim of the function is to enable the business to deliver key infrastructure projects whilst achieving its Zero Harm goal.

More recently the business has implemented Zero Tolerance rules for certain types of activity which are all based around fatal risk areas, such as the interface between people, plant and vehicles.

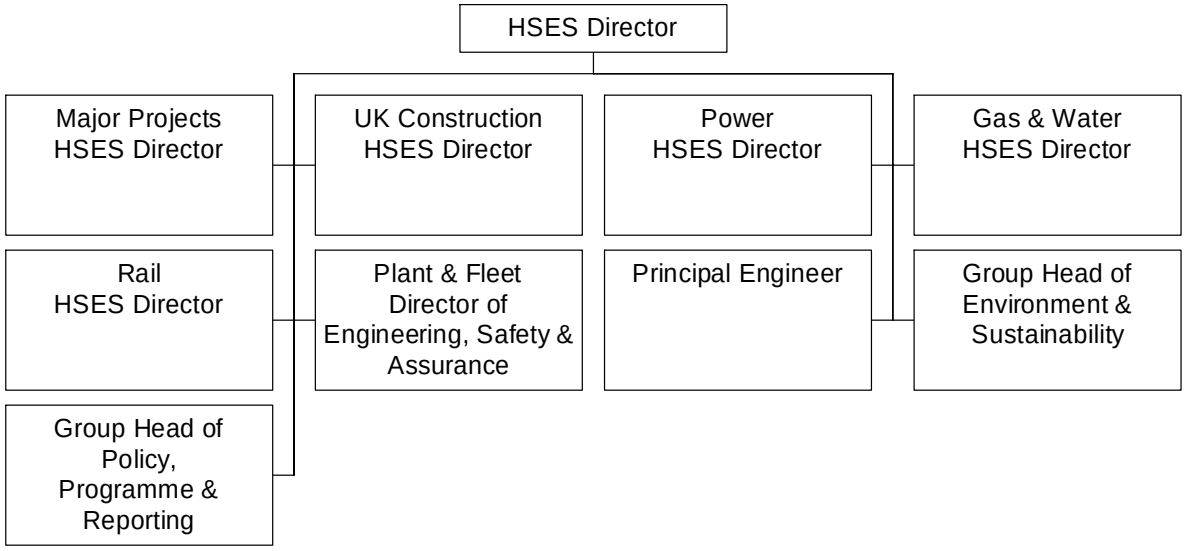


Figure 3 Structure of UK HSES Senior Leadership Team

The organisation also runs several fatal risk groups across the whole organisation, with the aim of eliminating the specific fatal risk from the workplace, or reduce it to an acceptable level. The fatal risks selected by the organisation are:

- People and Plant Interface
- Working at Height
- Electricity
- Lifting
- Health
- Driving
- Buried Services
- Excavations
- Traffic Management
- Catastrophic Events

Aims and objectives

The aim of the study is to find out if an improvement in accident performance following the encouragement of near miss and observation reporting is a result of interventions put in place.

Objectives

To achieve this, the objectives of the study are:

1. To establish the number of near misses and observations reported over a 12-month period
2. To establish Construction Workers and Line Managers/Supervisors opinions on the effectiveness of any interventions introduced
3. To identify if there are any changes in attitudes, beliefs or behaviours in the Construction Workers and Line Managers/Supervisors that may contribute to the improvements recorded.
4. To determine if the level of interventions introduced correlate to the improvements in accident performance.

Literature review

So that we can better understand the factors at work with near miss reporting, we need to review the vast knowledge base of previous research and papers. Research into near miss reporting, its benefits and limitations and associated areas such as learning from errors covers a multitude of industries and nations. The medical industry has more recently conducted several studies on opportunities to learn from errors and the barriers they face. Whilst some of these industries are completely different to the Construction Industry, a lot of the considerations can easily be transferred.

What is a Near miss?

A Near miss has a variety of different names such as a "close call," a "narrow escape," or in the case of moving objects, "near collision" or a "near hit. Definitions also vary slightly, but in essence it is "*an event not causing harm, but has the potential to cause injury or ill health"* as described by the United Kingdoms (UK) Health and Safety Executive (Health and Safety Executive, n.d.). According to BS OHSAS 18001:2007 an 'incident' is defined as *"Work-related event(s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred",* and goes on to note that *"An incident where no injury, ill health, or fatality occurs may also be referred to as a 'near-miss, 'near-hit', 'close call' or 'dangerous occurrence'* (bsi, 2007).

In 'Near miss Reporting as a Safety Tool' van der Schaff (1991, p. 1) starts with a working definition of *"A near miss is any situation in which an ongoing sequence of events was prevented from developing further and hence preventing the occurrence of potentially serious (safety related) consequences",* and concludes that a lower bound definition of what is called a near miss is necessary to prevent the Near miss Management System from straying into the realm of collecting all errors and becoming too cumbersome. In concluding the book, Van der Schaff et.al. (1991, p. 142) provides a much shorter definition of a near miss as *"a deviation which has clearly significant potential consequences"*. This conclusion is made from reviewing a number of different systems and definitions, and establishes that information systems are interested in what they can learn, whereas the monitoring systems of some industries is such that a lower reporting limit is needed. An example of this would be a process dominant industry such as petrochemicals or nuclear, whereby there should be monitoring arrangements for the process, and if limits are exceeded then these are acted upon and a near miss is recorded. They conclude that *"Accidents are by definition near misses which failed to be recovered in time"* therefore, that the modelling of the near miss system is of the utmost importance and *"The aim of such modelling is to produce such a good understanding of how systems produce accidents that countermeasures can be designed into them to prevent the accidents before they happen"* (1991, p. 148).

The common elements between these definitions are that an event has occurred and there was the potential to cause harm. Of course, the term 'harm' may need its own definition. For example, does harm include damage to property from say a fire or is it restricted to injury and ill health. Equally, is a verbally abusive customer whose behaviour leaves an employee shaken and fearful considered harm, and how does this apply if another employee laughs the same incident off. Some industries are very specific about what they consider to be a near miss. For example, an object dropped from height or Signals Past at Danger (SPADS) for the railways. In fact, the United States Occupational Safety and Health Administration (OHSA) define a near miss as '*Near misses describe incidents where no property was damaged and no personal injury sustained, but where, given a slight shift in time or position, damage and/or injury easily could have occurred'* (Gonzale, 2013) which therefore includes 'damage'.

Whichever way a near miss is defined, it should be taken with careful consideration as '*the more you specify, the more you may limit what people report, but no limits may result in an avalanche of reports that are difficult to manage.*' (Leathley, 2012). Ultimately, the aim of any near miss system is to prevent a reoccurrence of an event or ensuring that it could not have caused harm by recovering (controlling) the situation.

Observations

The participating organisation define observations as "… circumstances which may cause (or prevent) an incident to occur", and encourage the reporting of these just the same (if not more) as near misses. Researching the reporting observations appears to show the concept may have stemmed from the various behavioural safety programmes which use observations of specific behaviours to measure the impact of their behavioural programme. The organisation operates its own behavioural programme and the reporting of observations is very much a part of this, yet the two can and do work independently of each other. Typically, with behaviour observation programmes, peers conduct observations, but in some programmes, they are conducted by superiors (Health and Safety Executive, 2002) and target a specific set of behaviours in an effort to encourage the modification of the behaviours to what the organisation considers safe. In this case the observations are more of an extension of the near miss reporting system and include 'good' observations as well as unsafe situations. These are situations in which an individual has identified an opportunity or has been innovative to improve safety and the reporting of it provides the organisation a mechanism to share this information.

Reviewing research studies has shown that there doesn't appear to any previous studies on the area, as all the studies relate to either near miss or error reporting. This may be because some would not separate these unsafe circumstances from actual near misses. Equally some would not contemplate trying to capture information on the bottom level of the Heinrich triangle due to the sheer volume of unsafe acts, conditions and behaviours. However, one study does suggest that reporting should extend beyond near misses. (Gnoni & Saleh, 2017, p. 167) argue that *"… NMS (Near miss management system) should not be confined to event-based safety incidents. Many safety blind spots would remain and several learning opportunities to improve safety would be forfeited by doing so*".

Improving safety performance

It is widely understood within the health and safety profession that for any organization to improve its health and safety performance it must learn from previous incidents. According to Jones, et.al. '*Many industrial companies already recognise that they can learn from their near misses without having to suffer the consequences of a full accident. Focusing on reduction of actual near miss occurrences will reduce frequency of accidents'* (1999, p. 66). This is backed by several others (Oktem, 2002) (Borg, 2002) and van der Schaff states that *'Organisational learning should be central to the NMMS'* (Near miss Management System) (1991, p. 28).

According to Lanne & Ruuhilehto, *'for any learning from a near miss, it must be investigated to understand how the event occurred and what the causes were.'*

(2007, p. 2). Whilst this may sound an obvious statement, if we are to follow the 'common cause' theory, then every single event would need investigating to a sufficient level to establish its root causes and any contributory factors. If an organisation has a broad definition of a near miss and a positive reporting culture the organisation could quickly become swamped with events to investigate which could lead to employees becoming disillusioned if action is not taken quickly in some cases. Equally if the near miss system attempts to collect all errors it could become too cumbersome for the organisation to manage (van der Schaff, et al., 1991, p. 142).

However, there is some disagreement on Heinrichs 'common cause' theory which is linked to the triangle model.

Rightly or wrongly, the Heinrich triangle has been used by the Health & Safety community for years as the basis for encouraging the reporting of incidents such as near misses, under the belief that by learning from such incidents they will reduce the likelihood of a more serious incident. According to Jones et al. 'The exact figures vary from study to study, but the crucial thing to recognise is that reducing the number of near misses that occur reduces the number that proceed to become full accidents, with more severe human, economic and environmental impact.' (1999, p. 62). In fact, this article goes on to use an organisations accident and near miss reporting levels to demonstrate that the more reporting levels of near misses increased, then conversely the number of lost time incidents reported went down. *"… it has been demonstrated in this paper by way of a practical example from industry that there is an inverse proportionality between the number of reported near misses and the number of accidents*" (1999, : 66).

What the research doesn't look at it is any other contributing factors to the improved performance, such as interventions, management systems, training or culture. It loosely demonstrates a link between the two, which supports the theory of learning from lesser incidents. This apparent learning is supported by Borg, whom concluded that by encouraging and subsequently increasing the reporting of near misses, there is a positive impact of the organisations safety performance. "*Organisations that have managed to achieve effective Near miss reporting programs have achieved outstanding safety performance*." (Borg, 2002). However, the focus of that research seems to be around widening managers' knowledge of the incidents that are occurring by treating near misses as a positive and therefore targeting the number of near misses reported. *"It is intuitively obvious that the more knowledge a manager or supervisor has, the more effectively the causes of accidents can be eliminated"* (Borg, 2002). Whist we cannot argue with this intuition it neglects a variety of factors, such as the managers' resources, the culture of the organisation and if the manager truly understands how to eliminate

the causes. In an organisation that has a blame culture, the cause could be perceived as an individual, which could lead to the individual being blamed and subsequently removed from the organisation.

In fact, some industries such as the medical profession now consider this to be a fundamental part of their near miss reporting system. "*Learning from errors and near-miss events is an essential step in developing mechanisms and processes to prevent future occurrences of similar events."* (Smith, et al., 2014). Taking this one step further, does extending the reporting process to include positive observations, such as good practice or innovation help the learning process and the reporting culture? It may seem logical to some that the sharing of good practice would be a good addition to the reporting process; but does this really add to the organisations learning and encourage a mature reporting culture; or is it another burden on the workforce? According to (Gibb, et al., 2017, p. 36) "*If the workers find a better way of working, that is a good thing. The challenge is to capture and transfer any good practice that emerges from these activities as a potential source for solutions that can be proposed elsewhere*". The other challenge is to ensure that the better way of working isn't at the expense of safety and that any risk (old or new) continues to be managed.

Near miss reporting systems

In order that the organisation can learn from these incidents, it must firstly have a system in which to report, record and act on these incidents. Therefore, the effectiveness of the system used can have a bearing on its success and its long-term sustainability. Several researchers have attempted to measure the effectiveness of near miss reporting systems (NMRS). There are several factors that can impact the effectiveness of a reporting system, such as its ease of use, accessibility and its trending & tracking abilities.

Andriulo & Gnoni studied a methodological framework to verify the effectiveness of a NMRS by comparing near misses and injury events stating that *"Precursor and injury events are usually characterized by common causes"* (2014, p. 154). However, this approach is based upon the Heinrich principle that lesser incidents have the same causes as more serious injuries. As there are doubts about the reliability of this principle, we would have to question the reliability of this approach as well. Equally, it does not examine the attitudes and perceptions of either the reporter or receiver (i.e. the Line manager). Whilst the system itself may be very good at identifying precursors to serious event, the most efficient and effective system in the world can be made useless if the people using it find it difficult to use and subsequently stop using it.

Lanne & Ruuhilehto's suggest that *"… modelling the incident reporting process helps the organizations to better understand the process and highlight ideas for improvement",* also that the systematic evaluation of the reporting process can give the organisation important information about the quality of the data. (2007, p. 5)

In terms of measuring the effectiveness of a reporting system there are a few approaches that can be taken. The most basic quantitative measure is a count of the number of incidents reported, which is a common for many organisations and often leads to targets being set when reporting levels are low. However, whilst this approach is simple to use and quick to implement, it has its limitations in the information it provides the organisation. There is no categorisation of the potential severity of the near miss or any trending data. Furthermore, high levels of reporting could simply mean the causes are not being fixed.

A more qualitative measure would be to obtain views of the people using the system. This could be a basic questionnaire or simply interviewing the users of the system about their thoughts on the effectiveness of it. Most, if not all the research on NMRS have taken a quantitative method to evaluate its effectiveness; which is perhaps a missed opportunity to talk to the people and understand what they like and dislike about a system. This point was identified by Lanne & Ruuhilehto (2007, p. 5) whom stated that *"It is important to involve different points of view to the evaluation process. The identifiers and declarers, investigators, decision-makers and those who utilize all the associated information may have different experiences with the system".*

After all, the aim of any reporting system should be to allow the organisation to learn, otherwise it is useless and more likely a burden "*It is important to keep the focus on learning and improving when the objectives of incident reporting are made"* (Lanne & Ruuhilehto, 2007, p. 4).

There is sometimes a desire within industry to produce a metaphorical health and safety 'silver bullet', which will deliver an effective remedy to accidents. This is perhaps the reason that the Heinrich theory has flourished and remained in use almost a century later.

Attitudes to near miss reporting

Organisations wanting to improve their H&S performance using near misses, often focus on encouraging employees to report events, explaining why it is important and improving their understanding of what a near miss is. According to (Lanne & Ruuhilehto, 2007, p. 2) *"A major challenge for the organization is to motivate people to report their observations to supervisors or directly to an incident reporting system"*. Setting targets for reporting isn't always popular with the

workforce either, in fact according to Dunlop "*Obliging people to report every minor deviation from a process is both impractical and counter-productive. If workers cannot see the value in a reporting system, they will stop using it, or use it only under duress*" (2015)

However, there can be many reasons people don't report near misses voluntarily; according to La Duke as cited by (Walter, 2011) the top nine reasons that near misses are not reported are:

1. Fear
2. Embarrassment
3. Difficulty in reporting
4. Bureaucracy
5. Peer Pressure
6. Loss of reputation
7. It's easier not to
8. Lack of interest from the organisation
9. Perceived as pointless

Similarly, AbuAlRub et al. (2015, p. 2878) looked at the self-perceived barriers to reporting incidents of nurses' and physicians' and found "*The major three barriers to reporting incidents were believing that there was no point in reporting near misses, lack of feedback and fear of disciplinary actions."*. Equally, Douglas et al. (2014, p. 591) state that *"Research within industry has shown that the main barriers to reporting can include: the fear of being blamed, disciplined, embarrassed or found legally liable"*. Other research has found similar findings including unsupportive management, complacency and not having anything to report (Harper & Helmreich, 2005). Some of La Dukes' other top 9 reasons also appeared in AbuAlRub et al. findings but not as significantly as the top three.

In fact, when looking at the reporting within four large academic radiation oncology centers, Smith et al. (2014, p. 351) found that embarrassment is an important barrier for all staff members, stating that *"… analysis indicated that respondents were much more likely to report minor errors and major near-misses if embarrassment were not a factor*". Most notable Doctors were mush less likely to report critical errors due to embarrassment than their non-physician counterparts. Other factors included departmental or professional sanctions, getting colleagues into trouble, admitting liability, retribution from colleagues, and concern about damaging the department's reputation. These findings may be heightened due to the nature of the setting, where the topic of errors and liability are always going to cause concern. However, the topic of embarrassment was also cited by (Walter, 2011) in an American National Safety Council (NSC) Congress and Expo, stating that

"If workers see their supervisors or co-workers humiliate those who make mistakes or experience incidents, they may be too embarrassed to come forward and admit they experienced a near miss". This is supported by Wagner, et.al (2006, p. 85) *whom also identified "The staff members' feeling of fear and humiliation after committing an error is cited as another barrier to reporting adverse events".* Interestingly these barriers were to adverse events as against near misses, and therefore encouraging the reporting of near misses was seen as an opportunity to learn from these without the same barriers to reporting.

According to Smith et al. (2014, p. 351) the reporting culture within an organisation can have a big impact on the reporting of near misses. This is supported by (Lukhuani, et al., 2015) whom states that *"Studies have shown correlations between an organization's safety culture and their willingness to report near misses"* and goes on to say that *"One scenario based study conducted in 2006-2007 found a potential link between the indicators of safety culture and employees' willingness to report near misses"* (Lakhaini, 2011). A older study in 1998 which looked at Organizational factors affecting the incident reporting of train drivers which found that the reason given most frequently for intentionally not reporting an incident was that the incident was 'just part of the day's work' and concluded that incident reporting is influenced the most by the way they perceive their managers will react to the reports. (Clarke, 1998) Whilst this study looked at the reporting of all incidents, it could give us an important clue into the beliefs and attitudes of those reporting any kind of incident; and is an area that can be looked at further as part of this study.

Mandatory v Voluntary reporting

There have been a number of studies that look at the need for reporting errors especially in the medical profession. Some of these have touched on the subject of mandatory reporting and all have stressed the need for voluntary over mandatory reporting. However, the majority of these appear to be based upon opinion and accounts from the system designers/owners rather than evidence based.

According to Wagner, et al. (2006, p. 85) the fears of recrimination and liability previously mentioned, are real issues and are highly likely to affect the information reported. This is supported by Cohen (2000, p. 729) whom states that *"Practitioners who are forced to report errors are less likely to provide in depth information because their primary motivation is self-protection and adherence to a requirement, not to help others avoid the same tragedy."* Both Wagner and Cohen studies (and many others) are based upon the medical/nursing industries which since the late 1990s have been trying to improve its patient care by addressing human error.

Barach & Small *(2000, p. 760)* looked at the reporting systems of a number of industries (see *Appendix 2*) and reported that "*Some offered legal immunity to*

reporters as long as data were submitted promptly (up to 10 days after the event for the aviation safety reporting system". Such measures may well be necessary for organisations in which the professional liability of the individuals is a key factor, such as medicine or aviation. *However, according to Cohen (2000, p. 728), even with the offer of legal immunity, the safety culture within the organisation can influence mandatory reporting "Even if mandatory programmes offer an amnesty or immunity to individuals, they often punish those who fail to report*". However, making it a mandatory requirement to report certain events may well be a necessity for some industries. For example, for the nuclear industry the fear of even a single potential catastrophe and its implications for the whole industry outweighs any objection to a reporting system for near misses *(Barach & Small, 2000, p. 762)*

Both approaches (Mandatory and Voluntary) have their own benefits and limits, and the maturity of the safety culture is often driven by forces internal and external. In most cases overtime these forces will promote the need for a voluntary reporting system *(Barach & Small, 2000, p. 762).*

The confidentiality of the reporter may assist in moving a barrier to reporting and one way of ensuring confidentiality of the data and reporter is to have the reports filed anonymously. However, this can have its own problems, in terms of the quality of the information and the follow up investigation. For example, (Cohen, 2000, p. 729) states that *"… voluntary programmes provide frontline practitioners with the opportunity to tell the complete story without fear of retribution*". Equally, anonymity could also affect accountability and transparency of a profession, but may well be necessary to nurture and develop a reporting system in its infancy. In the end to maximise the utilisation of the reporting system there will need to be a balance between transparency, accountability and protection of the reporter. *"An overarching lesson from 25 years of aviation experience is that methods for data collection and structures evolved to simultaneously maximise confidentiality, bidirectional information flow, and improvement in local processes* (Pidgeon, 1996)" as cited by (Barach & Small, 2000). Also, any system (voluntary, mandatory or anonymous) is only as strong as its other parts, such as its analysis and response. (Cohen, 2000, p. 729).

Testing Heinrich theory

Ward (2012, p. 8) looked at the different aspects of Heinrich's findings, stating that "*The triangle or pyramid model is what's best remembered from Heinrich's work, and while one may question the arithmetic there's been general agreement (until recently, as reported by Paradies (2012)) that (a) a series of minor incidents may be the lead-up to an event of greater magnitude, and (b) if one looks back after a major incident there's probably a history of minor ones"*. However, Ward confesses that "*this author must admit they also reflect his personal opinion of the value of*

Heinrich's work". Subsequent to Heinrich's original triangle theory, there have been a few studies on the relationship between the number of near misses and minor and major accidents (e.g. Bird and Germain 1966, followed by Heinrich, et al. 1980) (Lanne & Ruuhilehto, 2007). Whilst there have been differences on the exact ratios, the principle of the triangle or 'iceberg' has remained for decades.

Heinrich originally proposed the 'common cause' hypothesis in his influential book 'Industrial Accident Prevention' [McGraw-Hill, New York].However, Wright & van der Schaaf, (2004, p. 105) argue that "*the hypothesis of similarity of causes for major and minor accidents has become confounded with the interdependence of the ratio relationship between severity and frequency*" According to them this has led to "*invalid tests of the hypothesis and erroneous conclusions*". This is supported by Alamgir et al. (2009, p. 74) whom conducted an analysis of the causes of near misses and minor injuries to establish if in fact there were common casual pathway with major injuries stated that "*When all reported events were considered there was no clear causal relationship between near miss, minor injury and major injury*". However, they did establish that near miss and minor injury had the same top three causes and activities, and concludes that their results combined with the studies of Wright & Van der Schaff (2004) and others that "*Our results add to this body of knowledge by suggesting that the common causal pathway may only be appropriate when limited to a single nature of injury*". An article by Manuele (2011, p. 52) starts by acknowledging Heinrichs work as a pioneer of the time, but is otherwise heavily critical of the theories that have prevailed over time, including the common cause stating that "*This is wrong. It is a myth that must be dislodged from the practice of safety"*. Manuele does state that in some cases Heinrichs findings have been misconstrued or misunderstood. For example, the use of the term 'Major Injury' appears to have had a different meaning to Heinrich than it does to current day health and safety professionals which could lead to "*Heinrich's 300-29-1 ratios have been misused and misrepresented many times as well"* (2011, p. 60)

Whilst there have been further studies since Heinrich's work which disagree with the triangle theory (Hale, 2002), (Ward, 2012). For example, according to Andrew Hale (2002) cited by (Dunlop, 2015) some major incidents can "*sometimes be predicted by minor accidents, but not always and that not all minor accidents could have been major accidents*". Whilst others such as Taubitz as quoted by Johnson, are more critical of the Heinrich's work *"The Heinrich myth prevails and we do little as a profession to dispel myths"* (Johnson, 2011).

Whilst according to Gallivan, et al (2008). the principle of a fixed ratio is not valid, and that *"introducing measures to reduce the incidence of minor incidents will not inevitably reduce the incidence of major incidents pro rata"* and goes on to say that any safety policies based on this assumption need to be rethought. This is supported by Taxis, et al. whom states that *"This paper raises serious doubts about*

the validity of assuming a constant Heinrich ratio linking the frequency of occurrence of safety incidents of different severities" (Taxis, et al., 2008, p. 5)

Oladejo & Macaule, Taubitz (1980) also questioned the Heinrich model, stating they *"…intuitively understand the Heinrich model didn't fit because it cannot help to forecast severe accident and fatalities"* and went on to say that the *"Heinrich model is just a foundation for accident prevention"* (Oladejo & Macaule, 2014). However, Embrey (1992) as quoted by Ward (Ward, 2012) reasons that investigating minor events such as a number of near misses provides a pool of data which can act as an early warning system to identify errors before a major incident. In fact, it is often highlighted by investigators of major incidents, that there were 'early warnings' reported prior to a major catastrophe. These early warnings can be months or even years before a major incident and are often minor in nature at the time.

For example, the investigation report into the now infamous Deep Water Horizon disaster identified *'there has historically been no legal requirement that industry track or report instances of uncontrolled hydrocarbon releases or "near misses"—both indicators that could point to a heightened potential for serious accidents'* (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). In fact, according to a report issued by a Joint Investigation Team of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) and the U.S. Coast Guard *'The investigation further found that BP and Transocean employees aboard the rig had—while engaged in testing procedures—ignored early indications of a problem and thus missed opportunities to prevent a full-scale blowout'* (Encylopedia Brittanica, 2017). Whilst *these early indications may have not been 'near misses' per se, opportunities to learn had been ignored in this case, and these reports show that looking for these minor events is very much in the psyche of those investigating major incidents.*

What is often missed by the application of Heinrichs' triangle is the principal of risk assessment. For example, the identification of a hazard that could cause a minor cut; the person completing the risk assessment, then identifies the likelihood of the harm being realised. The likelihood of it causing a cut will depend on the control measures being applied. Obviously if these controls are not followed or clash with other requirements then the likelihood of a cut will increase. Equally, there may be near misses that occur that indicate the controls are not working or being applied successfully. However, having a large number of near misses reported, does not usually indicate that the severity of the incident is ever going to get worse, merely the likelihood is increasing. According to Leathley (2017, p. 55), *"… we should be guided by our own risk assessments in choosing which near-misses we want reported and investigated – and which we can be brave enough to ignore"*

Of course, if one of those failing controls reduces the severity of the hazard (i.e. wearing protective gloves) then it could be argued that near misses are an early indication of the harm being realised. Therefore, it is feasible that with the failure of multiple control measures that even a minor cut could be a lot worse. For example, getting an infection in the wound due to poor hygiene controls or lack of appropriate first aid treatment could lead to a more serious injury and lost time. If we are pessimistic about the potential harm, then even a minor cut can lead to a fatal outcome. A slip or trip hazard that could vary in severity from a strain to bruising to broken bones, could prove fatal if the victim was unfortunate to suffer a blow to the head in the process of the fall (Dellorto, 2009).

Near misses affecting decision making

In looking at why safety performance is improved by the encouragement of near miss reporting, we must consider if the process of reporting incidents and near misses etc changes people's perception of risk and ultimately affects their decisions and behaviour. According to Rundmo (1996, p. 197) "*There was a significant positive correlation between perceived risk and risk behaviour, but risk perception was not found to predict risk behaviour*". This may be because the safety culture plays a major factor in how people behave, despite their own personal perceptions of the risk, as a 'just get the job done' mentality may exist.

We can look at any potential changes in two ways. The first is how it affects an individual's awareness of hazards and their perception of the level of risk, and the secondly, how it affects the organisations perception of the level of risk.

Studies by Kirchsteiger (1997) cited by Jones et al (1999, p. 66) showed that, the inclusion of near miss events not resulting in an accident has the potential to significantly increase the values of corresponding risk estimates. Likewise, not considering near miss occurrence can mean the organisation underestimates the 'true' risk. It would seem logical that an organisation armed with more accurate data of the likely hood of a hazard being realised, would be better prepared. According to van der Schaff (1991, p. 3) *'An important advantage in this respect is that near miss investigation provides a preventative perspective much more than accident investigation which is corrective in nature'*

Of course, this could work both ways, as the likelihood may not be as frequent as first perceived. In a study by Lanne & Ruuhilehto (2007, p. 5)the incident reporting process and risk assessment processes were linked by using the same classification titles for describing event types and by using incident data to update risk analyses etc. According to them, "*The study indicates that modelling the incident reporting process helps the organizations to better understand the process and highlight ideas for improvement." Jones, et.al* (1999, p. 66) *takes it further than the*

organisation by suggesting "… that the rate of near miss reports is an important numerical indicator of industry's safety awareness".

On a smaller scale, according to Borg (2002, p. 15) "*The other area that was improved was the work group's skill in looking for and recognizing the causes of accidental loss*". According to (Masden, 2008) as cited by (OJP Diagnostic Center, 2015) "*Research has also shown that even just the act of reporting reminds workers of the hazards inherent in their jobs, helping them to change their own mental safety models and become more compliant with existing safety regulations*".

As observed by Bulgen (2017) "*…as the guys get into the frame of mind of reporting, the range of hazards they identify broadens."* This all suggests that the act of reporting near misses makes the individual more aware of the hazards around them, which if backed up by management support for reporting and dealing with near misses and unsafe situations can only help promote a positive safety culture.

Unfortunately, "*For those employed in work environments with a mature safety culture, it eventually becomes difficult to maintain a minimum level of risk awareness in the absence of clearly visible adverse events*". (Institute of Medicine of the National Acadamies, 2004, p. 230). This of course is a distant situation for some industries as their methods of work are forever evolving, and therefore the absence of clearly visible events is perhaps a long way off. However, for some process based or predominately automated industries, this may well be a reality.

Some organisations actively welcome the sharing of near misses so that it "*will provide their peers with the knowledge to help them go home safely every day*" (OJP Diagnostic Center, 2015). Interestingly, according to Dillion, et. al. (2011, p. 448) providing people with some information about near misses can have the wrong effect, especially if the near miss involves a level of luck as people mistake this as an indicator of resiliency. They go on to conclude that "*People with near-miss information are more likely to choose a riskier option than people without near-miss information, and this observation has important implications for risk communication*". Similarly, experimental studies found *"…that subjects who are led to believe they are very competent at decision making see more opportunities in a risky choice and take more risks. Those who are led to believe they are not very competent see more threats and take fewer risks"* (Krueger Jr & Dickson, 1994, p. 385). However, it must be pointed out that this research was based upon gambling and dilemma risks, rather than physical health and safety risks.

The communication of near misses can also tie in with the culture within the organisation, because a blame culture may easily prevail without the full facts of

the situation. After all, often the press and media mock someone for doing something that seems to go against common sense. Therefore, a similar situation can occur within an industry or organisation, whereby an employee reports a near miss, only for it to be ignored or worse mocked for them making an error or mistake. The association between an individual's perception of risk and their behaviour are complex (Rundmo, 1996, p. 200) and there can be many factors that affect our perceptions of risk, such as age, gender, upbringing and experience.

Learning from Incidents

As we have already found the basis of all near miss reporting is so that the organisation can learn from the incident and take action to prevent a reoccurrence. Cooke & Rohleder (2006, p. 226) believe that *"A paradox of incident learning is that incidents cause accidents and disasters, yet they are needed for learning to occur*". In fact, according to (Gnoni & Saleh, 2017, p. 154) "*The aim of a NMS (Near miss management system) is to ''harvest value" from near-miss data by assessing and prioritizing their risk implications, identifying their failure generating mechanisms, and guiding interventions and safety improvements and awareness*".

A problem with this situation can occur when the organisation starts to receive numerous near miss reports and its resources start to be overwhelmed with the need to investigate all the circumstances. Not wanting to put barriers in the way of reporting, they may choose to only select certain incidents for investigation, which usually means the ones with the highest potential impact. (Drupsteen & Guldenmund, 2014, p. 94) state that "*Because mainly, incidents with high impact are used to learn from, this means that a limited number of opportunities is used and also that most learning efforts take place when the pressure to identify lessons is highest*". Alternatively, (Jeffs, et al., 2012) suggests a more proactive approach "*To optimise learning, organisations will need to determine which near misses are appropriate to be responded to as 'quick fixes' and which ones require further action at the unit and corporate levels*". There is no doubt that the aftermath of a serious incident will result in a great deal of pressure to identify lessons as quickly as possible. The author has seen and experienced this first hand, when organisation(s) (rightly so!) want to find out 'what went wrong' immediately so that it can prevent it happening elsewhere. However, this is unlikely to change for the most serious incidents, but it is how they deal with the others can just be as insightful.

One point to consider here is that not all near misses are of equal potential severity, and according to (Cooke & Rohleder, 2006, p. 226) the solution to the learning paradox is to *"... recognize that every incident has a different severity or magnitude of loss*". They are referring to incidents in general, but near misses are no different and to an extent so are observations. A near miss could have resulted in a fatality or a just a bruise and circumstances that could cause harm will vary in

the extent of the potential harm just the same. If we believe the near miss ratios so often used within the profession, then even a medium sized company could experience hundreds if not thousands of near miss reports. (Gnoni & Saleh, 2017, p. 159) states "*It is clear therefore that some down-selection and prioritization is needed to carefully allocate an organization's limited resources for safety considerations*". Their research extends to look at possible ways of selecting which reports to focus on and suggests a five-point system for deciding (Figure 4) the priority of the near miss and add that "*It is advisable not to reduce the complexity of the down-selection problem by adopting a single criterion, and to grapple instead with an overall holistic view of the different characteristics of the near-misses reported before selecting them for further analysis or rejecting them upfront*". They suggest the radar plot could be used as a visual tool to aid the selection process and that like medical triage the prioritisation is often done quickly and qualitatively with limited information. However, if such a tool was used, it would have to be reviewed at regular points as new information emerged during the investigation. Equally if only a single classification is used (i.e. severity of potential consequences) this may not give sufficient priority to minor incidents that repeatedly occur (i.e. the frequency of occurrence). Of course, the frequency of occurrence may be infrequent in one area/section/project but may be very frequent across the whole organisation or even industry.

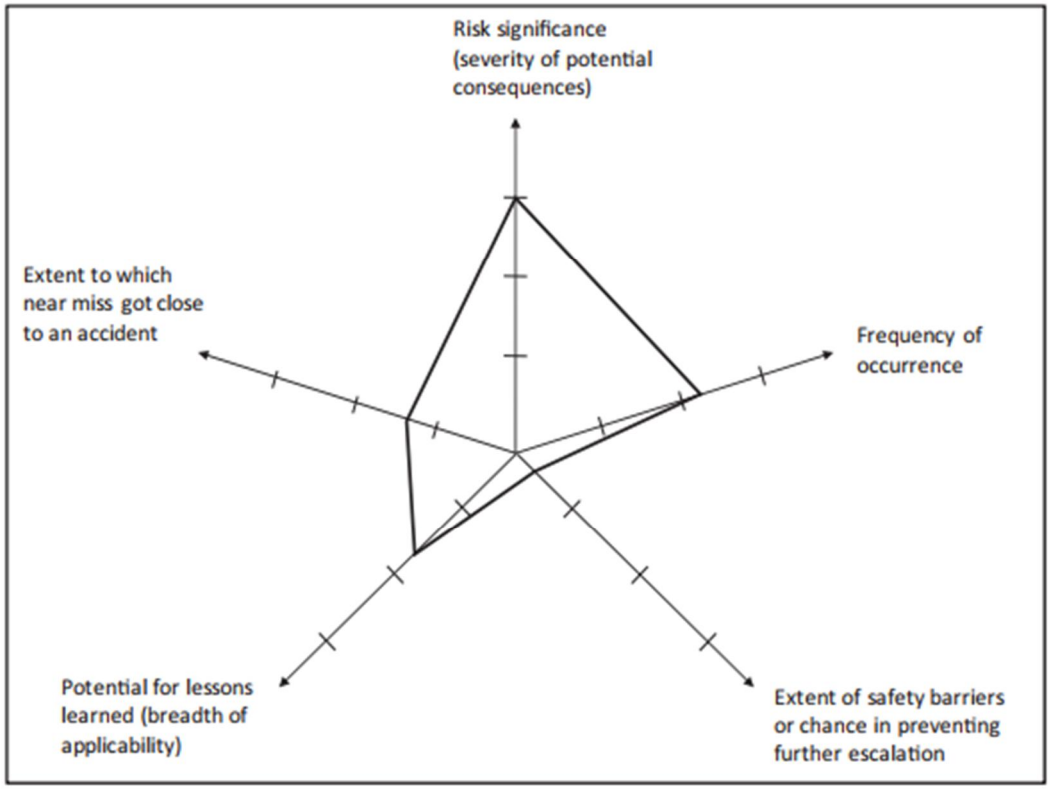


Figure 4 Illustration of a radar plot for a quick qualitative assessment of near-miss reports, and down-selection for further more detailed analysis or rejection (scales can be rough Low–Medium–High categories courtesy of (Gnoni & Saleh, 2017)

The encouragement of near miss reporting can mean the organisation receives a lot of low severity reports, and whilst we have already looked at reporting difficulties being a potential barrier, we also need to consider how the organisation learns from all the information they could collect about these events. According to (Cooke & Rohleder, 2006, p. 233)*"Since an organization may experience thousands of low-severity incidents a year, there must be an easy-to-use database for capturing the lessons learned*". This is an important point because no matter how good your employee engagement, reporting levels, investigation process and data collection facilities are; if causes of near misses are not being captured sufficiently or management information reported on easily then the potential for learning will break down as the system becomes too cumbersome to gain meaningful information and it starts to become a barrier itself.

Interestingly, (Cooke & Rohleder, 2006, p. 236) were engaged in working on the implementation of an incident learning system at a health care organization. and one of the point they expected to be able to prove, was that "*In an organization with an effective incident learning system, the number of incidents reported may increase initially but the average severity of the incidents reported will drop over time*". Unfortunately, the author has not been able to trace an subsequent research that supports this. However, this suggests they must have already experienced this situation enough to suggest they expected to be able to prove it. Again, there was nothing else in the article to back this u:

Of Course, if an organisation is to 'learn', it would need to remember its previous mistakes otherwise it would keep making the same ones over and over again. However, according to (Kletz, 2001, p. 313) *"Organizations have no memory. Only people have memory and they move on*". Equally, the organisations 'memory' isn't just a database with all the incidents stored on it, after all whatever method an organisation chooses to store its records on, they are simply a record or a library of records. If no one uses the library or knows how to search the library, then its function remains more of an archive of records rather than a powerful knowledge base. According to the Health and Safety Executives research report (2003) "*even data from past incidents can be analysed for:*

- *trend analysis (e.g. is the frequency of a particular type of incident rising or falling),*
- *identifying proportions for different incident types,*
- *zonal analysis (e.g. identifying specific "hot spots" with high incident frequencies)".*

This information can then be used to set management priorities and improve the knowledge within the organisation. (Bishop, et al., 2003)

A significant amount of research over the years suggests that organisations learning potential is in how it incorporates its learning into its systems and structure so that it can improve its performance (European Safety, Reliability and Data Association, 2015).

Data from past incidents provides an information repository that can be analysed to determine preventive actions.

> *However, a significant body of research over the last forty years suggests that it is useful also to think of organizations as having learning potential, in the sense that they have adaptive capacity and can incorporate knowledge in system artefacts (equipment, design rules, operating procedures, databases, documents) and organizational structure in order to improve their performance*
>
> *(European Safety, Reliability and Data Association, 2015)*

For us to better understand how we can learn from Incidents, we need to understand how an organisations learn. According to (Lukic, et al., 2001) "*The first distinction in the learning process from safety incidents is between formal and informal initiatives*" citing (Beckett & Hager, 2002).

In most companies, any kind of initiative would be a formal actions and procedures, and therefore any learning from an incident would be one of specific objectives in the form of safety procedures, processes and communications. More informal learning would be occurring during and shortly after the investigation process, when an incident or a near miss is discussed informally with a colleague or during shift handovers etc. (Lukic, et al., 2001, p. 486) go on to review the literature on a number of factors in workplace learning and propose a framework for learning (Figure 5) but conclude with *"The framework is unlikely to be exhaustive. However, it serves as a useful tool to analyse LFI (Learning from Incidents)*".

Figure 5 Framework for learning from safety incidents (Lukic, et al., 2001, p. 486)

Lukic, et al. (2001) study found "*Few examples of learning initiatives addressing all relevant factors identified by the literature review and the baseline qualitative study*". This is supported by (Cooke & Rohleder, 2006, p. 236) "*While it is probably true that an effective incident learning system is more likely to be found at a petrochemical plant than at a farm or construction site, further research is needed to determine which industries have implemented systems for incident learning.*"

Methodology

Secondary Data

The first aspect to study would be to establish that it has improved its safety performance because of encouraging near miss reporting. Then, we will analyse any data from the organisation on the near misses & observations reported, to see how many had interventions introduced. Also, we want to establish the effectiveness of the interventions. However, here lies a problem; due to the nature

of near miss events and the element of chance, to effectively analyse the interventions introduced, the circumstances for each event would need to be replicated or as a minimum in a virtual manner. Likewise, if we are to accept the triangle theory or not, the number of events that would need analysing would be significant, which would be both costly and would take considerably more time than this study permits. To keep the numbers to a manageable amount, a small setting could be used. However, due to the relatively low frequency of accidents, this could mean that it would be difficult to draw any reliable conclusions from the accident data.

Whilst this method will help identify if interventions are being introduced because of the reports, it will not identify any other aspects that may contribute. After all it is more difficult to prove why an accident didn't occur than why it did occur, as the failings can be traced back to the root causes. In this situation, we are trying to establish why accidents don't occur as often as a result of the near miss reporting.

The secondary source of data, will be the organisations incident database records, which will not only provide statistical data on the numbers of near misses and observations reported, but will also allow for the tracking of the introduction of interventions. Obviously, this will mean that the reliability of this source of data is reliant on the accuracy of the data entered. Again, with the support of the organisation it is hoped that problems with this source of data will be minimised.

The analysis of the data will be mainly on a numerical basis, as it is not the intention of this study to examine each intervention in detail. We will also look at how the organisation decides on the priority of its near misses and observations, if at all and what level of action it should take. As part of this process we will be looking at how the organisation establishes the causes of a near miss and if the data is being used for organisational learning.

Survey

As we have stated earlier, there can be many reasons accident performance improves and the second part of the study needs to explore the likelihood of these reasons to enable further study. For this reason, a survey is to be conducted with the source of the reports (i.e. the people that report near misses and observations) and those that would introduce interventions (i.e. Line Managers or Supervisors).

Also, the survey could establish their opinions on if interventions were introduced following a near miss report and the effectiveness of these. As the survey is looking at changes made as a result of the encouragement of reporting, it would seem logical to conduct a before and after study. However, as we can only look at settings that have achieved a reduction in accidents this restricts our ability to gain pre-intervention information. Therefore, this should be done retrospectively and the study population will be asked to recall their attitudes and beliefs etc. Likewise,

as the intended setting have a very transient workforce and supply of sub-contractors it would be extremely difficult to track the sample population over an extended period.

As we have seen on the literature review, there have been a few studies that have already looked at evaluating the effectiveness of near miss reporting systems (Lanne & Ruuhilehto, 2007) (Andriulo & Gnoni, 2014), therefore it is not the intention of this study to look at the effectiveness of the settings reporting system. However, some observations about the settings reporting system may naturally occur as part of this research, and any opportunities for improvement will be included in the recommendations.

This study will need to use both Primary and Secondary sources of data collection. The primary sources will be the opinions of the workforce and the Line Managers, via an opinion survey. The opinions of these people are tied into achieving research objectives 2 and 3 and there are a number of ways of establishing these as shown in Table 1.

Table 1 Methods of establishing the opinions of participants

Method		Advantages	Disadvantages
Observation	Participant	Opportunity to participate in the near miss reporting	Very time consuming Limits the sample size of the study population, due to geographical distribution Very limited range of opinions Observer bias Unlikely to observe an immediate impact Possible 'Hawthorne effect'
Interviewing	Structured	Provides uniform questioning and provides comparable results. Requires fewer interviewing skills	Very time consuming. Limits the sample size of the study population due to geographical distribution. Doesn't allow the flexibility to explain and expand on questioning

Method		Advantages	Disadvantages
	Unstructured	Freedom to ask extra questions and explain the questions, could be useful for exploring the situation	Very time consuming. Limits the sample size of the study population, due to geographical distribution Reliant on the skills of the interviewer
Questionnaire	Mailed	Relative ease of obtaining data Uniform questions Anonymity of responses Less expensive than interviews or observations	Low response rates Requires access to addresses Costly (i.e. postage and printing) May preclude those with reading and writing difficulties
	Collective	Higher response rate than mailed. Allows personal contact with the study population	Very time consuming Difficulties in obtaining a captive audience for an extended period Strong characters in the group may influence the answers
	Online	Less expensive Uniform questions Opportunity to include additional information with questions (i.e. help buttons) Analyse of data Allows respondents to complete in their own time Can be used to target the sample size more accurately Not limited by geographic distances	Limited to those that have access to the technology Doesn't allow the flexibility of interviews or observations

The method chosen for this research is an online questionnaire which can be emailed out across the setting. This will allow the use of several electronic devices currently used within the organisation such as laptops and tablets to distribute and

complete the survey. This also has the added benefit of enabling the collection and analysis of the data electronically without the need to transfer the results from paper records.

Whilst this method of data collection could restrict access to some of the study population, it was thought that with the support of the organisation this should not be too limiting. The benefits of using this method are that it can be quickly utilised across the country regardless of location and will greatly aid with data analysis (Kumar, 2014, p. 180) Additionally, this would allow the option of posting a paper version out if the electronic version proved an issue (although this would be a costly option).

The questionnaire contained a few mandatory closed questions regarding their experience of near miss reporting, along with questions to establish the study populations' attitudes towards the subject using a 'Likert scale' (Kumar, 2014, p. 203) and the extent and effectiveness of any interventions introduced. These were typically on a scale of 1 to 5, with the 1 representing a negative (i.e. never or strongly disagree) and the 5 being a positive (i.e. Always or Strongly agree). The questionnaire was split into five sections:

- Reporting health & safety issues
- Beliefs about reporting
- Attitudes towards reporting Near misses and Observations
- Behaviours
- Interventions

In reporting health and safety issues, we try to establish the level of reporting from everyone, if they are currently being encouraged to report, how likely they are of reporting and ask them to compare this to 1 year ago. This is to see how involved they are in the reporting culture which is important when looking at their views on the effectiveness of interventions (Objective 4) as well as establishing if the levels of reporting are a short-term spike or a longer-term improvement in the culture and maturity of the organisation.

In the next section, we ask if they believe reporting is worthwhile and give them a choice of two situations to establish which they are more likely to report. In attitudes to reporting we want to briefly look at if there is conflict with colleagues or supervisor/Line Managers when reporting health and safety issues. This section was specifically kept brief as there are already several studies on the barriers to reporting.

The questions in the behaviour section was looking for how the positive reporting culture affected their behaviours and that of the people around them. Again, this is

tied into objective 3, which looks at if their behaviours may have contributed to the improvements in accident performance. The final section asks specifically about the introduction of interventions as a result of reporting health and safety issues and asks about the effectiveness of this reporting and along with feedback they get. Whilst feedback may have been covered in previous studies, these questions were included to help give us a better picture of the reporting culture.

Initially the construction industry may not be seen as information technology savvy, but even in the year 2000 it was reported that "Construction companies are using handheld computers to access the Internet and communicate project details and speed paperwork to all members of the construction team" (Electrical Construction and Maintenance, 2000). Likewise, the organisation is one of a few leading the industry in the use of Building Information Modelling (BIM) to generate and manage information about a building, with the use of mobile tablets (Participating Organisation, 2016).

Photo 1- mobile technology used for BIM. Photo courtesy of Participant Organisation

The size of the organisation is very large, so for the convenience of the researcher and the length of time available for the study, a minimum of two projects within the UK construction division will be randomly selected based upon achieving increased near miss reporting. The extent of the improvement will not determine the inclusion, provided the improvement is made within a 12-month period to keep the information recent. This will effectively exclude projects that have not encouraged or achieved increased near miss reporting over the period. This could be considered as restricting the sample size and biasing the results; however as key questions are about near miss & observation reporting and the introduction of interventions, the results would be unreliable if it included projects that had low levels of reporting in which to base our findings on.

The method could be considered convenience sampling, however in terms of the sample size, the intention is to sample two groups or clusters (Kumar, 2014, p. 240) within the selected projects. The criteria for these clusters will be based upon whether they have the responsibility for a team or not (i.e. a supervisor/manager or construction worker).

The size of a project could vary dramatically, but will be structured in a similar manner to each other. As this study is looking purely at the construction workers and their supervisors/managers, the presence or absence of other professions (i.e. designers, architects, engineers etc.) should have limited impact on the study. With the support of the UK HSES Director, a representative for each selected project was contacted to explain the purpose of the study and gain agreement on its

involvement. This then lead the way to setting up access to and participation with the online survey.

The first group will be the construction workers, made up of a variety of different trades. This is so that we can collect the opinions of those that are most exposed to near miss events and the effectiveness of interventions.

The construction workers will be provided with access to the online survey via either a tablet or laptop, with a printed letter explaining: -

a) Who the researcher is and the purpose of your study
b) The survey's benefit to the individual as well as to the industry
c) Length of survey
d) Privacy statement, if required by the organization. (Jensen, 2016)

For this group, the main indicators are: -

- Retrospective opinion on near miss reporting before encouragement
- Number of near misses reported by themselves within given period
- Knowledge of interventions introduced
- Opinion on the effectiveness of any interventions introduced
- Current opinion of reporting near misses

To reduce the possibility of 'self-selecting bias' (Kumar, 2014, p. 182), the sample size will include those that have not reported near miss events as well as those that have. However, this will be dependent on the responses received.

The second group will be the supervisors and line managers of the construction teams, to establish their attitudes towards those reporting near misses and the introduction of interventions.

The supervisors/managers that have access to a corporate email address will be contacted via email explaining: -

a) Who the researcher is and the purpose of your study
b) The survey's benefit to the individual as well as to the industry

c) Length of survey
d) Privacy statement, if required by the organization. (Jensen, 2016)
e) A link to the online questionnaire

For this group, the main indicators are: -

- Retrospective opinion on near miss reporting before encouragement
- Number of near misses reported by their teams within given period
- Knowledge of interventions introduced
- Opinion on the effectiveness of any interventions introduced
- Current opinion of reporting near misses

Methods of reaching the population

There are a number of ways the survey could have been circulated for completion, each with their own benefits and difficulties as described in Table 2.

Table 2 Potential methods of distributing the survey to the target population

Method	Detail	Pros	Cons
Direct email	Request email address for all potential participants, and email them directly	Direct contact with the participant, less likely to feel pressurised by the organisation. Cheap, easy to produce and distribute	Not everyone has access to email. Increased likelihood they will forget or ignore the email
Site Visit	Physically visit each site and ask each person to complete the survey whilst there	More likely to get a high completion rate and presence on site allows the researcher to answer any concerns	Very costly and time prohibitive. May require additional time to complete a site induction etc to gain access to

Method	Detail	Pros	Cons
			sites.
Letter or flyer	Send a letter or distribute a flyer to all potential participants asking them to go to a website	Direct approach to individuals. Cheap, easy to produce and distribute	High probability of a low take up rate
Email represen tatives	Email site representatives nominated by the HSES function to circulate the link	Cheap, easy to produce and distribute	Individuals may feel pressurised to complete the survey

It was decided that the best approach on this occasion was to email representatives of each project nominated by the HSES function, and ask them to circulate the email and the link to the online survey. As the representative would be known to the employees on the project they are perhaps in a better position to encourage completion of the survey. The numbers of submissions were monitored by the researcher and reported to the Project representatives and H&S Director on a regular basis. Additionally, contact was made with the Project representative to ensure there are no problems being experienced by the respondents accessing the survey. The initial contact to the representatives included a closing date for the survey and reminder emails were also sent to encourage participation and remind them of how many days were left until the survey closed. This was especially useful to ensure there was a representative sample of both Construction Workers and Supervisors/Managers, as it seemed that the initial reaction was for those with access to email to complete the survey and notify their project representative that they had completed the survey. This resulted in a very low response from Construction Workers in the early days of the survey. It was only within the final weeks of the survey period that a larger proportion of Construction Workers responded.

The email included a front page that requests the consent of everyone, an explanation of how confidentiality will be maintained and how the respondents can contact the researcher if they have a query. It is important that the respondents feel involved in the results and understand how these can be shared with them (Jensen, 2016). Therefore, it is intended that the results of the survey are published online which will be shared via email.

Data collected from the secondary sources will be numerical in nature which will allow for analysis without editing. With the use of online questionnaires for the primary source, the need for cleaning up the raw data should be kept to a minimum unless there are high levels of incompleteness or incorrect choice of grouping. The results of each question will be analysed on Median and Model calculation.

The analysis of both primary and secondary data was carried out with a simple spread sheet (e.g. Microsoft Excel) to cross tabulate attitudes, beliefs and behaviours towards near miss reporting and effectiveness of interventions by role (i.e. Construction workers v Supervisors/Manager). The results on effectiveness of intervention will then be compared with the secondary data provided by the organisation.

Strengths and limitations of chosen design

Some of the advantages and disadvantages of the study design have already been briefly covered. However, further analysis of the strengths and limitations of the design are shown below:

Strengths: -

- Combines Primary and Secondary data
- Uses a large data source, with several different trades and backgrounds
- Easy to conduct the study in a short period
- Limits research costs by using available technology with an organisation
- Targets the sample of the study population, without watering down the data with organisations that haven't experienced an improvement in accidents.
- Isn't restricted to geographic location. Whilst this study is restricted to the UK, there is nothing to stop a similar study being performed in other countries.
- Provides a platform for uniform questions
- Easy to replicate and doesn't require extensively questioning skills

Limitations: -

- Information Technology requirements

- Doesn't explore the views and attitudes of respondents beyond the chosen questions. A qualitative study may have allowed greater flexibility for this purpose, but would have required significant time, cost and resource to complete across national geographic areas. The results of this study may provide an opening for further research that would explore this further.
- Obtains the respondents attitudes, but doesn't directly observe their behaviours. "*Behaviors usually, but not always, reflect established beliefs and attitudes*" (Ford-Martin, 2016)
- The study is based upon one organisation and one industry. Although a very large organisation with multiple stakeholders, attitudes will be affected by the culture of the organisation.

Potential problems will be the availability of the data on the number of interventions introduced.

Results and discussion

Secondary Data

To achieve objectives No 1 & 4 we must analyse the data from the organisation participating in the study. Firstly, that they have achieved an improvement in accident performance by the encouragement near miss reporting, and secondly to determine if the improvements in performance correlate to the level of intervention introduced because of the near misses and observations being reported.

Near misses and Observations reported

To achieve objective No1, we have established the number of near misses and observations reported within a 12-month period (2016) within the UK for the organisation. The data provided by the organisation shows that a significant increases of reporting of both near misses and observations were made in the period from 2015 (Table 3).

Table 3 No of Observations and Near misses reported in 2015 & 2016

	2015	2016	Percentage Increase/ (Decrease)
Reported observations	74,375	121,282	63%
Reported Near misses	14,562	20,585	41%

When we look at the numbers of near misses reported monthly for both 2015 and 2016, we can clearly see an acceleration of reporting in the period April to May 2016 compared to the previous year. The increased reporting was sustained for the remainder of 2016, whereas reporting in 2015 it plateaued for the rest of the year before the end of year decline (

Figure 6). The reduction in the month of December is to be expected due the shutdown of much of the construction industry over the festive period; Likewise, a dip in reporting over the August/September period is often seen due to people taking annual leave in this period.

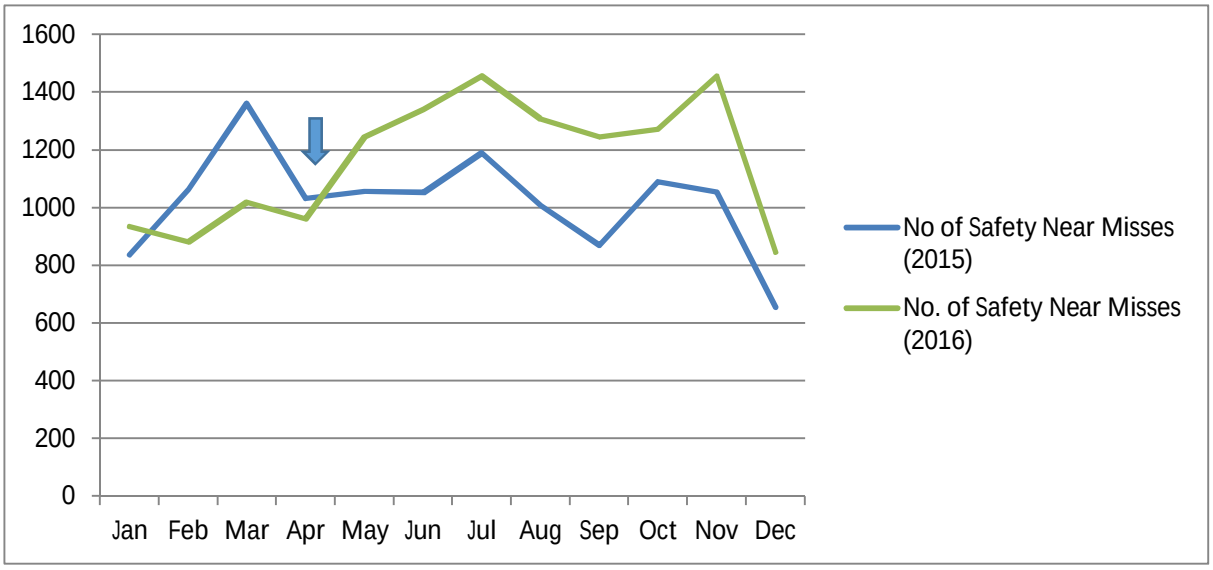


Figure 6 Near misses reported between Jan – Dec 2015 & 2016

Of course, the increase in reporting could be due to an increase in work compared to the previous year. However, according to the information provided by the organisation the number of hours worked dropped in 2016 (4.55%) compared to the previous year Table 4.

Table 4 Number of hours worked courtesy of the Participating Organisation

	Hours Worked
2015	84,028,000
2016	80,201,000
Increase/*Decrease*	*-3,827,000*

As is common practice for benchmarking safety performance, the organisation uses the number of hours worked to calculate its accident performance statistics, to create a frequency rate. Typical example:

No of lost time injuries x 100'000/hours worked = Lost time injury frequency rate

If we are to compare the numbers reported appropriately, we should do a similar calculation for the numbers of near misses and observations reported. With such large numbers being reported, the usual calculations of using 100,000 hours do not provide a very meaningful figure. Therefore, for simplicity for Table 5, we have divided the numbers reported by 365 days and then by 24 hours (i.e. No of Observations/365/24= Observation rate). This method gives us the number of observations and near misses reported every hour. Whilst it may not be the most representative way to calculate a rate (i.e. most site don't work 24hours a day) it does give an easy representation of the number of reports being made daily. As we can see from Table 5, even with 4.55% less working hours in 2016, the hourly rate of reporting is better for both observations and near misses.

Table 5 Observations and Near misses reported hourly rate

	Observations	Near misses	Observation reporting hourly rate	Near miss reporting hourly rate
2015	74,375	14,562	8.49	1.66
2016	121,282	20,585	13.84	2.35

This clearly indicates that the levels of reporting were significantly improved from the previous year, not just for near misses but for observations as well.

As mentioned previously, the organisation encourages the reporting of good practice observations as well to encourage the sharing of initiatives that could be used across the whole organisation. Unfortunately, the data provided does not distinguish how many of the observations reported were in fact 'good'. So, it is unclear at this point how successful this type of reporting is and whether the sharing results in any organisational initiatives.

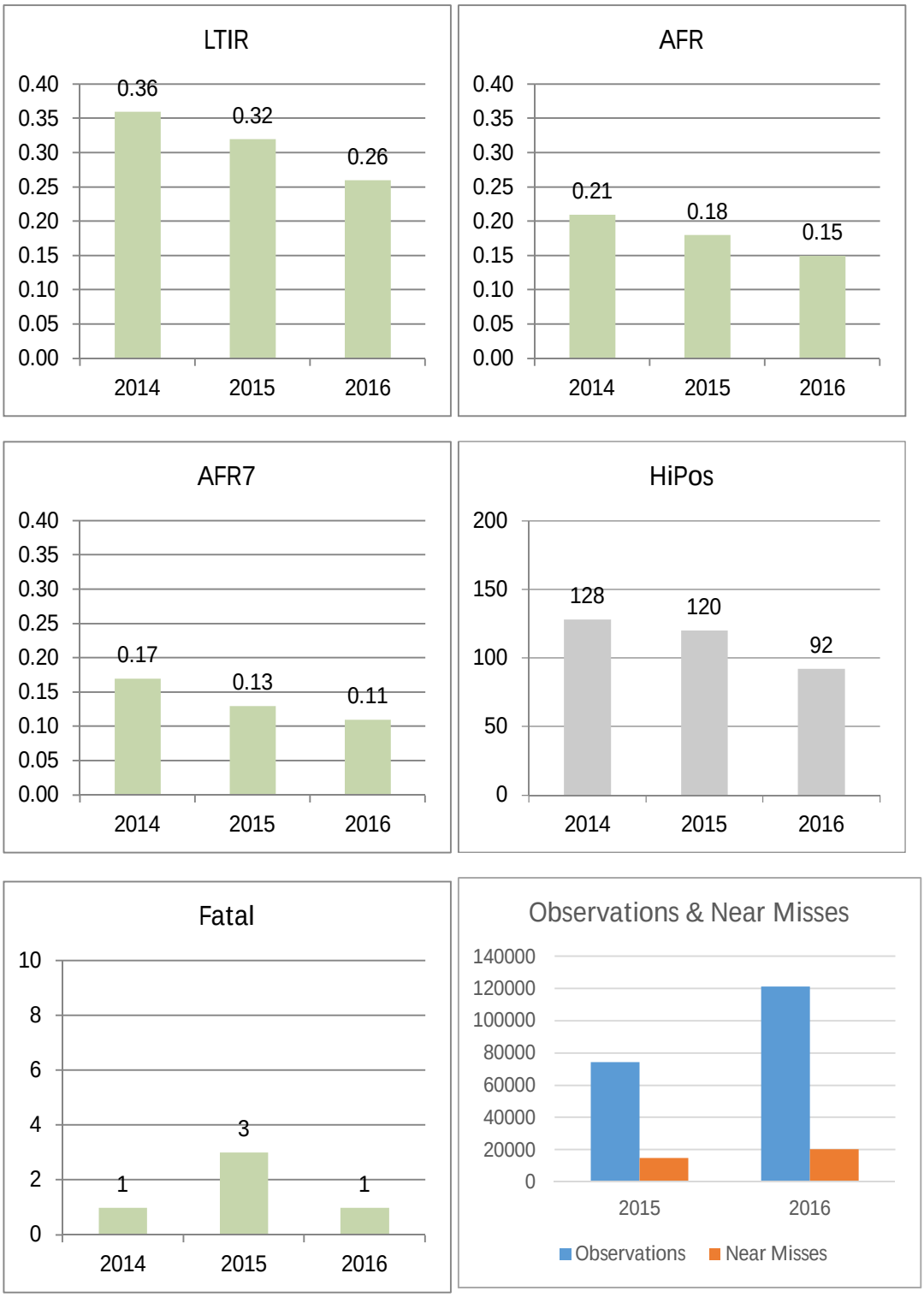
Accident Performance

To show that an improvement on accident performance was achieved over the period for objective no.4, we need to look at how the organisation measures its health and safety performance. In total, the organisation uses five lagging indicators to measure its performance for the period in 2016, which were:

- Lost time injury frequency rate (LTIR)
- Accident frequency rate (AFR)
- Accident frequency rate over 7 days (AFR7)
- High potential Incidents (HiPos)
- Fatalities

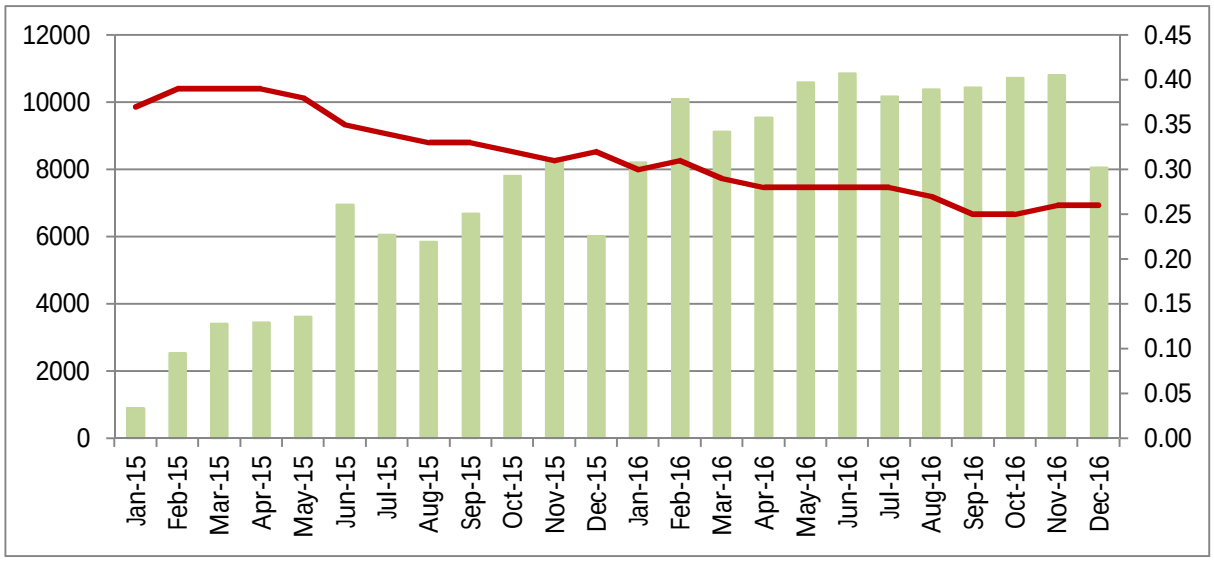
In all cases there was an improvement in 2016 compared with 2015 (Figure 7), although it should be noted at this point there was still a fatality in the period, even if it was a marked improvement on the previous year.

Figure 7 Accident Performance data courtesy of Participating Organisation



To better show the comparison between the reduction in lost time injuries and the increase in observations, the organisation has charted the results over an extended period (Figure 8). Whilst this chart only compares the observation rate against lost time injuries it does give a very visual representation of two areas of improvement.

Figure 8 UK Lost Time Injury Rate v Observations, courtesy of the Participating Organisation



Potential Severity

As we are looking at the links between near miss reporting and the common causality to prevent serious or fatal incidents, we should look at how the organisation considers the seriousness of these near misses and if it affects how they deal with it. It is the organisations policy to rate each incident with an 'actual' and 'potential' severity level as defined in Appendix 1. This rating extends to all types of incidents but not to observations. As a near miss means that the harm is not fully realised, there is no level of 'actual' harm to record, only a potential level of harm. Table 6 shows the number of near misses per the potential severity level recorded for 2015 and 2016 and gives a typical triangle to the levels of severity. The table clearly shows that whilst the number of potentially fatal incidents (Levels 4 & 5) had reduced, the biggest increases were seen in levels 2 & 3 which correspond with 1-day lost time & major injuries. Interestingly, level 1 (minor injury) incidents increased by a sizable number in the period (n=330) but not to the same levels as 2 & 3. We should also note how the numbers reported for the severity level has similarities to a typical 'Bird' triangle (see Figure 1)

Table 6 Potential severity level of near misses reported, courtesy of the Participating Organisation.

Potential Severity Level	No. of Near misses (2015)	No. of Near misses (2016)	Increase/ Decrease
5	3	2	-1
4	62	45	-17
3	523	1129	+606
2	2107	2881	+774
1	9580	9910	+330
Total	**12275**	**13967**	**+1692**

It should also be noted that whilst most of the incidents had been rated, there was a number that had not (*n=6618*), which is why the numbers portrayed in Table 6 do not completely align with Table 3. Whilst this may be an administrative oversight, it could lead to inappropriate levels of investigation and analysis of incidents if not rectified by the organisation.

As we have seen in the literature review, a method of prioritising reports is widely recommended (Jeffs, et al., 2012) (Cooke & Rohleder, 2006). However, the method is a singular classification and could lead to some reports not being prioritised sufficiently as emphasised by (Gnoni & Saleh, 2017). Whilst a local Health and Safety Advisor may recognise local trends and informally prioritise, there is scope for improvement in how the organisation looks at these overall.

Organisational Learning

According to the organisation the occurrence of any potentially serious near misses (HiPos (Participating Organisation, 2017)) is recorded in a weekly report along with lost time accidents and major injuries, which is distributed throughout the organisation and includes the CEO in the distribution. Currently the company uses the information to identify trends on a mainly informal basis. Hazard categories from HiPos (Figure 9) and lost time incidents (Figure 10) and historical performance are used to help identify some themes for a 'Zero Harm Calendar' (Appendix 3) which includes toolbox talks, videos and stand down days to raise awareness about a chosen hazard. Near misses and observations are also one of four leading indicators that the company publishes monthly in a league table format. The other leading indicators involve safety initiatives such as completion of training sessions linked to their behaviour safety programme, and the number of site tours completed by members of the Executive Committee.

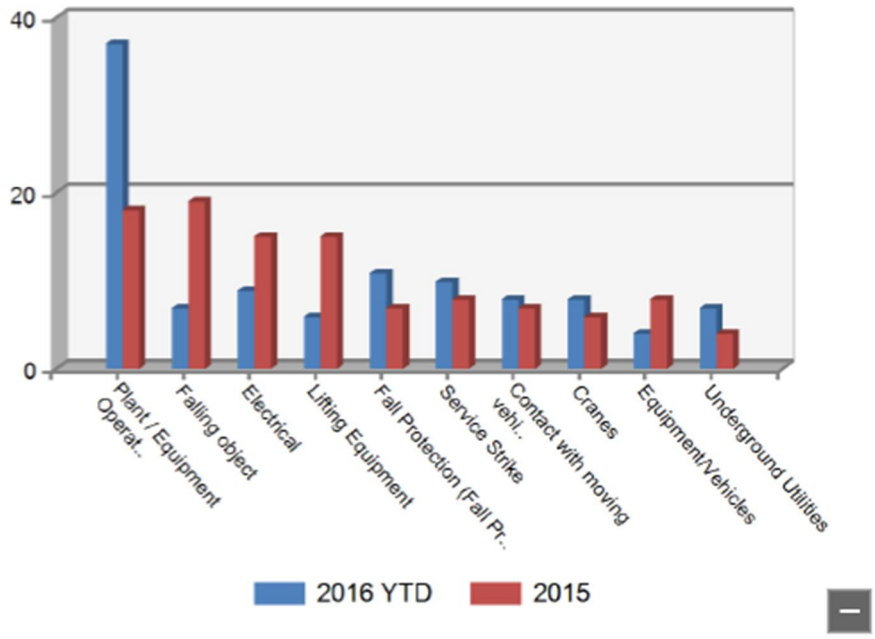


Figure 9 Top 10 HiPos by type of hazard courtesy of the (Participating Organisation, 2016)

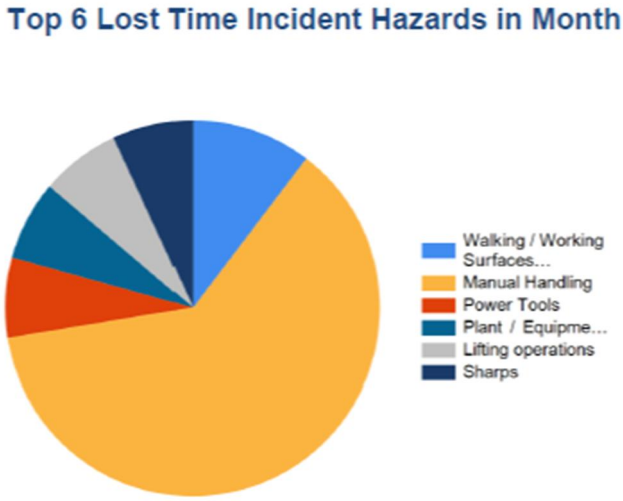


Figure 10 Top 6 Lost time incident hazards for the month (Dec 2016) courtesy of the (Participating Organisation, 2016)

The organisation uses a Human Factors Analysis Classification System (HFACS) for its root cause analysis investigations of serious accidents and near misses. This is based upon the systems developed by behavioural scientists (Dr. Douglas Wiegmann and Dr. Scott Shappell) in the Unites States Navy (HFACS Inc, 2014). Such a classification system should identify the underlying causes of an incident and ultimately allow the organisation to identify the so called common causes. Learning and findings from investigation of the most serious incidents are shared within the company and, in some instances, redefine their governance approach. However generally lower level incidents are either investigated only at a project

level using this system or investigated without using the system altogether. The potential severity of the incident is used to help decide the level of investigation as seen in this extract Table 7 from the organisation Incident Investigation procedure. This means that a large proportion of the investigations do not share sufficient detail of the causes to enable some of the more detailed trend analysis. Of course, some of the underlying causes may well be addressed in the actions taken at a local project level, but this doesn't allow the sharing of this knowledge or the more comprehensive trend analysis that the classification system could help address.

Table 7 Investigation level matrix courtesy of Participating Organisations Incident Investigation Procedure

Severity Level	Type of Investigation	Lead Investigator	Investigation team Members	Investigation team appointed by	Management Review
Actual 4/5	HFACS Investigation (Major Incident)	Director or Senior Operational Manager	As Potential 4/5 but Independent of SBU	Organisation's Senior Leader	CEO & HSES Director
Potential 4/5	HFACS Investigation	Director or Senior Operational Manager	Operations, HSES Advisor, Technical Expert (as required)	Organisation's Senior Leader	Director & Head of HSES
3	Local	Senior Operational Manager or HSES Advisor	Operations & HSES Advisor	Site Lead	Senior Site Lead/Function Head
1/2	Local	Line Manager	Operations	Site Lead	Site Lead & HSES Advisor

Whilst Table 7 will direct the organisation on the type of incident investigation, who must be involved in it and who must review it, there appears to be no guidance or instruction on how the organisation decides what action to take. The findings of the investigation and involvement of certain roles within the review may naturally lead to the interventions being aimed at a certain level within the organisation. i.e. the involvement of a UK director will mean a higher likelihood of the scope of the intervention will not be limited to local arrangements. Equally the full use of the classification system (HFACS) identifies organisational failings as well as more local or individual errors, mistakes or violations. This should prompt organisational action(s), however with a large organisation it could be easy for an action to be too siloed within a section.

The next area to look at in organisational learning is the introduction of interventions. Whilst the organisation uses a single database to collate its accident and near miss data and is the source of much of the data provided for this study, it was found that much of the reporting is generated from information provided by separate spreadsheets The complex nature of the businesses and projects that exist within the organisation such as joint ventures, alliances and investment infrastructure means that the collation of the data each month is a task in its self, requiring a network of incident recording/administrative staff as well as the Investigative teams and Management Information staff. The database has the facility to record both immediate actions taken and corrective actions for all incidents; whereas the recording of actions taken from an observation is slightly more basic. However, possibly due to the sheer volume of observations recorded each month, a large percentage (82%) of observations are recorded locally by the project on spreadsheets. In these instances, only the number of observations are fed back to the central reporting team to create management reports. This means that we are unable to analyse a significant number of observations (*n=98,923*) for the introduction of interventions. Equally, as this information isn't currently recorded centrally, it is not shared with the rest of the organisation for trend analysis. Based on this finding, the following analysis has been conducted only on the information recorded on the database. Whilst the numbers are still in their tens of thousands, they don't fully represent the whole organisation. There are however, currently moves to correct this situation so that bulk uploads of data can be made to the database which include the development of a mobile application (App) so that employees with a smart phone or tablet can record the observation directly into the app which then submits it electronically (see Image 1).

As previously mentioned the recording of actions taken for observations is more basic within the database although it does have two fields to record the 'Recommended Actions' and 'Corrective Actions Taken'. Unfortunately, it also appears that it is significantly underutilised as can be seen in Table 8.

Table 8 Number of observations recorded on the organisation database with either a recommendation or corrective action.

	Recommended Actions	Corrective Actions Taken
Observations with Entries in field	1770	1527
% of 2016 database observations	7.9%	6.8%
% of 2016 total recorded observations	1.4%	1.2%

An alternative way of analysing the observations for interventions, is to look at the status of the observation as these can be either 'open' or 'closed'. Table 9 shows the status of the 2016 observations which shows that 67.1% were closed, which leaves 32.8% open. Whilst this might be an indication that some action has been taken to correct an observation, it cannot be considered any kind of evidence that this is the case. However, it does suggest that either the person reporting the observation; felt that the issue was now closed or that it had been subsequently closed by the person investigating the incident. Equally, as good observations are also included within these figures there is no way of knowing for definite if these good practices have been shared, although best practices are shared within the business in a weekly update of significant incidents. This does mean that little meaningful analysis could be made from this in terms of our objectives Also, we are only able to analyse the quantities of actions raised rather than the quality of the actions taken and how effective they were in preventing a reoccurrence or in dealing with any common causes.

Table 9 Status of observation provided by the Participating Organisation

Count of Obsv ID	Status	
Month	Closed	Open
1	992	602
2	1675	731
3	1383	566
4	1052	545
5	1187	587
6	1347	660
7	1400	689
8	1346	739
9	1147	708
10	1155	658
11	1297	625
12	1029	239
Grand Total	15010	7349

In terms of actions raised from near misses, again there was limited information available from the database (Table 10). Whilst the information may or may not be available at a more local project level, obtaining this from each project or business sector was not included in the original study methodology or timescales allowed. The information provided for actions raised in 2016 also relates to all incidents (i.e. all injuries, road traffic events etc.) and the organisation are unable to filter out actions raised from just near miss reporting.

Status	No of action items
Open	4

Overdue	116
Closed	182
Total	302

Table 10 Number of actions recorded with database in 2016 courtesy of Participating Organisation

It should also be pointed out that the actions in Table 10 also can relate to a limited number of incidents as the system allows the recording of multiple actions against a single incident. Even an average of 3 actions per incident would suggest that only 100 incidents had actions recorded against them.

This suggest that the database isn't being used at any substantial level across the whole organisation for the recording of actions and that only a pocket full of incidents are being tracked. Also, the fact that 38% of these 2016 actions are labelled as overdue, suggests the data isn't being maintained after initial entry. In terms of achieving objective no.4, it would be impossible to suggest that the level of interventions introduced in any way correlates to the improvements in accident performance.

Other Interventions

During this study, we have mentioned a few other initiatives that the organisation has introduced during 2016, either because of historic accident performance or an effort to improve best practice across the industry. These include consolidating and refreshing the Fatal Risk Groups, the introduction of Executive Site Tours, the expansion and development of a singular behaviour safety programme, quarterly health and safety campaigns and consolidating the various business rules into one set of four golden rules. As you will see, some of the actions taken were more about consolidating the initiatives being taken across the business, rather than launching new ones. Whilst there is no evidence on the impact of these initiatives, we can only surmise that they will each have their own objectives for improving the health and safety performance of the organisation.

Survey Findings

The first question of the online survey was a choice between what role the respondent held within the construction industry. Overall, there were a total of 67 respondents to the survey, with the majority 59.70% (n=40) reporting their role was a 'Supervisor or Line Manager' (SLM) and 40.30% (n=27) 'Construction Operative' (CO) Figure 11. The nature of and distribution of the survey (i.e. email and online) may have contributed to this result, with the Supervisors and Line Managers having access to email and the internet more readily. Whilst a more balanced result would have been preferable, the result should still be considered a reasonable representation of construction workers.

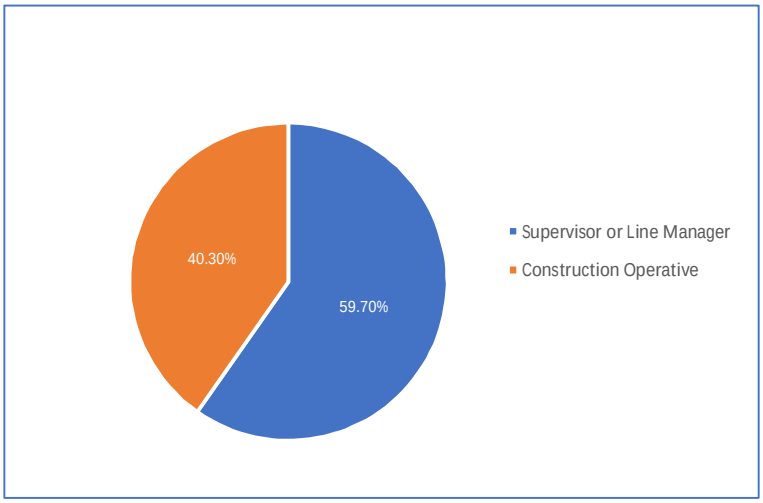


Figure 11 What is your role in the Construction Industry?

Reporting health and safety issues

The sampling was aimed at projects that had achieved an improved accident performance through the encouragement of near miss and observation reporting, so that the results were not influenced by respondents that were not being encouraged to report. It is therefore of no surprise that the majority of respondents (97%, N=67) reported in question no.3 that they were currently being encouraged to report either near misses or observations. With only 2 respondents (1 CO and 1 SLM) reporting that they were not being encouraged to report. Identical responses were given when asked about being encouraged to report observations in question No7.

When asked how many near misses or observations have they reported in the last 12 months from a range of 0 to 10+ in questions no.2 & 6 the average response was 3.2 for Near misses and 6.4 for Observations. However, what are more telling is the differences in reporting from the two roles. As can be seen in Table 11, Supervisors or Line Managers report near misses or observations the most, with the most common response from Construction Operatives being zero.

Table 11 Numbers reported in the last 12 months

	Near misses			Observations		
	Mean	Median	Mode	Mean	Median	Mode
Construction Operative	1.1	0	0	4.2	3	0
Supervisor or Line Manager	4.67	4	10	7.92	10	10
Combined	3.2	2	0	6.4	8	10

There could be a few factors driving this response, for example a better reporting culture within the management teams, a better understanding of what constitutes a near miss or observation, or a desire/expectation to show a good reporting performance from the management team. Whilst the number reported by Construction Operatives is low in comparison and the most common response was zero, there is some reporting, mostly of observations with an average of 4.2 which suggests that only a few are reporting these initially but they go on to report others in the afterwards.

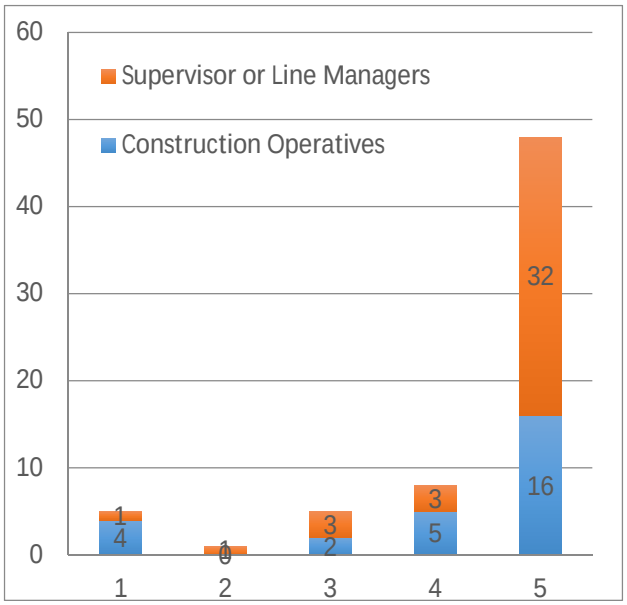


Figure 12 -Likelihood of reporting near misses in the future

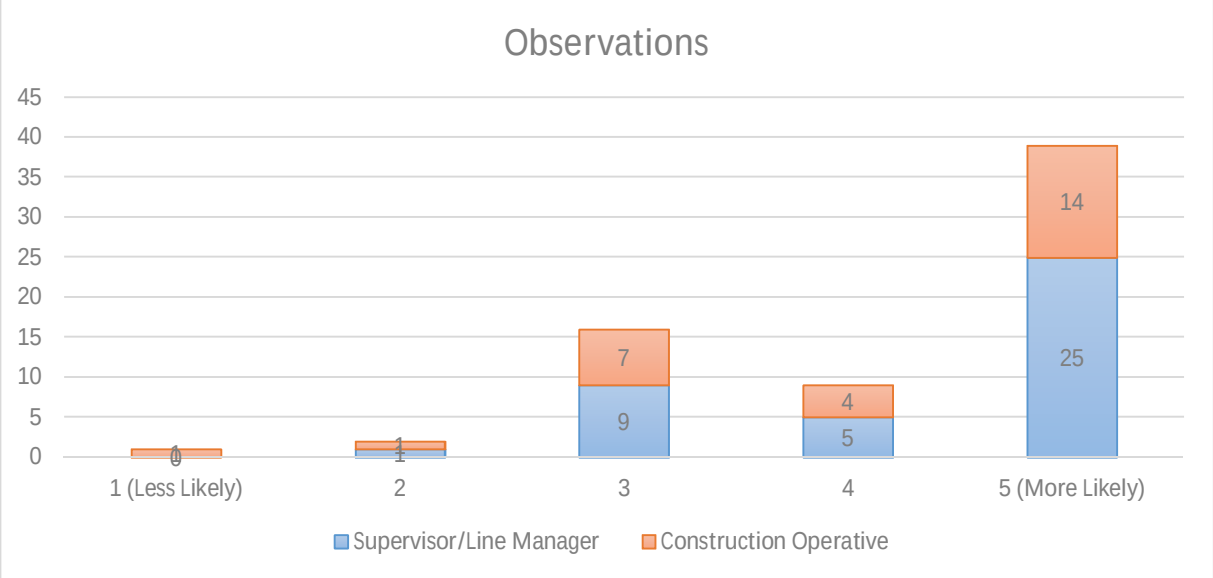
In terms of how likely they are of reporting in the future, on a scale of 1 to 5 (Not very likely to Very likely) the response for question no.4 was a lot clearer, with the most common response (Mode) being 5 for both roles for both near misses and observations Figure 12. This could be a case that the encouragement of reporting is promoting a better reporting culture with both roles very likely to report either a near miss or an observation in the future. However, there was a small number (*n=6*) (mainly Construction Operatives) that responded that they were not likely to report a near miss in the future, as result which was nearly replicated when asked the same question about observations (*n=5*). On closer analysis of these responses, the respondents that replied with either a 1 or 2 (Not very likely or not likely) to questions 4 and 8 had a mode score of zero for the number of near misses or observations they had reported in the last 12 months and included some of those that stated they were not being encouraged to report, although the most common response was that they were being encouraged to report. This could suggest that the encouragement wasn't enough to convince them or change their behaviour; equally they could simply perceive there would be less to report in the future. This could be via improved safety or a change of employment circumstances. As the majority reported they were very likely to report an event in the future, the value in studying these few may be limited, unless the majority started to deteriorate in the future.

To look at if the encouragement influenced the likelihood of reporting, the respondents were asked to compare how likely they were to reporting a near miss or observation compared to 1 year ago in questions no.5 and 9. The most common response for both near misses and observations was a score of 5 (more likely). The same results were seen for both roles and were fairly consistent for all the

responses. However, whilst the majority(68.6%) reported that they were likely or more likely to report compared to 1 year ago, there was nearly a quarter of respondents that scored a 3, which would suggest they would be no more or less likely than 1 year ago. (See Figure 13 & Figure 14)

Figure 13 Compared to 1 year ago, how likely are you to report a near miss?

Figure 14 Compared to 1 year ago, how likely are you to report an observation?



This could just mean that they were already likely to report events over a year ago, but further analysis of these individuals shows that they most commonly reported no near misses or observations in the last 12 months, with an average reporting rate of 1.61 for near misses and 1.87 for observations between them. This means that these individuals haven't reported much or changed the likelihood of them

reporting over the last year. Strangely, this group have a high average score for their responses to the likelihood of reporting in the future (questions no.4 & 8) (near misses 3.88, observations 4.06). Consisting of both job roles, further study would be needed of this group to better understand the situation, preferably via a qualitative study to allow a broader discussion, especially as their responses to the next section of the survey suggests they believe reporting is worthwhile.

Beliefs about reporting

Survey questions 10 to 13 look at respondent beliefs about reporting and relate to research objective 3. When asked if respondents believed that reporting was worthwhile in questions no.10 & 11, on a scale of 1 (Strongly disagree) to 5 (Strongly agree) there was a clear indication that they believed both near miss and observation reporting was worthwhile, with 86.5% (*n=58*) and 82% (*n=55*) respectively agreeing; with only slight differences in the responses from either role.

Figure 15 Reporting near misses are worthwhile?

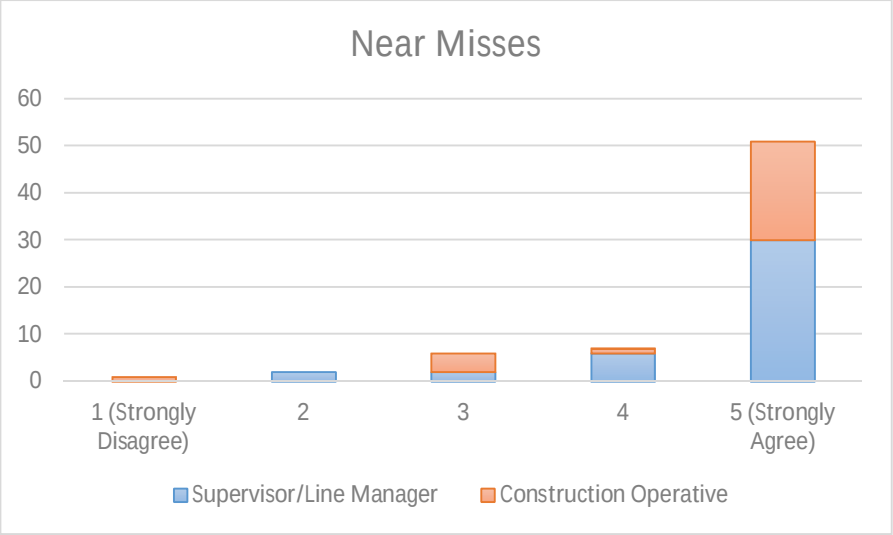
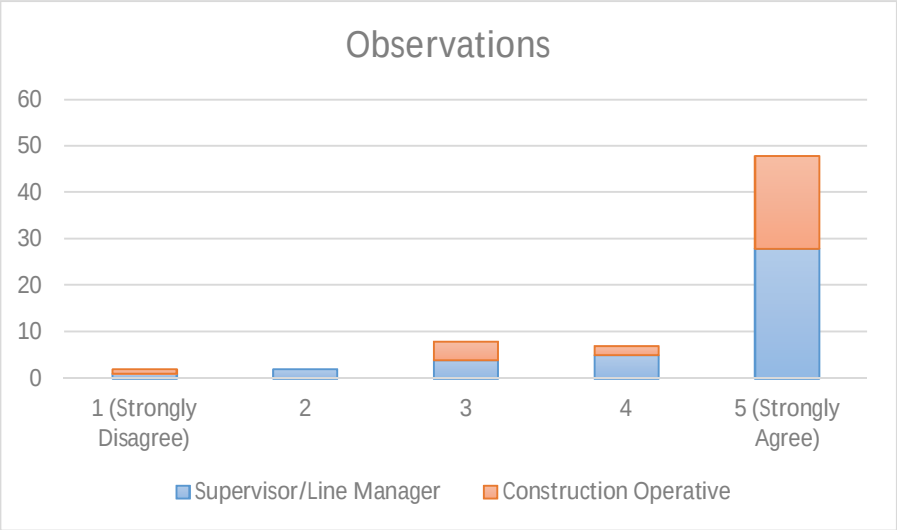
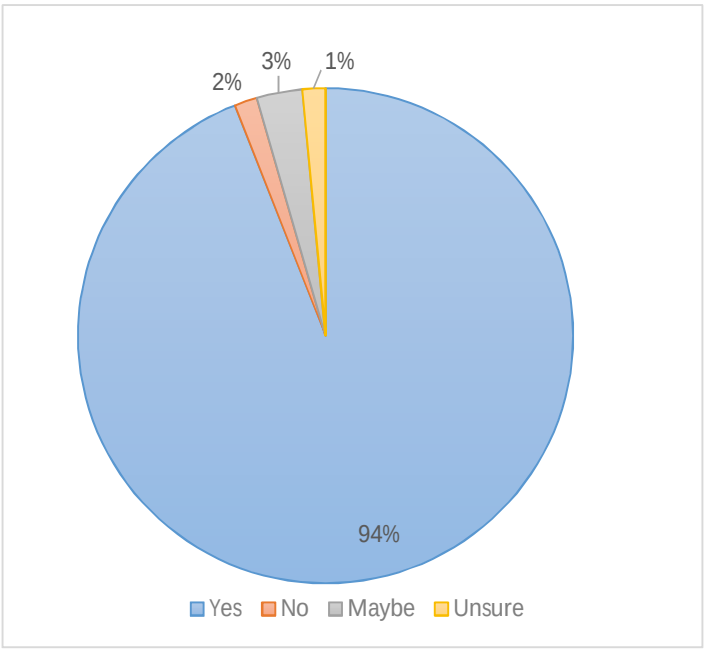


Figure 16 Reporting observations are worthwhile?



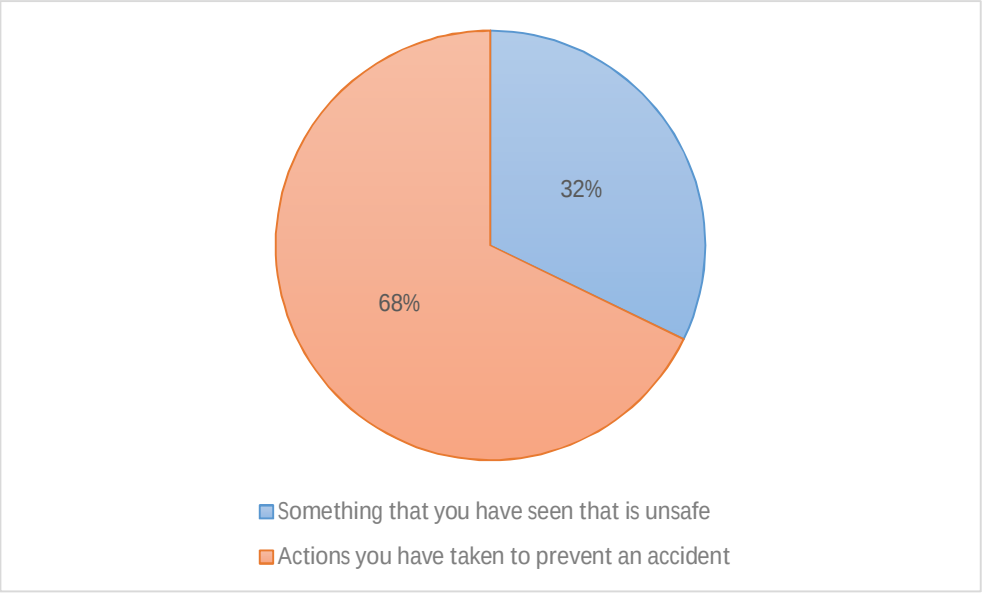
With such a strong majority stating they strongly agree that reporting is worthwhile and the responses to the previous section, we would have to question why so many hadn't actual reported either a near miss or observation in the last 12 months. This could be down to lack of opportunity, difficulties reporting or because of some of the barriers discussed in our literature review. Attitudes towards reporting are looked at further in the next section of the survey.

Figure 17 -Do you believe it is important to report good health & safety as well as bad?



As the participating organisation encourages the reporting of good safety practices; question no.12 asked if they believed it is important to report good health and safety as well as bad. A clear majority of 94% (*n=63*) responded positively to this question and only 1 individual responded negatively (Figure 17). However, when asked in question no.13 which they were more likely to report, 67.8% (*n=40*) responded that they were more likely to report something that they have seen that is unsafe, whereas the remaining 32.2% (*n=19*) stated they were more likely to report actions they had taken to prevent an accident (see Figure 18). On reflection, this question could be improved as respondent may not always have an opportunity to take action to prevent an accident.

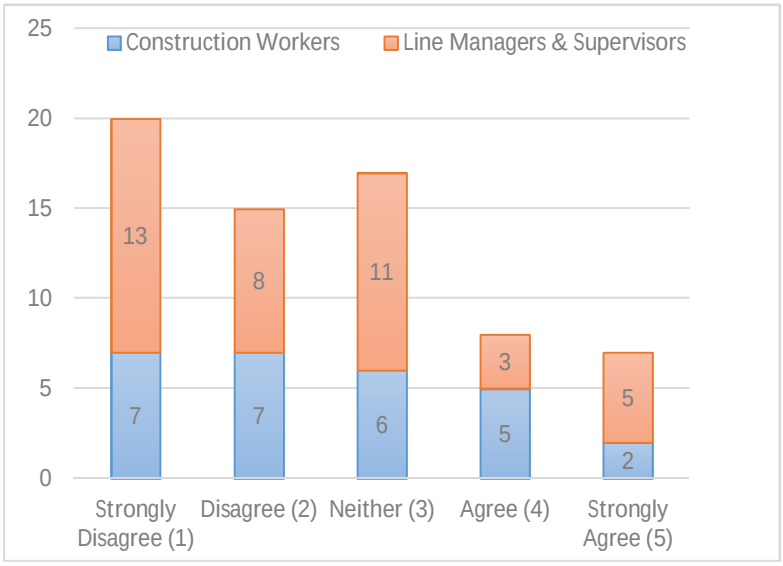
Figure 18 Which are you more likely to report?



Attitudes towards reporting

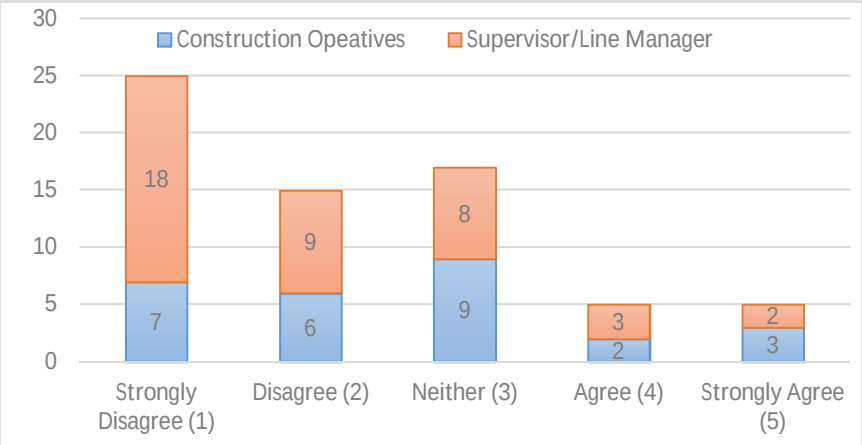
Survey questions 14 to 16 look at attitudes towards reporting near misses and observations and relate to research objective 3.

Figure 19-Reporting health & safety issues causes conflict with your colleagues?



From the previous section of the survey we have seen that most of Construction Operatives and Line Managers/Supervisors agree that reporting is worthwhile; however, when examining people's attitudes towards reporting, the responses are not as clear cut. For example, when asked in question no.14 for respondents to score (1 to 5) if reporting health and safety issues causes conflict with their colleagues, 52.2% (n=35) of respondents either disagreed or strongly disagreed. However, 25% (n=17) neither agreed nor disagreed with the statement and the remaining 22.3% (n=15) agreed with the statement (see Figure 19). There was no discernible difference in the response between the two roles questioned. The result could be because of the potential of reporting unsafe acts caused by team mates or fellow managers as peer pressure was identified as one of the top nine barriers to reporting in a previous study (Walter, 2011) Despite this when looking closer at the responses, the number of reports in the last 12 months made by the individuals scoring this question with a three or above showed relatively high average reporting rates (Observation -6.69, Near misses= 3.01). It would therefore appear that the potential conflict with their colleagues doesn't stop them reporting.

Figure 20 -Reporting health & safety issues causes conflict with your Supervisor or Line Manager?

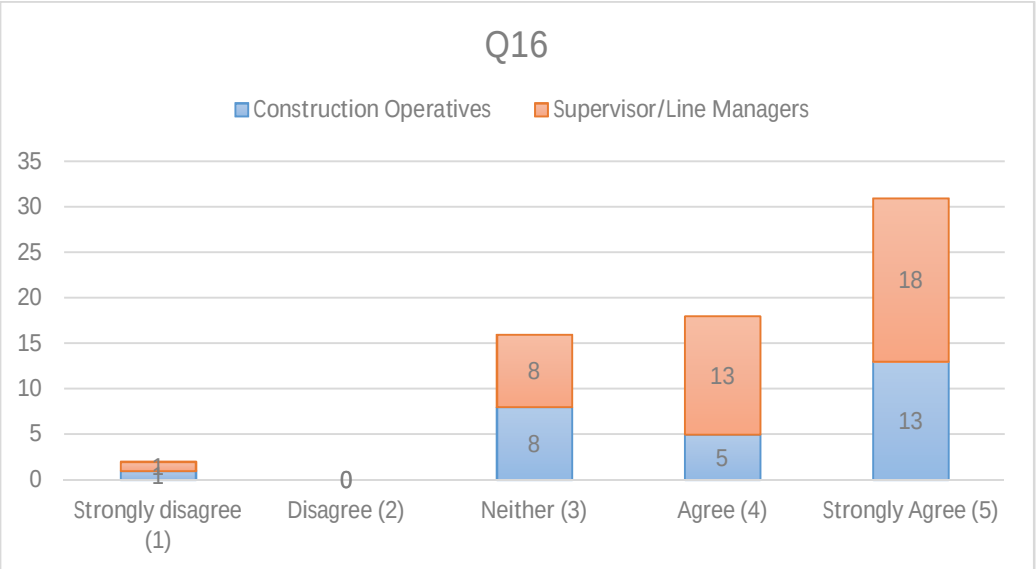


The response to question no.15 which looks at the potential for conflict for line managers and supervisors shows a very similar response to the previous question, but a difference of opinion between the two roles

for question 14. Collectively, the mode score was 1 (Strongly disagree), however when this is broken down into the two roles, Construction Workers responded with a mode score of 3 (unsure) whereas Line Managers and Supervisors mode score was 1 (strongly disagree) Figure 20. This could suggest a level of uncertainty by the Construction Workers into how their supervisors and managers will react to them reporting concerns. Other causes could be, not wishing to cause more work for them, potentially causing embarrassment to them or they are undecided because it may depend on the circumstances of the event. Equally, we have already seen that the fear of recrimination is a main barrier to reporting in the literature review; Yet the Line Managers and Supervisors themselves did not have the same concerns. Whilst overall only 15% (n=10) agreed with the statement, combining it with those that neither agree or disagree, would take this score up to 40.2% (n=27), which is still substantially below the 'agree' score, but does demonstrate that there are several individuals that did not feel they could disagree with the statement. The relationship between the operatives and their supervisors is an important factor in influencing safe behaviours (LANGFORD, et al., 2000, p. 138), and therefore it is important that these uncertainties are addressed.

When looking at if respondents believed that reporting health & safety issues encourages others to report them, we received a clear indication from both roles that that they did, with over 73% (n=49) agreeing and a mode score of 5 and a median score of 4(Figure 21). However, a further 23.9% (n=16) scored neither (3). Interestingly this group also had a mode score of 4 for question 14, which suggests they could see potential conflict with their colleagues as a reason that it doesn't encourage others to report issues; combined with a mode score of 3 for question 13 when asked about supervision and management conflict.

Figure 21 Reporting health & safety issues encourages others to report them!

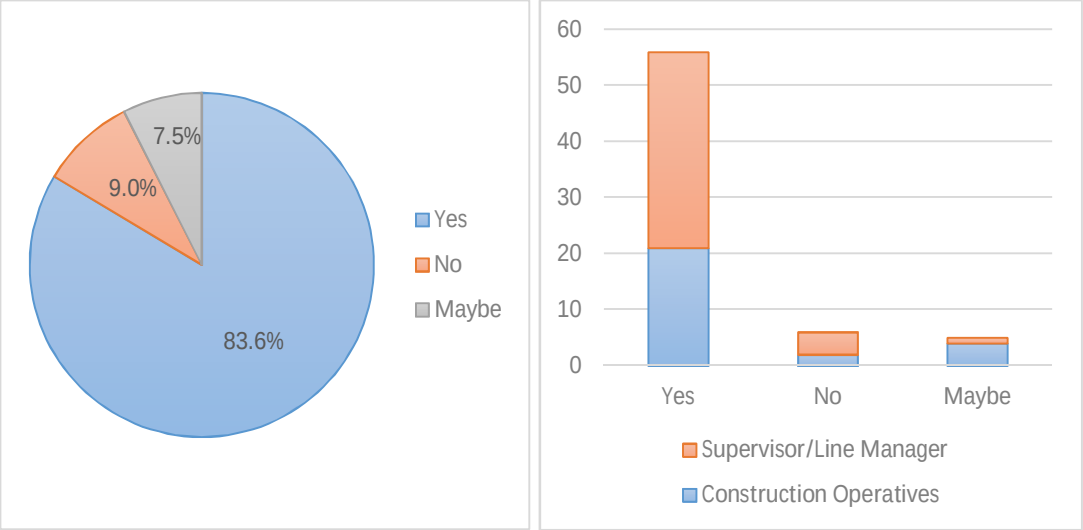


Behaviours

The next section of the survey asks how people's behaviours are affected by reporting, which ties in to achieving objective no.3. As we have already seen from the literature review, the relationship between people's attitudes and beliefs is complex; and whilst we cannot physically observe their behaviours within the period of this study, we can at least ask their opinions on any possible affects.

In the literature review we also found that there is a link between the perception of risk and reporting near misses. Question no.17 looks at this very issue by asking 'Does reporting health & safety issues make you think more about the hazards at work?'. The response to this question was very positive with 83.6% (n=56) selecting a 'yes' and 7.5% (n=5) selecting 'maybe'. In this case only 9% (n=6) responded with a 'no', however it was the Supervisor/Line Managers that were the majority (Figure 22)

Figure 22 Does reporting health & safety issues make you think more about the hazards at work?

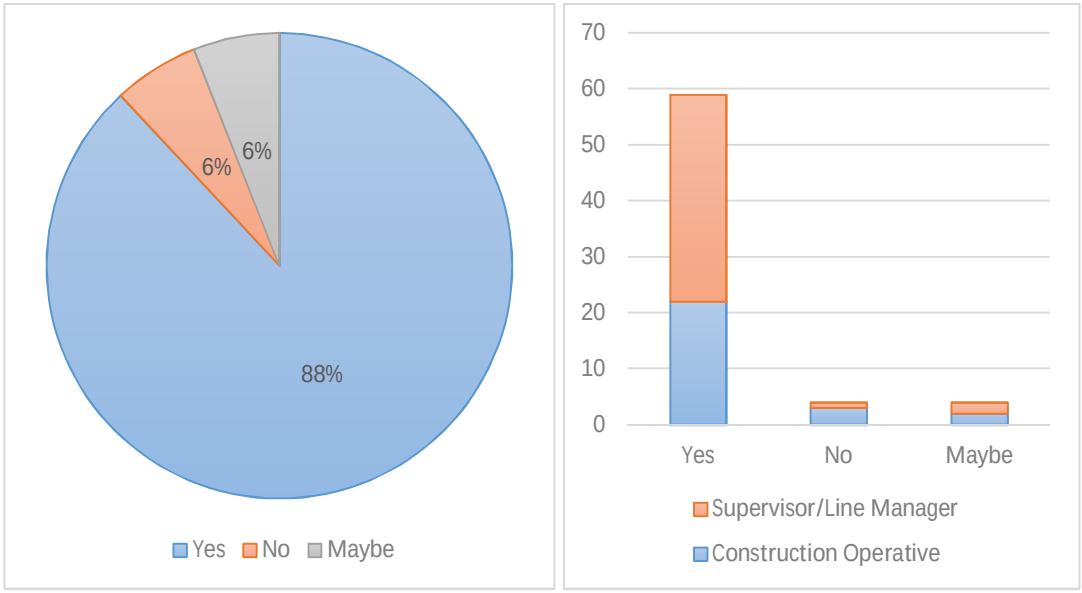


This confirms the findings of the literature review (Bulgen, 2017) (Borg, 2002) (Masden, 2008), and that the whole process of reporting near misses has a positive effect on the workforce. This could suggest that some of the improvement made in performance is achieved through better observation of the hazards around them, rather than just accepting the risks as 'part of the job'. Alternatively, the encouragement and support of reporting creates a more positive culture, which makes everyone more open to looking at the different risks rather than just accepting them because they know they won't get the support to do anything about it.

Obviously, this is just one question, so question no.18 looks at this a bit further by asking if this encouragement transfers to working safely. Again, the response was

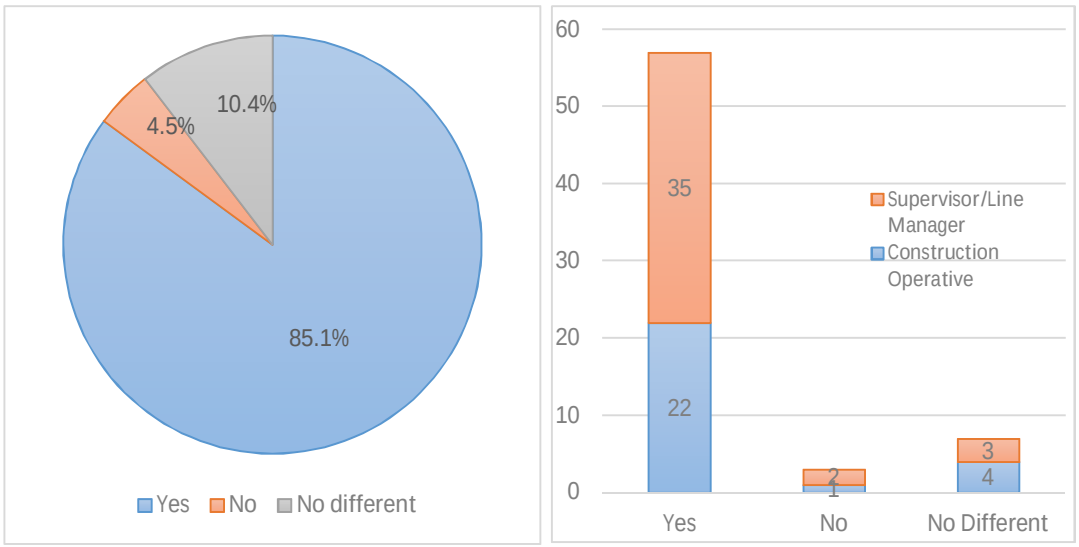
very positive with 88% (n=59) agreeing that 'yes' the encouragement of reporting health and safety concerns does encourage them to work safe (Figure 23). On reflection question no.18 is a positive question, and could have influenced the responses given, as many may believe they work safely anyway.

Figure 23 When you are encouraged to report health & safety concerns, does it encourage you to work safe?



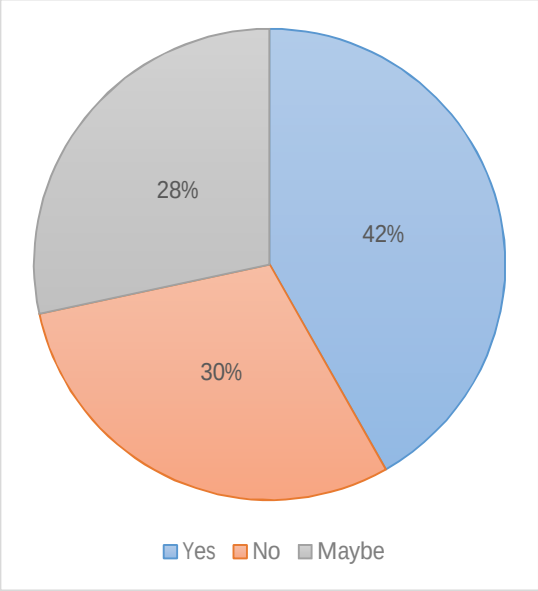
The next question (no. 19) looks at how people perceive the effect of the encouragement to report health and safety issues on their colleagues. Whilst the response to this question was a clear majority 'Yes' (85.1%, n=57) it was not quite as clear cut as the previous question (Figure 24) with nearly 15% (n=10) responding 'No' or 'No different' with equal responses from both roles. The majority response does again suggest that the encouragement of reporting process can have a positive influence on the safe behaviours of individuals.

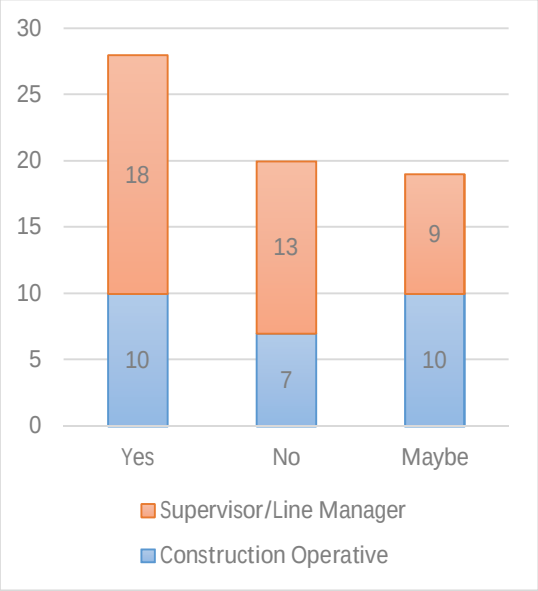
Figure 24 Do your work colleagues seem more safety conscious when they are encouraged to report health & safety concerns?



The final question for this section tries to look again at any conflict of reporting health and safety concerns with Managers and Supervisors. The responses to question no.20 gave a very mixed response with 42% (n=28) stating that they think Managers and Supervisors are concerned about criticism from the reporting of health and safety concerns. However, 30% (n=20) responded 'No' and the remaining 28% (n=19) responded 'Maybe'. Breaking the response down between the two roles should show any major differences of opinion i.e. Managers and Supervisors less/more concerned than their operatives believe. Unfortunately, as can be seen from Figure 25 this is not the case and the responses are nearly evenly split between the options.

Figure 25 Do you think Managers and Supervisor are concerned about criticism from the reporting of health & safety concerns?



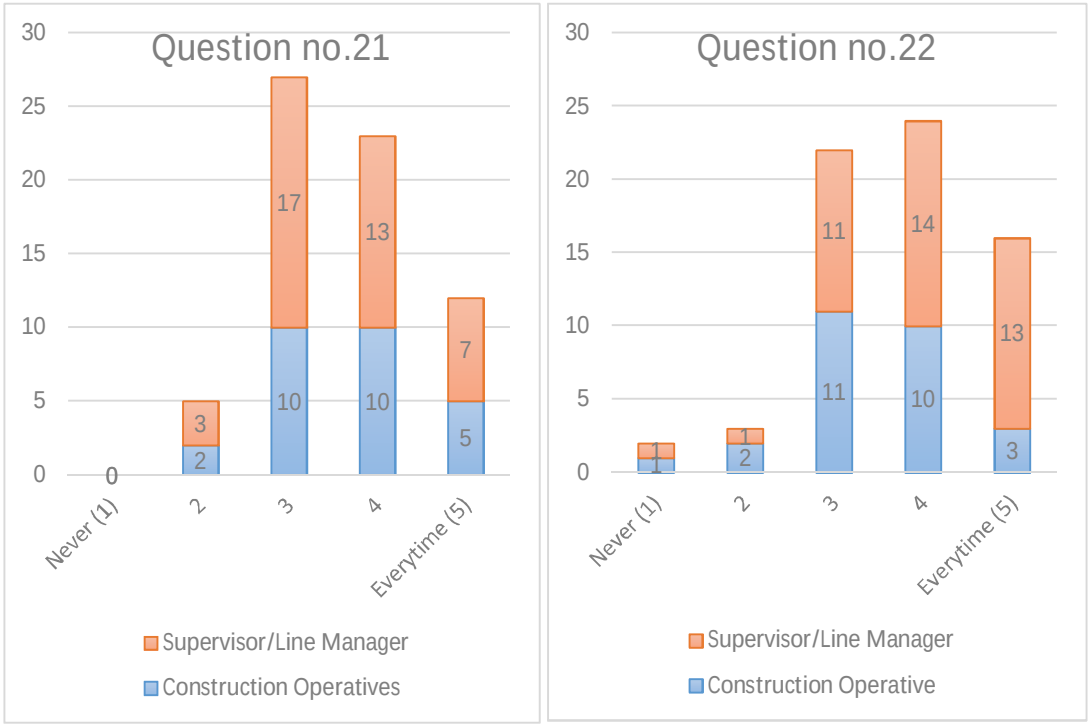


Interventions

This section of the survey is to examine the perceptions of how effective near miss and observation interventions introduced by the organisation are and the feedback they receive, which relates to objective no.2.

The first two questions in this section (no.21 & 22) tries to look at if people are aware of interventions being introduced because of near miss reports etc., and asks them to score (1 to 5) how often these are introduced. Question no.21 asks if interventions are introduced following reports made by other people. Overall the most common score was a 3 with a median score of 4, suggesting that interventions are being introduced on a regular basis but not every time.

Figure 26 Interventions have been made because of the health & safety issues reported by other people you know of at work, or reported by you!



When asked the same question about issues they had reported themselves in question no.22, the results were similar although there was a shift in the scores of the Supervisors/Line Managers.

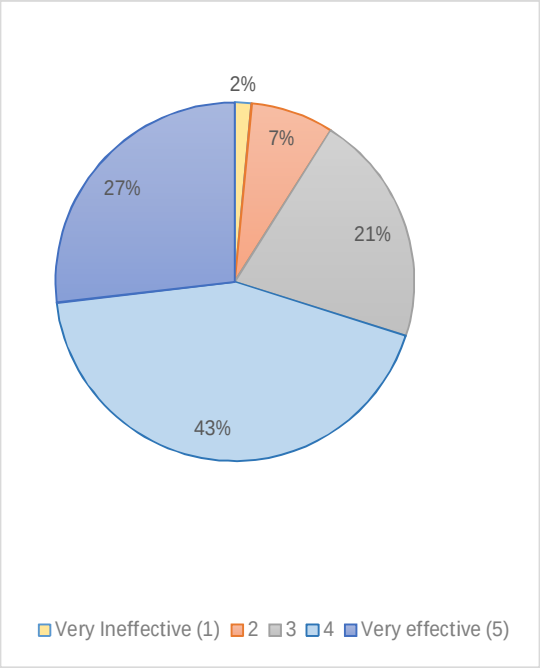
Interestingly the scores for question no. 21 varied slightly between the two roles, as the Construction Operatives were slightly more positive with a mode and median score of 4 and 4, compared to the Supervisor/Line Managers scores of 3 and 3.5 respectively. It's possible that because the Supervisors/Line Managers have more knowledge about the volume of reports made, that they perceive the amount of interventions being introduced to be less than the Operatives. However, when you analyse the result for question no 22 the mode and median scores for the

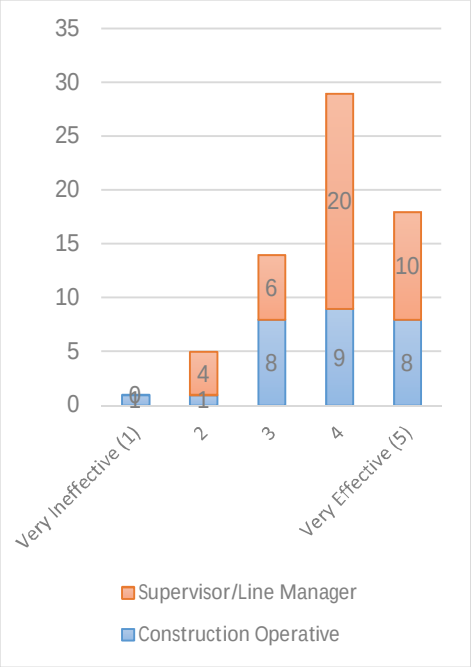
Supervisor/Line Managers shifts to a 4 and 4 (Figure 26). This could suggest that the Supervisor/Line Managers have interventions introduced more often from the reports they make, than their operatives do, but this would need further study to qualify.

In addition, there were a small handful of people from both roles that felt that interventions were never (or rarely) introduced because of the reports made. A closer look at those that scored question no.22 low (1 or 2) shows that these individuals didn't report many near misses over the last 12 months, with a median of 1, and they scored a low likelihood of reporting a near miss in the future (mode score 1). Although, the number of observations reported by these individuals was higher with a median of 2, the mode score was still zero. Combined with a low likelihood of reporting an observation in the future (mode score 1) suggests that this maybe their reason for scoring this question low. Although this small number of people (n=5) do appear to believe that reporting is worthwhile based upon their responses to questions No 10 & 11.

The next area for the survey was to establish the respondent's views on the effectiveness of the interventions introduced by the organisation. Question no.23 asks the question of how effective the interventions introduced are on a scale of 1 to 5 (Very Ineffective to Very Effective). The results for this question showed that just over 70% of respondents (Figure 27) thought that the interventions introduced by the company in preventing accidents were effective (Score 4 or 5). The most common score was a 4 for both roles as well as overall, although only just for the Construction Operatives. Again, only a small group (*n*=6) of predominately Supervisors/Line Managers felt the interventions introduced were ineffective (Score 1 or 2). Whilst this is only a small group, the fact it is mainly Supervisors/Line Managers is surprising and as this is an anonymous survey it isn't possible to ask them about these scores, but it may be worthwhile to study this further in the future.

Figure 27 How effective are Interventions introduced by the company in preventing accidents?



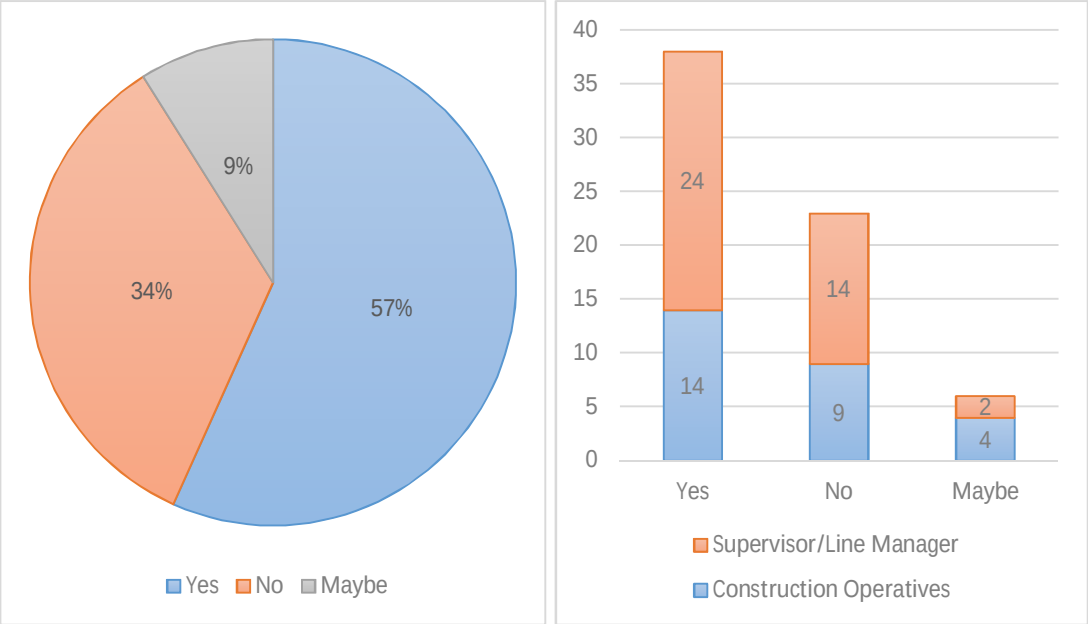


Question no.24 looks at if the effectiveness of the intervention introduced effects the likelihood of the person reporting a near miss in the future. We are looking at this to see if there is any connection between the effectiveness of the actions taken by the organisation and any slowing down or plateau of incidents reported. The results from this question was that 57% (n=38) replied that 'yes' the effectiveness would affect the likelihood of them reporting health and safety issues in the future (Figure 28), with an additional 9% (n=10) selecting 'maybe'. A slightly larger percentage (60%) of Supervisor/Line Manager role selected 'yes' compared to the Construction Operatives (51.8%). Whilst the barriers to reporting found in the literature review do not look specifically at this area; the ineffectiveness of interventions could easily lead people to think that reporting was pointless or the organisation wasn't interested (Walter, 2011). Equally, interventions that introduce more bureaucracy or 'red tape' could ultimately lead to recrimination from colleagues who start to resent the reporting of the near miss in the first place. We have already seen in question no.14 that there is some potential for conflict with colleagues when reporting health and safety issues.

In terms of the 34% (n=23) that responded that 'no' the effectiveness of interventions didn't affect the likelihood of them reporting in the future, analysis showed there was little discernible features of their previous responses to suggest why they gave this response. However, this group did respond positively to questions no.4 & 10 (mean 4.3 & 4.4 respectively) on the likelihood of future reporting and it was worthwhile, which suggests that they believe in near miss reporting regardless of the organisations actions. Although this could be a purely

protective measure to ensure they cannot be held responsible for not reporting something.

Figure 28 Does the effectiveness of the interventions introduced, effect the likelihood of you reporting health & safety issues in the future?

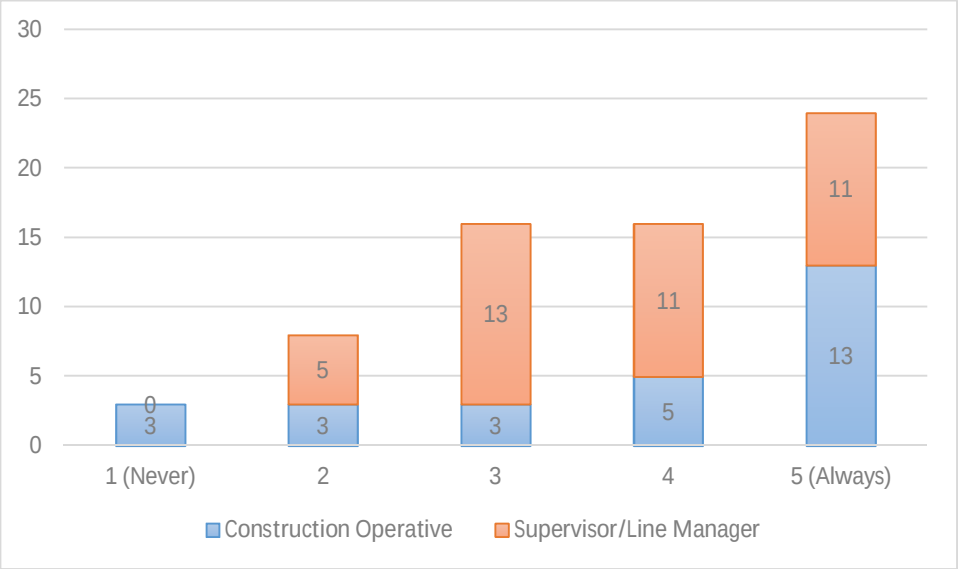


The final three questions look at the impact of getting feedback after reporting a near miss or observation. We have already found that lack feedback from a near miss report can be a demotivator for reporting in the future (AbuAlRub, et al., 2015, p. 2878). According to (Barach & Small, 2000) all the organisations they studied (Appendix 2) each claimed to have a feedback mechanism, which would seem to indicate that these industries felt it was important to the process.

Question no.25 asks respondents to score if they get feedback on the concerns that they have reported (1= Never to 5= Always). The results show that 35.8% (n=24) always receive feedback, with answers 3 & 4 equally receiving 23.9% (n=16) each. This shows that getting feedback to those that report near misses and observations is occurring within the organisation, even if it is not on every occasion. What is interesting is the responses from the two roles, as the most common score for Construction Operatives was 5 (median 4) compared to the Supervisor/Line Managers mode score of 3 (median 4). This suggests that the Construction Operatives are getting better feedback than their Supervisors or Managers. This may be because in this organisation, the management are often involved in the investigation of an incident or introduce an intervention as a result, therefore they don't necessarily get feedback from their own line management. However, it is something that shouldn't be overlooked if the organisation wishes to maintain a healthy reporting culture.

Incidentally, analysis of the few that reported they never receive feedback (n=3) shows they have not reported any near misses in the last 12 months, although they averaged 5 observations each. Two of the individuals also reported that they had a very low likelihood of reporting a near miss or observation in the future (questions no 4 & 8), and that they strongly agreed that reporting caused conflict with colleagues or their Supervisor/Line Manager (questions no. 14 & 15). This would suggest that more needs to be done to help address some people's fears of reporting.

Figure 29 Do you get feedback on the concerns that you have reported?



The next question (no.26) asks how important (on a scale of 1 to 5) it is that they get feedback on the near misses and observations they have reported. The responses from this question was very clear with over 67% (n=45) selecting that it was 'very' important that they get feedback and an additional 20% (n=14) selecting a 4 (Figure 30). The most common score for both roles was a 5, with just 11% (n=8) selecting a 3. Analysis shows that all the respondents that selected a score of 3 also answered the same as each other for Question no.13 i.e. that they were more likely to report 'Actions you have taken to prevent an accident'. Therefore, this may have something to do with their responses to question no.26.

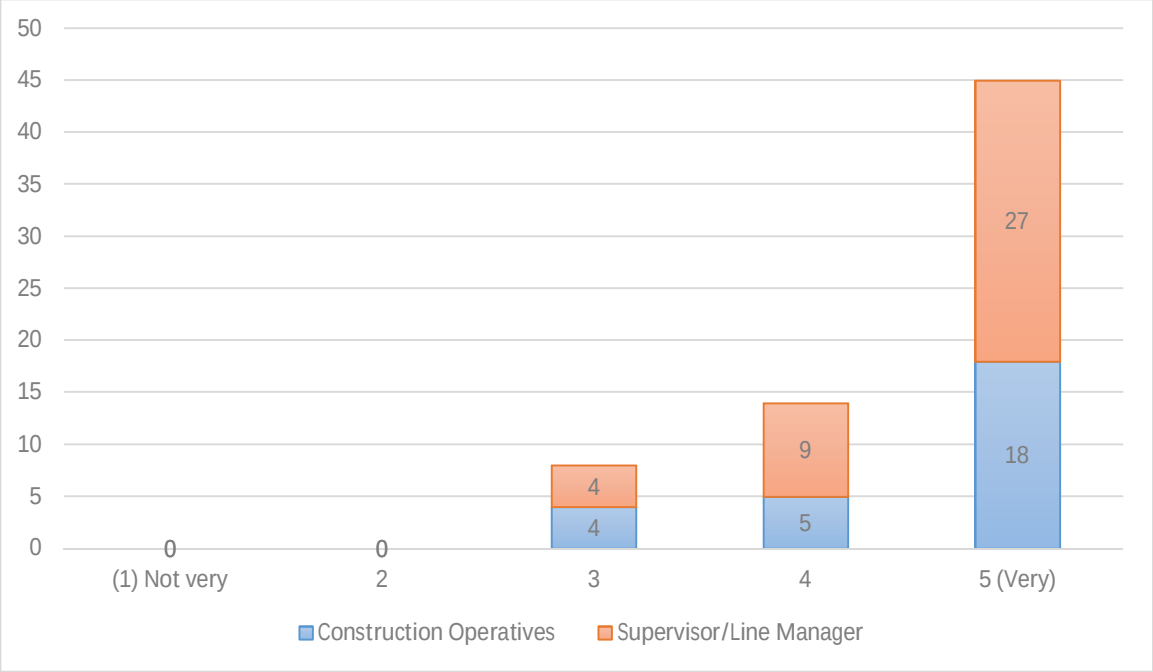


Figure 30 How important is it for you to get feedback on near misses & observations you have reported?

The final question (no.27) of this section and the survey looks at the importance of getting feedback about concerns other people have raised, Again, asking them to score the level of importance from 1 to 5 (Not very important to Very Important). Like the previous question there was a clear response that it was important to them that they got feedback about concerns other people had raised. With 91% selecting a 4 or 5, with the most common score being a 5 for both roles. Again, the few that scored a 3 had answered the same as each other for question no.13 but also had a very low reporting rate (Average NM =0.8, Average observation =1.8) or likelihood of reporting.

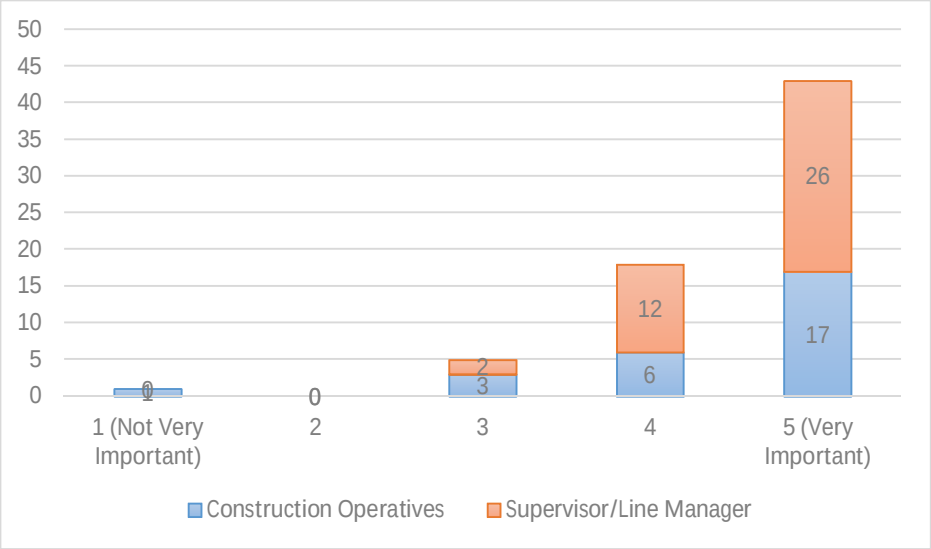


Figure 31 How important is it for you to get feedback on near misses & Observations others have reported?

Conclusion

Objective No.1 -To establish the number of near misses and observations reported over a 12-month period.

In achieving this objective, we established from the secondary data provided by the participating organisation that the number of near misses reported in the 12-month period of 2016 was 20,585 and that the number of observations reported was 121,282 (Table 3). We established that in both cases there was a significant increase in the numbers reported compared to the previous year and that unlike 2015, the rate of reporting didn't plateau but increased shortly after the first quarter (Figure 6). We also found that the accident performance of the organisation had improved on a number of measures and that when the rate of reporting of observations was compared against a typical accident performance rate (Lost time injuries), there was a definite improvement.

This reflects the improvements seen by other research (Jones, et al., 1999) (Borg, 2002) that have studied the benefits of near miss reporting, and demonstrates that the near miss reporting culture had improved during the period.

Objective No.2 -To establish Construction Workers and Line Managers/Supervisors opinions of the effectiveness of any interventions introduced.

To establish this objective, we conducted an online survey of both roles to ask them questions about the introduction of interventions and about their opinions on the effectiveness. What we found from the survey was that in the opinions of those asked, most thought that interventions were introduced regularly but not every time. Also, that 70% thought the interventions were either effective or very effective. We also found that 57% agreed that the effectiveness of the interventions would affect the likelihood of reporting in the future. Whilst 34% stated the effectiveness wouldn't affect the likelihood of them reporting in the future, they still indicated that they thought that reporting near misses and observations was worthwhile.

We also asked about the importance of feedback and how often they received it. What we found was that 35.8% stated that they always received feedback and that Construction Workers were more likely to receive feedback than Supervisors/Line Managers.

Objective No.3 -To identify if there are any changes in attitude, beliefs or behaviours in the Construction Workers and Line Managers/Supervisors that may contribute to the improvements recorded.

So that we could try and establish this objective we asked several questions in the survey about the attitudes towards reporting, their beliefs about reporting and if there was any affect to their behaviours. The findings showed that the majority of

both Construction Workers and Supervisors/Line Managers believed that reporting (near misses and observations) was worthwhile and that the reporting should include 'good' health and safety. However, whilst 52% stated that reporting health & safety issues doesn't cause conflict with their colleagues, the remaining sample either disagreed with the statement or neither agreed or disagreed. Despite this their levels of reporting remained high, suggesting that the conflict doesn't stop them reporting any issues.

When we looked at if reporting caused conflict with their Supervisor or Line Manager gave a similar response, however the Construction Workers responses were more unsure than the Supervisors/Line Managers, who were less inclined to agree. This shows that if we want to remove a potential barrier to reporting, Supervisors/Line Manager need to make it clear to their teams their commitment to reporting and minimise any possibility of reporting causing conflict, regardless of the potential consequences. Interestingly, 41% think that Managers and Supervisors are concerned about criticism from reporting with no major difference in the selections made by the two roles.

In terms of what affect reporting has on behaviours, 83.6% agreed that reporting health and safety issues makes them think more about the hazards at work. This supports the findings of (Borg, 2002)(Bulgen, 2017), and suggests that the encouragement of reporting will have a positive impact on the teams' perceptions of hazards and risk at work. Also we found that 73% agreed that reporting health and safety issues encourages other to report them which will mean that the number of people reporting issues should increase with time as they see their colleagues reporting without fear of retaliation.

Whilst 88% agreed that when they are encouraged to report health and safety issues, it encourages them to work safely, on reflection this would benefit from further research. However, 85.1% agreed that their work colleagues seemed more safety conscious when they are encouraged to report health and safety issues.

To find out if these attitudes had changed, we asked the respondents to compare their reporting of near misses and observations to 1 year ago. The most common response for both was that they were more likely to report than 1 year ago. A quarter of respondents indicated there would be no change in reporting compared to 1 year ago; however, we found that they had a low reporting rate in the last 12 months yet gave high responses to the likelihood of reporting in the future.

Overall, this all suggest that having a good reporting culture does have the potential for: -

- improving the attitudes to reporting,
- increasing hazard awareness and encourage safe behaviours,
- increasing the likelihood of reporting in the future, and

- having a positive impact on accident performance.

Also, Supervisors and Line Managers may become more conscious of the potential for criticism for health and safety failings, however this should tie into how the organisation deals with failings i.e. just culture v blame culture.

All this potential is with the caveat that a healthy reporting culture is maintained and that the organisation actively looks to remove actual or perceived barriers/conflicts to reporting.

Objective No.4 -To determine if the level of interventions introduced correlate to the improvements in accident performance.

To establish this objective we looked at the data within the organisations incident database and asked questions about interventions in the survey.

Unfortunately, whilst there was some limited data relating to actions introduced as a result of observations reported, there was insufficient information to make any kind of firm conclusion about the levels reported for near misses. Despite an extensive database, the information fields were generally not populated. The few records of action taken that did exist were not maintained or couldn't be separated from injury or damage records.

The results of the survey were more positive with the majority indicating the interventions were introduced regularly if not every time. Construction Workers were more positive than the Supervisors/Line Manager about the introduction of interventions. Whilst this may contradict the information from the database, it is believed that the interventions are being introduced at a local level, but the information is not being transferred to the database. However we don't have evidence to support this belief.

In terms of the effectiveness of the interventions introduced, 70% agreed that the interventions introduced were effective and that 57% agreed the effectiveness of the intervention affects the likelihood of them reporting in the future. Equally, getting feedback from reports made is important to the vast majority of the sample.

Overall

Overall in achieving our aim of finding out if an improvement in accident performance following the encouragement of near miss and observation reporting is a result of interventions put in place. We have not been able to prove for definite that this is correct. What we have found is that an improvement in accident performance was achieved and that there was a significant increase in the level of

reporting in the period. Whilst there are indications that interventions are being introduced that could account for the improvement in accident performance, these are mainly the opinions of the sample group with a small amount of data. There are however, good indications that encouraging the reporting of near misses, coupled with effective interventions and feedback process can have a positive effect on the attitudes and behaviours of the Construction Workers and Supervisors/Line Managers within the construction industry. Whilst this alone may not be enough to cause the improvement in accident performance, it can help improve safety behaviours and reporting on site and greatly assist the implementation of any interventions the organisation may introduce. After all, even if the correct interventions were put in place to deal with the causes, unless they are accepted and adopted by those that are required to follow the; they are worthless at best and disruptive to the organisation at worst, possibly even causing accidents if the change isn't properly managed.

From the perspective of the construction industry, it is encouraging that such a positive reporting culture exists within such a large business, and that in general anyone wanting to improve or introduce a near miss reporting system can gain a better understanding about some of the factors that influence it.

Recommendations

As we have not definitely proven that improvements in accident performance are a result of interventions introduced, it is recommended that additional studies are conducted to attempt to establish this. It is suggested that a study on a smaller organisation may be more achievable. Initially, it should be established at the beginning of the study the extent of their recording of actions taken following the report of a near miss.

We have also identified some recommendations or opportunities for improvement by the participating organisation:

Simplification of data recording and reporting process

The organisation may benefit from conducting some additional research of their own on the near miss reporting system. This needs to take the form of a qualitative measures to better understand people's views on the system, and should cover everyone in the whole process of learning from near misses and observations. This also needs to look at why the majority of Construction Workers do not report near misses or observations. There may be a simple explanation for this, but the organisation would benefit more by understanding why this is.

Currently the systems used are a mixture between paper and electronic recording, with varying routes of reporting. Equally the database used seems complex to interrogate for management information and may also be the cause of some of the data entry issues.

Monitoring of data compliance

The lack of data or missing data within the organisations database will not allow them to adequately report trends across the organisation or to effectively monitor to completion of actions raised against a specific incident. This combined with the fact that a large proportion of observations are being recorded on separate spreadsheets means that large chunks of data cannot be used for analysis.

Review of the severity selection process

With such large volumes of near misses and observations being reporting, the organisation may benefit from reviewing its selection process for near misses, and for introducing one for observations. This may help resource the subsequent investigations better and place the appropriate level of priority on interventions. For example, should the fatal risk categories identified by the organisation be given any higher priority than other fatal risks? The organisation may choose not to, but a formal review would help give structure to the prioritisation process and clarify when they choose not to.

A guide on the extent and type of intervention expected by the organisation based upon the selection may assist local teams in their decisions about interventions. Equally, gaining a better understanding of if Supervisors/Line Managers have any issues with the introduction and effectiveness of interventions may help in the future.

Analysis of near miss and observation trends, including causes, hot spots and frequency information.

We have seen from the literature review that many studies believe that analysing near miss data can provide organisations with significant benefits in terms of address its risks. Whilst some information is analysed, there is clearly significant scope for improvement in how the organisation uses the information. This could not only help identify trends but give early warnings about new emerging risks or changes in reporting.

Specific types of incident

Whilst the common cause pathway isn't necessarily that clear for the majority of incidents; the organisation may benefit from identifying specific types of near misses or circumstances that it would like to be reported, especially if these are linked to their fatal risks. This should encourage better identification of specific

circumstances or deviations that are attributable to their fatal risks and allow better tracking of these.

Feedback Process

We have seen that getting feedback is an important issue for everyone involved. The organisation may benefit from introducing a more formal process for giving feedback to people that report near misses especially Supervisor and Line Managers. Even a check that feedback has been given would help protect an important element of the reporting culture from any degradation.

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Appendices

- Appendix 1 Severity matrix courtesy of Participating Organisation
- Appendix 2 Non-medical reporting systems courtesy of Barach & Small, 2000
- Appendix 3 Zero Harm Calendar 2016 courtesy of the Participating Organisation
- Appendix 4 Blank survey questionnaire

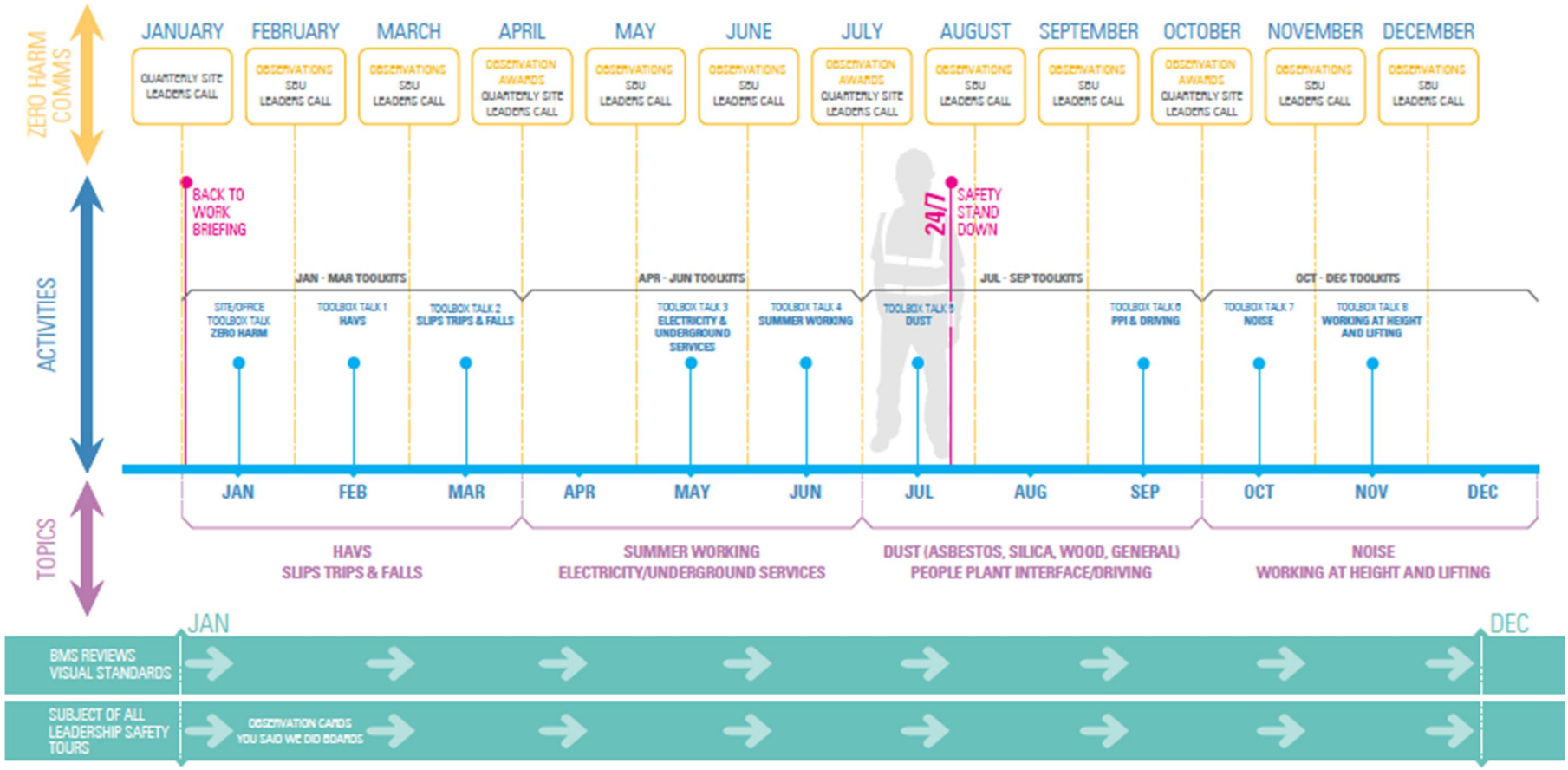
Appendix 1 Severity matrix courtesy of Participating Organisation

Scale	Health	Safety	Environment	Programme/Quality (meeting customer requirements)	Stakeholders	Legal action	Operating margin
Catastrophic (5)	• Multiple deaths e.g. asbestosis, cancers	• Multiple deaths	• Catastrophic environmental incident resulting in irreversible, long term or widespread damage	• Extreme product / service non-conformance resulting in catastrophic failure • Critical impact on customer business • Permanent stoppage	• Serious long term disruption in stakeholder confidence with potential for share price free-fall e.g. association with high profile, sensitive issue resulting in significant public opposition	• High profile prosecution • Public Inquiry • Class action	> £50m > US $75m
Major (4)	• Single death • Life-shortening health effect • Health effect causing significant irreversible disability e.g. lung diseases	• Single death • Multiple major injuries (worker or third party) • Significant irreversible disability	• Major environmental incident resulting in local damage that is reportable to authorities and requires high level of resource and time to ensure recovery	• Major non-conformance or delay that adversely affects customer interests	• Significant disruption to stakeholder confidence, potentially long term, and major drop in share price e.g. significant interest group action and/or extensive negative national media coverage	• Company or individuals facing prosecution • Citation • Major fine • Loss of licence/safety case	£10m -50m US$15m - $75m
Moderate (3)	• Irreversible health effect e.g. loss of hearing, HAVS stage 2 (late) requiring notification to the relevant authority • Serious illness from which there is full recovery e.g. poisoning, Legionnaires disease, MRSA, serious dermatitis	• Single major injury (worker or third party) • Worker injury resulting in reportable notification to the relevant authority or over 7 days lost time	• Moderate local environmental impact that is reportable to authorities and requires management action to enable recovery	• Partial delivery or delay to customer requirements	• Stakeholder confidence disrupted short to medium term with moderate drop in share price e.g. extended negative local/industry media coverage	• UK Prohibition Notice • Ban on operational activity by enforcing authority until stated requirements are met • Minor fines	£5m - £10m US$7.5m - $15m
Minor (2)	• Reversible health effect, e.g. minor dermatitis, asthma, tinnitus • Minor illness	• Minor injury (worker or third party) • Injuries resulting in one day away from work • Restricted work • Medical treatment beyond first aid	• Minor local impact requiring management action that leads to immediate recovery	• Delayed or inconsistent delivery of customer requirements	• Stakeholder confidence disrupted short-term with minor impact upon share price e.g. series of articles in local/industry press	• UK Improvement Notice • Actions required by enforcing authorities for continued operations • Warning from enforcing authorities	£1m - £5m US$1.5m - $7.5m
Insignificant (1)	• Mild health effect for short period with no lost time e.g. local skin irritation	• First aid case with no lost time • Negligible safety impact	• Minimal local environmental impact	• Slight deviation from specification, of little customer concern	• Negligible impact on stakeholder confidence e.g. letters to local/industry press	• Recommendations by enforcing authorities	<£1m <US$1.5m

Appendix 2 Non-medical reporting systems courtesy of Barach & Small, 2000

Reporting system	Ownership	Regulatory	Mandatory	Voluntary	Anonymous	Confidential	Narrative	Immunity	Threshold	Feedback
Aviation safety reporting system[w12]	Federal funded, administered by NASA	Yes	No	Yes	After filed	Yes	Yes	Yes	All non-accidents	Yes (*Callback*)
Aviation safety airways program[w13]	American Airlines	No	No	yes	No	Yes	Yes	No	All non-crashes	Yes
Airline Pilots Association[w14]	FAA in with private pilot association	No	No	Yes	No	Yes	Yes	No	All incidents	Yes
British Airways safety information system:										
Air safety report[w20]	British Airways	No	Yes	No	No	Yes	Yes	No	Safety related events	Yes (*Flywise*)
Confidential human factors reporting program[w15]	British Airways	No	No	Yes	No	Yes	No but can expand	No	Human factor data	Yes
Special event search and master analysis[w16]	British Airways	Yes	Yes	No	Yes	Yes	N/A	Yes	Monitors flight data recorders	Yes
Human factors failure analysis classification system[w17]	US navy and US marines	Yes	Yes	No	No	No	Yes	No	All crashes	Yes
NASA[w18]	Federal	Yes	Yes	No	No	Yes	Yes	No	All safety events	Yes
Prevention and recovery information system for monitoring and analysis[w19]	Institutional	No	No	Yes	Yes	Yes	Yes	No	Accidents and near misses	Yes
Human factors information systems[w20 w21]	Federal with private input (INPO)	Yes	No	Yes	No	Yes	Yes	Yes	Human factor issues related to nuclear safety	Yes
NRC allegations systems process[w22]	Federal	Yes	No	Yes	No	Yes	Yes	Yes	All safety concerns	Yes
Diagnostic misadministration reports-regulatory information distribution system[w23]	Federal, nuclear regulatory control	Yes	Yes	No	No, patient ID is	No	Yes	?	All misadministration	Yes

Appendix 3 Zero Harm Calendar 2016 courtesy of the Participating Organisation



Appendix 4 Blank survey questionnaire

Near Miss/Observation Survey

Research survey on the reporting of near misses and observations

*Required

Aim of Research:

To find out if there is a link between the reporting of near misses/observations and a business having fewer accidents in the workplace. Part of this research is to carry out an opinion survey on reporting of near misses and observations.

This is an anonymous questionnaire. Please ensure that you do not write your name or any other comments that will make you identifiable, on the questionnaire. By completing the questionnaire you are consenting to take part in the research. You are advised to first read the enclosed letter carefully as it explains fully the intention of this project.

Definitions

For ease, the following words have been used to describe a number of phrases.

NEAR MISS - Near miss, Near Hit, Close Call, Narrow escape, Near Collision (an event not causing harm, but has the potential to cause injury or ill health).

OBSERVATIONS - Circumstances which may cause or prevent an incident

INTERVENTION- an action taken to improve a situation

Reporting health & safety issues

1. **What is your role in the Construction Industry?** *
   Mark only one oval.
   - ◯ Supervisor or Line Manager
   - ◯ Construction Operative

2. **How many near misses have you reported in the last 12 months?** *
   Mark only one oval.

0	1	2	3	4	5	6	7	8	9	10	
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	+

3. **Are you currently being encouraged to report near misses?** *
   Mark only one oval.
   - ◯ Yes
   - ◯ No

4. **How likely are you to report a near miss in the future?** *
   Mark only one oval.

	1	2	3	4	5	
Not very likely	◯	◯	◯	◯	◯	Very Likely

5. **Compared to 1 year ago, How likely are you to report a near miss?** *
Mark only one oval.

	1	2	3	4	5	
Less Likely	◯	◯	◯	◯	◯	More Likely

6. **How many observations have you reported in the last 12 months?** *
Mark only one oval.

0	1	2	3	4	5	6	7	8	9	10	
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	+

7. **Are you currently being encouraged to report observations?** *
Mark only one oval.

◯ Yes
◯ No

8. **How likely are you to report an observation in the future?** *
Mark only one oval.

	1	2	3	4	5	
Not very likely	◯	◯	◯	◯	◯	Very Likely

9. **Compared to 1 year ago, Are you likely to report a Observation?** *
Mark only one oval.

	1	2	3	4	5	
Less Likely	◯	◯	◯	◯	◯	More Likely

Beliefs about reporting Near Misses & Observations

Please indicate what your beliefs are about reporting near misses and observations

10. **Reporting near misses are worthwhile?** *
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

11. **Reporting observations are worthwhile?** *
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

12. **Do you believe it is important to report good health & safety as well as bad?**
Mark only one oval.

- Yes
- No
- Maybe
- Unsure

13. **Which are you more likely to report?**
Mark only one oval.

- Something that you have seen that is unsafe
- Actions you have taken to prevent an accident

Attitudes towards reporting Near Misses & Observations

Please indicate what you believe other peoples attitudes are to reporting Near Misses and Observations

14. **Reporting heath & safety issues causes conflict with your colleagues?** *
Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

15. **Reporting health & safety issues causes conflict with your Supervisor or Line Manager?** *
Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

16. **Reporting health & safety issues encourages others to report them!** *
Mark only one oval.

	1	2	3	4	5	
Strongly disagree						Strongly agree

Behaviours

Please indicate what you think the effect is on behaviors

17. **Does reporting health & safety issues make you think more about the hazards at work?** *
Mark only one oval.

- Yes
- No
- Maybe

18. **When you are encouraged to report health & safety concerns, does it encourage you to work safe?** *
Mark only one oval.

- Yes
- No
- Maybe

19. **Do your work colleagues seem more safety conscious when they are encouraged to report health & safety concerns?** *
Mark only one oval.

- Yes
- No
- No different

20. **Do you think Managers and Supervisor are concerned about criticism from the reporting of health & safety concerns?**
Mark only one oval.

- Yes
- No
- Maybe

Interventions

Please indicate your beliefs about the introduction of Interventions

21. **Interventions have been made because of the health & safety issues reported by other people you know of at work!** *
Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Every time

22. **Interventions have been made because of the health & safety issues you have reported?** *
Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Everytime

23. **How effective are Interventions introduced by the company in preventing accidents?**
Mark only one oval.

	1	2	3	4	5	
Very ineffective	◯	◯	◯	◯	◯	Very effective

24. **Does the effectiveness of the interventions introduced, effect the likelihood of you reporting health & safety issues in the future?** *
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

25. **Do you get feedback on the concerns that you have reported?** *
Mark only one oval.

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Always

26. **How important is it for you to get feedback on near misses & observations you have reported?** *
Mark only one oval.

	1	2	3	4	5	
Not very important	◯	◯	◯	◯	◯	Very Important

27. **How important is it for you to get feedback on near misses & observations others have reported?** *
Mark only one oval.

	1	2	3	4	5	
Not very important	◯	◯	◯	◯	◯	Very Important

Thank You

Thank you for your time in completing this survey.

Please click the 'SUBMIT' button to submit your answers.

If for any reason you no longer wish to participate in the survey, please close the webpage down, without submitting. Once submitted, answers cannot be removed from the overall results as they are anonymous.